Improving the quality of care for patients with faecal incontinence.

-One Volume-

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Abstract

Objective:

Up to 0.5–1.0% of adults will experience varying degrees of faecal incontinence that affects their quality of life. The management of a patient with faecal incontinence is often difficult in spite of a diversity of treatment options for such patients.

Material & Methods:

By conducting a randomised control trial, using the Sealed Envelope Randomisation Technique, a sample size of 40 patients was arbitrarily chosen to evaluate the feasibility of implementing an Integrated Rapid Assessment and Treatment (IRAT) Pathway and assess its influence on patient's outcome measured using FI severity score and quality of life score. We then evaluate the reliability of these assessment tools by measuring the inter- and intra-rater test-retest reliability. Furthermore, we assessed the correlation between anorectal physiology study results and patients' symptoms measured with FI severity score to understand the role and limitation of these investigations. Finally we perform a systematic review on injectable bulking agents and report our experience with Permacol ® injections which is the main intervention offered in our unit when conservative managements fail.

Results:

The Implementation of IRAT pathway did not improve objective patients' outcome measures compared to Standard Care Pathway. However, patients were more satisfied with their management which may reflect the support and thorough education these patients received. All assessment tools used to measure patients' outcomes (SMIS, CCIS & FIQoLS) showed a good level of reliability. The same can not be said about

anorectal physiology studies which demonstrated weak correlations with patients' symptoms. However, some of these studies (MMRP, MMSP, rVV and sVV) were significantly different when compared in patients with and without FI, and among subgroups of incontinent patients (urge, passive and mixed FI). Our systematic review of the published literature on injectable bulking agents has identified methodological variation between studies. The technique is safe but complications can occur. Some 70 per cent of patients have an early clinical response but less than 50 per cent of patients are able to maintain this response on maximum follow-up. The choice of material is likely to influence the outcome and the use of a general anaesthetic during the procedure and laxatives in the postoperative period are associated with favourable outcomes. Trans-submucosal Permacol® injection is associated with 72% and 63% improvement in St. Mark's Incontinence Score in patients with idiopathic faecal incontinence at short and medium term follow-up respectively. However only 39% and 27% of patients achieve a 50%, or more, improvement in St. Mark's Score in the short and medium term follow-up.

Conclusions:

Despite widespread enthusiasm for critical pathways, rigorous evidence to support their benefits in health care is limited. However, understanding what evidence-based information is, and translating this information into practice using reminder systems or other effective implementation strategies, can potentially improve care, reduce costs, and enhance safety. CCIS, SMIS, and FIQoLS, all have good test-retest reliability and adequately reflect the global disease burden. Therefore, they are appropriate tools to objectively measure symptoms and compare the various management modalities. Physician should understand the limitation of anorectal physiology studies when they are used in the assessment of patients with defective continence mechanism. The current success rate and durability of symptomatic control with the use of IBA makes it an acceptable option for managing faecal incontinence owing to the simplicity, minimal invasiveness, safety and low cost. Unlike artificial anal sphincter, stimulated graciloplasty and SNS, IBAs can be implemented in units with limited resources, experties and infrastructure, making a potential treatment of FI more widely available and contributes to the overall improvement in the quality of care provided. Routine

maintenance and follow-up is not needed and therefore IBAs may be more suitable for elderly patients and patients with comorbidities or impaired mental capacity who constitute the major group among those with faecal incontinence.

CONTENTS **PAGE**

List of tables

List of figures

Acknowledgements

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Author's declaration

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1. Introduction

Faecal incontinence (FI) covers a wide spectrum of symptoms. It ranges from involuntary but recognized passage of gas, liquid, or solid stool (urge incontinence) to unrecognized anal leakage of mucus, fluid, or solid stool (passive incontinence). Faecal incontinence can be socially debilitating, and some patients inevitably change their lifestyle according to their disease depending on their personal character. In this context, it is the kind of disorder that needs a symptom-based approach rather than a traditional disease-based approach (1, 2).

Current epidemiological information shows that between 1% and 10% of adults are affected with faecal incontinence. It is likely that 0.5–1.0% of adults experience regular faecal incontinence that affects their quality of life (3, 4).

Management options in faecal incontinence are varied, ranging from conservative management with dietary modification, medications and behavioural interventions (5) to supplementation of damaged or non-functioning anal sphincter complexes by means of a dynamic graciloplasty (6) or artificial bowel sphincter (7) A recent systematic review of faecal incontinence reported a trend favouring conservative management, such as biofeedback and less invasive surgical procedures, amongst which the more promising are sacral neuromodulation, the SECCA procedure and injectable bulking agents. Most of these treatment modalities have been discussed in details in previous literature, however, notable advances have been a change in perspective when treating faecal incontinence, from a rather blinkered concern about a local abnormality such as sphincter defect to a more holistic approach involving the pelvic floor, rectum, colonic transit and, most importantly, psychological wellbeing(8). To the best of our knowledge, no study has previously addressed the influence of providing a seamless multidisciplinary care to patients with faecal incontinence in a timely fashion, by mean of clinical pathway model, on the overall patient care and clinical outcome, and this will be the main focus of this thesis.

In the first chapter of this thesis we review the pathophysiology, classification and management of FI with special emphasis on the recent trends in the management of FI, i.e. minimally invasive and non-invasive techniques, such as PTNS and TENS. In chapter two, we conduct a randomised control trial, using the Sealed Envelope Randomisation Technique, where sample size of 40 patients was arbitrarily chosen to evaluate the feasibility of implementing an Integrated Rapid Assessment and Treatment (IRAT) Pathway and assess its influence on patient's outcome measures using FI severity score and quality of life score. We then evaluate the reliability of FI severity scores and quality of life score by measuring the inter- and intra-rater test-retest reliability in chapter three. Furthermore, we assessed the correlation between anorectal physiology study results and patients' symptoms measured with FI severity score to understand the role and limitation of these investigations in chapter four. In chapter five we perform a systematic review on injectable bulking agents, a relatively new minimally invasive treatment used in the management of faecal incontinence, and report our experience with Permacol ® injections which is the main intervention offered in our unit when conservative management fails to improve patient symptoms. Finally we discuss our findings and state our conclusions in chapter six of this thesis.

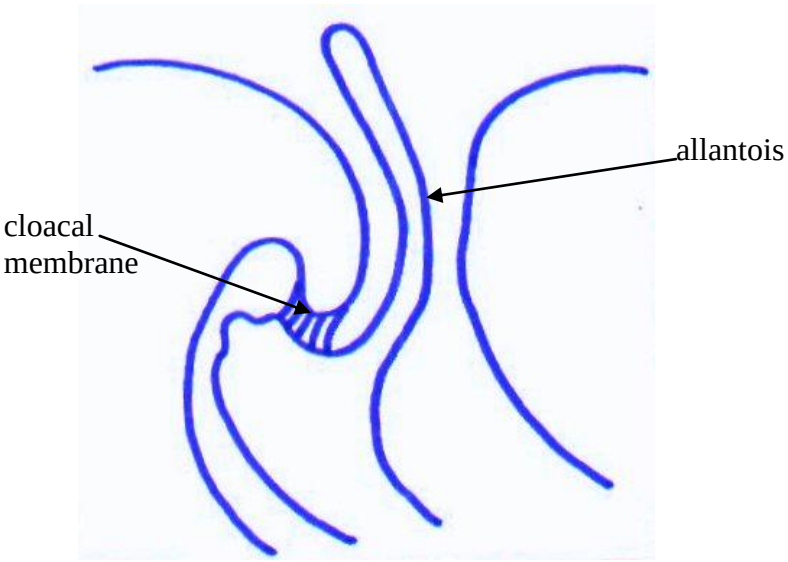
1.1. Embryology of the anorectum

The primitive gut is formed during the third week of gestation. The anorectal region in humans derives from four separate embryological structures: the hindgut, the cloaca, the proctodeum, and the anal tubercles(9). Knowledge of this development is necessary for the understanding of many anorectal conditions. Acquisition of these data has been derived from research examining human and animal embryos, both normal and abnormal.

4 weeks (4mm)

The primitive gut is formed during the third week of gestation(9). During the 4th week cephalo-caudal folding enables the dorsal aspect of the endoderm lined yolk sac to

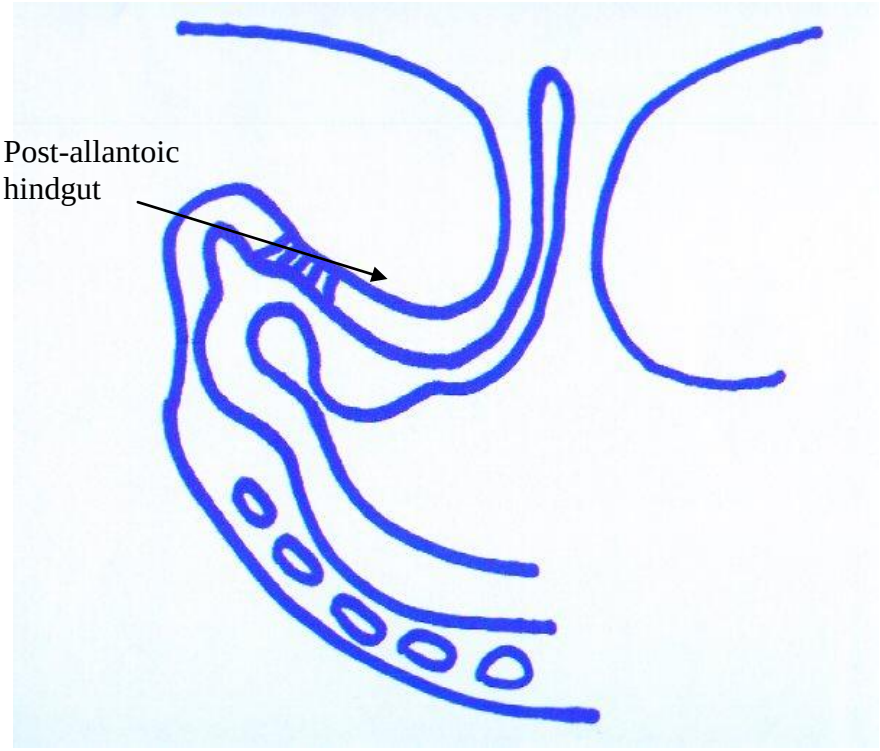
develop the primitive fore-, mid- and hindguts. This ventral migration of the body stalk causes angulation of the lumen of the dilated hindgut. This dilatation along with the entry of the mesonephric ducts is termed the cloaca, an endoderm-lined cavity that is in direct contact with the surface ectoderm.



5 weeks (6mm)

During the 5th week there is further angulation backwards beyond the body stalk. At this stage the cloacal membrane becomes prominent as a substantial structure connecting the ventral aspect of the cloaca to the amniotic cavity. The cloaca is initially a single tube that is subsequently separated by caudal migration of the urorectal septum which originate from transverse and longitudinal grooves that advance caudally towards the cloacal membrane creating a thin partitioning segment along the way.

At this point the anlage is thought to develop (10). The anlage is an anal indentation on the cloacal membrane dorsally and is thought to be imperative for development of a normal anorectum.



5.5 weeks (8mm)

Two major theories exist to explain the differentiation of the hindgut into the urogenital (ventral)
and anorectal (dorsal) part:

1. The theory of the septation of the cloaca; and
2. The theory of the migration of the rectum.

The latter had been modified by van der Putte in 1986. Another controversy exists of whether the urorectal septum fuses with the cloacal membrane (CM) in normal development or not(11).

The anorectal septum of the hindgut

Since the work of Tourneux and Retterer at the end of the 19th century, it generally has been accepted that the normal development of the primitive hindgut depends on the proper subdivision of the cloaca by a septum, the so-called "urorectal septum."(12, 13) According to this theory, abnormal septation development always should result in

abnormal cloacal development. However, there is no agreement about the nature and formation of this septum.

While Tourneux thought that the septum moves down from cranial to caudal "like a French curtain," Retterer speculated that lateral folds or ridges appear in the lumen of the cloaca (12, 13) These ridges should fuse in the midline to form the septum, beginning cranial and ending caudal at the level of the cloacal membrane(14).

In the past, numerous investigators supported one of these theories. Stephens combined both theories, believing that this could best explain the various forms of anorectal malformations(15). He claimed that the cranial part of the septum should grow downward as explained by Tourneux, whereas in the caudal part lateral ridges should fuse to form the septum in this area. In 1986, van der Putte denied the major role of the urorectal septum in the process of "cloacal" differentiation.

It is important to comprehend that anorectal malformations are thought not to be due to failure of these folds to form but rather due to defective cloaca. It is more likely that a normal looking septum is a result of normal cloacal development than its cause (16). There is, at this point, still a connection between the ventral and dorsal compartments in the form of a cloacal passage.

The migration of the rectum

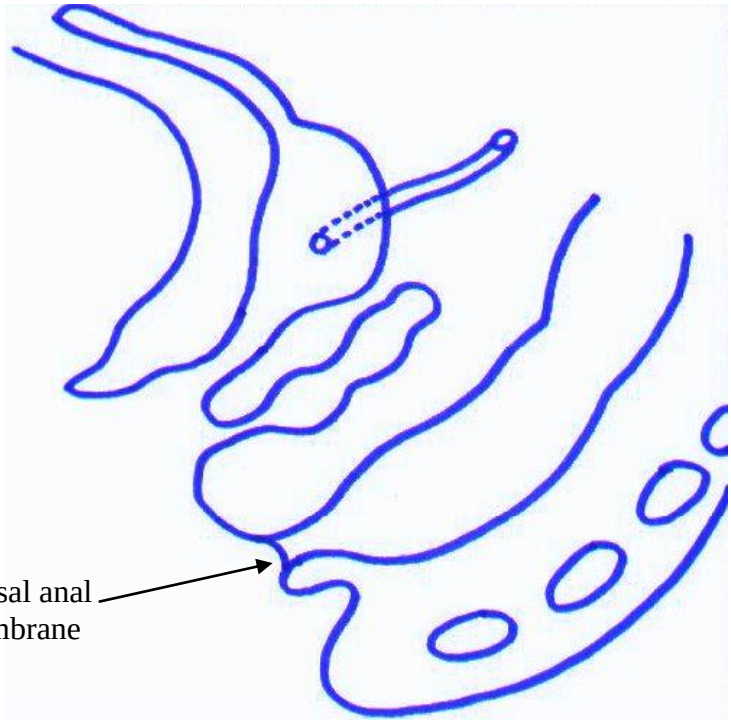
Studying the morphology of anorectal malformations (ARMs) in human newborns, Bill and Johnson (17) and later Gans and Friedman(18) stated that in most forms of ARM the fistula may present an "ectopic" anal opening. Following these observations they concluded that the rectum actually "migrates" during normal development, from a rather high position to the anatomic area of the anal opening. If this process of migration is disturbed, an ectopic anal canal results. Although this hypothesis is rather attractive, neither these investigators nor other researchers were able to show any embryologic evidence of this "migration."(14)

The shift of the dorsal cloaca

In 1986, van der Putte modified the theory of a “rectal” or “anal” migration (19). After studying normal and abnormal pig embryos, he speculated that a “shift” of the dorsal cloaca takes place. This shift brings the dorsal cloaca down to the area of the tail groove, thus establishing the future anal opening.

7 weeks (14mm)

At this stage the two cavities become separate and the cloacal membrane is divided into a ventral urogenital membrane and a dorsal anal membrane. These embryological entities make up the primitive perineum. With the development of the anal tubercles and the proctodeum the anal membrane gradually thins until it eventually ruptures at 8 weeks.



By the eighth week gross anatomy is in place. However, it is during this four to eight week period that anorectal malformations are thought to develop(10, 11)

1.1.1. **Internal anal sphincter**

During the ninth week smooth muscle becomes evident below the anal epithelium as a direct extension of the circular muscle of the developing rectum. This extension appears to be triggered by the rupture of the anal membrane (20). Differentiation of the smooth muscle continues until at 12 weeks the IAS is well differentiated and fully formed (21), although it doesn't become fully functional until 28 weeks (20).

1.1.2. **Longitudinal muscle fibres**

Longitudinal muscles fibres (LMF) are first seen in the primitive rectum at 9 weeks and muscular fibres appear confluent with the pubococcygeus muscle at this point. Extension into the anal canal is not evident until the 12^{th} week when fibres are seen descending into the intersphincteric space, and hence LM involvement within the anus appears only after development of the IAS (21).

1.1.3. **Pelvic floor musculature**

This first becomes evident at 6 weeks in the form of promyoblasts and myoblasts distributed within the mesenchyme surrounding the primitive rectum. These blasts are the beginning of the levator ani muscle. During the next 2 weeks these blasts develop and form extensions anteriorly towards the pubis, posteriorly towards the coccyx and laterally to meet the developing internal obturator muscle. At this stage the puborectalis muscle and pubococcygeus muscle are evident as extensions of the primitive levator muscle attaching to the rectal wall. By 9 weeks the pelvis has been separated from the perineum as the levator secures all its circumferential attachments. It is at this point the puborectalis muscle is identifiable as a sling around the rectum (21).

1.1.4. **External anal sphincter**

The proctodeal portion of the cloacal membrane disintegrates to form the anal tubercles that join posteriorly and migrate ventrally to encircle a depression, known as the anal dimple or proctodeum. The anal tubercles join the urorectal septum and genital tubercles to form the perineal body, completing the separation between the rectum and

the urogenital tract (22). In the 7th week a primitive perineal body is present separating the primitive rectum and urogenital sinus; these structures are enveloped circumferentially by promyoblasts which are a separate entity from the blasts of the primitive levator (21). This ring of cells is termed the cloacal sphincter. During the 8th week the ring separates to form anteriorly, a urogenital sphincter and posteriorly, an anal sphincter (the primitive external anal sphincter). This immature muscle then splits into a superficial component with an attachment to the cutis, and a deep component in close relation to the puborectalis. The EAS is embryologically fully developed at this stage; all that is remaining is growth of the muscle.

In the female, the fused Mullerian ducts that will form the uterus and vagina move downward to reach the urogenital sinus about the sixteenth week. In the male, the site of the urogenital membrane will be obliterated by fusion of the genital folds and the sinus will become incorporated into the urethra. The sphincters apparently migrate during their development; the external sphincter grows cephalad and the internal sphincter moves caudally. Concomitantly, the longitudinal muscle descends into the intersphincteric plane(20).

1.2. Anatomy of the anorectum

1.2.1. **Anal canal structure, anus, and anal verge**

The anal canal is anatomically peculiar and has a complex physiology, which accounts for its crucial role in continence and, in addition, its susceptibility to a variety of diseases. The anus or anal orifice is an anteroposterior cutaneous slit, that along with the anal canal remains virtually closed at rest, as a result of tonic circumferential contraction of the sphincters and the presence of anal cushions. The edge of the anal orifice, the anal verge or margin (anocutaneous line of Hilton), marks the lowermost edge of the anal canal and is sometimes the level of reference for measurements taken during sigmoidoscopy. Others favor the dentate line as a landmark because it is more precise. The difference between the anal verge and the dentate line is usually 1–2 cm (23). The prime function of the anorectum is to allow or prevent the passage of excreta

as a controlled conscious event. The anatomy of the anorectum revolves primarily around the structures controlling this event; the anal sphincters, anal mucosa and the anal cushions.

1.2.2. **Anatomic versus surgical anal canal**

Two definitions are found describing the anal canal. The “anatomic” or “embryologic” anal canal is only 2.0 cm long, extending from the anal verge to the dentate line, the level that corresponds to the proctodeal membrane.The “surgical” or “functional” anal canal is longer, extending for approximately 4.0 cm (in men) from the anal verge to the anorectal ring (levator ani). This “long anal canal” concept was first introduced by Milligan and Morgan (24) and has been considered, despite not being proximally marked by any apparent epithelial or developmental boundary, useful both as a physiologic and surgical parameter. The anorectal ring is at the level of the distal end of the ampullary part of the rectum and forms the anorectal angle, and the beginning of a region of higher intraluminal pressure. Therefore, this definition correlates with digital, manometric, and sonographic examinations (23).

1.2.3. **Anatomic relations of the anal canal**

Posteriorly, the anal canal is related to the coccyx and anteriorly to the perineal body and the lowest part of the posterior vaginal wall in the female, and to the urethra in the male. The ischium and the ischiorectal fossa are situated on either side.

1.2.4. **Muscles of the anal canal**

The muscular component of the mechanism of continence can be stratified into three functional groups: lateral compression from the pubococcygeus, circumferential closure from the internal and external anal sphincter, and angulation from the puborectalis. The internal and external anal sphincters, and the conjoined longitudinal are intrinsically related to the anal canal, and will be addressed here.

1.2.4.1. Internal anal sphincter

The internal anal sphincter represents the distal 2.5- to 4.0-cm condensation of the circular muscle layer of the rectum. As a consequence of both intrinsic myogenic and extrinsic autonomic neurogenic properties, the internal anal sphincter is a smooth muscle in a state of continuous maximal contraction, and represents a natural barrier to the involuntary loss of stool and gas. The lower rounded edge of the internal anal sphincter can be felt on physical examination, about 1.2 cm distal to the dentate line. The groove between the internal and external anal sphincter, the intersphincteric sulcus, can be visualized or easily palpated. Endosonographically, the internal anal sphincter is a 2- to 3-mm-thick circular band and shows a uniform hypoechogenicity (23, 25). A further feature of the IAS is periodic contractions (15 times/minute) (26). This results in a retro-peristaltic action that is thought to prevent leakage by returning faecal debris to the rectum (27).

1.2.4.2. External anal sphincter

The external anal sphincter is the elliptical cylinder of striated muscle that envelops the entire length of the inner tube of smooth muscle, but it ends slightly more distal than the internalanal sphincter. The external anal sphincter was initially described as encompassing three divisions: subcutaneous, superficial, and deep (24). Goligher and *colleagues*(28) described the external anal sphincter as a simple, continuous sheet that forms, along with the puborectalis and levator ani, one funnel-shaped skeletal muscle. The deepest part of the external anal sphincter is intimately related to the puborectalis muscle, which can actually be considered a component of both the levator ani and the external anal sphincter muscle complexes. Others considered the external anal sphincter as being subdivided into two parts, deep (deep sphincter and puborectalis) and superficial (subcutaneous and superficial sphincter) (20, 29). The external anal sphincter is more likely to be one muscle unit, attached by the anococcygeal ligament posteriorly to the coccyx, and anteriorly to the perineal body, not divided into layers or laminae(23). Nevertheless, differences in the arrangement of the external anal sphincter

have been described between the sexes (30).In the male, the upper half of the external anal sphincter is enveloped anteriorly by the conjoined longitudinal muscle, whereas the lower half is crossed by it. In the female, the entire external anal sphincter is encapsulated by a mixture of fibers derived from both longitudinal and internal anal sphincter muscles(23). The predominant function of the EAS is to allow voluntary contraction in order to aid closure of the anal canal. There is also evidence that the tonic activity of the EAS contributes to the resting tone (31).

1.2.4.3. Conjoined longitudinal muscle

Whereas the inner circular layer of the rectum gives rise to the internal anal sphincter, the outer longitudinal layer, at the level of the anorectal ring, mixes with fibers of the levator ani muscle to form the conjoined longitudinal muscle. This muscle descends between the internal and external anal sphincter, and ultimately some of its fibers, referred to as the *corrugator cutis ani muscle,* traverse the lowermost part of the external anal sphincter to insert into the perianal skin(23). Some of these fibers may enter the fat of the ischiorectal fossa (32). In its descending course, the conjoined longitudinal muscle may give rise to medial extensions that cross the internal anal sphincter to contribute the smooth muscle of the submucosa (*musculus canalis ani, sustentator tunicae mucosae, Treitz muscle, musculus submucosae ani*)(23). Possible functions of the conjoined longitudinal muscle include attaching the anorectum to the pelvis and acting as a skeleton that supports and binds the internal and external sphincter complex together(32). Haas and Fox (33) consider that the meshwork formed by the conjoined longitudinal muscle may minimize functional deterioration of the sphincters after surgical division and act as a support to prevent hemorrhoidal and rectal prolapse. Shafik (34) ascribes to the conjoined longitudinal muscle the action of shortening and widening of the anal canal as well as eversion of the anal orifice, and proposed the term *evertor ani muscle*. This is controversial (23). In addition to this primary function during defecation, a limited role in anal continence, specifically a potentialization effect in maintaining an anal seal, has also been proposed (34).

1.2.5. **Epithelium of the anal canal**

The lining of the anal canal consists of an upper mucosal (endoderm) and a lower cutaneous (ectoderm) segment. The dentate (pectinate) line is the "saw-toothed" junction between these two distinct origins of venous and lymphatic drainage, nerve supply, and epithelial lining. Above this level, the intestine is innervated by the sympathetic and parasympathetic systems, with venous, arterial, and lymphatic drainage to and from the hypogastric vessels. Distal to the dentate line, the anal canal is innervated by the somatic nervous system, with blood supply and drainage from the inferior hemorrhoidal system. The pectinate or dentate line corresponds to a line of anal valves that represent remnants of the proctodeal membrane. Above each valve, there is a little pocket known as an anal sinus or crypt. These crypts are connected to a variable number of glands, in average 6 (range, 3–12). (35).

Cephalad to the dentate line, 8–14 longitudinal folds, known as the rectal columns (columns of Morgagni), have their bases connected in pairs to each valve at the dentate line. At the lower end of the columns are the anal papillae. The mucosa in the area of the columns consists of several layers of cuboidal cells and has a deep purple colour because of the underlying internal hemorrhoidal plexus. The function of these columns is not yet fully understood but it is likely that they have a role to play in defaecation, such as lubrication of the anus (36) and/or recto-anal sampling (37).

The 0.5- to 1.0-cm strip of mucosa above the dentate line is known as the anal transition or cloacogenic zone. Cephalad to this area, the epithelium changes to a single layer of columnar. The cutaneous part of the anal canal consists of modified squamous epithelium that is thin, smooth, pale, stretched, and devoid of hair and glands. The terms pecten and pectin band have been used to define this segment (38). However, as pointed out by Goligher, the round band of fibrous tissue called pecten band, which is divided in the case of anal fissure (pectenotomy), probably represents the spastic internal anal sphincter (23, 28, 39).

1.2.6. **Anal cushions**

The basic anatomy of the anal cushions relates to an anastamosis of the portal (superior rectal vein) and systemic (inferior and middle rectal veins) venous systems. This anastamosis occurs in the submucosa of the anal canal as the internal rectal venous plexus. This plexus is most prominent in the 3, 7 and 11 o'clock positions corresponding to the three largest terminal radicles of the superior rectal vein. It is assumed that these three plexuses constitute the anal cushions (40). They are prevented from being traumatized during defaecation by strands of fibroelastic tissue arising from the LMF. It is thought that when these strands are disrupted that symptomatic haemorrhoids occur. The anal cushions contribute to the anal continence mechanism by forming a seal within the anal canal, particularly in the erect position when gravity fills them with blood (41).

1.2.7. **Perineal body**

Also called the central perineal tendon. This structure is a fibromuscular mass lying anterior to the anal canal. Its relations depend on gender. In the female these are the rectovaginal septum (superiorly), the EAS (posteriorly), the external urethral sphincter (anteriorly) and the deep and superficial transverse perinei (laterally). In the male, the posterior and lateral attachments are the same; however, the superior attachment is the rectovesical septum and anteriorly the bulbospongiosus. It is important to understand the difference in shape of the perineal body when comparing males and females. In the male it is long in its cephalo-caudal extent and short in its antero-postero length, in the female the opposite is true making it particularly susceptible to obstetric related injury. The perineal body acts as a major stabilizing structure for the pelvic floor and perineal structures.

1.2.8. **Vasculature**

1.2.8.1. The arterial blood supply to the anorectum

The proximal anal canal is supplied by branches of the superior rectal artery and the distal end by branches of the inferior rectal artery. The superior rectal artery is the continuation of the inferior mesenteric artery. In 80% of cases, it bifurcates into right, usually wider, and left terminal branches; multiple branches are present in 17% of cases (42) These divisions, once within the submucosa of the rectum, run straight downward to supply the lower rectum and the anal canal. The superior and inferior rectal arteries represent the major blood supply to the anorectum. In addition, it is also supplied by the internal iliac arteries. The contribution of the middle rectal artery varies with the size of the superior rectal artery; this may explain its controversial anatomy. Some authors report absence of the middle rectal artery in 40% to 88%(43, 44) whereas others identify it in 94% to 100% of specimens (42). The anorectum has a profuse intramural anastomotic network, which probably accounts for the fact that division of both superior and middle hemorrhoidal arteries does not result in necrosis of the rectum. The paired inferior hemorrhoidal arteries are branches of the internal pudendal artery, which in turn is a branch of the internal iliac artery.

1.2.8.2. Venous and lymphatic drainage of the anorectum

Venous drainage corresponds to arterial supply, the upper part of the anus draining via the superior rectal veins into the portal circulation while the middle and inferior rectal veins, to the internal iliac vein and then to the inferior vena cava. The paired inferior and middle rectal veins and the single superior rectal vein originate from three anorectal arteriovenous plexuses. The external hemorrhoidal plexus, situated subcutaneously around the anal canal below the dentate line, constitutes when dilated the external hemorrhoids. The internal hemorrhoidal plexus is situated submucosally, around the upper anal canal and above the dentate line. The internal hemorrhoids originate from this plexus. The perirectal or perimuscular rectal plexus drains to the middle and inferior rectal veins(23).

Lymph from the upper two-thirds of the rectum drains exclusively upward to the inferior mesenteric nodes and then to the paraaortic nodes. Lymphatic drainage from the lower third of the rectum occurs not only cephalad, along the superior rectal and inferior mesentery arteries, but also laterally, along the middle rectal vessels to the internal iliac nodes. In the anal canal, the dentateline is the landmark for two different systems of lymphatic drainage: above, to the inferior mesenteric and internal iliac nodes, and below, along the inferior rectal lymphatics to the superficial inguinal nodes, or less frequently along the inferior rectal artery. In the female, drainage at 5 cm above the anal verge in the lymphatic may also spread to the posterior vaginal wall, uterus, cervix, broad ligament, fallopian tubes, ovaries, and cul-de-sac, and at 10 cm above the anal verge, spread seems to occur only to the broad ligament and cul-de-sac(23, 45).

1.2.9. Innervation

The internal anal sphincter is supplied by sympathetic (L-5) and parasympathetic nerves (S-2, S-3, and S-4). The external anal sphincter is innervated on each side by the inferior rectal branch of the pudendal nerve (S-2 and S-3) and by the perineal branch of S-4. Despite the fact that the puborectalis and external anal sphincter have somewhat different innervations, these muscles seem to act as an indivisible unit (34). After unilateral transection of a pudendal nerve, external anal sphincter function is still preserved because of the crossover of the fibers at the spinal cord level.

Anal sensation is carried in the inferior rectal branch of the pudendal nerve and is thought to have a role in maintenance of anal continence. The upper anal canal contains a rich profusion of both free and organized sensory nerve endings, especially in the vicinity of the anal valves(46). Organized nerve endings include Meissner's corpuscles (touch), Krause's bulbs (cold), Golgi-Mazzoni bodies (pressure), and genitalcorpuscles (friction)(23).

1.2.10. Pelvic floor musculature

The muscles within the pelvis can be divided into three categories: 1) the anal sphincter complex; 2) pelvic floor muscles; and 3) muscles that line the sidewalls of the osseous

pelvis (47). Muscles in this last category form the external boundary of the pelvis and include the obturator internus and piriformis. These muscles, compared with the other two groups, lack clinical relevance to anorectal diseases.

1.2.10.1. Levator Ani

The levator ani muscle, or pelvic diaphragm, is the major component of the pelvic floor. It is a pair of broad, symmetric sheets composed of three striated muscles: ileococcygeus, pubococcygeus, and puborectalis. A variable fourth component, the ischiococcygeus or coccygeus, is rudimentary in humans and represented by only a few muscle fibers on the surface of the sacrospinous ligament. The levator ani is supplied by sacral roots on its pelvic surface (S-2, S-3, and S-4) and by the perineal branch of the pudendal nerve on its inferior surface. The pelvic floor is "incomplete" in the midline where the lower rectum, urethra, and either the dorsal vein of the penis in men, or the vagina in women, pass through it. This defect is called the levator hiatus(23).

The puborectalis muscle is a strong, U-shaped loop of striated muscle that slings the anorectal junction to the posterior aspect of the pubis. The puborectalis is the most medial portion of the levator ani muscle. It is situated immediately cephalad to the deep component of the external sphincter. Because the junction between the two muscles is indistinct and they have similar innervation (pudendal nerve), the puborectalis has been regarded by some authors as a part of the external anal sphincter and not of the levator ani complex (30, 34). Anatomic and phylogenetic studies suggest that the puborectalis may be a part of the levator ani (48) or of the external anal sphincter (34). Embryologically, the puborectalis has a common primordium with the ileococcygeus and pubococcygeus muscles, and it is never connected with the external anal sphincter during the different stages of development (20). In addition, neurophysiologic studies have implied that the innervation of these muscles may not be the same, because stimulation of the sacral nerves results in electromyographic activity in the ipsilateral puborectalis muscle but not in the external anal sphincter (49).

1.2.10.2. The Anorectal Ring and the Anorectal Angle

Two anatomic structures of the junction of the rectum and anal canal are related to the puborectalis muscle: the anorectal ring and the anorectal angle. The anorectal ring, a term coined by Milligan and Morgan (24), is a strong muscular ring that represents the upper end of the sphincter, more precisely the puborectalis, and the upper border of the internal anal sphincter, around the anorectal junction. Despite its lack of embryologic significance, it is an easily recognized boundary of the anal canal appreciated on physical examination, and it is of clinical relevance, because division of this structure during surgery for abscesses or fistula inevitably results in faecal incontinence.

The anorectal angle is thought to be the result of the anatomic configuration of the U-shaped sling of puborectalis muscle around the anorectal junction. Whereas the anal sphincters are responsible for closure of the anal canal to retain gas and liquid stool, the puborectalis muscle and the anorectal angle are designed to maintain gross faecal continence(23).

1.3. Physiology of continence

Normal defaecation is a complex process involving initially the myenteric plexus as well as efferent and afferent pathways of the autonomic nervous system. Under normal circumstances faeces in the lower rectum are prevented from being expelled by continuous sympathetic stimulation of the IAS. When the volume of faeces in the rectum is sufficiently large, rectal distension activates the parasympathetic neurons leading to muscular contractions of the rectum and sigmoid. At the same time this rectal distension causes proximal IAS relaxation with stimulation of the afferent fibres conducting information to the central nervous system regarding discrimination of rectal contents. At this point defaecation can be deferred by voluntary contraction of the EAS.

The automatic continence mechanism is formed by the resting tone, maintained by the internal anal sphincter, magnified by voluntary, reflex, and resting external anal sphincter contractile activities. In response to conditions of threatened incontinence,

such as increased intraabdominal pressure and rectal distension, the external anal sphincter and puborectalis reflexively and voluntarily contract further to prevent faecal leakage. Because of muscular fatigue, maximal voluntary contraction of the external anal sphincter can be sustained for only 30–60 seconds. However, the external anal sphincter and the pelvic floor muscles, unlike other skeletal muscles, which are usually inactive at rest, maintain unconscious resting electrical tone through a reflex arc at the cauda equina level. Histologic studies have shown that the external anal sphincter, puborectalis, and levator ani muscles have a predominance of type I fibers, which are a peculiarity of skeletal muscles connecting tonic contractile activity (23, 50).

If defaecation is desired then this process is started by increasing the intra-abdominal pressure which in turn is associated with relaxation of the EAS. Accompanying this process is excitation of efferent parasympathetic fibres to the colorectal musculature and inhibition of efferent sympathetic fibres to the IAS. The resultant effect being the lowering and relaxation of the pelvic floor with successful expulsion of faeces. The ability to prevent unwanted defaecation is dependent upon several factors.

1.3.1. The resting pressure

The IAS contributes 55% to the anal resting pressure. The myogenic activity contributes 10%, and 45% is attributed to the sympathetic innervation. The remainder of the resting tone is from the hemorrhoidal plexus (15%) and the EAS (30%) (31). Spinal anesthesia decreases rectal tone by 50% and the decreased resting tone seen in diabetic patients may be attributable to an autonomic neuropathy (27). The IAS has slow waves occurring 6–20 times each minute increasing in frequency toward the distal anal canal. When function is normal there is sufficient pressure and distribution of pressure to keep the anal canal closed and at a higher pressure than the rectum. This is termed the resting tone. If one or more of the factors that contribute to resting tone is defective then the patient may experience symptoms of passive incontinence.

1.3.2. Sensory component

Anal canal sensation to touch, pinprick, heat, and cold are present from the anal verge to 2.5–15 mm above the anal valves. This sensitive area is thought to help discriminate between flatus and stool but local anesthesia does not obliterate that ability. The rectum is only sensitive to distension. Rectal sensation may be attributable to receptors in the rectal wall but also in the pelvic fascia or surrounding muscle. The sensory pathway for rectal distension is the parasympathetic system via the pelvic plexus to S2, S3, and S4. Below 15 cm, rectal distension is perceived as flatus, but above 15 cm, air distension causes a sensation of abdominal discomfort. Anal canal sensation is via the inferior rectal branch of the pudendal nerve that arises from S2, S3, and S4. This is the first branch of the pudendal nerve and along with the second branch, the perineal nerve, arises from the pudendal nerve in the pudendal canal (Alcock's canal). The remainder of the pudendal nerve continues as the dorsal nerve of the penis or clitoris (51). Damage to the pudendal nerve can lead to impaired function of the EAS. Similarly, damage to the sympathetic fibres to the IAS will lead to loss of function of the smooth muscle. The pudendal nerve has a sensory as well as motor component. Sensation is important in the continence mechanism. This allows discrimination of rectal contents and knowledge of when defaecation is occurring. Impaired innervation may be due to coexisting medical disease (diabetes mellitus, Parkinson's' disease), spinal pathology (tumour, trauma, spina bifida) or trauma to the pudendal nerve in the pelvis (pregnancy, chronic straining).

1.3.3. Reflexes

There are a great number of reflexes that end with the name ". . . anal reflex." Consequently, there are several ways that one can assess the integrity of neurologic connection through or around the spinal cord (52).

1.3.3.1. Cutaneous-anal Reflex

The cutaneous-anal reflex was first described by Rossolimo in 1891 as a brief contraction of the anal sphincter in response to pricking or scratching the perianal

skin(23). This is a spinal reflex that requires intact S4 sensory and motor nerve roots. Both afferent and efferent pathways travel within the pudendal nerve. If a cauda equina lesion is present, this reflex will usually be absent. The response to perianal scratch fatigues rapidly so it is important to test this as the first part of the sphincter examination.

1.3.3.2. Cough Reflex

The visible contraction of the subcutaneous EAS as a consequence to cough and sniff stimulation is a simple nonintrusive validation of the pathways involved in the anal reflex. This response can also be displayed during anal sphincter manometry. The reflex is preserved in paraplegic patients with lesions above the lumbar spine but it is lost if the trauma involves the lumbar spine or with cauda equine lesions(53). The mechanism of the cough–anal reflex contributes to the maintenance of urinary and fecal continence during sudden increases in intraabdominal pressure as might also be seen with laughing, shouting, or heavy lifting.

1.3.3.3. Bulbocavernosus Reflex

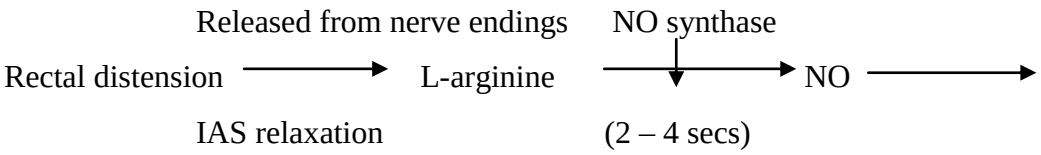
The bulbocavernosus reflex was first described by Bors and Blinn (54) in 1959. The bulbocavernosus reflex is the sensation of pelvic floor contraction elicited by squeezing the glans penis or clitoris. The EAS is usually used as the end point. The bulbocavernosus reflex latency will be prolonged by various disorders affecting the S2-S4 segments of the spinal cord(23).

1.3.3.4. Rectoanal Inhibitory Reflex

The rectoanal inhibitory reflex (RAIR) represents the relaxation of the IAS in response to distension of the rectum. This was first described by Gowers (55) in 1877 and documented by Denny-Brown and Robertson (56) in 1935. It is believed that this permits faecal material or flatus to come into contact with specialized sensory receptors in the upper anal canal (57) This sampling process, the sampling reflex, creates an awareness of the presence of stool and a sense of the nature of the material present. It is believed that this process of IAS relaxation with content sampling

is instrumental in the discrimination of gas from stool and the ability to pass them independently (57). The degree to which IAS relaxation occurs seems to be related to the volume of rectal distension more so in incontinent patients than in constipated or healthy control patients (58). The amplitude of sphincter inhibition is roughly proportional to the volume extent of rectal distension.

The RAIR is primarily dependent on intrinsic innervation in that it is preserved even after the rectum has been isolated from extrinsic influences, following transaction of hypogastric nerves and the presence of spinal cord lesions. The process is mediated via the intrinsic myenteric plexus and probably involves the neurotransmitter: nitrous oxide (NO) (59).



Rectal distension stimulates the release of L-arginine from nerve endings in the IAS. L-arginine is then broken down by NO synthase into nitrous oxide, which has a smooth muscle relaxant effect. This only lasts for 2 to 4 seconds before NO is "mopped up" by local super oxides. The reflex matures quite early in that it is generally present at birth and has been detected in 81% of premature infants older than 26 weeks (60). The reflex is destroyed in Hirschsprung's disease when myenteric ganglion are absent. In addition, the reflex is lost after circumferential myotomy and after generous lateral internal Sphincterotomy (61), in 64 % of patients after total mesorecrtal excision (57) and in 47% of patients following restorative proctocolectomy (62).

1.3.3.5. Rectoanal Excitatory Reflex

The rectoanal excitatory reflex (RAER), or inflation reflex, is the contraction of the EAS in response to rectal distension. Rectal distension sensation is likely transmitted along the S2, S3, and S4 parasympathetic fibers through the pelvic splanchnic nerves(63). However, on the motor side, a pudendal nerve block abolishes the excitatory reflex suggesting that pudendal neuropathy may interfere with the RAER.

1.3.4. Mechanical Factors of Continence and Defecation

1.3.4.1. Anorectal Angle and Flap Valve

As a part of the pelvic floor musculature, the puborectalis arises from the pubic bone and passes horizontally and posteriorly around the rectum as the most medial portion of the levator ani muscle. This forms a U-shaped sling around the rectum near its anatomic junction with the anus, pulling the rectum anteriorly, and giving rise to the so-called anorectal angle. It is most commonly defined as the angle between the anal canal axis and the posterior rectal wall (64) and on average is around 90. However, there is a wide range of normality (up to 140°), particularly in men(65), and measurement inter-observer agreement is poor (66). Qualitative assessments of changes in the anorectal angle in individual patients are more useful than absolute angle measurements. During evacuation, the anorectal angle typically increases by around 20–30° (67) and during voluntary squeeze, the angle becomes more acute, approximately 70°, although, as already stressed, absolute measurements are of limited value for individual patients. After evacuation is complete, the anal canal should close, the anorectal angle recover, and the pelvic floor return to its normal baseline position. The puborectalis muscle impression is often visible at rest. The puborectalis length can be estimated by measuring the distance between the anorectal angle and symphysis pubis (67). Again, qualitative assessment of the puborectalis in individuals is of greater use than reliance on absolute measurements.

There are differences of opinion as to whether the puborectalis and anorectal angle are truly important in maintaining continence. Unlike the fine control of the external and internal sphincter muscles, the puborectalis sling is believed to be more involved with gross faecal continence(23). Parks (68) postulated a mechanism by which this takes place. As intraabdominal pressure is increased—such as with sneezing, coughing, or straining—and the force is transmitted across the anorectal angle. The underlying mucosa is opposed against the upper anal canal, creating a flap-valve mechanism that prevents stool from passing to the lower anal canal and preserving continence. Yet other authors have disputed this flap-valve mechanism and downplayed the role and reliability of measuring the anorectal angle. Bannister and *colleagues*(69) in a study of 29 patients including 14 patients with incontinence, found no evidence of a flap valve

in the normal subjects by using manometric measurements during increasing intraabdominal pressures.

1.3.4.2. Reservoir

As an additional part of the continence mechanism, the rectum must be able to function as a temporary storage site for liquid and solid stool. With passage of the faecal stream into the rectum, the pliable rectal walls are able to distend and delay the defecation sequence until an appropriate time. This process relies both on rectal innervation to sense and tolerate the increasing volume of stool (capacity), as well as maintain a relatively low and constant pressure with increases in volume (compliance). Extremes of either of these components can lead to faecal incontinence through decreased accommodation or overflow states(23).

Although decreased compliance has been demonstrated more often in patients with faecal incontinence, it has also been shown to occur as a normal consequence of aging (70). In addition, Bharucha and colleagues (71), in a study of 52 women with faecal incontinence, demonstrated that the rectal capacity was reduced in 25% of women, and these lower volume and pressure thresholds were significantly associated with rectal hypersensitivity and urge faecal incontinence. A non-compliant rectum may be associated with an underlying pathological process such as proctitis (radiation induced or inflammatory) or rectal neoplasia. Diverticular disease, occult recto-rectal intussusception and irritable bowel syndrome may also occasionally result in a non-compliant rectum and/or sigmoid.

1.3.4.3. Consistency of stool

Consistency of stool plays an important role in the continence mechanism: loose or watery stool being more commonly associated with leakage or frank incontinence than solid stool. In a healthy colon water absorption and normal gut transit leads to a soft, yet formed, motion being presented to the rectum for expulsion. Any variation to this form presents the rectum with a stool that it was not designed to efficiently deal with. It

is unusual for loose/watery stool alone to cause faecal incontinence. Yet coupled with a defective sphincter or a sensory defect then incontinence can be severe (72).

1.3.5. Voluntary contraction

Stimulus to normal defaecation occurs under two circumstances. Either when the threshold rectal volume or the maximum tolerated volume is reached. It is possible to defer defaecation by contracting the EAS. This increases the pressure within the anal canal. If the pressure generated is greater than the pressure in the rectum then defaecation may be deferred. This is known as voluntary contraction. However, like all striated muscle, the EAS can tire quickly and as a result sufficient voluntary contraction can rarely be held for more than 50 seconds (73). If contraction of the EAS is impaired then incontinence may occur in response to rectal distension. This is termed urge incontinence.

1.4. Etiology and classification of faecal incontinence

Although data for obstetric-related symptoms (the most common cause in women) are becoming well recognised. For other risk factors, there is a paucity of prospective data, perhaps not surprising in view of the difficulties related to the carrying out of appropriate methodology, and most evidence comes from retrospective observation. Many specific (diabetes mellitus, multiple sclerosis, Parkinson's disease etc.) and nonspecific (ageing) conditions may be associated with their effect on continence through their effects on mobility, ability to carry out activities of daily living etc., which make cause–effect associations even harder to determine. Table 1.1 provide brief explanation of the most important risk factors for faecal incontinence and their pathophysiological mechanisms

Onset/risk factors	Pathophysiology of faecal incontinence
1) Congenital/childhood	
Anorectal anomalies	Congenital and iatrogenic bowel dysmotility; rectal irritability; sphincteric dysfunction
Spina bifida	Congenital sphincter and neuropathic bowel dysfunction; overflow
Hirschsprung's	Residual primary bowel dysmotility; congenital sphincter dysfunction; overflow; iatrogenic IAS sphincter injury
Behavioural	Wilful soiling; overflow secondary to voluntary faecal retention
2) Acquired/adulthood	
Diabetes mellitus	Primarily relates to neuropathy: disturbances to bowel motility and sphincteric function; steatorrhoea
CVA	Disruption of cerebrointestinal pathways; cognitive/language deficit; concurrent neuropathy; drugs (secondary effects); overflow
Parkinson's	Disturbances to bowel motility (decreased GI transit); overflow; sphincteric dysfunction
Multiple sclerosis	Conal/supraconal involvement; loss of rectal reservoir function/rectal irritability; sphincteric dysfunction
Spinal cord injury	Depends on site of lesion; disturbances to bowel motility (increased/decreased GI transit); loss of visceral perception; loss of rectoanal coordination; rectal hyperreactivity; sphincteric dysfunction
Other neurological conditions	Striated muscle degeneration–sphincteric dysfunction Multiple autonomic system atrophy; intestinal myopathy; overflow; sphincteric dysfunction Primarily relates to neuropathy: disturbances to bowel motility (increased/decreased GI transit); steatorrhoea
GI infection	Decreased GI transit; colorectal irritability (overwhelmed sphincter); ?secondary enteric neuropathy
Irritable bowel syndrome	Heightened visceral perception; disturbed colorectal sensorimotor function; ?enteric neuropathy
Metabolic bowel disease	Steatorrhoea
Irritable bowel disease	Decreased GI transit; loss of rectal reservoir function; rectal irritability/hyper-reactivity; sphincteric dysfunction
Megacolon/megarectum	Loss of visceral perception; secondary decrease in colonic transit; overflow
Anal trauma	Sphincteric injury; pudendal nerve injury Decreased GI transit; altered visceral reflexes? Decreased GI transit; altered visceral reflexes?

Pelvic surgery	Loss of anatomic supporting structures; autonomic neuropathy; loss of visceral perception
Pelvic malignancy	Loss of reservoir function; altered visceral reflexes? Loss of rectal reservoir function; sphincteric dysfunction
Pelvic radiotherapy	Loss of rectal reservoir function; rectal irritability/hyper-reactivity; sphincteric dysfunction
Rectal prolapse	Loss of rectal reservoir function; rectal irritability/hyper-reactivity; sphincteric dysfunction
Rectal evacuatory disorder	Overflow
Anal surgery	Sphincteric injury (primarily IAS and vascular cushions); loss of rectal reservoir function Sphincteric injury Sphincteric injury (primarily IAS) Sphincteric injury (primarily EAS)

Table 1.1: Risk factors for faecal incontinence and pathophysiological mechanisms

There is no universally accepted classification system for feacal incontinence. The system used in our department is the Leeds Classification of Faecal Incontinence(74) which is both simple and useful. It basically classifies patients into four groups:

Classification Incontinence	score	Results of anorectal physiology
Continent	0	Any
TFI	>0	Sphincter defect, no neuropathy
CFI	>0	Sphincter defect, neuropathy
NFI	>0	Normal sphincters, neuropathy
IFI	>0	Normal sphincters, no neuropathy

Table 1.2: Leeds Classification of Faecal Incontinence TFI, traumatic faecal incontinence; CFI, combined faecal incontinence; NFI, neuropathic faecal incontinence; IFI, idiopathic faecal incontinence

1.4.1. Traumatic incontinence

Disruption of the anal sphincter complex caused by local trauma can cause faecal incontinence. The cause of the trauma may be iatrogenic (surgery performed for the treatment of fistula-in-ano, haemorrhoids and anal fissures) (75), obstetric (associated with uncontrolled tears, episiotomy or instrumental deliveries) (76-78) and rarely with direct trauma due to accidents or anal rape Muleta (79). The commonest of these is obstetric trauma. Fourth degree tears are associated with a higher degree of incontinence than third degree tears (30% vs. 4%), with assisted deliveries (i.e. forceps or vacuum extraction) being the biggest risk factor for developing a fourth degree tear. The EAS is the commonest muscle damaged, although the IAS can be torn as well. It is interesting to note that although third/fourth degree tears occur in 10% of patients a further 20% of post partum patients have occult sphincter defects as seen on EAUS yet have no symptoms of faecal incontinence (80, 81).

1.4.2. Neuropathic incontinence

Neuropathic incontinence is diagnosed when there are prolonged bilateral PNTMLs and/or abnormal AME tests. Despite this, patients with neuropathic incontinence are often a mixed group. Primary neuropathic incontinence indicates loss of function of the peripheral nerves (in this case the pudendal nerve) at a local or systemic level (82-84). This may be due to local trauma (i.e. stretching of the PN during childbirth (85), chronic straining) or a local/systemic neuropathy (as seen in diabetes mellitus and multiple sclerosis (86). Secondary neuropathic incontinence is seen in patients with an underlying condition that does not affect the nerves uniformly throughout the PNS but rather at a certain point, resulting in disruption e.g. traumatic transection of the spinal cord, myelomeningeocoele, spina bifida, spinal cord haematoma/space occupying lesion. These conditions are uncommon though.

1.4.3. Combined incontinence

Patients with combined incontinence have sphincter defects as well as pudendal neuropathy. The majority of patients in this group have sustained nerve and muscle injury during a traumatic delivery (87). These patients are particularly difficult to treat.

1.4.4. Idiopathic faecal incontinence

Increasingly accepted as the commonest type of faecal incontinence (88). Over the last 25 years the label "idiopathic faecal incontinence" has been ascribed to various categories of patients with faecal incontinence. This has led to inconsistency in the literature as to the true meaning of the term. The commonest example has been the use of the term IFI in patients who have no other obvious cause of incontinence other than pudendal neuropathy (89). Such a patient may be labeled as having neuropathic or neurogenic incontinence and in such patients with an identifiable cause of the neuropathy (i.e. diabetes mellitus, spinal disease, etc.) this is an acceptable term. Other researchers only classify a patient as having IFI when no identifiable cause of their symptoms can be found (both clinically and physiologically). Thus there seems to be an overlap in the terms neuropathic and idiopathic.

Several studies have made an attempt to define the physiological abnormalities in patients with IFI with no conclusive results. Patients with idiopathic faecal incontinence are a heterogeneous group (56), a theory supported by a further paper evaluating test results of 302 patients with faecal incontinence (90). Further evidence to suggest that IFI is a distinct entity is evident in Rasmussen's study where he showed that 79% of patients with "IFI" have normal PNTMLs (91) although this is contrasted by a smaller earlier study which showed pudendal neuropathy to be present in 94% of patients with IFI (92).

Undoubtedly some of the studies performed in the 1980's involved patients with sphincter defects. It was not until the advent and refining of EAUS in the mid 1990's that such defects could be accurately diagnosed. Despite this advancement our

understanding of idiopathic faecal incontinence remains limited, an understanding that remains confounded by variations in the definition of the condition.

1.5. Assessing Patients with Faecal Incontinence

In addition to full clinical assessment, including careful history taking and physical examination to determine any possible underlying cause, there are two important aspects in evaluating the severity and aetiology of faecal incontinence. These are:

- FI severity scoring systems and FI quality of life scales/questionnaires.
- Anorectral physiology and imaging studies.

Both of these important instruments are discussed in details in chapters 3 and 4 respectively.

1.6. Current treatment options in faecal incontinence

Treatment of faecal incontinence is initially directed at treating the underlying cause. If this is not possible then surgical and/or non-surgical methods can be used to reinforce the continence mechanism. It is important to fully investigate the patient and if possible try to classify the incontinence (93).

A recent systematic review of patients with faecal incontinence reported a trend favouring conservative management, using dietary modification, biofeedback and minimally invasive procedures, including sacral neuromodulation, the SECCA procedure and the use of injectable bulking agents (8).

1.6.1. Supportive therapy

1.6.1.1. Optimizing stool consistency and frequency and nutrition

Stool consistency and frequency can be altered using dietary measures. For example, increased coffee consumption leads to stronger gastrocolic responses, resulting in increased colonic motility. However, fiber-rich, expanding foods and carbonated

beverages/beer can also provoke or exacerbate incontinence, as they reduce continence by increasing stool frequency and decreasing stool consistency. Basic treatment, including after surgery, is therefore first to optimize stool consistency and frequency and bowel habits. A balanced intake of fiber and fluids is essential. This, alone, can often improve continence(94).

1.6.1.2. Toilet training

Specific toilet training must avoid excessive forcing and lengths of time on the toilet(94). Patients with incomplete evacuation benefit from evacuation aids such as enemas or glycerine suppositories. For overflow incontinence, the intestines must be completely emptied before any other therapeutic measures can be taken.

1.6.1.3. Care provision

Patients who are immobile and require care benefit substantially from careful hygiene. Regularly changing clothes and/or positions prevents damage to the perianal skin. Creams, ointments and pastes can be used either prophylactically or to treat skin irritation or lesions(94).

1.6.1.4. Anal plugs

Polyurethane anal plugs are available for use in patients with faecal incontinence. These plugs are inserted into the anus where they plug the anal canal. They gradually dissolve over a period of twelve hours when they can be removed via a tape which hangs through the anal canal. Disadvantages of this technique include initial discomfort, general inconvenience, plug slippage and long term cost. Advantages include improved symptoms (particularly incontinence to flatus) and improved overall quality of life (95, 96).

1.6.1.5. Biofeedback training

Biofeedback training, a learning strategy derived from psychology, is an established form of treatment. The activity of the sphincter ani externus muscle is measured using an anal EMG sensor and fed back to the patient using optical and/or acoustic signals. Regular, active, controlled training motivates patients and increases the efficacy of exercises. This should increase the contraction strength of the anal sphincter, shorten the latency period between rectal distension stimulus and sphincter contraction, and improve awareness of rectal distension stimuli. The plateau contraction should be maintained for 10 to 20 seconds and the relaxation cycles should last for 20 to 30 seconds in sessions lasting approximately 15 to 30 minutes (94).

1.6.2. **Medical Treatment**

1.6.2.1. Treating underlying conditions

When there is an underlying condition, such as inflammatory bowel disease (Crohn's disease and ulcerative colitis) and IBS, the first step of management is treating that condition. Corticosteroids, immunosuppressants and salicylates are used in such cases. Chologenic diarrhoeas that place excessive demand on continence are treated with cholestyramine(94). ncontrolled symptoms should contraindicate a major surgical approach(97).

1.6.2.2. Drug-based measures

These work mainly by slowing passage through the intestines and increasing reabsorption of fluids. This results in increased stool consistency on the one hand and decreased stool frequency on the other. The opioid loperamide and a combination of diphenoxylate and atropine are used. Several placebo controlled studies have shown reduced stool (94) frequency and urge, longer colonic transit time, reduced stool weight,

and increased resting anal pressure. Read and *colleagues* showed in 1982, in a placebo controlled double blind crossover trial, that loperamide when compared to placebo improved continence in incontinent patients and in particular seemed to increase resting pressures (98). They postulated that loperamide has an effect on the IAS. In 1987 Rattan showed how loperamide affects the IAS of the opossum by increasing resting tone and inhibiting its relaxation in response to rectal distension (99). Two further papers in 1994 and 1997 reported similar improvements in symptoms and resting pressures in patients with faecal incontinence (100, 101)

The enkephalinase inhibitor racecadotril is now also available as additional treatment for diarrhoea. Racecadotril is an antisecretory and reduces intestinal hypersecretion of water and electrolytes. Clinical studies are investigating the efficacy of the 5HT3 antagonist alosetron in the treatment of incontinence. The tricyclic antidepressant amitriptyline has been used to good effect in patients with irritable bowel syndrome possibly due to its anticholinergic effect (102). Santoro and *colleagues* have used this drug in a small clinical trial in order to determine its efficacy in the treatment of patients with idiopathic faecal incontinence (103). They report success rates in the region of 90% and also show increases in anal canal pressures. Further trials will be needed to confirm these findings

Topical use of phenylephrine (concentration 30%) leads to short-term increases in resting anal pressure of up to 33% in healthy subjects and incontinent patients(94). Phenylephrine is an alpha-1-agonist. Such drugs have been shown to stimulate the IAS and hence increase resting pressures in *in vitro* studies (Yamato S 1990). Clinical trials have been performed at St. Mark's Hospital using topical phenylephrine applied to the anal margin in varying concentrations. The initial study using a concentration of 10% failed to show any benefit both symptomatically and manometrically (104) in patients with idiopathic faecal incontinence. In a later study using higher concentrations of 30% and 40% a significant increase in resting pressure, as well as symptomatic improvement, was seen (105). These studies have been performed with relatively small numbers of patients. Further larger studies need to be performed before the therapeutic benefits of topical phenylephrine can be determined.

1.6.3. **Physiotherapy**

Pelvic floor rehabilitation, including biofeedback, kinesitherapy, sensory retraining, and electrostimulation, is frequently regarded as a first-line treatment for FI. However, disagreement exists about indications for rehabilitative techniques. Selection criteria cannot be based on anal pressures(106, 107),whereas altered threshold and rectal urgency sensations have been found to be predictive of a positive treatment response(107, 108).

1.6.3.1 Targeted muscle training

Special instruction and physical measures performed by specialized physiotherapists according to this diagnosis are of great benefit in the treatment of faecal incontinence (94). The phases of pelvic floor training involve development of targeted awareness, isolated muscle contraction and relaxation, exercising in functional muscle chains and with modulated weight-bearing, and integration of activity into everyday weight-bearing (automation). A home exerciseprogram is also developed gradually from the beginning of therapy onwards.

1.6.3.2 Electrostimulation

Electrostimulation is used to provide proprioceptive awareness of the pelvic floor muscles and to make muscle fiber recruitment easier. Patients feel the “passive” muscle contraction, and this leads to better understanding, for targeted, active muscle work. Perianal or anal electrostimulation is only sensible when the nerve supply is intact.

Lack of standardized methods makes it difficult to compare results of this approach, even in patients accurately selected. Moreover, in the limited number of well-conducted studies, there is no agreement concerning outcome parameters to measure or predict therapy outcome(108). A rational modulation of the algorithm for rehabilitation could

play a key role for therapy success. Patient compliance and good psychological status are preliminary requirements for rehabilitation, being predictors of therapy success (109, 110).

Although controversies exist about the outcome predictive value of PNTML in individuals undergoing rehabilitation, its alteration seems to be regarded as a predictor of negative response However, an external anal sphincter defect is not an absolute negative predictor of success (108, 111). Biofeedback, electrostimulation, and kinesitherapy could be scheduled in patients with such a defect.

1.6.4 Surgical Treatment

1.6.4.1 Sphincteroplasty

Sphincter lesions due to obstetric trauma (third- and fourth-degree tears) have traditionally been submitted electively to sphincteroplasty. This technique can be performed by edge-to-edge approximation or overlapping of the external anal sphincter (22).

Immediate repair, at the time of delivery or delayed to 24 hours, has been suggested to obtain best results. The failure rate with functional defects is 10% to 59% (112, 113). However, sphincteroplasty can frequently be performed a few decades after childbirth, when the patient presents clinically with FI. Early results of secondary defect reconstruction are satisfactory, particularly of defects caused by birth traumas. In long-term follow-up, results deteriorate again, with full continence in less than 50% of patients. Risk factors are age, concomitant diseases, wound dehiscence, and muscle denervation (112). As sphincter reconstruction surgery has a limited risk, attempted reconstruction is always indicated in appropriate cases, as quality of life will be improved, though possibly only for a limited time.

Manometric parameters seem not to be useful for patient selection to sphincteroplasty, whereas a pudendal neuropathy, measured by a prolonged PNTML (particularly if bilateral), should be considered as a predictor of poor outcome (114-117). However,

conflicting results are also reported (118-122), attributable to correct definition of PNTML normality, adequate evaluation of pudendal neuropathy when assessed by standard PNTML measurement with St. Mark's electrode, and the role of symmetric pudendal innervation (119). Although EAUS is determinant today in diagnosing a sphincter tear, ultrasonographic aspects are not considered valid criteria to select patients to this procedure.

To improve the long-term results displayed by sphincteroplasty alone, which are sometimes limited (123). this operation has been performed within a total pelvic floor repair(124) or with anterior levatorplasty (125). However, again, anorectal physiological parameters were not predictive of symptom improvement (22).

1.6.4.2 Surgery for neurogenic faecal incontinence

1.6.4.2.1 Postanal repair

For neurogenic incontinence, the aim is to achieve better muscular abutment by plicating the available muscles (postanal repair, anterior levatorplasty, total pelvic floor repair). The crura of the puborectalis on both sides and the externus muscles are plicated, but long-term results are disappointing, with full continence at only (94)14%. The extent of neurogenic damage limits the success of treatment. Unfortunately, no physiological parameters have been found to be indicative for this approach (126-128). Considering the poor long term results the postanal repair is now rarely performed (129).

1.6.4.2.2 Total pelvic floor repair

This procedure combines a postanal repair with anterior levatorplasty. This is performed via two incisions, anterior and posterior to the anal verge. The puborectalis muscle and levator plate anteriorly and posteriorly are identified. A postanal repair is performed, as described above, followed by approximation of the levators anteriorly

and posteriorly. This procedure has the effect of elongating the anal canal. This procedure is usually reserved for the severely traumatized anal canal. Results of the procedure are reasonable although the few trials that have been reported have only involved relatively small numbers of patients (130, 131). The procedure is rarely performed.

1.6.4.3 Surgery for sensory incontinence

Sensory incontinence due to so-called whitehead damage (radical removal of the hemorrhoidal tissue and the anoderm) is now found only rarely. Reconstruction is carried out by moving the sensitive perianal skin into the anal canal (using the Ferguson technique). Results with irritation-free healing are good (94).

1.6.4.4 Surgery for rectal prolapse

Rectal prolapse is a common cause of incontinence. It is treated using abdominal resection rectopexy (94), usually using minimally invasive techniques. In this operation, the rectum is separated from the tissues around the anus as far as the pelvic floor, encased in plastic mesh (various materials and structures), and secured to the promontory/os sacrum. Bowel resection is not compulsory. Sixty to ninety percent of patients achieve subjectively satisfactory continence following surgery.

Older patients with increased surgical risk may benefit from perineal intervention. Rehn-Delorme mucosal resection and Altemeier rectosigmoid resection more frequently lead to relapses, although Cochrane analysis was unable to confirm differences from other treatments (132). Another approach for managing rectal prolapsed is the STARR (Stapled TransAnal Rectal Resection) procedure(133). Evaluation of treatments demonstrates that so far there is no gold standard for the treatment of rectal prolapse.

1.6.4.5 Neosphincters

These procedures must be regarded as major sphincter replacement operations, dedicated only to patients with very severe FI due to a wide sphincter lesion (more than half the circumference) or fragmented sphincters not amenable to neither sphincteroplasty or other surgical approaches (i.e., SNS). In case of failure of previous sphincteroplasty (when there is no indication to redo it), which is not suitable for SNS, these techniques can also be indicated(22).

Moreover, if severe FI is consequent to neuropathy or anorectal malformations, one of these operations could be performed (specifically, in cases of neuropathy when SNS has failed). Usually, patients present a very low or absent squeeze pressure, which isassociated with a decreased or absent resting pressure if an internal sphincter lesion/alteration coexists. Dysfunctions of rectal sensations should be regarded as negative predictors of success, as reported in different experiences (6, 134, 135).

The only contraindications to the sphincter replacement procedures are very severe chronic bowel diseases causing intractable defecation dysfunctions (severe diarrhoea as well as severe constipation) and coexistence of rectal prolapse, intussusception, rectocele, or enterocele.

1.6.4.5.1 Gluteoplasty

Performed by transposing both gluteus maximi to create a new unstimulated sphincter. First described 100 years ago (Chetwood CH in 1902) there have been less than 100 cases since reported in the literature. The latest (and biggest) series is reported by Devesa and *colleagues*. They reported a good result in 9 out of 20 patients (136) The technique, however, is not widely performed.

1.6.4.5.2 Graciloplasty

Graciloplasty has been widely performed. First described in 1952 by Pickrell to treat children with faecal incontinence due to congenital malformations, the procedure became very popular in the 1990's when the technique of stimulated graciloplasty was first described (137). The procedure involves anchoring of the gracilis muscle to the contralateral ischial tuberosity having been wrapped around the anal canal. It is important that muscle surrounds the anal canal and not tendon. Stimulation of the gracilis muscle is achieved by implanting two neuro-muscular stimulation electrodes in the proximal nerve-vessel bundle and a stimulation generator which is introduced into a generator-bed pouch in the left portion of the lower abdomen after subcutaneous pull-through of the electrodes.

Long term follow up is lacking but medium term results of success vary from 44 to 90% (129). The procedure is frequently associated with complications(8). Matzel and *colleagues* showed that in 93 patients 211 complications occurred. Of those 89 were severe treatment related complications, of which major infection was the highest (138). Nevertheless the procedure does seem to be promising and long term results are awaited.

1.6.4.5.3 Artificial bowel sphincter (ABS)

The first ABS was implanted in 1987 by Christiansen. Since then modifications and newer designs have been made. Today's ABS comprises an inflatable cuff (inserted around the anus), a reservoir (inserted underneath the rectus sheath) and an activation device (inserted into the scrotum or labia majorum). The cuff of the ABS is constantly filled with fluid, when the patient wishes to defaecate he/she presses the activation device which empties the cuff of fluid thus allowing successful defaecation. The cuff then slowly refills over the following 5 to 7 minutes. Early studies on small groups of patients have shown success rates of 70 to 88% (139-142). Follow up is short, however, and it is clear that removal of the device may be required in a number of patients. This may be due to several reasons: infection, cuff erosion or device failure(142). Wong and *colleagues* reported long term outcome (64.3 +/- 46.5 months) of ABS in 52 patients,

26 (50%) of them required revisions after a mean of 57.7 +/- 35.0 months, with 73.1% due to a leaking cuff from a microperforation; 14 patients (26.9%) required definitive explantation after a mean of 14.6 +/- 7.9 months, with the majority (42.9%) due to infection. Nine patients were lost to follow-up and 35 patients (67.3%) with an activated device experienced significant improvements in both median CCIS ($P < 0.0001$) and FIQoLS scores. There was a significant difference between preoperative resting anal pressures and closed pressures at activation and latest follow-up.

1.6.4.6 Stoma formation

Formation of a permanent colostomy for faecal incontinence is usually an end result of failed surgical and medical therapies. Some patients have intractable faecal incontinence that has not responded to various therapies. Eventually these patients are left with a choice of suffering with their symptoms or opting for a permanent colostomy. Although in the eyes of clinicians' colostomy formation is the final step in admitting defeat, many patients actually experience an excellent quality of life (143). Despite this, the purpose of developing new techniques for the treatment of faecal incontinence is to prevent the need for a permanent colostomy.

1.6.5 Minimally invasive surgical procedures

1.6.5.1 Sacral nerve stimulation

This technique was originally used to treat urological incontinence (Bosch JLHR 1995) with some success. This led to postulation that faecal incontinence may also be helped using this technique and was first described in 1995 (Matzel KE 1995). The technique involves surgically placing electrodes through the sacral foramen (usually S3). The sacral nerves are then stimulated and the electrode adjusted until the correct position is achieved. The equipment used in this initial stage is temporary. The patient then completes an incontinence diary for the following 3 weeks and if there is an improvement in symptoms a permanent stimulator can be inserted. When defaecation is

desired a magnet is used to inhibit stimulation and allow successful passage of stool. Several studies report significant improvements in objective and subjective measures for faecally incontinent patients after SNS with very few complications(144-153).

In a meta-analysis, by Tan and *colleagues*(154), 665 patients underwent permanent SNS in 34 studies. The weekly incontinence episodes (weighted mean difference (WMD) −6.83; 95%, CI −8.05 to −5.60; $p<0.001$) and incontinence scores (WMD −10.57; 95% CI −11.89 to −9.24; $p<0.001$) were significantly reduced with SNS. Ability to defer defecation (WMD 7.99 min; 95% CI 5.93 to 10.05; $p< 0.001$) was increased. Most SF-36 and FIQLS domains improved following SNS, and mean anal pressures increased significantly ($p<0.001$). Results remained consistent on sensitivity analysis. The under-56 years age group showed smaller functional but greater physiological and quality of life improvements. Results were similar between sphincter intact and impaired subgroups. The complication rate was 15% for permanent SNS, with 3% resulting in permanent explanation.

Complications which have occurred include infection at the implant site, electrode dislodgment and chronic pain. A further side effect which has been seen in some female patients is that of non-coital orgasm.

1.6.5.2 Posterior tibial nerve stimulation

Posterior tibial nerve stimulation (PTNS) is a new approach in the management of FI. It is gaining progressive popularity due to its simplicity, relatively low cost and safety. It is now accepted as second line treatment for patients with faecal incontinence (FI) unresponsive to conservative measures. There is however a paucity of data in the literature regarding its efficacy.

Peripheral neuromodulation has been used for the treatment of urinary incontinence, chronic pelvic pain and sexual dysfunction since 1983 (155-159), and is hypothesised to modulate the sacral plexus indirectly via the posterior tibial nerve(160), which contains sensory, motor and autonomic fibres derived from the fourth to fifth lumbar and first to third sacral roots. The mechanisms by which posterior tibial nerve

stimulation (PTNS) ameliorates incontinence have yet to be fully elucidated, but extrapolation from SNS and urological evidence would suggest both sensory and motor neuromodulatoryeffects.

These putative effects include upregulation of afferent rectal sensory perception and striated muscle function (161) allowing generation of increased maximum squeeze and resting pressure. Both the former and the latter, however, have been questioned (162). There is also evidence of a reduction in spontaneous anal relaxations and rectal contractions (161) Furthermore, enhancement of rectal mucosal blood flow (as a surrogate marker of autonomic nervous function) has also been demonstrated as has an alteration in the central neurotransmitter environment(159, 160).

1.6.5.2.1 Percutaneous posterior tibial nerve stimulation

The first published work came in 2003, from Shafik *and colleagues* (161) in the European Journal of Surgical Research was a prospective controlled trial in Egypt, since then several other small studies have been published (table 1.3).

The needle electrode in its guide tube is positioned at a 60-degree angle 5cm towards the knee from the medial malleolus and 2 cm posterior to the tibia. The tip of the needle is gently tapped so that it penetrates the skin, the needle guide removed and the needle gently advanced until about 1.5cm of the tip is exposed. The needle electrode is then connected to the lead wire. Electrical stimulation is then delivered for 20-30 min, several times a week.

Study	Approach	Design	No of patients	results	Follow up	maintenance
Shafik *and colleagues*, 2003(161)	Percutaneous	Prospective controlled	32	84.3% greater than 50% iimprovement	30 months	yes
Queralto *and colleagues*, 2006(162)	Transcutaneous	Prospective uncontrolled	10	80.0% greater than 60% improvement. Subsequent top-up treatment effective	3 months	yes
Mentes *and colleagues*, 2007(163)	Percutaneous	Prospective uncontrolled	2	30% improvement in CCIS	6 months	yes
Vitton *and colleagues*, 2009(164)	Transcutaneous	Prospective uncontrolled	12	1/12 improvement in CCIS. VAS 5/12 some improvement	–	
De la Portilla *and colleagues*, 2009(165)	Percutaneous	Prospective uncontrolled	16	CCIS >40% improvement in 62.5%	6 months	no
Govaert *and colleagues*, 2009 (166)	Percutaneous	Prospective uncontrolled, multicentre	22	CCIS score >50% improvement in 63.5%	1 year	yes
Boyle *and colleagues*, 2010(167)	Percutaneous	Prospective	31	CCIS: 65% improved Diary 71%>50% improvement	3-14 months	yes
Findlay *and colleagues*, 2010(168)	Percutaneous	Retrospective	13	Defecation diary Reduction in median incontinence episodes to 0: 76.9%.. FIQL score >50% improvement	1 month	-
Hotouras *and colleagues*,2012(169)‡	Percutaneous	Prospective	100	Improvement in CCIS in patients with urge, not passive FI	6-12 weeks	-
Hotouras *and colleagues*,2012(170)‡	Percutaneous	Prospective	88	Improvement in CCIS in patients with urge, but not passive FI	6-12 weeks	-
Vitton and *colleagues*, 2010 (171)	Transcutaneous	Prospective	24	At 3 months significant improvement in 54% CCIS (14 Vs 12,). At 15 months: 11 still improved	15 months	Yes
Eléouet and *colleagues*, 2010 (172)	Transcutaneous	Prospective	32	subjective improvement in 30%, some improvement in CCIS (of 3-4 scores)	6 month	yes

Table 1.3. summary of published studies on PTNS for the management of FI. ‡ both papers may represent the same study.

Findlay and *colleagues* reported a sustained reduction in incontinence of wind only (0 episodes), with non-significant reductions of liquid and solid stool (168) incontinence at 1 month follow up. Hotouras *and colleague* (169) also assessed short term (6-12 weeks) outcome of percutaneous PTNS in 100 patients. Those with urge (n-25) and mixed (n=65) incontinence demonstrated a significant improvement in the mean CCIS (11.0 ± 4.1 to 8.3 ± 4.8 and 12.8 ± 3.7 to 9.1 ± 4.4, respectively) with an associated improvement in the QoL score. This effect was not observed in patients with purely passive FI (n=15). Govaert *and colleagues* (166) reported a significant and progressive improvement with maintenance treatment. Seventy two percent of patients had a more than 50% decrease in incontinence episodes. Overall incontinence episodes fell from 19.6 ± 21.0 at baseline to 9.9 ± 15.5 (P = 0.082) at 6 weeks and to 3.6 ± 4.8 (P = 0.029) at 1 year.

Sphincter damage and altered rectal sensation did not appear to influence the outcomes(170). When PTNS was performed in 88 female patients with FI that was predominantly a late consequence of obstetric injury. Significant improvement in CCIS, the median deferment time and median number of weekly incontinence episodes(170). Furthermore, patients with partial spinal cord injury seems to show similarly good response(163).

There are conflicting reports about he influence of PTNS on anorectal physiology parameters. While Mentes and *colleagues* (163) confirmed improvement in rectal sensory threshold, pudendal nerve terminal motor latency, resting pressure, and maximum squeeze pressure measurements, other authors (161, 162) observed no such changes.

1.6.5.2.2 Transcutaneous posterior tibial nerve stimulation

Transcutaneous electrical posterior tibial nerve stimulation (TENS) has recently been described as a possible mean of treating faecal incontinence, even in patients suffering from inflammatory bowel diseases (162, 164). TENS is simple to perform, non-invasive and cheap(171). The results of TENS is said to be comparative to those of PTNS (171).

An adhesive surface electrode placed under the arch of the foot and the lead connected to the stimulator. The current is gradually increased until a motor response is obtained (the toes flex or fan out, or the entire foot extends) or the patient describes a sensory response.

Larger studies are required, not only to assess the efficacy of PTNS and TENS, but also to determine the optimum technique, such as stimulatory strength, timings and length of treatment. The use of needle rather than adhesive electrodes has also been suggested to be more effective, due to closer proximity to the posterior tibial nerve (173). The question of the duration of effect of PTNS requires further assessment, with follow-up (without maintenance treatment), limited currently to 6 months (165). The case is now strong for an adequately powered double blind randomised controlled trial. Three such multicentre studies are currently ongoing the Netherlands, France and the United Kingdom.

1.6.5.3 Radiofrequency

Application of high-frequency energy to the muscles of the anal canal and lower rectum should lead to a remodelling of the lower rectum via a temperature controlled collagen contraction. This method has not yet become widely used. Abbas and *colleagues* observed treatment response in 78% of patients underwent the dadiofrequency procedure. Mean CCIS in these patients improved form 16 (baseline) to10.9 (3 months postoperatively). A sustained long-term response without any additional intervention was noted in only 22% of the patients(174). Ruiz and colleagues(175) reported a mean improvement in CCIS from 15.6 at baseline to 12.9, at 12 month follow up in 16 patients. The mean FIQoLS improved in all subsets except for the depression domain. Although radiofrequency seems to be a safe, minimally invasive intervention for treating patients with faecal incontinence, studies available in literature are conducted in small sample of patients with heterogeneous mixture of FI etiologies(174-176). Larger studies and longer follow up are required.

1.6.5.4 Injectable bulking agents

Injection of anal bulking agents (IBA) is a new minimally invasive procedure with promising results (177, 178). A variety of materials and techniques for injections of these agents have been described in the published literature(179-184). In a previous Cochrane review several of the studies showed that there were short term improvements in faecal incontinence after injections of a variety of materials using several injection techniques(185). The ideal method of injection has not yet been established (186). There is also a debate as to which injectable agent is the most effective. The aim of this systematic review is to investigate the various injectable agents and techniques used for the treatment of faecal incontinence and to study the safety and efficacy of these techniques. This is discussed in further details in chapter five.

1.7 Discussion

The management of a patient with faecal incontinence is often difficult. A detailed knowledge of the embryology, anatomy and physiology of the anorectum is required. A recent systematic review of faecal incontinence reported a trend favouring conservative management, such as biofeedback and less invasive surgical procedures, amongst which, the more promising are sacral neuromodulation, the radiofrequency procedure and injectable bulking agents(8). In relation to the number of sufferers, surgery is rarely indicated to improve continence. Some methods have been tested for several decades, while others have been developed more recently using modern techniques or implants. As continence cannot always be fully restored, the indication and choice of treatment are of great importance.

The fundamental reason for the less than satisfactory results achieved is likely to be our failure to fully understand the continence mechanism and how this is affected in patients with faecal incontinence. In addition, many treatment strategies that have been

gaining an increasing popularity such as SNS, PTNS, TENS and IBA are of uncertain mechanism. There have been conflicting reports about how would these intervention influence anorectal physiology studies. Moreover, it is not clear what group of patients would respond to a particular treatment based on the results of these investigations. At the present, it seems more logical to rely on clinical picture when evaluating patients' requirements and response.

2 Implementation of the Integrated Rapid Assessment and Treatment (IRAT) Pathway to improve the quality of care for patients with faecal incontinence

2.1 Introduction

Critical Pathways & Process Mapping methodology was used in industry, particularly in the field of engineering from as early as the 1950s. In the 1980s, clinicians in the USA began to develop the pathway tools and tried to re-define the delivery of care and attempted to identify measurable outcomes. They were focusing on the patient rather than the system and needed to demonstrate efficient processes in order to fulfil the requirements of the insurance industry. Developed and used initially for the purpose of cost containment, in the UK in the late 1980s, the emphasis has been to use clinical pathways as a quality tool(187).

Techniques from industry quality management science are among the newer approaches to managing the delivery of health care. Clinical pathways are an application of this industrial quality management science to health care. They standardize practice in the unique culture and environment of individual hospitals and the clinical pathway timeline defines the expected flow of services for a group of patients with a particular diagnosis or undergoing a particular procedure(187).

The rationale for creating critical pathways is that there are certain tasks that are routinely performed in managing the care of hospitalised patients. Care may become more efficient if key aspects of clinical care are systematically expressed in a time and task matrix model, and that model is used to guide the care of patients. Experiences in industries other than health care suggests that this approach can improve efficiency(188, 189).

The initial focus was to reduce length of stay (LOS) with an emphasis on nursing care(190). Originally, critical pathways began with admission and ended with discharge from the hospital. Today, they are usually interdisciplinary in focus, merging the medical and nursing plans of care with those of other disciplines, such as physical therapy, nutrition, or mental health. They provide opportunities for collaborative practice and team approaches that can maximize the expertise of multiple disciplines(187).

Clinical pathways have four main components(191):

- A timeline
- The categories of care or activities and their interventions
- Intermediate and long term outcome criteria
- The variance record (to allow deviations to be documented and analysed).

Goals of pathways include 1) defining standards for expected LOS and for use of specific tests and treatments, 2) giving all team members a plan and specific roles, 3) decreasing nursing and physician documentation burdens, 4) providing a framework for collecting data, and 5) educating and involving patients and families in their care and 6) provide better care through a mechanism that is able to coordinate clinical processes and to reduce unjustified variations and, ultimately, costs(190, 192).

2.2 Terminology

The term "critical pathway" was first introduced by National Library of Medicine (NLM) in the USA in 1996, defining it as "Schedules of medical and nursing procedures, including diagnostic tests, medications, and consultations designed to effect an efficient, coordinated program of treatment" (1).

The terminology used in pathways varies (193-196). Internationally, many terms are used for clinical pathways, thereby causing confusion. De Luc and *colleagues* (194) identified 17 different terms describing this concept. The most frequently encountered terms in the literature are Clinical Pathway, Critical Pathway, Integrated Care Pathway

and Care Map (193). Some of the other names used to describe clinical pathways include: Anticipated Recovery Pathways, Multidisciplinary Pathways of Care, Care Protocols, Pathways of Care, Care Packages, Collaborative Care Pathways, Care Profiles (197). At present, 15 different equivalent terms exist in the NLM's medical subheading database (198).

2.3 Definition

A literature review(199) comprising data obtained from a Medline search for articles published from 2000 to 2003 identified 84 different clinical pathway definitions. Some of the popular definitions of clinical pathway include:

- Specific guidelines for care that describe patient treatment goals and define a sequence and timing of intervention for meeting those goals efficiently(200).

- Care plans that detail essential steps in patient care with a view to describing the expected progress of the patient(201).

- Plan of care that is developed and used by a multidisciplinary team, and is applicable to more than 1 aspect of care (199).

- Multidisciplinary plans of best clinical practice for specified groups of patients with a particular diagnosis that aid in the coordination and delivery of high quality care(197).

- A complex intervention for the mutual decision making and organization of predictable care for a well-defined group of patients during a well defined period(202).

- Clinical management tool used by health care workers to define the best process in their organization, using the best procedures and timing, to treat patients with

specific diagnoses or conditions according to evidence based medicine (EBM) (203).

- A tool used in achieving coordinated care and desired outcomes within an anticipated time frame by utilizing the appropriate resources available. A clinical pathway is a blueprint that guides the clinician in the provision of care (204)
- Clinical pathways are pre-conceived patient care algorithms, or paths, that are intended to reduce variability and cost, increase efficiency, and ultimately improve patient care(205)

- "Pathways provide patient focused care with benefits to the patient, family and members of the multi-disciplinary team. They allow for the continuous evaluation and improvement of clinical practice and help to stimulate research. Their use represents a new approach to patient care, fulfilling many of the demands of clinical practice"(197).

- Critical pathways are structured multidisciplinary care plans that detail essential steps in the care of patients with a specific clinical problem(206).

The common defining characteristics of pathways in these definitions includes: 1) An explicit statement of the goals and key elements of care based on evidence, best practice and patient expectations 2) The facilitations of the communication and coordination of roles, and sequencing the activities of the multidisciplinary care team, patients and their relatives 3) The documentation, monitoring, and evaluation of variances and outcomes 4) The identification of relevant resources (198, 202)

2.4 The purpose of Clinical Pathways

There are four major reasons for developing clinical pathways(197). These can also represent the outcome measures for the effectiveness of implementation of CP:

- To improve the quality of patient care through consistent management, encouraging patient involvement and identifying and measuring improvements in patient care and outcomes.

- To maximize the efficient use of resources by reducing unnecessary documentation and overlap of care and reduced length of hospital stay for particular conditions. Patients who do not make expected progress can be easily identified and the appropriate interventions made.

- To ensure continuity of patient care by reducing unnecessary variations. The development and implementation of clinical pathways increases collaboration between the disciplines, professionals and agencies.

- To support clinical effectiveness, clinical audit and risk management. Clinical pathways also provide an appropriate framework to promote and measure the success of the clinical effectiveness cycle, which encompasses: evidence based practice, clinical audit, patient involvement, multi-disciplinary, multi-professional working, outcome measures and clinical benchmarking.

2.5 Designing and implementing a pathway:

Pathways are an evidence-based response, at both a structured and a local level, to specific problems and care needs, and for this reason they could have a higher level of compliance compared with other instruments such as practice guidelines, which may not be based on local professional consensus (207). There is a great variability in how researchers define the implementation of the "clinical pathway" from implementing a new patient record with minor or no changes in clinical practice to totally redesigning care given by a multidisciplinary team (208).

Here we adapt the strategies that were advocated by Panella and *colleagues* (192, 209) among other authors; to build a clinical pathway, we need to merge Evidence Base

Medicine (EBM) tools with business process re-engineering techniques (209) as follows:

1. Select the area of practice. Choosing an area with a selection matrix, including diagnoses, with higher costs, higher volumes, higher mortality, higher length of stay, or greater number of outcome variations. There is evidence that pathways are more likely to be effective when applied to procedures with lower severity/complexity of illness, high volume and higher length of stay (199)

2. Build the multidisciplinary work-team. Involving physicians, nurses, therapists, social workers and administrators providing care in the selected area. The element of clinician support, such as having a strong physician or nurse champion, may be very important for effective quality improvement(210)

3. Define the diagnosis. Identifying clinical selection criteria for each diagnosis with explicit and shared disease-staging scales when required.

4. Define the patients. Identifying other selection criteria as non-clinical, such as socio-economic factor, housing status, age of the patient, etc.

5. Review practice and literature. Analysing the care processes and researching the best evidence for the patients. All members of the team can contribute to this phase.

6. Develop the clinical pathway. Defining the appropriate goals to satisfy the multidimensional needs of the patients (patient focus phase) 'and translating' the results from the review phase into elements of care detailed in local protocols and documentation, including the sequence of events and expected progress of the patients over time. The elements of care for each professional are defined according to the care categories.

7. Pilot and implement the clinical pathway. Educating the staff and monitoring the use of the pathway. This last step can be carried out by completing data record sheets that summarised the tasks of each professional during the care of the patients and the possible deviations from the path.

8. Ongoing evaluation. Assessing and analysing any deviations from the pathways and measured patients' outcomes.

9. Implementation. The last phase consisted of the daily utilization of the clinical path, its regular monitoring and updating (usually yearly).

2.6 Issues and Problems with implementation

1. Finding the proper balance between clinician autonomy and standardisation can prove difficult. Many doctors still consider clinical pathways as 'cookbook medicine', even though they could change the pathway for a patient at any time (189). On the contrary, they sometime refuse to change their routines even when they have been proved to be ineffective. To solve this problem a constant dialogue must be created within the team, between clinicians and managers. A good tool suited to this purpose is the analysis of variance grids. When the team examine variance sheets regularly, it is possible to identify common reasons why the clinical path is not being followed. This can lead to discussion within the team, which then facilitates full implementation of the clinical pathway (206). When it is impossible to create such a dialogue, the implementation of the pathways fails.

   According to Panella and *colleagues* (192), quantification of outcomes can provide the key to an effective dialogue with clinical teams, because outcome assessment provides reports that are easy to use by health care professionals that will support clinical decision systems.

2. The key people involved in the implementation of the pathways are clinicians. They are less well educated about concepts such as 'the market', 'the organisation', 'managed care'…etc. Therefore, a thorough education, particularly to physicians, would enhanced the implementation of clinical pathways, resulting in greater success (192, 211).

3. The cost of the development and implementation of the pathways is not thoroughly evaluated. Although some pathways reduced length of stay or cut costs for diagnostic exams…etc, we can not conclude that the implementation of a clinical pathway is a cost-effective process based solely on this information (192). The cost effect assessment should extend to include health care requirements following discharge, the process of developing and implementing the pathway and the necessary measures undertaken to overcome certain obstacle such as appointing a project leader

2.7 Overcoming obstacles for successful implementation of clinical pathway**:**

The strategy to overcome obstacles and ensure a successful implementation and of a clinical pathway should include (190)

1. Senior leadership support is essential. The Chief Medical Officer and Chief Nursing Officer are key executive sponsors.

2. There must be physician and nurse champions.

3. Involve all stakeholders in development of pathways.

4. Physicians need ongoing encouragement and education about the value of pathways.

5. There is considerable work involved for unit coordinators in using pathways on a medical and surgical floor. Charts must be reviewed and updated on a regular basis. Progress notes need to be placed in the proper location. This is done when all charts are reviewed each day.

6. There must be ongoing feedback to users.

7. Continuous input from users and edits improve the product.

2.8 Limitations of clinical pathways study designs in literature

2.8.1 Methods Used in Critical Pathway-related Research

Campbell and *colleagues* used the results of a comprehensive review performed by the National Health Service in Wales in 1996, which comprise approximately 4000 references to integrated care pathways and related topics worldwide. Most of the studies they found were uncontrolled 'before–after' studies and no randomized controlled studies were found. Therefore these reports do not provide reliable evidence and publication bias is highly likely, favouring publications reporting favourable experience (206, 212).

In 2007 a systematic review of randomized controlled or quasi-experimental studies evaluating the efficacy of clinical pathway implementation by El Baz *and colleagues* (212) detected 12 retrospective studies (10.4% of the included studies) that controlled for confounding through matching, of which three studies used a random sample from a clinical pathway group which was matched with controls from the pre-pathway period. Furthermore, 10 randomized controlled studies were found, of which two studies randomly assigned hospitals either to implement a clinical pathway or to remain on standard care. Eight studies randomly assigned patients in single centre.

More recently, a systematic review of the effect of using clinical pathways on length of stay (LOS), hospital costs and patient outcomes by Rotter *and colleagues* identified a total of only 17 randomised controlled trials (RCT) or controlled clinical trials (CCT) where management strategy included "clinical pathways" (213). Only the investigation from Marie *and colleagues* (214) used a robust cluster randomised design, with 19 hospitals as unit of allocation to avoid "unit of analysis error". None of the other investigators reported protection against contamination (communication between experimental and control professionals) and it is possible that control subjects received the intervention.

2.8.2 Power analysis

The sample size constitutes a crucial part of any research. However, only 16.5% (*n*=19) of the studies reviewed by El Baz and *colleagues (212)* conducted a power analysis in advance to determine the number of observations sufficient to provide the required precision of results. Among the 115 studies included in this systematic review, 25% of the samples were very small ($n < 50$), 25% ranged from 51 to 100 patients, 25% ranged from 100 to 200 patients and 25% had samples greater than 200 patients in either the clinical pathway or the control group. No statistically significant association was found between sample size ($n<100$ vs. $n>100$) and performance for a statistical power analysis (Chi-square, $P=0.56$).

Another example is the lack of clear sample size calculation for over 60% of studies included in a systematic review and meta-analysis of the effect of clinical pathway on LOS, cost and patients outcome conducted by Rotter and *colleagues* in 2008.*(213)*. Poor reporting of the power calculations makes it difficult to rely on the results of such studies.

2.8.3 Accuracy and validity of outcome measures in clinical pathways:

- Length of stay (LOS): are evaluated in most studies that investigate variable aspect of clinical pathways. However, in one systematic review(212), more than a quarter (28.1%) of these studies gave no accurate or a clear description of the way it was assessed.

- Cost and economic outcomes: There is a considerable methodological variation due to different methods of cost calculation used by the investigators. Some investigators used a full cost approach (fix and variable costs included), whereas others calculated only direct hospital costs (213) focusing on hospital LOS and costs effects, rather than on a full economic evaluation (215). The cost effect assessment should extend to include health care requirements following discharge, the process of developing and implementing the pathway and the necessary measures undertaken to overcome certain obstacle such as appointing a project

leader. On the other hand, cost and hospital charges are assessed in the majority of studies, usually with a clear description of the charges and costs calculated (212).

- Other outcomes such as readmission rates, complications and clinical quality of care indicators are being increasingly, and more accurately, reported. However patient reported outcomes such as quality of life, patient satisfaction and psychological distress are often overlooked and when assessed, authors may not use appropriate and validated tools such as functional health-related scores or Hospital Anxiety and Depression Scale (212, 216).

- Work satisfaction seems to improve. According to Goode *and colleagues*, CP increased job satisfaction related to the quality of care delivered (217). However, in most studies, this is rarely assessed or reported (212).

2.8.4 Appropriateness of statistical methods

The statistical methods adapted in a significant number of primary studies evaluating clinical pathways are not based on rigorous and statistically sound assessment (212). More than half (59.1%) of the studies analysed by El Baz *and colleagues* adopted parametric statistical tests, while the rest (40.9%) tested variables over normal distribution plot and, depending on the outcome, used non-parametric tests. Outcomes such as reduction of LOS, costs, readmission rates and number of complications were not always tested statistically (212).

2.8.5 The selection of comparators.

Although comparators are usually stated and justified by authors of primary studies, a clear description of what was meant by traditional care or usual care (control group) is often missing which make it relatively difficult to assess the relevance of the study to other settings (213).

2.8.6 Publication bias

As most of the reported studies in literature are uncontrolled 'before–after' studies and not randomized controlled studies, these reports do not provide reliable evidence and publication bias is highly likely, favouring publications reporting favourable experience (199, 212)

2.9 Condition Specific Pathways:

In the period between 1995 and 2005, 115 randomized controlled or quasi-experimental studies evaluating the efficacy of clinical pathway application were reviewed and analysed by El Baz and *colleagues.*

- The most common disease specific pathways were those in the field of cardiovascular surgery (17.4% of the study sample).

- Studies evaluating clinical pathways addressing conditions such as (1) respiratory diseases and thoracic surgery (2) gastrointestinal diseases and surgery and endoscopic surgery (3) multiple trauma and orthopedic surgery (4) oncological diseases and surgery(5) neurological trauma and diseases and pain management (6) vascular surgery and (7) gynaecological diseases and surgery and maternity care, each of these categories accounted for 5% to16% of the study sample.

- Categories of diseases representing less than 5% of the study sample comprised studies on urological diseases, surgery and procedures, psychological and mental health illness, metabolic diseases; paediatric conditions, burn and skin reconstructive surgery and head and neck surgery.

- Example of condition specific pathways and clinical outcome include:

2.9.1 Cardiovascular diseases

Every and *colleagues*. reported that in cardiovascular medicine, although the studies they evaluated were somewhat under-powered, the overall experience had been promising. Clinical pathways applied to patients with a cardiovascular disease showed a tendency towards a decreased treatment variation, improved guideline compliance and reduced costs. However, the evidence of the effectiveness of clinical pathways in cardiovascular medicine cannot be generalized because of the insufficient number of controlled studies.

The implementation of the clinical pathway for heart failure in an observational (before-after study) reduced in-patient mortality and outcome variations. There was significant improvement in the quality of almost all clinical processes after the development of the clinical pathways without increasing the costs(218)

2.9.2 Stroke and Rehabilitation:

In an RCT comparing rehabilitation in stroke patients using a clinical pathway based on evidence of best practice, professional standards, and existing infrastructure and coordinated by an experienced nurse (n=76) to conventional multidisciplinary care (n=76), Sulch *and colleagues* (216) detected no benefit of using clinical pathway over conventional multidisciplinary care. Functional recovery was faster and Quality of Life outcomes were better in patients receiving conventional multidisciplinary care. These finding were supported by a systematic review conducted by Kwan and *colleagues* regarding clinical pathways for stroke patients (199, 219) including both randomized and non-randomized studies. They found no evidence that clinical pathways provided any significant additional benefit over standard medical care in terms of major clinical outcomes (death or discharge destination). Moreover, they concluded that stroke patients in CP groups were more dependent on discharge, while the effect on LOS and hospitalization costs remained unclear. Some studies reported major failures in implementation of clinical pathways for stroke and their implementation was discontinued(192).

2.9.3 Surgical Procedures (Two examples)

2.9.3.1 Inguinal hernia

A significant increase in day-surgery activity, demonstrating a more rational use of hospital stays in the unit was observed after implementation of the clinical pathways(192). As a consequence, there was a strong decline in both the average length of stay and its variation however, there were no significant differences in patient outcomes between pre- and post-pathway implementation, as measured using local or early complication rates.

2.9.3.2 Total knee and total hip arthroplasty

Kim *and colleagues.* conducted a systematic review which focused on the effectiveness of clinical pathways for total knee and total hip arthroplasty (220). They included 11 papers and identified only one randomized controlled study. There was a decrease in length of stay (LOS) and in costs with either reduced or unchanged rates of complications and either improvement or no change in patient-reported outcomes. Furthermore, they concluded that, although the data in their review supported the effectiveness of clinical pathway ‘definitive conclusions cannot be made because of methodological limitations.

2.10 Clinical Outcomes of Clinical Pathways in General

Renholm *and colleagues.* concluded in a review article that clinical pathways had positive effects on patient-care outcome. Although some studies did suggest that the use of clinical pathways had no influence on patient-care outcomes, by the same token they also stated that there was no evidence at all that they had any negative effect(201). Similarly, Van Herck *and colleagues.* concluded that clinical pathways did have a positive effect on patient outcome, but they did not take methodological weaknesses into consideration, because they analysed most of the manuscripts

(55.5%) by means of abstracts. Additionally, they expressed their concerns about ‘publication bias since clinical pathways with no, few, or even negative results hardly ever get published.

Rigorous evaluation of CP and medical management approaches is essential in order to determine the effectiveness of CP in particular area of medical care. Pearson and colleagues (221) reported significant reductions in lengths of stay after implementation of CP for surgical conditions. However, the reductions were similar to those at health care organisations at which there were no organised CP efforts in place. The critical pathway program was responsible for very modest improvements in patient care, and was probably without a measurable “return on investment.” These results occurred in an organization where the investigators are extremely knowledgeable and experienced in the field of critical pathways(189). Only after the authors observed declining lengths of stay in organisations without critical pathways did they believe that the reductions at their organisation were more likely to be a result of secular trends rather than the critical pathways(188).

2.11 Study -1- Implementation of the Integrated Rapid Assessment and Treatment (IRAT) Pathway to improve the quality of care for patients with faecal incontinence

2.11.1 Objectives

Here we describe the development and implementation of the Integrated Rapid Assessment & Treatment (IRAT) Pathway in the management of patients with faecal incontinence and report the outcome of a feasibility study.

2.11.2 Methods

2.11.2.1 Study design

Randomised controlled trial of patients entering the Standard Care Pathway compared to patients following the Integrated Rapid Assessment/Treatment (IRAT) pathway for the management of faecal incontinence in single centre.

2.11.2.2. Patients

Adult patients referred form primary care for management of faecal incontinence in York Teaching Hospital were prospectively recruited. Following patients' initial referral, Invitation Letter and Patient Information Sheet were sent to all potential participants. Patients were then contacted by phone by the principal investigator to discuss any query they may have and obtain initial verbal consent prior to the written informed consent that was obtained on the first clinic visit.

2.11.2.2.1. Inclusion criteria

Adult consenting patients referred form primary care for management of faecal incontinence in York Teaching Hospital.

2.11.2.2.2. Exclusion criteria

Patients with underlying colorectal cancer or active inflammatory bowel disease were excluded from this study.

2.11.2.3. Randomisation

Following patients' initial referral, Invitation Letter and Patient Information Sheet were sent to all potential participants. Patients were then contacted by phone by the principal investigator to obtain initial verbal consent. Randomisation took place by mean of Sealed Envelope Randomisation Technique using the "random permuted blocks protocol to balances the number of patients allocated to each treatment group. The allocations are randomly generated and kept within sealed opaque envelopes. Once a patient has consented to enter a trial an envelope is opened and the patient is allocated either to the IRAT pathway or the Standard Care Pathway. The randomisation envelopes and allocation are sequentially numbered to detect any attempt to allocate a patient out of sequence. Randomisation was performed by the Hull York Medical School (HYMS) Statistical Consultancy service in line with the York Hospital's Standard Operating Procedure. Patients were informed about the results of randomisation by post together with the clinic appointment letter.

2.11.2.4.Sample size

This is a feasibility study. A sample size of forty patients was arbitrarily chosen to perform this feasibility study.

2.11.2.5.End points:

- Primary endpoints: Percentage improvement in Faecal Incontinence Scores (FIS) and Rockwood Faecal Incontinence Quality of Life Scales.

- Secondary endpoints:

    - Time scale required to achieve full assessment and management of patients in each arm. Two periods of times were calculated; time from referral by primary care to first clinic appointment and time from initiation of management, i.e. first clinic appointment to competition of management.

    - Patient satisfaction.

2.11.2.6.Data analysis

Data were assessed using Microsoft Excel Spreadsheet (Microsoft Corporation, Seattle, WA, USA) and statistical analysis was performed using SPSS v14.0 (SPSS Inc., Chicago, IL, USA). Continuous data are expressed as median (interquartile range, IQR). The Chi-square test was used to compare categorical variables (sex, number of deliveries, perineal tear, long labour and episiotomy, EAUS findings). The Mann–Whitney U test was used to compare continuous demographic variables, anorectal physiology studies, time periods, Rockwood FIQoLS, SMIS, CCIS and patient satisfaction score. A *p*-values of 0.05 or less was considered significant.

2.11.2.7.Ethical consideration

This study was approved by The North and East Yorkshire Alliance Research and Development Unit and the NRES Committee of the Yorkshire and the Humber Research Ethics Office.

2.11.2.8 The Pelvic Floor Assessment Pathway (PFAP) Form.

The PFAP Form (Appendix 2.1) was developed, in cooperation with Clinical Effectiveness Team, in order to construct a data base for all participants in this study. It comprises two parts "one" and "two", consisting of four and three divisions respectively. Part 1 of the PFAP is concerned with documenting demographic data, medical and obstetric history, baseline St. Marks and Cleveland Faecal Incontinence Scores, baseline Rockwood Faecal Incontinence Quality of Life Scale (FIQoLS), quality of life Visual Analogue Scale (VAS), in addition to questionnaires specific to assessment of faecal incontinence in line with NICE Guidelines recommendations. It also documents the results of anorectal laboratory studies (anorectal manometry, endoanal ultrasound, rectal compliance and anorectal mucosal electrosensitivity) in addition to any further investigation or assessment that might be required for managing individual patients. Part 2 of the PFAP documents patients' management and monitors their progress and outcome. Patients' outcome is assessed using similar assessment tools to those used in part 1, i.e. FIQoLS, SMIS and CCIS in addition to patient satisfaction and feedback score. The later comprises 9 questions that cover patients' perception of variance aspects of their management, including waiting time from referral to first clinic appointment, time required for completion of management, adequacy of time given to the patient, protection of patient's privacy and the overall quality of care in addition to feedback about the PFAP form questionnaire itself. The patients were asked to rate these various aspects of care on a scale of 1 to 5, 1 being "strongly disagree" and 5 being "strongly agree". (Appendix 2.2).

2.11.2.8.1. Cleveland Clinic Incontinence Score (CCIS):

Developed in 1993, the CCIS (222) is probably still the most widely used FI severity scoring system. It gives a total score for the severity of the incontinence ranging between 0-20; where 0 represent full continence while 20 represent the worst possible incontinence. The CCIS comprises five questions accounting for incontinence to solid stool, liquid stool and flatus in addition to the use of protective pads and change in lifestyle. Each question is scored according to the frequency of occurrence of the symptom from 0 (never) - 4 (daily). This scoring system is simple and easy to

understand and formed the base of almost all subsequent FI scoring systems that are currently used.

2.11.2.8.2. St. Marks Incontinence Score (SMIS):

In addition to the five questions composing CCIS, St Mark's Score (223) introduced an assessment of the ability to defer defecation, an additional score for the use of antidiarrhoeal medication and reduced the emphasis on the need to wear a pad. This scoring system comprises seven questions, each question is scored according to the frequency of occurrence of the symptom from 0 (never) - 4 (daily). The total score ranges between 0-24, where 0 indicates full continence while 24 represents the worst possible incontinence.

2.11.2.8.3. Rockwood Fecal Incontinence Quality of Life Scale

Fecal Incontinence Quality of Life Scale (FIQLS)(127) measures specific quality of life issues expected to affect patients with fecal incontinence. It is derived from a 29 item questionnaire comprising four domains; lifestyle, coping/behavior, depression/self-perception and embarrassment. Each domain ranges from 1 to 4; with 1 indicating a lower functional status of quality of life.

2.11.2.9. Data collection and case identification mechanism

All collected data were initially entered into the sequential parts of the PFAP form which are kept as part of the patient clinical notes after assigned a specific identification code. Data were then transferred into a password-protected Excel sheet, where they can only be identified by the assigned "identification code", by the principal investigator. The Excel sheet is stored on a password-protected NHS computer in York Teaching Hospital.

2.11.2.10. The Integrated Rapid Assessment & Treatment (IRAT) Pathway

The Integrated Rapid Assessment & Treatment (IRAT) Pathway is designed to provide a seamless multidisciplinary care to patients with faecal incontinence in a timely fashion. Patients referred from primary care are assessed and managed by a team of surgeons, pelvic floor physiotherapist and anorectal physiology nurse practioner. Each step in patient assessment and management "event" takes place according to a preconceived timetable.

To achieve the goals of the IRAT pathway, a specialised IRAT Clinic was introduced where patients are seen and assessed jointly by a colorectal surgeon, with special interest in the management of faecal incontinence, pelvic floor physiotherapist and a colorectal research fellow to assess and document patient progress. This clinic takes place once every 8 weeks.

2.11.2.11. Events in IRAT Pathway (Appendix 2..3)

- Participant randomised to IRAT pathway are asked to complete part 1.a. of the PFAP before attending the first IRAT clinic.
- Week 1: patients are seen in IRAT clinic by surgeons & physiotherapist, completing part 1.b of PFAP.
- Week 3: All patients undergo assessment by the pelvic floor physiotherapist for suitability of biofeedback.
- Week 6: patients undergo assessment in the Anorectal Physiology Laboratory, Part 1.c of PFAP is completed by the patients and Part 1.d of PFAP is completed by the nurse practioner.
- Week 8: a second IRAT clinic visit takes place for reassessment & management plan based on anorectal physiology studies and clinical and biofeedback assessments, using part 2.a of PFAP. No management takes place before this time point.
- Week 16: Follow-up after completion of management.
- After completion of management, all patients, in both study arms, were asked to complete part 2.b. (final assessment) and 2.c. (patient satisfaction and feedback) of

the PFAP for comparison of outcome. A reminder, by post, was sent to those who did not return the completed part 2.b. and 2.c. forms in a median of 2 moths.

2.11.2.12. Events in the Standard Care Pathway

1. Participant randomized to Standard Care Pathway are asked to complete part 1.a. of the PFAP before attending the first clinic.
2. Patients are seen in a colorectal clinic by colorectal surgeon, completing part 1.b of PFAP.
3. Patients are assessed and treated according to the surgeon's clinical judgment. All management options available to patients in the IRAT pathway are also available to the Standard Clinic Pathway patients, including biofeedback, surgical intervention…etc

After completion of management, all patients, in both study arms, were asked to complete part 2.b. (final assessment) and 2.c. (patient satisfaction and feedback) of the PFAP for comparison of outcome. A reminder, by post, was sent to those who did not return the completed part 2.b. and 2.c. forms in a median of 2 moths.

2.11.2.13. Anorectal physiology laboratory assessment:

Anal manometry study variables were obtained using an eight-channelled solid-state transducer catheter (Flexilog 3000, Oakfield Instruments Ltd, Evensham, Oxon, UK) using a continuous "pull through" technique. Manometric data were analysed using commercial software (Flexisoft III, Oakfield Instruments Ltd, Evensham, Oxon, UK). This included calculation of the maximum mean resting pressure (MMRP), maximum mean squeeze pressure (MMSP), rVV, sVV, RAI,

SAI and resting and squeeze vectorgrams. In addition data from endoanal ultrasound (EAUS), rectal compliance and rectal mucosal electrosensitivity studies were included. EAUS was performed using a standard 2D 10 mHz probe (B&K, Denmark). Colonic imaging was also performed where indicated.

2.11.2.14. Assumptions

- Initiation of management is defined as any conservative, medical or surgical intervention including alteration of patient current medication, biofeedback or physiotherapy.
- Completion of management was defined as the time point of discharging patient back to primary care.

2.11.3. Result

2..11.3.1. Patient introduced to the study

A total of 43 eligible patients invited to participate in this study over a period of 18 months. Thirty-nine patients, 34 females, consented to participate. Median (IQR) age was 65 (55-75) years. Of those, 20 patients were randomised to the IRAT pathway and 19 patients were randomised to the Standard Care Pathway. The median (IQR) time period from referral by primary care to first clinic appointment in our department was 5 (3-6) weeks and 6 (4-8) weeks for the Standard Care Pathway and the IRAT pathway respectively. The median (IQR) time period from initiation of management, i.e. first clinic appointment, to competition of management, i.e. discharge back to primary care was 4.5 (4-7) months and 4 (2-6) months for the Standard Care Pathway and the IRAT pathway respectively.

2.11.3.2. Patient withdrew from the study

One patient withdrew from the IRAT pathway arm of this study because of resolution of her symptoms and declined further assessment. Another patient withdrew from the Standard Care Pathway without stating the reason.

2.11.3.3 Patient included in final analysis

Of the initial 39 patients recruited in the study, 31 (79.5%) patients completed their final assessment (part 2.b) and patient satisfaction/feedback (part 2.c) components of the PFAP form. Only data from those 31 patients was included in our analysis. Demographic data (age, sex, BMI) and medical and obstetric history (history of urinary incontinence, history or symptoms of pelvic floor weakness, history of vaginal delivery, difficult labour, perineal tear and forceps delivery) of those patients are detailed in tables 2.1 and 2.2 respectively.

Pathway	Number of patients	BMI Median (IQR)	Age Median (IQR)	sex	
Standard Care Pathway	16	26.75 (23-31.9)	70.5 (60 - 76)	female	14
				male	2
IRAT	15	27.7 (22.8-35.8)	66 (59 - 77)	female	12
				male	3
P-value		0.767	0.599	0.570	

Table 2.1. Demographic data of patients included in analysis.

Pathway	vaginal delivery	Difficult labour	Perineal tear	Forceps delivery	Concurrent urinary incontinence	symptoms of global pelvic floor weakness
Standard Care Pathway	14/14	10	9	6	13	9
IRAT	12/14	9	8	4	9	6
p-value	0.213	0.319	0.257	0.361	0.176	0.171

Table 2.2 detailing obstetric history and concurrent urinary incontinence in patients included in analysis.

There was no significant difference in demographic data, obstetric history and anorectal laboratory test results between the two groups of this study. Details of anorectal laboratory tests and their corresponding *p*-values are explained in tables 2.1, 2.2 and 2.3.

Anorectal physiology variables	IRAT Ppathway Median (IQR)	Standard Care Pathway Median (IQR)	*p*-value
MMRP	46 (36-80)	55 (38.5-72)	0.959
MMSP	74 (57-89)	50 (37-72)	0.884
Resting Victor Volume	33308 (16559.2-54994)	51224 (29444- 77663)	0.174
Squeeze victor volume	61168 (44393-165403)	81303.00 (51751- 118808.5)	0.786
Squeeze asymmetry	29.7(11.7-27.1)	14.35 (8.4-16.9)	0.065
Resting asymmetry	20.9 (13.5-31)	17.9 (11.2-27.1)	0.406
USS-IAS	2 abnormal	2 abnormal	1.000
USS-EAS	2 abnormal	1 abnormal	0.586
Resting vectrogram	4 abnormal	5 abnormal	0.940
Squeeze vectrogram	3 abnormal	5 abnormal	0.431
TRV	85 (50-100)	80 (50-95)	0.849

MRV	140 (100-195)	140 (100-195)	0.939
AME (*high*)	6.50	7.10	0.931
AME (*mid*)	5.30	5.90	0.885
AME (*low*)	4.70	5.10	0.852

Table 2.3 detailing anorectal laboratory test results in patients included in the analysis.

Similarly, there was no significant difference in baseline FIQoLS, SMIS and CCIS between the two study groups (tables 2.4 & 2.5)

Baseline	FIQoLS 1 lifestyle Median (IQR)	FIQoLS 2 coping/behavior Median (IQR)	FIQoLS 3 depression Median (IQR)	FIQoLS 4 embarrassment Median (IQR)
IRAT pathway	3.60 (2.2-4)	2.66 (1.42-3.36)	3.71 (2.32-4.12)	2.66 (1.3-3.75)
Standard Care Pathway	3.45 (2.3-3.7)	2.38 (1.62-3.0)	3.13 (2-3.66)	1.98 (1.3-2.66)
p-value	0.441	0.937	0.105	0.218

Table 2.4. Comparison between baseline Rockwood Faecal Incontinence Quality of Life Scales of both study groups.

Baseline	CCIS Median (IQR)	SMIS Median (IQR)
IRAT pathway	8 (3.5-11.5)	13 (5.5-13)
Standard Care Pathway	9.5 (5-15)	12 (7-16)
p-value	0.114	0.179

Table 2.5. Comparison between baseline SMIS and CCIS of both study groups.

Three patients in Standard Care Pathway underwent perianal injection of bulking agent (Permacol®), one of them subsequently referred to SNS in a tertiary care centre due to persistence of symptoms. Another patient in the Standard Care Pathway was referred to the gynaecology team with severe uterine prolapse and subsequently underwent hysterectomy. One patient in the IRAT pathway was referred for SNS a tertiary care centre. The rest of the patients in both study groups were managed conservatively, mainly with pelvic floor exercise and biofeedback. One patient's symptoms resolved after amending his cholesterol medication, changing Simvastatin to Atorvastatin.

The median (IQR) time period from referral by primary care to first clinic appointment was similar at 5 (3-7) weeks for the both Standard Care Pathway and the IRAT pathway (*p*-value=.889). The median (IQR) time period for completion of management was 4.5 (4-7) months and 4 (2-5) months for the Standard Care Pathway and the IRAT pathway respectively. This was not significantly different (*p*-value=0.307).

Final follow-up with FIQoLS, SMIS, CCIS and patient satisfaction score was carried out in a median (IQR) of 1 (1-3) months after completion of management. This shows no significant difference in any of the four scales of FIQoLS, i.e. the lifestyle, coping, depression and embarrassment scales, between both study groups (table 2.6). Similarly there was no difference in CCIS or SMIS at final follow-up (table 2.7).

After completion of management	FIQoLS 1 lifestyle Median (IQR)	FIQoLS 2 coping/behavior Median (IQR)	FIQoLS 3 depression Median (IQR)	FIQoLS 4 embarrassment Median (IQR)
IRAT pathway	3.90 (2.15- 4)	2.88 (1.83 3.77)	3.85 (2.28-4.07)	3.00 (1.83-3.83)
Standard Care Pathway	3.6 (2.4-4)	3.75 (1.66-4)	3.5 (2.1-3.85)	2.33 (1.6-3.66)
p-value	0.506	0.921	0.176	0.867

Table 2.6. Comparison between Rockwood Faecal Incontinence Quality of Life Scales of both study groups after completion of management.

After completion of management	CCIS Median (IQR)	SMIS Median (IQR)
IRAT pathway	6 (1.5 -11.5)	7 (3-15.5)
Standard Care Pathway	7.5 (3-12)	9.5 (4-11)
p-value	0.372	0.849

Table 2.7. Comparison between SMIS and CCIS of both study groups after completion of management.

Patients' satisfaction scores in 7 of the 9 item questionnaire were not significantly different (table 2.8). However patients in the IRAT pathway were more satisfied with the time required for completion of treatment (form first clinic appointment to discharge) than those in the Standard Care Pathway (*p*-value = 0.033). There was also a stronger agreement among the IRAT Pathway group that the questionnaire in the FPAP covered all aspects of their problem (*p*-value = 0.006).

Please rate your degree of satisfaction with each of the following aspect	Standard Care Pathway Median (IQR)	IRAT Pathway Median (IQR)	*p*-value
1. The waiting time from seeing your GP until been seen at York hospital was acceptable.	4 (3-4)	4 (4-5)	0.069
2. The waiting time from being seen at York Hospital until completing your treatment was acceptable	4 (3-4)	4 (4-5)	0.033
3. The questions you were asked to complete were relevant to your problem?	4 (4-4)	4 (4-5)	0.237
4. The questions you were asked to complete were clear and easy to answer?	4 (4-4)	4 (4-5)	0.283
5. The questions you were asked to complete covered all aspect of your problem?	4 (3-4)	4 (4-5)	0.006
6. You were supported and given clear advices/instructions throughout	4 (4-4)	4 (4-5)	0.080
7. You were given enough time to explain your problem/concerns	4 (4-4)	4 (4-5)	0.080
8. Your privacy and dignity were respected throughout management.	4 (4-5)	4 (4-5)	0. 424
9. The over all quality of care you received was high.	4.5 (4-5)	4 (4-5)	0.853

Table 2.8. Comparison of patient satisfaction score between the IRAT and the Standard Care pathways

2.11.4. Discussion

This study shows that there is no advantage of managing patients in the IRAT Pathway compared to the Standard Care Pathway. Outcome measures such as FIQoLS, SMIS and CCIS were not significantly different. The IRAT Clinic was designed to expedite the management of patients with FI. It takes place once every 8 weeks. During the time periods between first and second and second and third clinic visits, the patient would have completed all their assessments and treatment respectively. However, this study shows that there was no significant difference in the waiting time for the first clinic appointment and in the time required for completion of management between the two study groups. This could well be due to the stringent timetable imposed to the IRAT Pathway. When patients have asked to postpone or change their clinic dates for various reasons, they had to wait for another 8 weeks for the next clinic appointment. The Standard Care Pathway, on the other hand, was more flexible, and since colorectal clinics take place every week, they could accommodate for patients' cancelations and appointment changes on weekly basis. By the same token, patient factors and preferences may have influenced these time scales. This is reflected in the patient satisfaction questionnaire, where patients in the IRAT pathway were more satisfied with the time required for completion of management, in spite of absence of significant difference in the time scale itself.

Patients in the IRAT Pathway also had stronger agreement that all aspects of their problem were addressed. This could reflect the support and thorough education that patients in this group received along with interaction with pelvic floor and biofeedback therapists both in the clinic and in the laboratory.

Both study groups have rated the overall quality of care equally, which, in addition to a non-significantly different outcome measures (FIQoLS, CCIS and SMIS), means the introduction of the IRAT Pathway did not have a major impact on the quality of patient care.

There is evidence that pathways are more likely to be effective when applied to conditions and procedures with lower severity / complexity of illness, high volume and

higher length of stay (199). This does not apply to FI which is a multifactorial condition with complex aetiology. In addition the volume of patient referred our department for management of FI was relatively low. The risk of "contamination" of the control sample, i.e. communication between experimental and control professionals, was not considered in this study, especially that some of the Standard Care Clinic were run by the same colorectal consultant conducting the IRAT Clinics. Some or all of these factors could have contributed to the final outcome of this study.

In spite of the outcome measures of this study, patient satisfaction seemed to increase with the use of the IRAT pathway. This finding is compatible with outcomes of other similar studies. Lawson *and colleagues* (224) report that patient and parent satisfaction increased because of the promptness of securing discharge prescriptions (224). Goode (217) discovered that patients who had a care map and a nurse case manager were more satisfied with their care.

How health care should respond to clinical pathways that have not been shown to improve care, such as some the pathways for strokes and renal failure (192) is not clear and further research is needed to answer this question (188). The answer depends on the risks, costs, and opportunity costs of continuing to implement critical pathways or other strategies (188).

It has been assumed that critical pathways are not associated with risk, although there are relatively few studies to support or refute that belief. However, critical pathways might be costly to develop, update, and implement. There may also be opportunity costs of not pursuing other strategies that might more effectively improve quality, reduce costs, and enhance patient safety, since these other strategies must compete for organizational resources.(188)

Despite widespread enthusiasm for critical pathways, rigorous evidence to support their benefits in health care is extremely limited. However, understanding what evidence-based information is, and translating this information into practice using reminder systems or other effective implementation strategies, can potentially improve care, reduce costs, and enhance safety (188, 225-228).

Studies should also determine the clinical and financial return on investment of these efforts. Organisations should identify which components of their current clinical quality improvement efforts are effective, and which are not. For strategies that are without measurable benefit, consideration should be given to learning from those experiences and may be redirecting resources to more effective quality improvement strategies(188).

3. Test-retest reliability of FI severity and quality of life assessment tools

3.1 Introduction

Faecal incontinence (FI) covers a wide spectrum of symptoms. It ranges from involuntary but recognized passage of gas, liquid, or solid stool (urge incontinence) to unrecognized anal leakage of mucus, fluid, or solid stool (passive incontinence). Faecal incontinence can be socially debilitating, and some patients inevitably change their lifestyle according to their disease depending on their personal character. In this context, it is the kind of disorder that needs a symptom-based approach rather than a traditional disease-based approach (1, 2).

For measuring symptoms of faecal incontinence, many systems of assessment have been developed. They can be broadly classified into descriptive measures, severity measures, and impact measures. Descriptive measures evaluate various aspects of faecal incontinence with numerous items of questions, each item is analyzed separately without giving any score (229-234). Severity measures are more commonly used among assessment systems in clinical practice(235) and aims to give a total score that correspond to the degree of incontinence. Impact measures focus on the impact of incontinence on the individual's quality of life. Generic impact measures(236) and faecal incontinence-specific impact measures(127, 237) coexist. In reality, these three measures may overlap.

For any assessment system to be valid, it must meet several criteria: (a) it must be easily completed and acceptable to the population under study; (b) it must be reproducible, i.e. elicit similar responses when repeated in an individual with a stable clinical picture. This includes intra-rater and inter-rater reliability; (c) it must be discriminant for the disorder under study; (d) it should be valid, i.e. give a true picture of the symptoms; and (e) finally, it should be sensitive to changes in the grade of dysfunction (238).

Initial attempts of devising FI assessment system were mostly descriptive in nature using loose measures such as "occasional accidents," which could be interpreted differently (234, 239, 240). Neither the consistency nor the frequency of faecal incontinence is described using these systems. Other authors did describe the stool consistency but did not mention the frequency of faecal incontinence (241-243). Keighley and Fielding(232) in 1983 used the terms "once a month" and "once a week" but did not provide a corresponding score(244). These assessment tools are historical and are not widely used in clinical practice (appendix 3.1).

In this study we are going to focus on the other two types of assessment tools, i.e. the faecal incontinence severity scoring systems and the quality of life assessment systems.

In the previous study, we used CCIS, SMIS and FIQoLS as endpoints to the study and as a mean to evaluate patients' outcomes. In this study we will be evaluating how reliable these assessment tools are. Although *internal consistency* has been used to evaluate reliability of various quastionaires, ***test-retest reliability*** is more relevant evaluation of reliability in the setting of clinical medicine because the constructs we attempt to measure are heterogeneous. For example, many instruments used by physicians combine apparently diverse domains such as quality of life scales (general impact of incontinence, physical function, social function, personal relationships, emotion… etc). Thus, a poor internal consistency is expected(245).

3.2. Faecal incontinence severity scoring systems:

Clinical assessment of patients with faecal incontinence may still be the gold standard in the evaluation of the severity of symptoms. Seong and *colleagues*(246) demonstrated no significant difference between clinical scores of two experienced investigators assessing 43 consecutive patients with faecal incontinence (paired t-test, $P = 0.988$). The inter-observer reliability was 0.95 (Intra-class correlation coefficient (ICC), 95% confidence interval 0.91 to 0.98).

However clinical assessment may vary between clinicians according to their expertise, in addition to the difficulty rising when comparing results of published data, often making comparisons of treatment modalities meaningless (223). Therefore, a scoring system for the assessment of severity of faecal incontinence is required to gain an objective comparison of outcomes of both conservative and surgical treatments (223).

Quantifying patients' complex and variable symptoms into an objective scale that is both simple and reproducible has always posed a challenge to clinicians and researchers (1). Unlike urinary incontinence, where only liquid is lost, faecal incontinence may be for solid or liquid stool or for flatus alone (223). The usual severity measures are summary scoring systems that assign values for certain categories of incontinence and produce summary scores based on the addition of values for each category (222, 223, 244, 247).

A perfect scale for rating FI severity has not been devised yet, as evidenced by the existence of multiple scales (126, 222, 223, 244, 248). In this section we are going to review the major FI severity scoring systems with special emphasis on the Cleveland Clinic Incontinence Score (CCIS) and St Mark's Incontinence Score which are the most widely used severity scoring system in current literature, and indeed in our unit.

3.2.1. The Pescatori Grading and Scoring System:

The Pescatori Faecal Incontinence Grading and Scoring System (244), that was published by Pescatori and *colleagues* in 1992, was the first severity scoring system that took into account the degree and the timing of any incontinence episodes, even minor ones, and was expressed by a score (tables 3.1.a and 3.1.b.). Most classifications of faecal incontinence reported by the literature up to that point considered the severity of the incontinence, without taking into account how often the incontinence episodes occur and without giving a score to quantify the degree of faecal incontinence (244).

Earlier attempts to provide an effective score, such as the classification proposed by Kelly (231) in 1969 which used the term "sometimes" to define a moderate frequency of FI was considered inadequate. Keighley and Fielding(232) in 1983 used the terms "once a month" and "once a week"; but they did not provide a corresponding score.

○ A	Incontinence for flatus/mucous	Less than once a week	1
		At least once a week	2
		Every day	3
○ B	Incontinence for liquid stool	Less than once a week	1
		At least once a week	2
		Every day	3
○ C	Incontinence for solid stool	Less than once a week	1
		At least once a week	2
		Every day	3

Table 3.1.a. Pescatori Grading System: A, B, and C indicate the degree of faecal incontinence; 1, 2, and 3 indicate the frequency of symptoms. The score is then obtained by adding the points of FI degree to the points of FI frequency. It ranges between 0 (full continence) and 6 (daily incontinence for solid stool). A1 is 2 points, A2 and B1 are 3 points, B2 and C1 are 4 points, B3 and C2 are 5 points, C3 is 6 points(244).

AI degree	*Points*	*AI frequency*	*Points*	*AI score*
A	1	1	1	2
A	1	2	2	3
A	1	3	3	4
B	2	1	1	3
B	2	2	2	4
B	2	3	3	5
C	3	1	1	4
C	3	2	2	5
C	3	3	3	6

Table 3.1.b. The Pescatori Scoring System(244)

Pescatori Grading and Scoring system took into account the degree and frequency of FI and expressed a total score of severity. However, there was a limited score out of only

six points with the assumption that solid faeces indicate worse FI (223). Like most of the other scoring system, Pescatori did not take an account of the amount of stool lost.

Pearson correlation coefficient between Pescatori Grading System and the mean "clinical scores" (on a scale of 0 to 20), given by two investigators based on detailed history, examination findings, anorectal physiology and EAUS tests, and designed to reflect the severity of FI, was 0.72 ($p < 0.001$)(223).

The Intraclass correlation coefficient (ICC) of the test-retest reliability performed on a randomly selected 13 of 24 patients at a median of 14 days (range 8–20 days) after the first test was 0.58 (223). Responsiveness refers to the ability of an outcome measure to detect clinically important changes over time(249). The correlation between Pescatori Grading System and the clinical assessment, performed by two investigators, of the degree of improvement in incontinence symptoms in female patients, six weeks after surgery for FI, was 0.87 ($p < 0.001$) (223).

3.2.2. Faecal incontinence severity index (FISI):

FISI was developed by Rockwood and *colleagues* in a multicentre study sponsored by the American Society of Colon and Rectal Surgeons(126). This index addresses the leakage of gas, mucus, liquid or solid stool at varying frequencies. It assigns a cumulative subjective weighted score from 0 to 61 to each patient, where a value of '0' indicates full continence and '61' indicates incontinence to gas, liquid, mucus and solid stool at least twice daily (tables 3.2 and 3.3). The FISI has no aspect of impact such as alteration of life style or the use of protective devices, which was accounted for in subsequent systems (222, 223). It has four types of incontinence including mucus, which is sometimes confused with liquid stool by the patient and may record a falsely high score.

	2 or More Times a Day (1)	Once a Day (2)	2 or More Times a Week (3)	Once a Week (4)	1 to 3 Times A Month (5)	Never (6)
a. Gas	□	□	□	□	□	□
b. Mucus	□	□	□	□	□	□
c. Liquid Stool	□	□	□	□	□	□
d. Solid Stool	□	□	□	□	□	□

Table 3.2. FISI, patients are asked to indicate, "on average, how often in the past month they have experienced any amount of accidental bowel leakage"

	2 or More Times a Day (1)	Once a Day (2)	2 or More Times a Week (3)	Once a Week (4)	1 to 3 Times A Month (5)	Never (6)
a. Gas	12	11	8	6	4	0
b. Mucus	12	10	7	5	3	0
c. Liquid Stool	19	17	13	10	8	0
d. Solid Stool	18	16	13	10	8	0

Table 3.3. FISI matrix with point assignment for FISI score calculaton.

3.2.3. The Cleveland Clinic Incontinence Score "Wexner Score" (CCIS)

Developed in 1993 by Wexner and *Colleagues*, the CCIS (222) is probably still the most widely used FI severity scoring system. It gives a total score for the severity of the

incontinence ranging between 0-20; where 0 represent full continence while 20 represent the worst possible incontinence (table 3.4). The CCIS comprises five questions accounting for incontinence to solid stool, liquid stool and flatus in addition to the use of protective pads and change in lifestyle. Each question is scored according to the frequency of occurrence of the symptom from 0 (never) - 4 (daily). This scoring system is simple and easy to understand and formed the base of almost all subsequent FI scoring systems that are currently used.

	Never	***Rarely***	***Sometimes***	***Weekly***	***Daily***
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

Table 3.4. Cleveland Clinic Incontinence Score: n**ever**, 0; **rarely,** <1/month; **sometimes,** <1/week, >1/month; **usually**, <1/day, >1/week**; always**, >1/day.0, **perfect**; 20, complete incontinence

CCIS take into account the impact of FI on patient's life style in a scale of 0 to 4 in a manor similar to all other items in the scoring system. Although some may argue that life style is a function of quality of life score, it is particularly important in a condition such as FI to account for the patients' own perception given the nature of the problem and the variable psychological impact in different individuals with similar objective severity of incontinence. However, CCIS also has some limitations such as giving equal weighting to all types of incontinence; therefore, the same frequencies of incontinence of gas and incontinence of solid stool contribute equally to the total severity score. This equality in weighting FI symptoms includes the usage of pads which may inevitably give erroneous measure of severity (250). The use of protective pads could be a measure of the patient's degree of fastidiousness rather than a measure of severity. It could also relates to the presence of coexistent urinary leakage (223). Furthermore,

male patients tend not to use a pad even with significant FI. Also, the amount of leakage is not represented in CCIS; hence, there is a possibility that two patients with the same frequency but a very different amount of leakage could have the same score (1)

Rothbarth and *colleagues* (251) attempted to determine the CCIS at which the quality of life, measured by the Gastrointestinal Quality of Life Index (GIQLI) (252) and Medical Outcomes Study Short-Form General Health Survey (MOS F-20)(253), will be impaired. The GIQLI cut-off value of 105, which implies that patients were less mobile in the community and were confined to their homes, corresponded with a CCIS of 9. Further analysis of the association between the CCIS and the GIQLI score in a subgroup of study patients, demonstrated a remarkable drop of 21 points in the GIQLI score at a CCIS of ≥ 9 ($P < 0.001$) (251). However, in clinical practice, this cut-off point in CCIS may be artificial.

The Pearson correlation coefficient between CCIS and the mean "clinical scores" (on a scale of 0 to 20), given by two investigators based on detailed history, examination findings, anorectal physiology and EAUS tests, and designed to reflect the severity of FI, was 0.78 ($p < 0.001$)(223). The ICC of the test-retest reliability of the CCIS that was performed on a randomly selected 13 of 24 patients at a median of 14 days (range 8–20 days) after the first test, was 0.75 (223).

The correlation between CCIS and the clinical assessment, performed by two investigators, of the degree improvement in incontinence symptoms in a 10, six weeks after surgery for faecal incontinence, was 0.87 ($p < 0.001$) (223).

3.2.4. St. Marks Incontinence Score (SMIS)

Vaizey and *colleagues* used CCIS as the basis for developing St Mark's Score (223). By modifying CCIS, Vaizey and colleagues introduced an assessment of the ability to defer defecation, an additional score for the use of antidiarrhoeal medication and reduced the emphasis on the need to wear a pad (223) as it may reflect the patient's degree of fastidiousness rather than a measure of severity.

This scoring system comprises seven questions, each question is scored according to the frequency of occurrence of the symptom from 0 (never) - 4 (daily). The total score ranges between 0-24, where 0 indicates full continence while 24 represents the worst possible incontinence. (Table 3.4)

	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Need to wear a pad or plug	0	2
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

Table 3.5. St Mark's Incontinence Score. **Never**, no episodes; **rarely**, 1 episode in past 4 weeks; **sometimes**, >1 episode past four weeks but <1 a week; weekly, 1 or more episodes a week but <1 a day; **daily**, 1 or more episodes a day.

The Pearson correlation coefficient between SMIS and the mean "clinical scores" (on a scale of 0 to 20), given by two investigators based on detailed history, examination findings, anorectal physiology and EAUS tests, and designed to reflect the severity of faecal incontinence, was 0.79 ($p < 0.001$)(223).

The ICC of the test-retest reliability of the SMIS that was performed by Vaizey and *colleagues* on a randomly selected 13 of 24 patients at a median of 14 days (range 8–20 days) after the first test was 0.87 (223). Bols and *colleagues* (254) measured the weighted kappa of SMIS and demonstrated a test-retest reliability of 0.55. They

interpreted reliability as adequate, which was supported by the non-significant *P*-values of the marginal homogeneity test (254).

The correlation between SMIS and the clinical assessment, performed by two investigators, of the degree of improvement in incontinence symptoms in a 10 patients, six weeks after surgery for faecal incontinence, was 0.94 ($p < 0.001$) reflecting an excellent sensitivity of SMIS to change (223). Bolts and colleague attempted to measure responsiveness of SMIS compared to changes in GPE following PFR. Neither pad nor medication use changed significantly ($P = 0.19$ and 0.38, respectively, Wilcoxon signed rank test), and both showed small effect sizes and small Spearman correlation coefficients with GPE.

St. Mark's incontinence score has a statistically moderate correlation with patients' subjective perception of bowel control ($r=-0.55$; $P<0.01$) assessed in 390 patients using 0–10 scale (1) regardless of type of incontinence, patients' age, or gender. Bols and *colleagues* estimated the "minimal important change" in SMIS (254) at "-5" using the GPE score as an anchor

Although the SMIS incorporates many important aspects of faecal incontinence, it also has some limitations. The amount of leakage is not represented; hence, there is a possibility that two patients with the same frequency but a very different amount of leakage could have the same score (1), in addition to giving equal weighting to all types of incontinence; therefore, the same frequencies of incontinence of gas and incontinence of solid stool contribute equally to the total severity score (250). Another important factor is the weighting given to the urgency component of the total score. Four points is given for lack of ability to defer defecation for 15 minutes, which is a significant proportion of the score. Some patients have urgency with minimal incontinence, whereas some have passive faecal incontinence alone, and the score for the latter patients may not adequately reflect their symptom severity (1) especially if they are assessed among a heterogeneous group of incontinent patients.

Avery and *colleagues* (249) indicate in their review on questionnaires used to assess urinary and anal incontinence a grade C recommendation for the St Mark's Score and CCIS. This means that these scores are in the early stages of development and further

study is required and encouraged. No questionnaire, used in the assessment of FI, was identified that meet the grade A criteria (highly recommended: validity, reliability and responsiveness established with rigor) and only three attained a grade B status, including the Faecal Incontinence Quality of Life Scale (FIQL)(127), the Manchester Health Questionnaire(237) and the Birmingham Bowel and Urinary Symptoms Questionnaire(255). These questionnaires are, however, quality of life assessment tools and are considerably longer than the 5-item CCIS and the 7-item SMIS.

3.2.5. The American Medical Systems score

The American Medical Systems (AMS) uses a more complex scoring questionnaire, asking the patient for a retrospective evaluation of the previous four weeks. It includes evaluation of the consistency and frequency in addition to the amount of stool lost and its effect on lifestyle. It was therefore the first severity scoring system that account for the significance, in terms of volume, of each episode of faecal incontinence (table 3.6). It was initially devised to evaluate the results of newly designed artificial bowel sphincter. Apart from the AMS, none of the widely accepted and used severity scoring systems grades the amount of stool leakage. Thus, incontinence severity would be identical for a subject who leaked a small amount of stool sufficient to stain underwear once a week, and another subject who was incontinent for a large liquid bowel movement once a week. However, it did not take into account symptoms of rectal urgency and, more importantly, it is a complex system with a final scores ranging from 0 to 120 and a choice of six different frequencies of incontinence, this may explain the limited used of this severity scoring system in the literature.

Over the past four weeks, how often:

	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*	*Several times*
Did you experience accidental bowel leakage of gas?	0	1	7	13	19	25
Did you experience minor bowel soiling or seepage?	0	31	37	43	49	55
Did you experience significant accidental bowel leakage of liquid stool?	0	61	73	85	97	109
Did you experience significant accidental bowel leakage of solid stool?	0	67	79	91	103	115
Has this accidental leakage affected your lifestyle?	0	1	2	3	4	5

Table 3.6. AMS; **Several times daily**, >1 episode a day; **daily**, 1 episode a day; **weekly**, 1 or more episodes a week but <1 a day; **sometimes**, >1 episode in the past four weeks but <1 a week; **rarely**, 1 episode in the past four weeks; never, 0 episodes in the past four weeks.

The Pearson correlation coefficient between AMS and the mean "clinical scores" (on a scale of 0 to 20), given by two investigators based on detailed history, examination findings, anorectal physiology and EAUS tests, and designed to reflect the severity of faecal incontinence, was 0.58 (p 0 0.003)(223). The ICC of the test-retest reliability of the AMS that was performed on a randomly selected 13 of 24 patients at a median of 14 days (range 8–20 days) after the first test was 0.84. The correlation between AMS and the clinical assessment, performed by two investigators, of the improvement in incontinence symptoms in 10 patients, six weeks after surgery for faecal incontinence, was 0.86 ($p < 0.002$) (223).

3.2.6. Other severity scoring systems

Few other severity scoring systems have been described; however, they are not widely in the literature and therefore have a limited value.

The *Rothenberger scale* [6], also known as modified Miller scale [5,6], gives variable weights to the same frequencies of different types of incontinence. Incontinence to liquid stool gets twice or more the value of incontinence to gas at the same frequency. Similarly incontinence to solid stool gets three times or more the value of incontinence to gas at the same frequency. But such distribution of weights is not based on patient perspective, and it may not reflect the subjective experience of patients.

The *Bowel Control Self Assessment Questionnaire* (BCSAQ) (256) consist of two parts, the first part of the questionnaire is similar in content to both St Mark's and the CCI scores. The second part, however, include a 'bothersome' score, which takes into account the level of impairment rather than simply the severity of symptoms. The Cronbach's alpha coefficient for internal consistency was 0.9. The Spearman correlation coefficient between the BCSAQ and the SF-36, was −0.28 ($p < 0.01$) and −0.29 ($p < 0.01$) for physical and mental scores respectively and between the BCSAQ and the Manchester Health Questionnaire was -0.43 ($p < 0.001$). Divergence validity and test-retest reliably were 0.56 and 0.9 respectively (Spearman correlation, $p<0.001$) (256).

The *Bowel Disease Questionnaire* (230) by Osterberg and *colleagues* comprises 47 questions, 15 were related to constipation, 12 covered issues related to faecal incontinence and 10 questions concerned common symptoms such as abdominal and pelvic pain, urologic symptoms, and previous anorectal surgery. Finally, there were 7 questions addressing obstetric events and 3 questions about social and physical impact. Three questions were in the form of visual analogous scales, in 2 questions the responder had to indicate a number, and in the remaining 42 the answers were categorical(230).

Overall reliability of faecal incontinence group was 0.57, and of constipation group was 0.60 (kappa statistic) and validity were judged acceptable. Several items distinguished

both patient groups from healthy controls ($p < 0.05$ to $p < 0.001$). Sensitivity to surgical treatment was seen in several items in both patient groups(230).

The *Faecal Incontinence and Constipation Assessment* (FICA) questionnaire was developed by Bharucha and *colleagues* in 2004 (248). It comprises 98 questions modelled after previously validated bowel diseases and focused FI questionnaires (229) to characterise bowel habits and assesses the impact of bowel function on activities. It also and identifies patients with associated urinary incontinence and anorectal trauma or disorders and measures the frequency and severity of somatic complaints.

The severity of FI was rated by using a subset of questions within the FICA instrument. In addition to the frequency and type of leakage that was used previously (222, 223, 244), Bharucha and *colleagues* incorporated the number of perineal protective devices used daily for stool (not urinary) leakage and the severity of urgency which was rated as never, sometimes (< 25% of the time), often (> 25% of the time) and usually (>75% of the time). The maximum score is 12, divided into 3 groups, 1–4, 5–8 and 9–12 to reflect mild, moderate and severe faecal incontinence, respectively(248).

3.3. Quality of life assessment tools

Although differences among various severity scoring systems do exist, similarities outweigh the differences. All of these systems have some limitations in common. They regard frequency of incontinence as a major category of measurement, while patients often alter their lifestyle enough to avoid events of incontinence. Clinicians tend to focus on symptoms, such as type and frequency of incontinence, urgency, ability to defer defecation and amount of stool loss. However, clinicians and patients differ in their perception of symptoms and discrepancies exist between clinical measures of symptom severity and the subjective patient perception of the condition (249). Protective measures taken by some patients such as locating toilets in advance, using pads or ensuring complete evacuation may mask the true degree of symptoms and the

clinician orientated questions may not be able to unearth the real effect of "pre-protective measures" status(1)

The results of many studies demonstrated incontinence to adversely affect social relationships and activities, impair emotional and psychological well-being and jeopardise sexual relationships. Feelings of embarrassment and negative self-perception are also common(257). The actual severity of symptoms measured by type and frequency of incontinence might not correlate well with the subjective perception as some patients are depressed by only minor leakage, whereas others with major incontinence manage to cope with their symptoms by protective measures(246). Therefore, the relationship between quality of life and severity of incontinence has been difficult to prove in previous studies, especially those who did not use incontinence specific quality of life measurement tools (251, 258, 259)

There is a need for a simple and reliable measure of quality of life in this group of patients in order to both stratify treatment options based on symptom severity and also to monitor the outcome of treatment. This idea has been supported by the National Institute for Health and Clinical Excellence Guideline, published in June 2007, which recommended development of a valid and reliable tool to measure patient-related outcomes, including symptom severity and quality of life for people with faecal incontinence(260).

In response to that, the measurement of these conditions has adopted a progressively more patient based approach in recent years. It is now recognized that the only valid way of measuring the patient perspective of the condition is through the use of psychometrically robust self-completion questionnaires (257, 261). Patient self-completed questionnaires provide a valuable method for the assessment of patients' symptoms and their impact on quality of life in both clinical and research arenas. Such instruments may be used as a screening tool to identify normal and abnormal symptoms, but can also be used to generate scores for specific groups of symptoms thus allowing symptom severity to be assessed in specific areas or domains (262). The calculation of a valid score also allows comparisons to be made between differing patient groups and to assimilate longitudinal data (255)

Interpreting previous research on the relationship between FI severity and quality of life is somewhat difficult, as previous studies demonstrating a relationship between severity and quality of life have used severity measures which include items relating to quality of life. Deutekom and *colleagues* (258) used the SMIS (223), in which one of the items addresses the impact of incontinence on daily living. Many others (251, 259) used the CCIS (222) in which one of the five questions within it refers to a lifestyle alteration. On the other hand, Damon and *colleagues* found no correlation between CCIS and the Gastrointestinal Quality of Life Index (GIQLI) when compared them in 173 patients with faecal incontinence and constipation (259).

Bordeianou and *colleagues* (263) attempted to explore the relationship between severity of incontinence and quality of life, measured by one disease-specific quality of life tool, the Roclwood Faecal Incontinence Quality of Life Scale (FIQoLS) (127), and one generic measure, the Medical Outcomes Study 36-item Short-Form Health Questionare. The aim was to enable a better understanding of the relationship between these two different variables as they measure either severity (FISI) or quality of life (FIQL) with no overlap(235, 264). The result was only moderate correlations between Incontinence Severity Index (FISI) and all subscales of a disease-specific quality of life measurement (FIQoLS) (- 0.29 to 0.41; $P < 0.0001$). Weak correlations were found between FISI and the social functioning (0.21) and mental health (0.17) scales in SF-36 ($P < 0.05$). This stresses the need of measuring both variables to determine the true impact of any treatment. (263)

Many clinical trials groups, including the United Kingdom Medical Research Council and European Organization for Research and Treatment of Cancer, have acknowledged the importance of assessing quality of life in health outcomes research and subsequently outlined policies stipulating that qualify of life should be considered as an end point in all new trials (265, 266). In a review of published studies that involved use of SF-36 for patients with chronic diseases that can be managed in an outpatient setting shows that patients with incontinence are worse off than those with rheumatoid arthritis or diabetes, and as severely affected as the patients with inflammatory bowel disease (267)

There are three approaches to measuring quality of life; the first approach is a generic measure that is designed to assess various aspects of health-related issues on the quality of life across a broad population. The second approach is a system-specific measures which assess the quality of life in relation to diseases experience in one system organ, for example the gastrointestinal system or the cardiovascular system. The third approach is condition-specific measures which evaluates the impacts of specific condition on the lives of people with a given disease. The former two offer the advantage comparability across conditions, but it is less likely to be as sensitive to the effects of a given health problem(127).

An example of ***generic*** quality of life questionnaires is The Medical Outcomes Study 36-item Short-Form Health Survey (SF-36) (268) which is used as a generic measure of overall quality of life. This 36-item questionnaire generates scores from 1 to 100 in each of the eight health concepts including (i) limitations in physical activities because of health problems; (ii) limitations in social activities because of physical or emotional problems; (iii) limitations in usual role activities because of physical health problems; (iv) bodily pain; (v) general mental health (psychological distress and well-being); (vi) limitations in usual role activities because of emotional problems; (vii) vitality (energy and fatigue); (viii) general health perceptions. In 1991, the SF-36 was selected as the instrument of choice in the International Quality of Life Assessment (IQOLA) Project (269, 270). Since then, the test has been widely used throughout the world and has been proven useful in assessing quality of life in a variety of gastrointestinal conditions, including faecal incontinence(253). Another examples of generic quality of life questionnaires are the short form-20, short form-12(271, 272) and the three and five-level versions of EQ-5D instrument (273).

System-specific (gastrointestinal) quality of life assessment instruments such as the Gastrointestinal Quality of Life Index (GIQLI) (252) have been used to assess FI in previous studies. The GIQLI comprises a fixed set of core gastrointestinal questions supplemented by a subset of organ-specific questions. During the developmental process, however, only few organ-specific items could be identified by their higher prevalence. For example, patients with oesophageal disease more frequently reported difficulties with swallowing. For the majority of organs, however, no organ-specific items were produced (252). The GIQLI measures the quality of life in patients with

gastrointestinal disorders on a four-point scale (0-4). It contains 36 questions about symptoms and physical, emotional, and social dysfunction related to gastrointestinal disorders. The final score ranges between 0, which indicate the worst quality of life and 144. The scores are subdivided into 4 groups; a score of 45-89 indicates bedridden patients, 89-105 indicates patients confined to home, 105-125.8 represent patients mobile in the community and 125.8 or higher reflects normal individuals(252). The GIQLI has been used in several settings in Germany to describe, compare and differentiate the outcomes of surgical treatment in patients with gastrointestinal diseases. Although the measure was developed in both German and English, it has been validated primarily with German-speaking patients (252). Both generic and system-specific quality of life assessment tools are out of the scope of this study.

There are several quality of life questionnaires specifically designed for patients with faecal incontinence. However none of them met the grade A criteria (highly recommended: validity, reliability and responsiveness established with rigor) proposed by Avery and *colleague* (249) and only three FI quality of life questionnaires achieved grade B status since their validity and reliability were established with rigor or their validity, reliability and responsiveness were indicated (127, 237, 255). These include the Rockwood Faecal Incontinence Quality of Life Scale (FIQoLS) (127), the Manchester Health Questionnaire (237) and the Birmingham Bowel and Urinary Symptoms Questionnaire (255). All of these have been validated and their use in research is likely to expand(256) and they will be the focus of this review.

3.3.1. The “Rockwood” Faecal Incontinence Quality of Life Scale:

Faecal Incontinence Quality of Life Scale (FIQoLS)(127) measures specific quality of life issues expected to affect patients with faecal incontinence. It is derived from a 29 item questionnaire comprising four domains; lifestyle, coping/behaviour, depression/self-perception and embarrassment. Each domain ranges from 1 to 4; with 1 indicating a lower functional status of quality of life.

Validity was assessed using discriminate and convergent techniques. Each of the four scales of the FIQoLS was capable of discriminating between patients with faecal

incontinence and patients with other gastrointestinal problems. The FI population should demonstrate a significantly lower quality of life than the control population for each of the four scales ($P < 0.01$, controlling for gender and education)(127).

To evaluate convergent validity, the correlation of the scales in the FIQoLS with selected subscales in the SF-36 was analyzed. The correlations range from 0.65 (FIQoLS depression scale and SF-36 Mental Health) to 0.28 (FIQoLS embarrassment scale and SF-36 Role Physical Limitation) and all are statistically significant. The authors concluded that the scales in the FIQoLS were significantly correlated with the subscales in the SF-36 (127).

The four scales also demonstrate acceptable internal reliability; all alpha values are well over the traditionally accepted level of 0.70. Using a matched pair t-test to evaluate the test/retest reliability, none of the scales showed significant difference. Although responsiveness of FIQoLS to the effects of treatment has been briefly described in some studies as part of their outcome measures(274) but, to our knowledge, no rigorous study about FIQoLS responsiveness has been conducted yet.

The FIQoLS has already been translated to many languages including French(275) , Portuguese (276), Italian (277), Spanish (278) and Japanese (279). Several changes to the psychometric construction of the scale were made during these translations in an attempt to improve the construct of the scale and adapt for cultural differences. In the Spanish version, the response sets in the scale were made uniformly frequency based (278) in contrast to the non-uniform mode of responses in the original scale. For example; items in Q2 consist of questions regarding the frequency of listed events as ‘‘none of the time’’ or ‘‘most of the time’’, whereas those in Q3 consist of an agree/disagree type of response. Despite this non-uniformity, the scores are equally counted.

In their Japanese version of the FIQoLS, Hashimoto and *colleagues* (279) proposed a modification of the scale where the modified version focuses on the ‘‘Lifestyle’’ and ‘‘Coping/Behaviour’’ subscales of the FIQoLS and omits the ‘‘Depression’’ subscale because a number of available validated generic scales were considered more suitable for assessment of this domain. Hashimoto and *colleagues* also omitted the three items

of the ‘‘Embarrassment’’ subscale because they were deemed not reflective of this emotion precisely as the sentiment of embarrassment depends on cultural norms of ‘‘embarrassment’’ and ‘‘shame’’, which are known to be quite diverse across cultures(280). Ultimately, a 14-item scale was developed, where the responses of all constituent items were frequency based, this approach follows that applied in the Spanish version(279). The authors reported a satisfactory performance of this shortened version of the FIQoLS in terms of conventional psychometric properties (item-rest correlation of 0.66–0.84 and a Cronbach’s alpha of 0.96) and was correlated with concurrently measured Social Functioning and Physical Role Limitation subscales of the SF36 (-0.70 and -0.61 respectively), the Depression subscale of Hospital Anxiety and Depression Scales (0.65) and the CCIS (-0.61) (281).

3.3.2. The Birmingham Bowel and Urinary Symptoms Questionnaire

A 22-item bowel and urinary tract symptoms questionnaire, encompassing all aspects of pelvic floor function in women. It is divided into four domains, that individually cover constipation, evacuation, faecal incontinence and urinary symptoms (255). The Birmingham Bowel and Urinary Symptoms Questionnaire (BBUSQ-22) was designed to be used in a clinic or other hospital setting or as a postal questionnaire. Recommendation is only for the instrument to remain as a patient-completed one to curb any unnecessary bias in the reporting of the symptoms, and for the allowance of as much time as required for completion of the instrument(255)

Abnormal scores for the four principle domains are defined as: constipation score -64%, evacuation score -17%, incontinence score -17% and urinary symptoms score -20%(255). These cut-off points provided correct identification in 81% of the time for symptomatic patients and 85% of the time for controls (P = 0.01 for all domains). A patient with an abnormal constipation score is four times more likely to be symptomatic. This likelihood increase to 14, 53 and 61 times for an abnormal evacuation score, abnormal FI score and abnormal urinary symptoms score respectively. This demonstrates that the clinically chosen cut-off points are sensitive for detecting abnormal levels of symptoms thus validating the accuracy of the scoring system(255).

Although content coverage is deemed complete within each domain, the domains were not designed to collectively cover all aspects as a whole. A single score calculated from all four domains is not considered to represent an adequate global symptom score(255).

3.3.3. Manchester Health Questionnaire

The Manchester Health Questionnaire is made up of items adapted from the King's Health Questionnaire, a condition-specific health-related quality of life questionnaire for the assessment of urinary incontinence (282). Each item from the King's Health Questionnaire was adapted to assess FI and the basic structure of the King's Health Questionnaire was incorporated into the new measure (237). This health-related quality of life scale has domains assessing general perception of health, general impact of incontinence, role, physical function, social function, personal relationships, emotion, sleep/energy and severity/coping measures, with a separate scale for the measurement of the severity of symptoms.

Unlike the King's Health Questionnaire, Bugg and *colleagues* used a five point scoring system in stead of the a four-point system in an attempt to improve reliability. Scores in each domain range between zero and 100, a higher score indicating a greater impairment of health-related quality of life (237).

The questionnaire was initially reviewed for content validity by physicians and pre-tested by specialist nurses, midwives and female patients with and without faecal incontinence. Changes were made to the questionnaire based on the comments made at each stage. The final version was tested for test–retest reliability, internal consistency, criterion validity and convergent validity. The Cronbach's alpha statistic exceeded the minimum requirements for reliability in all domains of the questionnaire (table 3.8). A total of 121 patients completed the questionnaire on two occasions in a mean time of 20 days (range 7-50) apart. The Pearson correlation coefficient of the two test results ranges from 0.81 to 0.92 (table 3.7).

Domains	Internalconsistency (a)	Test retest reliability (b)
General health	N/A	0.89
Incontinence impact	N/A	0.81
Role	0.77	0.82
Physical function	0.76	0.86
Social function	0.89	0.90
Personal function	0.91	0.93
Emotional problems	0.89	0.88
Sleep/energy	0.73	0.86
Severity measures	0.73	0.91

Table 3.7. internal consistency and test retest reliability: (a) internal consistency is expressed through the Cronbach's alpha statistic. (b) Pearson correlation (P =0.01 for all) (237).

One hundred and fifty-four women who correctly filled out the Manchester Health Questionnaire also completed the SF36 questionnaire. There were modest to strong correlation of the domains in both questionnaires (Table 3.8)(237).

Domain	Criterion validity	Convergent validity
General health	-0.77	0.30
Impact incontinence	N/A	0.46
Role	-0.50	0.57
Physical function	-0.50	0.55
Social function	-0.71	0.50
Personal function	N/A	0.47
Emotional function	-0.52	0.51
Energy	-0.35	0.60
Severity measures	N/A	0.65

Table 3.8 Tests of validity: criterion validity and convergent validity. Pearson correlation (P = 0.01 for all). N/A = not applicable. The SF36 score is higher for good results where the faecal incontinence questionnaire score is higher when results are poor.

3.4. Study -2- Test-retest reliability of FI severity and quality of life assessment tools

3.4.1. Objectives

St Mark's Incontinence Scores (SMIS) and Cleveland Clinic Incontinence Scores (CCIS) are used in our department to assess the severity of faecal incontinence, while Rockwood Quality of Life Scales (FIQoLS) is used to assess condition-specific quality of life.

This study aims to:

1) Determine the intra-rater reliability of SMIS, CCIS and FIQoLS.
2) Determine the inter-rater reliability of SMIS and FIQoLS

3.4.2. Methods

3.4.2.1. Patients:

Patients with faecal incontinence who were referred for management in York Teaching Hospital were prospectively recruited. This study was conducted as part of the IRAT trial. Each patient was sent a letter and a Patient Information Sheet explaining how to complete these assessment tools. In addition, the PFAP included clear instruction on how to complete each assessment tool. Patients were also provided with a contact number for any query or support required.

3.4.2.2. Faecal incontinence assessment tools

Patients were asked to complete 3 faecal incontinence assessment tools. These are the SMIS, CCIS, FIQoLS. Patients were also asked to use a visual analogue scale (VAS) to describe their quality of life.

To assess intra-observer reliability of SMIS, CCIS, FIQoLS and VAS, all patients were asked to complete these 4 assessment tools at two time-points: initially at recruitment (time point P1), using Part 1.a of the Pelvic Floor Assessment Pathway (PFAP), and then 6 weeks later (time point P2), using Part 1.c of the PFAP. No alteration to diet or medications and no treatment or intervention took place during this interval period. The Visual Analogue Scale (VAS) has been well studied in the context of pain and is known to allow patients to express the full spectrum of their problem in a simple scale(283). Therefore it has been chosen in this study as a generic tool for purpose of comparison of test-retest (intra-rater) reliability with FI-specific measures.

For inter-observer reliability, the SMIS and CCIS were also completed by a physician on the first outpatient clinic visit, using Part 1.b, and again by a nurse 6 weeks later (at time point P2) using Part 1.d of the PFAP respectively.

3.4.2.3. Ethical Consideration:

This study was approved by The North and East Yorkshire Alliance Research and Development Unit and the NRES Committee of the Yorkshire and the Humber Research Ethics Office.

3.4.2.4. Data analysis

Data were assessed using Microsoft Excel Spreadsheet (Microsoft Corporation, Seattle, WA, USA) and statistical analysis was performed using SPSS v14.0 (SPSS Inc., Chicago, Illinois, USA). Continuous data are expressed as median (standard deviations). Intra- and inter-rater scores were calculated using the Kendall rank correlation coefficient (Kendall's tau-c) test.

The Kendall rank coefficient is a non-parametric test used in a statistical hypothesis test to establish whether two variables are statistically dependent and ranges between −1 - 1. If the agreement between the two rankings is perfect (i.e., the two rankings are the

same) the coefficient has value 1. If the disagreement between the two rankings is perfect (i.e., one ranking is the reverse of the other) the coefficient has value of −1. If the values are independent, then we would expect the coefficient to be approximately zero. A *p*-value of 0.05 or less was significant

3.4.3. Results:

Thirty nine patients (34 female) with a median age of 65 (IQR 56-74) years with faecal incontinence were prospectively recruited. All patients completed part 1.a of the PFAP which included CCIS, SMIS, FIQoLS and VAS on the first clinic visit (time point P1). At baseline, the median (IQR) CCIS and SMIS were 9 (6-12) and 12 (6-14) respectively. The median (IQR) Life Style Scale of the FIQoLS was 3.6 (2.8-3.9), the median (IQR) Coping Score was 2.5 (1.6-3.3), the median Depression Scale was 3.25 (2.3-3.66) and the median (IQR) Embarrassment Scale was 2.3 (1.3-3). The median (IQR) VAS value was 7.7 (5.0-8.5).

3.4.3.1. Intra-rater test-retest reliability

Thirty-one patients (27 female) with a median age of 65 (55-75) years completed part 1.c of the PFAP which included the CCIS, SMIS, FIQoLS and VAS in a median time of 6 (IQR 4-12) weeks (time point P2) upon attending the anorectal physiology laboratory.

At time point P2 the median (IQR) CCIS and SMIS were 10 (7.5-14) and 13.5 (10-16.8) respectively. The median (IQR) of the Life Style Scale of the FIQoLS was 3.5 (2.5-3.9), the median (IQR) Coping Score was 2.3 (1.2-3.1), the median Depression Scale 3.3 (2-3.66) and the median (IQR) Embarrassment Scale was 1.8 (1.3-2.66)

Kendall's tau-c rank correlation coefficient (t) for CCIS at time point P1 and time point P2 was 0.645 (*p*-value < 0.001) and for SMIS it was 0.633 (*p*-value < 0.001) (table 3.9). The t for the Life Style, Coping, Depression and Embarrassment domains of the

FIQoLS were 0.619, 0.718, 0.684 and 0.649 (*p*-value < 0.001) respectively. Finally the VAS of quality of life had a t value of 0.761 (*p*-value < 0.001) (table 3.10).

Intra-rater reliability	Time point "P1" Median (IQR)	Time point "P2" Median (IQR)	Kendall's tau-c	*p*-value
CCIS	9 (5.5-12)	10 (7.5-14)	0.645	< 0.001
SMIS	12 (7-14.5)	13.5 (10-16.8)	0.633	< 0.001

Table 3.9. Intra-rater reliability for Cleveland Clinic and St. Marks Incontinence Scores

Rockwood QoLS	Life Style (Scale 1)	Coping (Scale 2)	Depression (Scale 3)	Embarrassment (Scale 4)	**VAS**
Time point "P1" Median (IQR)	3.6 (2.7-3.8)	2.5 (1.6-3.15)	3.3 (2.2-3.69)	2.3 (1.3-2.8)	7 (5-8)
Time point "P2" Median (IQR)	3.5 (2.5-3.9)	2.3 (1.2-3.1)	3.3 (2-3.66)	1.8 (1.3-2.66)	6.5 (5-8)
Kendall's tau-c	0.619	0.718	0.684	0.649	0.761
p-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Table 3.10. Intra-rater reliability of Rockwood Quality of Life Scores and VAS.

3.4.3.2. Inter-rater test-retest reliability

In 36 patients (31 female) with a median age of 65 (55-70) years CCIS and SMIS were also recorded by a physician and a nurse practitioner. The physician recorded CCIS and SMIS on the patients' first visit to the IRAT or Standard Care clinics, corresponding to

time point P1. The nurse obtained the same scores in a median time of 6 (IQR 4-12) weeks on the day of anorectal physiology study.

The median (IQR) CCIS in these 36 patients were 13 (8-14), (5-10), 9.5 (5-13) and 12.5 (7-15) as recorded by the patients, the physician and the nurse respectively. For SMIS, the median (IQR) were 14 (10-16), 10 (7-16) and 13 (8-17) as recorded by the patients, the physician and the nurse respectively.

The t-values for inter-rater reliability of CCIS and SMIS range form 0.538 (*p*-value <0.001) to 0717 (*p*-value <0.001) for CCIS and from 0.464 (*p*-value <0.001) to 0.658 (*p*-value <0.001) for SMIS (table 3.11).

Inter-observer reliability	**CCIS**					**SMIS**				
	Patient	Nurse	Physician	t-value	*p*-value	Patient	Nurse	Physician	t-value	*p*-value
Median (IRQ)	13 (8-14)	12.5 (7-15)		0.625	<0.001	14 (10-16)	13 (8-17)		0.471	<0.001
	13 (8-14)		9.5 (5-13)	0.538	<0.001	14 (10-16)		10 (7-16)	0.464	<0.001
		12.5 (7-15)	9.5 (5-13)	0.717	<0.001		13 (8-17)	10 (7-16)	0.658	<0.001

Table 3.11. Inter-rater reliability for Cleveland Clinic and St. Marks Incontinence Scores

3.4.4. Discussion

This study shows good intra- and inter-rater reliability of both CCIS and SMIS. However, CCIS seems to have better reliability than SMIS. This is especially true for inter-rater reliably. All domains of the FIQoLS demonstrate good intra-rater (test-retest) reliability, although a simple quality of life assessment tool such as VAS still maintains a better intra-rater agreement.

CCIS, SMIS and FIQoLS are the most important and most widely used objective FI assessment tools in current literature. Although some good studies have been ublished covering the aspects of validity, convergent validity and internal consistency (126, 127, 254, 284), there was still a scope for improvement in the research work addressing the issue of reproducibility, that is intra- and inter-rater reliability of these assessment tools.

Measuring reliability by the internal consistency method involves dividing the instrument into two equal parts and comparing the score on both halves (i.e. split-half reliability) using the Kuder Richardson formula 20 or Cronbach's α which is an extension of this formula for ordinal data (285). However Test-retest reliability is more relevant in the setting of clinical medicine because the constructs we attempt to measure are heterogeneous. For example, many instruments used by physicians combine apparently diverse domains such as quality of life scales (general impact of incontinence, physical function, social function, personal relationships, emotion… etc). Thus, a poor internal consistency is expected. Although, there is evidence that these instruments fulfill the criteria for internal consistency despite of their apparent heterogeneity(245)

The problem with testing reliability by the test-retest method is that there is a potential for learning, carry-over, or recall effects (i.e., the first testing may influence the second) (286).The length of time between the two test administrations also affects the test-retest reliability. A very short time interval makes the carryover effects due to memory, practice, or mood more likely, whereas a longer interval increases the chances that a change in status could occur(286).

Robert and colleague compared test-retest reliability of four knee-rating scales at 2 days and 2 weeks, a time frame that is generally believed to be a reasonable compromise between recollection bias and unwanted clinical change. There were no statistically significant differences in the test-retest reliability (intraclass correlation coefficient and limits of agreement statistics) for the two time intervals(287), which probably indicate that 2 weeks is still a too short time interval.

We believe that a time interval of about 6 weeks is suitable for measuring test-retest reliability of FI assessment tools, given the chronic nature of the problem and the low

likelihood of any significant change in symptoms over this period of time without intervention. Therefore, 6 weeks was the time interval we chose between the two test administrations in our study. However, there is no evidence available to aid in the selection of the correct time interval between questionnaire administration for a study of test-retest reliability for health status instruments(287).

Previous studies assessing test-retest reliability of CCIS, SMIS and FIQoLS either had unclear methodology, small study sample, conducted retrospectively or used a time interval that is more subjected to erroneous results. Vaizey and *colleagues(284)* assessed the test-retest reliability of both CCIS and SMIS in a sample of 13 patients at a median of 14 days (range 8–20 days). The methodology of this study was not stated in the published paper. The first test was performed by a physician, however it is not clear weather the second assessment was performed by the same physician (intra-rater), another physician or health professional (inter-rater) or by patients themselves. In addition to the small study sample in this study, the time interval between the two tests was rather short, caring a higher risk of the carryover effects.

Bols and *colleagues* assessed test-retest reliability of SMIS retrospectively by comparing SMIS in a sub-group of "stable patients who rated themselves as ''unchanged'' on the Global Perceived Effect (GPE) Score following Pelvic Floor Rehabilitation (PFR) (254), i.e. these patients have already undergone an intervention (PFR), before the second SMIS assessments were obtained, but the GPE score demonstrated no subjective improvement following treatment. The assumption that this group of patients adequately reflects a population with unchanged symptoms, hence suitable for intera-rater (test-retest) reliability, is misleading. SMIS and GPE score measure various parameters and are only adequately correlated when compared to each other in the very same study (Spearman's correlation, 0.55 ($P < 0.01$)). Therefore, measuring the intra-rater (test-retest) in this study has a limited value. Furthermore, details about time interval and the process of obtaining SMIS and whether or not they were recorded by patients themselves or by one or more clinician were not stated.

When Rockwood and *colleagues* measured the test-retest reliability of FIQoLS, only 9 of the 55 participants completing the retest version within the specified time frame (10-14 days) in the original study (127), another sample of 61 patients was identified and

the test-retest survey was conducted using the telephone mode. The response rate for this mode was 77% (N = 47). Retest administrations were completed eight days apart (SD +/-3) and only data collected from the telephone mode were used in the evaluation of test-retest reliability(127). Using a matched pair t-test to evaluate the test-retest reliability, none of the scales showed significant difference. Mail surveys generally tend to have lower response rates than the telephone. Thus, the telephone mode is primarily identified as a means of reducing non-response error (288) However, this reduction of non-response error comes with a price, the increased risk of measurement error (289). Measurement error is more of a problem in the telephone mode of administration than in other modes of survey administration(289, 290) and, in general, the Survey Research Community is starting to identify measurement error as greater concern in survey research than non-response error(291). Furthermore, the interval time period was rather short (8 days) which increasing the risk of carryover effect.

In our study we strictly used mail mode of survey. We posted the first questionnaire to every patient two weeks before their first clinic appointment, together with the clinic invitation letter, and collected the completed questionnaire on attendance to the clinic. The second questionnaire was posted couple of weeks before attending the Anorectal Physiology Laboratory for investigation and collected on arrival. This approach increased the response rate without having to increase the risk of measurement error by using the phone mode of survey.

In conclusion, CCIS, SMIS, and FIQoLS all have good test-retest reliability and adequately reflect the global disease burden. Therefore, they are appropriate tools to objectively measure symptoms and to compare the various management modalities.

4. Correlation between anorectal physiology studies and patients' symptoms

4.1. Introduction

Anorectal physiology studies are used routinely in the assessment of faecal incontinence and sometimes in the evaluation of chronic constipation. It involves endoanal ultrasound, manometry and pudendal nerve studies and provides quantitative measurements of the anatomy and function of the muscles and nerves of the anal sphincter complex(292).

4.2 Anorectal Physiology Studies

4.2.1 Anal manometry:

In our deprtment, anal manomentric variables are recorded with an eight-channelled solid-state transducer catheter (Flexilog 3000, Oakfield Instruments Ltd, Evensham, Oxon, UK) using a continuous "pull through" technique. An alternative technique to assess manometric parameters during EAS contraction (squeeze) is to use a balloon catheter in addition to manometric catheter and ask the patient to retain the balloon while applying a gentle traction. The balloon catheter inserted in the lower rectum simulates a faecal bolus and thus help patients to contract their EAS in a manner that replicates physiological processes more accurately (292)

Manometric data were analysed using commercial software (Flexisoft III, Oakfield Instruments Ltd, Evensham, Oxon, UK) (figures 4.1 and 4.2). This included calculation of the maximum mean resting pressure (MMRP), maximum mean squeeze pressure (MMSP), resting and squeeze vector volumetry (VV), resting and squeeze asymmetry index and vectrograms.

Figure 4.1: The Manometry machine

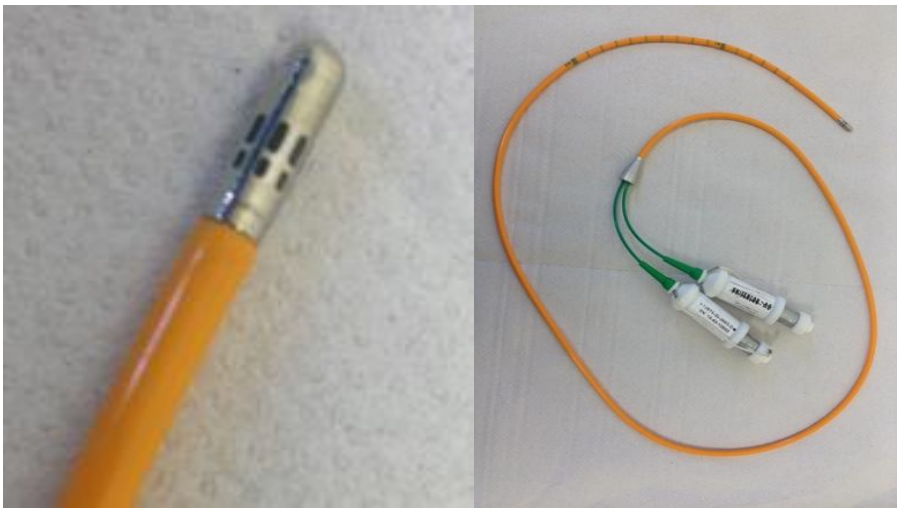


Figure 4.2: the eight-channeled solid-state transducer catheter

4.2.1.1 Resting pressure

This is the pressure within the anal canal at rest. The most commonly recorded resting variable is the maximum mean resting pressure (MMRP) which is defined as the highest pressure reading at rest within the anal canal and is a mean of the radial pressures at that point. It is primarily used as a measure of passive continence. Pressures are measured in mmHg. The normal range for the MMRP varies between different departments and according to the system used. Our departmental normal range 40 to 88 mmHg. Of all the manometric variables that can be measured in the anal continence mechanism, the MMRP is thought to be the most reproducible(293).

4.2.1.2 Squeeze pressure

This is the pressure within the anal canal during a voluntary squeeze. The most commonly recorded squeezing variable is the maximum mean squeeze pressure (MMSP). This is defined as the highest-pressure reading during a voluntary squeeze within the anal canal and is a mean of the radial pressures at that point. It is measured to give an idea of the function of the EAS. Our normal departmental range is 60 – 140 mmHg. The MMSP is less reproducible than the MMRP(293). Of note is the potential variation that gender and parity can have on both squeeze and resting pressures (294).

4.2.1.3 Vectorgrams

Vectorgram is a three-dimensional pressure profile both during rest and squeeze (295). The vectorgram is generated by performing a continuous pull through at a rate of 1cm/second. Pressures are recorded every mm over a 6cm length of anorectum with either 6 or 8 radial pressures at each point. This allows an assessment of the distribution of pressure of the whole sphincter (Figure 4.3).

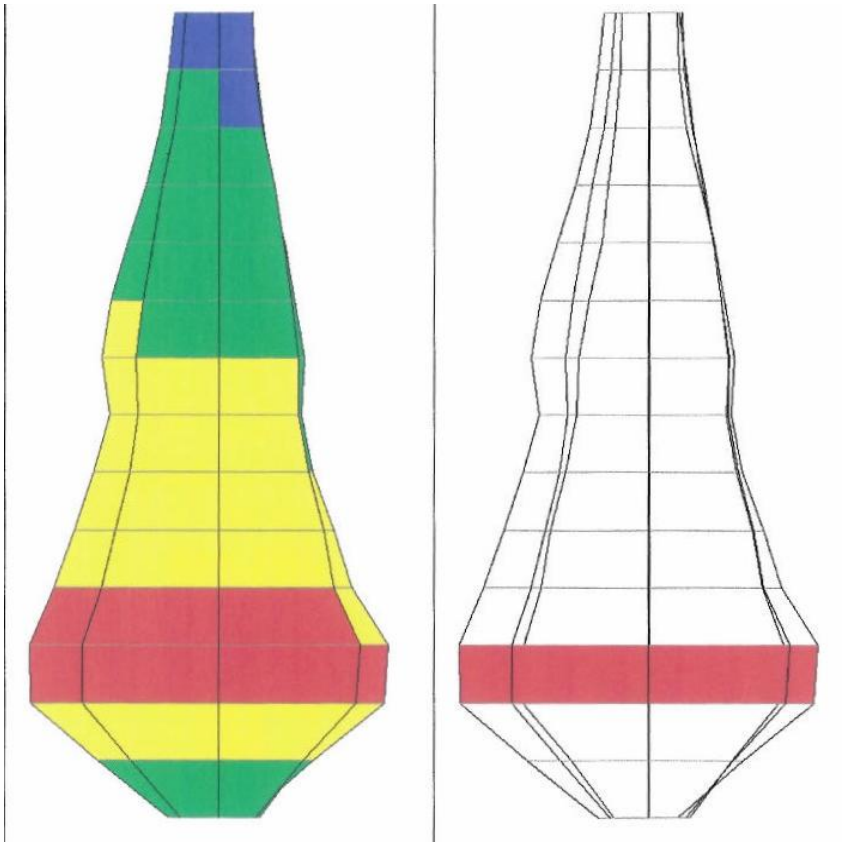


Figure 4.3: A colour coded resting vectorgram: demonstrating normal pressure distributed throughout the anal canal. Red = >75% of maximum mean pressure (MMP), Yellow = 50 – 75% of MMP, Green = 25 – 50% of MMP, Blue = <25% of MMP.

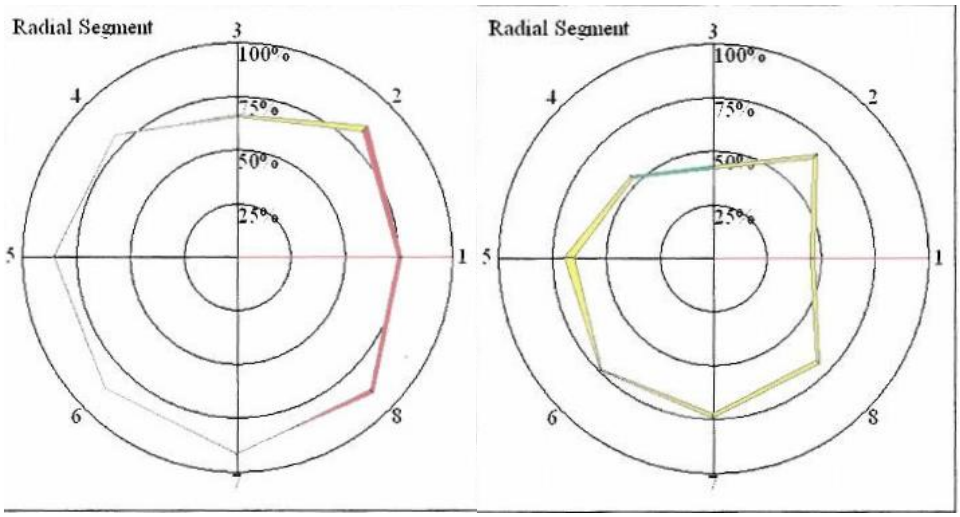
4.2.1.4 Vector volumes

Vector volumes are calculated from vectorgrams. They are the total volume of pressure throughout the anal canal (cm [mmHg] ^{2}). There is little evidence that vectormanometry is of any clinical use (296). However, research has suggested that it may have a role in identifying localized compared to global sphincter weaknesses (297).

4.2.1.5 Pressure asymmetry index

The similarity of these 8 pressures, radially recorded by an 8-channeled catheter at each millimeter within the anorectum is termed the pressure asymmetry index. (Figure 4.4). Whilst it has been shown that the level of radial pressure asymmetry is high in

sphincter defects (298) and idiopathic faecal incontinence (299), there is no convincing evidence that these coronal images can accurately identify the location of a defect (297, 300).



(a) (b)

Figure 4.4: Examples of the pressure asymmetry index in two different patients. In the first one (a) the symmetry index is 7%, while in the second patient (b) it is 16.9%. This demonstrate the 8 radial pressures measured at a given point within the anal canal in the transverse plane. The symmetry of the pressures are calculated by the software used. One can appreciate the difference in symmetries between these two patients.

4.2.2 Endoanal ultrasound:

In our department endoanal ultrasound (EAUS) is performed using a standard 2D 10 mHz probe (B&K, Denmark) (Figure 4.5). The three-dimensional EAUS is now widely available with increasingly expanding applications(301-303, 304). EAUS is a reproducible investigation (305). With high-resolution images and experience of the technique EAUS is very accurate in detecting sphincter defects (306). However, which defects are clinically significant and which are not, is an ongoing debate, especially in

view of the fact that defects may be present but squeeze and resting pressures are normal Schafer (307).

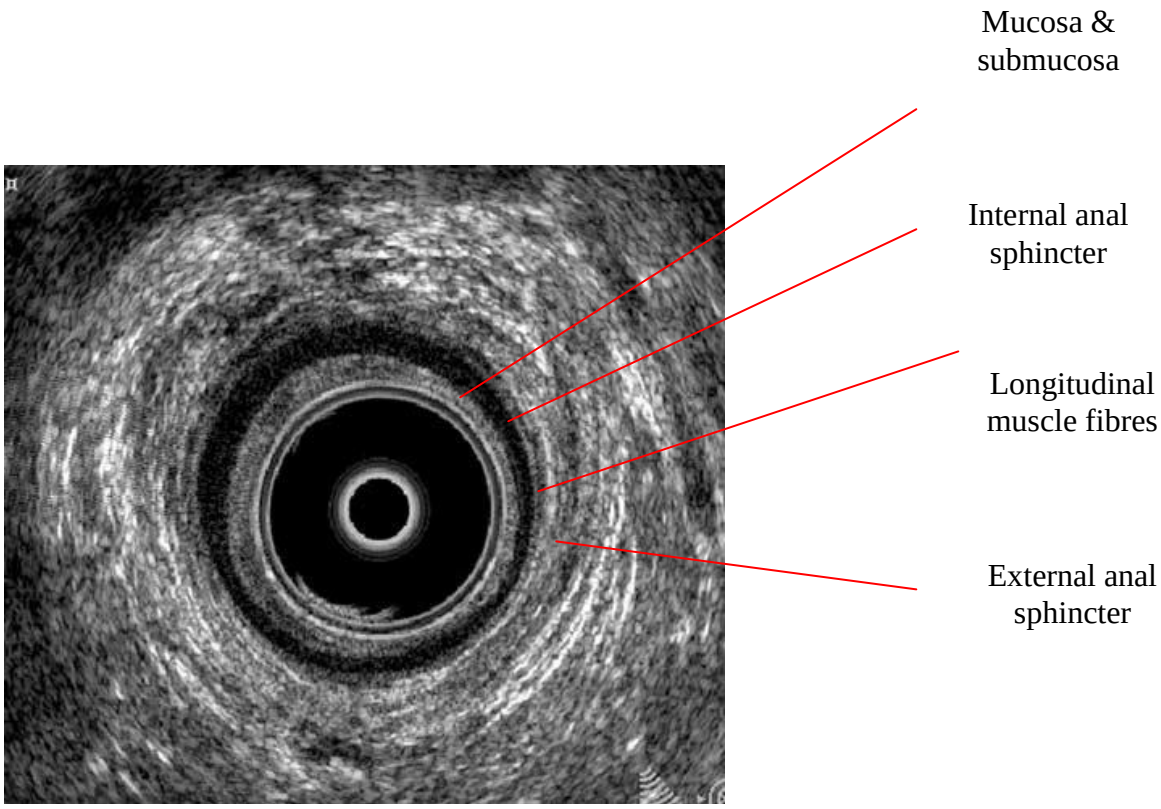


Figure 4.5: Images of the anal sphincter complex as seen on EAUS

4.2.3 Other imaging modalities:

Exoanal ultrasonography (syn. transperineal ultrasonography) is used as a possible alternative to the endoanal technique (308). There are some potential advantages to this technique; firstly, patient comfort and secondly the ability to look at the anal cushions and determine degree of anal canal closure. However, Its main use has been in departments where cost prohibits use of an endoanal transducer (309).

Endoanal MRI offers good quality images of the sphincter complexes (310) in spite of the discrepancy when comparing sphincter dimensions on MRI and on EUAS in the same patient, as well as difficulty in diagnosing IAS injury (311). However, the main limitation of Endoanal MRI are cost, the length of time of the examination and patient discomfort.

Finally, dynamic evacuation proctography and dynamic evacuation MR are sometime performed when investigating faecal incontinence to exclude pathologies such as intussusception that may be giving rise to incontinence and to detect and characterise pelvic floor weakness(312, 313). Reproducibility and inter/intra observer reliability of dynamic proctography are generally good (314). Similarly, MR defecography, performed either with an open- or closed-configuration unit, appears to be an accurate imaging technique to assess clinically relevant pelvic floor abnormalities. Moreover, MR defecography negates the need to expose the patient to harmful ionizing radiation and allows excellent depiction of the surrounding soft tissues of the pelvis(313).

4.2.4 Pudendal nerve studies.

Anal mucosal electrosensitivity (AME) is used to assess pudendal nerve function (315). St Marks Pudendal Electrode (Dantec Electronics, Bristol) (Figure 4.6) is used to obtain anal mucosal electrosensitivity measures(316). This device is a combined stimulation and recording electrode, used in conjunction with an EMG stimulator, to determine the pudendal nerve conduction (83). The electrode has self-adhesive tabs for mounting onto the examiner's gloved index finger. It has two stimulating electrodes, mounted on the tip of the index finger, and two recording electrodes mounted at its base (Figure 4.7).

This technique is based on the assumption that if there is impairment to the sensory branch of the pudendal nerve then there may also be impairment of the motor component. AME is tested by passing a short electrical current through the electode inserted into the anus. The ampere of the current is gradually increased by the examiner until the patient feels the electric current. Readings are taken at three deferenet efect

levels, upper, mid and lower anal canal. Multiple readings are obtained at the same and at differing levels. The normal values of AME in our department are ≤5mA, ≤5mA and ≤ 7 mA for the lower, mid and upper (anorectum) anal canal respectively, although the AME might still be normal at higher values in a short anal canal(317).

In our department we have preferred the method of AME over Pudendal nerve terminal motor latency (PNTML) for assessing nerve function because AME assess nerve function from the anal mucosa through to the cerebral cortex whereas PNTML only assesses nerve function over a 2-3cm length. In addition, the variable anatomy of the pudendal nerve(318-320) and patient discomfort during the procedure might lead to difficulties in obtaining an accurate reading. However, the advantage of PNTML over AME is that it is an objective measurement whereas AME is subjective.

Both AME and PNTML, which is an alternative technique for assessing pudendal nerve function have been shown to have good levels of reproducibility(315, 321). Studies have shown that AME testing can be abnormal in other conditions affecting the anal canal such as haemorrhoidal disease and previous anal scarring (315). Similarly, PNTML studies are not without problems. Suilleabhain and colleagues(322) demonstrated no correlation between abnormal PNTML, i.e. pudendal neuropathy, and squeeze pressures. Also, there is evidence that EAS atrophy is not present in patients with prolonged PTNML (323). A further study of 1026 patients, with a variety of anorectal complaints who underwent PNTML testing, showed a limited value of this measurement except in patients with rectal prolapse (324).

Figure 4.6: St. Mark's pudendal electrode (13L40, Dantec Electronics, Bristol, UK) used for measuring AME and pudendal motor nerve latencies. (Benign Anorectal Diseases Diagnosis with Endoanal and Endorectal Ultrasound and New Treatment Options. Springer Science & Business Media).

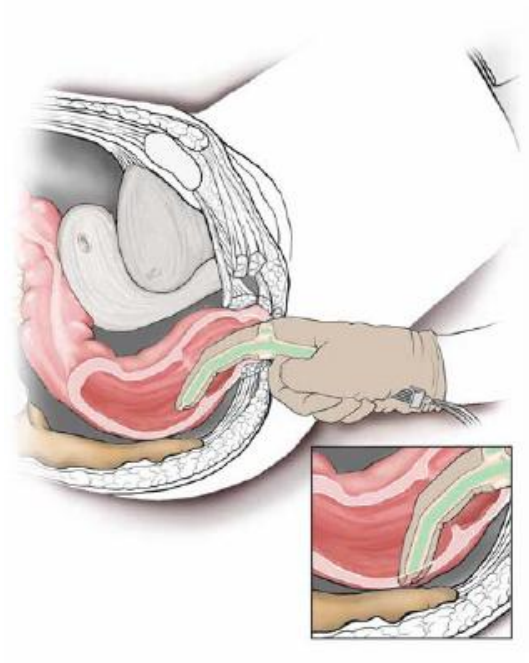


Figure 4.7: Schematic representation of pudendal nerve stimulation (Benign Anorectal Diseases Diagnosis with Endoanal and Endorectal Ultrasound and New Treatment Options. Springer Science & Business Media).

4.2.5 Rectal compliance

Two rectal volumes are commonly measured. Firstly the threshold rectal volume (TRV). This is the volume at which the individual first perceives pressure within the rectum (60 – 150mls). Secondly, the maximum tolerated volume (MTV). This is the volume at which the patient experiences a degree of discomfort in the rectum and immediate defaecation is necessary (120 – 300mls). The anorectall inhibitory reflex (AIR) usually seen when the TRV is reached, although further IAS relaxations can also be seen with gradual rectal distension beyond the TRV until the MTV is reached. To measure rectal volumes, a deflated balloon is inserted into the anorectum and gradually inflated (with either air or water) whilst the patient is asked to report the first urge to defaecate (TRV) and when they feel as though immediate defecation is necessary (MTV).

Whilst Holmberg and colleagues(325) showed good levels of reproducibility in their studies, the opposite was seen in Frey's study(293). The clinical relevance of rectal compliance has also been questioned. Holmberg and colleagues (325) showed that rectal sensibility and compliance did not differ between patients with urge faecal incontinence and a control group.

4.3 Study -3-Correlation between anorectal physiology studies and patients' symptoms

4.3.1 Objectives

The primary objective of this study is to assess the correlation of the anorectal physiological measurements with the severity of faecal incontinence, measured by St Mark's Faecal Incontinence Score (SMIS).

The secondary objective is to compare anorectal physiological measurements in patients with & without faecal incontinence on one hand, and among three subgroups of incontinent patients, i.e. those with passive, urge or mixed faecal incontinence on the other.

4.3.2 Methods

4.3.2.1 Study design

Data were collected retrospectively from a prospectively maintained database of all patients attended the Anorectal Physiology Laboratory in York Teaching Hospital over a period of 5 years

4.3.2.2 Patients

All adult patients attended the Anorectal Physiology Laboratory in York Teaching Hospital as part of their investigations, mainly for faecal incontinence, but also for other problems such as obstructed defecation, persistent anal fissure and unexplained proctalgia were included.

4.3.2.2.1 Inclusion criteria

- All adult patients attended the Anorectal Physiology Laboratory in York Teaching Hospital as part of their investigations over a period of 5 years.
- All patients should have completed SMIS on the day of attending the Anorectal Physiology Laboratory.

4.3.2.2.2 Exclusion criteria

- Patients with no record of their SMIS on the day of attending the Anorectal Physiology Laboratory.

4.3.2.3 Definitions

- **"Continent patient"**

These patients had no symptoms of incontinence such as leakage, urgency or rectal prolapse. This group consisted of constipated patients, patients with obstructive defaecation and patients awaiting surgery for persistent anal fissure or perianal fistulas. By definition, these patients' SMIS = 0.

- **"Incontinent patient"**

In this study, patients were as classified as "incontinent" on clinical bases. Those This group consisted of patients with a range of symptoms such as faecal leak and urgency. In this group SMIS is always > 1.

- **"Passive, urge and mixed incontinence"**

This classification is purely based on clinical judgement of attending colorectal surgeon after assessing the patient's presentation, examination and investigation.

- **“Abnormal anal sphincter”**

Abnormal anal sphincter refers to either an anal sphincter defect or a gross abnormality such as scaring from previous injury or severe degenerative changes.

- **“Abnormal vectorgrams”**

Abnormal looking pressure gradient in the anal canal.

4.3.2.4 Data collection

Data collected includes anal manometry parameters, endoanal ultrasound (EAUS) findings, rectal compliance and rectal mucosal electrosensitivity studies. On the day of anorectal physiology testing, the SMIS was recorded for each patient. All data were collected from the patients clinical records by the principle investigator. Data were then transferred into a password-protected Excel sheet. The Excel sheet is stored on a password-protected NHS computer in York Teaching Hospital.

4.3.2.5 The St. Marks Faecal Incontinence Score (SMIS)(326)

This scoring system comprises seven questions, each question is scored according to the frequency of occurrence of the symptom from 0 (never) - 4 (daily). The total score ranges between 0-24, where 0 indicates full continence while 24 represents the worst possible incontinence

4.3.2.6 Anorectal physiology laboratory assessment

Data collected includes anal manometry study parameters such as maximum mean resting pressure (MMRP), maximum mean squeeze pressure (MMSP), resting vector volume (rVV), squeeze vector volume (sVV), resting asymmetry index (RAI), squeeze

asymmetry index (SAI) and resting and squeeze vectorgrams. In addition data from endoanal ultrasound (EAUS), rectal compliance and rectal mucosal electrosensitivity studies were included.

4.3.2.7 Data analysis

Data were assessed using Microsoft Excel Spreadsheet (Microsoft Corporation, Seattle, WA, USA) and statistical analysis was performed using SPSS v14.0 (SPSS Inc., Chicago, IL, USA). Spearman's rank correlation coefficient was used to measure correlation of continuous data from anorectal physiology study with CCIS while the Chi-square test was used to measure categorical variables. Spearman's rank correlation coefficient (r_s) ranges from -1 to +1. Both -1 to +1 indicate perfect correlation while a value of zero indicates no relationship between the variables. The Mann–Whitney U test was used to compare continuous variables between various groups of patients within the study while categorical variables were compared using the Chi-square test. *P*-values of 0.05 of less were considered significant.

4.3.2.8 Limitation of protocol

One limitation in this study is its retrospective nature, which lead to the inevitable loss of some data. Another limitation is the nature of the continent patients group. These are patients with anorectal problems other than FI, such as constipation, obstructive defaecation or anal issues. Therefore, they do not accurately represent a normal control group.

4.3.3 Results

Data was collected form a total of 325 patients, 281 female, over a period of 5 years. Median (IQR) age was 68 (52-79). Of those 325, 285 patients were being investigated for faecal incontinence, while the rest 40 continent patients were being investigated for

other conditions. The main indications for investigation in continent group of patients were proctalgia with or without persistent anal fissure (18 patients), followed by obstructed defecation (10 patients). Of the 285 incontinent patients, 151 had passive FI, 65 had urge FI and 18 had mixed FI. The type of FI was not specified in 50 patients.

4.3.3.1 Correlation between anorectal physiology studies and severity of FI

Spearman's rank correlation coefficient (r_s) between SMIS and anorectal physiology variables was weak, ranging from -0.326 to 0.213 (table 1). This correlation with SMIS was significant when MMRP, MMSP, rVV, sVV, RAI and SAI were compared (*p*-value < 0.001). The presence of abnormal vectorgram, at rest or at squeeze, did not correlate with SMIS, with *p*-values of 0.559 and 0.572 respectively. Similarly the presence of abnormal IAS and / or EAS did not influence SMIS (*p*-value = 0.284 and 0.419 respectively).

Variable		r_s	*p*-value
MMRP		-0.250	< 0.001
MMSP		-0.250	< 0.001
rVV		-0.278	< 0.001
sVV		-0.326	< 0.001
RAI		0.213	< 0.001
SAI		0.199	< 0.001
TRV		-0.117	0.283
MRV		-0.176	0.112
AME	Upper	0.149	0.140
	Mid	0.161	0.113
	Lower	0.198	0.049

Table 4.1. Spearman's rank correlation coefficient (r_s) between continuous anorectal physiology variables and SMIS.

4.3.3.2 Comparison of anorectal physiology studies between continent and incontinent patients:

The MMRP, MMSP, rVV, sVV and RAI were all significantly different when compared in continent and incontinent patients. Patients with FI seem to have lower MMRP, MMSP, rVV, sVV and higher asymmetry index at rest with *p*-values of 0.001, 0.013, 0.002, 0.004 and 0.023 respectively. However, the SAI, TRV, MRV and AME values did not vary significantly in these two groups of patients (table 2). The rVG was abnormal in 18.5% of continent patients, compared to 37% of incontinence patients while sVG were abnormal in 18.5% of continent patients and 26% of incontinent patients. However, these differences were not statically significant with *p*-values of 0.403 and 0.403 respectively. Fourteen percent of incontinent patients and 11.5% of continent patients had abnormal looking IAS on EAUS and although none of the continent patients had abnormal EAS compared to 11% of incontinent patients, none these finding was significant with corresponding *p*-values of 0.403 and 0.403 respectively.

Variable	Incontinent Mean (IQR)	Continent Mean (IQR)	*p*-value
MMRP	51 (35-61)	67 (46-89)	<0.001
MMSP	75 (52-106.25)	92 (67-115)	0.013
rVV	33575 (15560-56718.25)	53988 (24256-91824)	0.002
sVV	72157 (38469-147672)	114587 (59418-176554)	0.004
RAI	0.16 (0.10-0.237)	0.13 (0.072-0.18)	0.023
SAI	0.12 (0.08-0.18)	0.11 (0.054-0.157)	0.281
TRV	90 (60-105)	85 (50-90)	0.498
MRV	160 (105-200)	140 (130 -250)	0.778
rVG	37% abnormal	18.5% abnormal	0.403

sVG		26% abnormal	18.5% abnormal	0.403
IAS		14% abnormal	11.7% abnormal	0.153
EAS		11% abnormal	0% abnormal	0.153
AME	Upper	7.5 (5.9-9.2)	4.4 (3.7-7.20)	0.100
	Mid	5.3 (4.4-6.9)	5.05 (4.10-6.00)	0.624
	Lower	4.7 (3.7-6.0)	7.30 (4.60-10.00)	0.976

Table 4.2. Comparison of anorectal physiology study results in patients with and without FI

4.3.3.3.Comparison of anorectal physiology studies in passive, urge and mixed faecal incontinence

When comparison was made among these three subgroups of incontinent patients, only MMRP, MMSP, rVV and sVV were found to be significantly different (table 3). The rest of the anorectal physiology studies did not vary significantly. Low MMRP and rVV were seen in patients with urge and mixed incontinence compared to those with passive FI (*p*-value = 0.001), while MMSP and sVV were particularly lower in patients with mixed FI when compared to the other two croups (*p*-value = 0.029 and 0.002 respectively).

Variable		Passive FI Mean (IQR)	Urge FI Mean (IQR)	Mixed FI Mean (IQR)	*p*-value
MMRP		52 (35-72)	35 (50-64)	37 (27-47)	<0.001
MMSP		72 (50-113)	74 (55-95)	64 (45-97)	0.029
rVV		31773 (15201-57319)	15893.5 (30170-51338)	16763 (9218-41721)	0.001
sVV		73604 (34207-171954)	65552 (43519.5-114061.25)	37316.5 (24808.5-63203.25)	0.002
RAI		0.16 (0.11-0.24)	0.15 (0.09-0.21)	0.17 (0.10-0.26)	0.184
SAI		0.12 (0.08-0.18)	0.12 (0.74-0.18)	0.1 (0.07-0.22)	0.795
TRV		80 (50-100)	90 (70-105)	100 (90-110)	0.266
MRV		140 (100-200)	160 (120-200)	210 (205-215)	0.419
rVG		34%	41%	40%	0.225
sVG		26%	37%	18%	0.213
IAS		12%	17%	11%	0.691
EAS		12%	8%	5%	0.406
AME	Upper	7.5 (5.4-8.9)	7.8 (6.7-10.1)	7.6 (6.1-9.5)	0.405
	Mid	5 (3.8-6.9)	5.1 (4.8-7.2)	8.2 (5.2-11.3)	0.387
	Lower	4.4 (3.6-5.8)	5.4 (4.3-6.1)	12.9 (7.4-14.8)	0.298

Table 4.3 Comparison of anorectal physiology studies in passive, urge and mixed faecal incontinence

4.3.4 Discussion:

This study shows weak correlation between anorectal physiology studies and the severity of FI measured by SMIS. This weak correlation was only significant when mean rectal pressure, vector volumes and asymmetry index were measured

Of all anorectal studies, only four manometric parameters, namely the MMRP, MMSP, rVV and sVV, demonstrated consistently significant variations when measurements were compared between different groups of patients in this study, i.e. incontinent patients versus continent patients and among the three subgroups of incontinent patients.

Thorson(327) identified several problems with anorctal investigation. These are; the lack of standardization of the tests, the lack of normative data from significant numbers of normal patients and the issue of reproducibility of the tests. This is a serious problem with anorectal manometry. However, the weak correlation of anorectal investigation parameters with patients' symptoms may represent a more serious problem and raise the question of the value of performing many of these investigations.

Although some authors advocated the important influence of anorectal physiology on the management of incontinent patients (328-330) (i.e. whether treatment should be surgical or medical), the outcome of treatment has not been shown to be influenced by performing these tests.

The role of EAUS in evaluating IAS and EAS anatomy and detecting the present of sphincter defects is a good example of the controversial role of anorectal investigations and their influence on patients' management. When anal sphincter defects were seen, they were most likely due to an obstetric injury, yet the patients did not present with symptoms of faecal incontinence until well after their deliveries. There are two possible explanations for this: firstly, that the faecal incontinence is not due to the sphincter defect or secondly, that compensatory mechanisms, i.e. stronger pelvic floor muscles, were in place when the patient was younger.

One limitation in this study is its retrospective nature, which lead to the inevitable loss of some data. An example of this would be the limited number of patients who underwent AME testing, which was only 99 out of the 325 patients included in this study. Another limitation is the nature of the continent patients group. These are patients with anorectal problems other than FI, such as constipation, obstructive defecation or anal issues. Therefore, they do not accurately represent a normal control group.

Until we have larger and well designed studies to identify the exact role of various anorectal physiology studies in the assessment and management of FI, we must interpret the results of anorectal physiology on patients with symptoms of a defective continence mechanism with care.

5.1 Study -4- Systematic review of the techniques of Injection of perianal bulking implants for the treatment of faecal incontinence.

5.1.1. Abstract

5.1.1.1 Objectives

Injectable bulking agents have been used with varying success for the treatment of faecal incontinence. This systematic review aims to investigate the various injectable agents and techniques used for the treatment of faecal incontinence and to study the safety and efficacy of these techniques.

5.1.1.2 Methods

Medline, Pubmed, Embase, Cochrane Library and ZETOC database of conference abstracts, in addition to references obtained from proceedings of annual meetings were searched using several keywords (detailed in Appendix 5.1). Thirty-nine publications were identified and studied. The following variables were pooled for univariate analysis: type, location, route and quantity of bulking agents, the use of ultrasound guidance, antibiotics, laxatives and anaesthetics. Predictors for the development of complications and successful outcomes were identified with multivariate logistic regression analysis. Odds ratios and 95% confidence intervals were calculated, a *p*-value of <0.05 was considered significant.

5.1.1.3 Results

A total of 1070 patients were included for analysis. On multivariate analysis, one variable was a significant predictor for the development of complications: the route of injection of bulking agents (OR 3.4 (95% CI 1.6-7.1, p-value 0.001). Two variables were significant predictors for a successful short-term outcome. The use of either PTQ (OR 5.9 (95% CI 2.2-16.1, *p*-value=0.001) or Coaptite materials (OR 10.7 (95% CI 1.7-65.3, *p*-value=0.001) was associated with a greater likelihood of success. Conversely, the use of local anaesthetic was associated with a lower likelihood of success (OR 0.18 (95% CI 0.05-0.59, *p*-value=0.005). The use of post-operative laxatives was the only significant predictor of a successful medium to longer-term outcome (OR 0.13 (95% CI 0.06-0.25, *p*-value=0.001).

5.1.1.4 Conclusion

This systematic review has identified variations in the practices of injectable bulking agents which appear to influence the likelihood of complications and affect the outcomes after treatment.

5.1.2. Introduction

Up to 0.5–1.0% of adults will experience varying degrees of faecal incontinence that affects their quality of life (4, 331). There is a diversity of treatment options for such patients. A recent systematic review of patients with faecal incontinence reported a trend favouring conservative management, using dietary modification, biofeedback and minimally invasive procedures, including sacral neuromodulation, the SECCA procedure and the use of injectable bulking agents(8).

Injection of anal bulking agents is a new minimally invasive procedure with promising results (177, 178). A variety of materials and techniques for injections of these agents have been described in the published literature(179-184). In a previous Cochrane review several of the studies showed that there were short term improvements in faecal incontinence after injections of a variety of materials using several injection techniques(185). The ideal method of injection has not yet been established (186). There is also a debate as to which injectable agent is the most effective. The aim of this systematic review is to investigate the various injectable agents and techniques used for the treatment of faecal incontinence and to study the safety and efficacy of these techniques.

5.1.3. Methods

5.1.3.1. Search strategy

Medline, Pubmed, Embase, Cochrane Library and ZETOC database of conference abstracts were searched using several keywords. These are detailed in Appendix 5.1. In addition to references obtained from these online searches, proceedings from annual meetings of the American Society of Colon and Rectum Surgeons and the Association of Coloproctology of Great Britain and Ireland which were published in the Diseases of

the Colon and Rectum and Colorectal Disease journals respectively were also examined (figure 5.1).

The first study which described the use of injectable bulking agent for the treatment faecal incontinence by Shafik and colleagues from 1993 was the starting point of our search. This search was terminated on the 20th of July 2010. There were no language restrictions. Papers of all relevant published studies identified from the above search strategy were obtained and assessed for potential eligibility independently by two of the authors (ZH and ML).

5.1.3.2. Data extraction:

Data were extracted by the same two authors independently. Details on the employed technique, material, dose, site of implant, route of injection, need for further injections, use of ultrasound guidance, use of antibiotic prophylaxis, use of enema and laxatives were obtained from individual studies. Data on complications and outcomes after treatment were also collected. All data were recorded on Excel and then transferred on to SPSS for statistical analysis.

5.1.3.3. Inclusion criteria

- All papers and abstracts reporting the use of IBA for the treatment of faecal incontinence were reviewed for potential inclusion in the study.

- Papers and abstracts that clearly mentioning the number of patients who responded to treatment and not merely the mean/median improvement in incontinence scores were included for efficacy analysis.

- Papers and abstracts with details of adverse events were included in the safety analysis of this systematic review

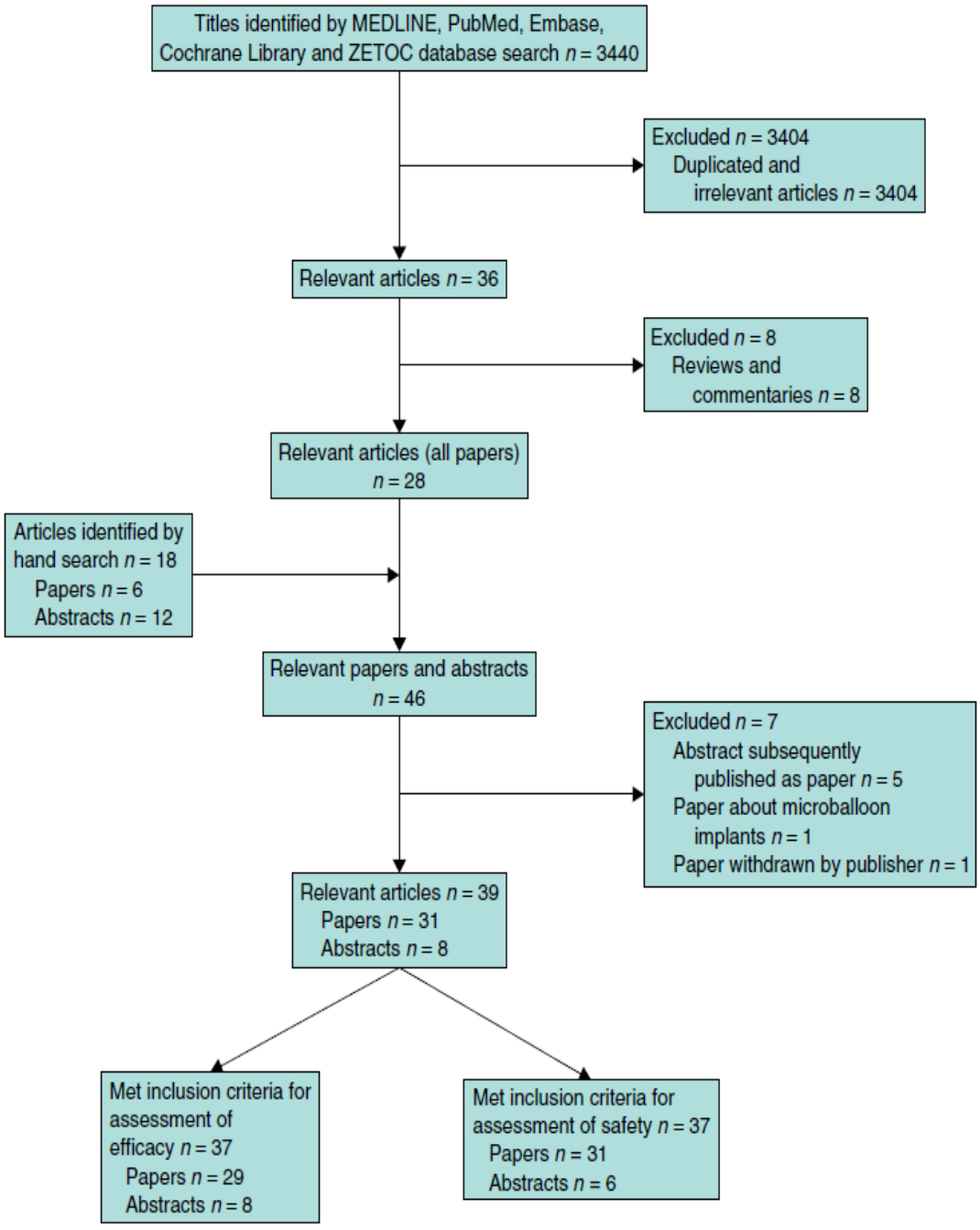


Figure 5.1: Summary of article selection for systematic review.

5.1.3.4. Exclusion criteria

- Papers and abstracts that do not detail the number of patients who responded to treatment with IBA were not included in the efficacy analysis .

- Papers and abstracts with no clear details about the adverse events encountered during the use of IBA were not included in the safety analysis of this systematic review

5.1.3.5. Data analysis

On statistical analysis, the data were found to be non parametric using the Kolmogorov-Smirnov test. Hence all variables are displayed in medians and interquartile ranges. Univariate analysis was initially performed. Categorical data was compared using the Chi-Square. Variables with significant differences were entered into a multivariate analysis model using logistic regression analysis. Odds ratios and ninety-five percent confidence intervals were calculated for significant predictors of the binary outcome. A *p*-value of less than 0.05 was deemed significant.

5.1.3.6.Primary endpoints

5.1.3.6.1. Safety of treatment

Adverse events and complications were obtained from the results of individual studies. Only studies with details of adverse events were included in the safety analysis of this systematic review. Numerous adverse events were noted after the injection of bulking agents, these included infection or abscess formation, ulcerations of anal mucosa, haemorrhagic events, hypersensitivity, pain and persistent pruritus ani. Although pain is not an unusual event following surgical procedures, it may reflect an underlying problem such as mucosal ulceration, infection or haematoma formation at the site of

injection. In this systematic review pain was considered an adverse event when it was significant/persistent enough to be reported by authors. The presence of any of the above complications was coded into yes while the converse was coded into the no category.

5.1.3.6.2. Efficacy of treatment

The assessments of efficacy after treatment were obtained from clinical assessments that were done in individual studies of the systematic review. In general, the outcomes from injections were studied at several key time-points in the majority of studies. The three common time points were at 3 months, between 3 and 12 months and beyond 12 months. Clinical assessments varied between studies with a range of outcomes, (such as good, fair and poor) grades of improvement (grade I, II and III etc) or responders (based upon percentage improvement in scores of faecal incontinence e.g. >50% improvement versus < 50% improvement). The authors studied these outcomes and reclassified the data. Reclassification of data of efficacy are detailed in Appendix 5.2.

Efficacy from treatment was studied at two time points; short (less than 3 months) and longer term (greater than 12 months). The degree of efficacy was reclassified similarly at both time-points. Patients with no response or a minor response were coded as failures of treatment. Patients with a good response or restoration of full continence were coded as successes of treatment (Appendix 5.2). Only studies clearly mentioning the number of patient who responded to treatment and not merely the mean/median improvement in incontinence scores were included for efficacy analysis.

5.1.4. Results

5.1.1.1 Patients

Thirty nine studies were identified in this systematic review, including 9 abstracts. Details of all identified studies are listed in (Appendix 5.3)

There were only five randomised and quasi randomised control trials (RCTs). One of the five published RCTs, compared an injectable bulking agents (Elastomer) to a saline control(332). Two RCTs compared different injectable agents (PTQ vs. Durasphere(333) and Permacol vs. Bulkamid(334)). Other RCTs used the same agent in both arms of the study but varied the use of imaging (ultrasound vs. no ultrasound guidance)(335, 336). Zoler and colleagues have reported a study of 117 patients (77 had Durasphere and 40 had saline injections) but data from control patients have yet to be published(337).

A total of 1030 patients from 37 studies were available for safety analysis and 1001 patients from 37 studies were available for efficacy analysis.

5.1.1.2 Follow-up

Follow-up for the majority of studies was no more than a median of 3 years, so it was impossible to comment on the true long-term durability of the procedure. Some 46.1 per cent of patients had assessment conducted at a single time-point and 47.3 per cent of patients had assessment conducted at two time-points; only 2.8 per cent of patients had assessments at three time-points. Adverse events occurred in 139 patients (13.5 per cent). The most common complication was pain in 67 patients (6.5 per cent) and leakage of injected material in 58 patients (5.6 percent).

The efficacy of injection of bulking agents was fairly favourable. On early follow-up (below 3 months), 69.7 per cent of patients had a response. In all, 56.3 per cent had a good response with 13.4 per cent achieving complete continence. At late follow-up

(beyond 12 months), a smaller proportion of patient had a benefit; 45.2 per cent had a persistently good response and 12.3 per cent remained completely continent.

5.1.1.3 Variations in practice

5.1.1.3.1 Injectable bulking agents

Ten injectable bulking agents have been described in literature. These are detailed in Table 5.1. The most frequently used is PTQ® or silicone biomaterial (Uroplasty BV, the Netherlands) and Durasphere® (Carbon Medical Technologies, St. Paul, Minnesota, USA).

Material	NOT an updated table Details	Number of studies described this material	Total No of patients in literature
1. PTQ ®	Silicone biomaterial or Bioplastique (Uroplasty BV, the Netherlands). Polydimethylsiloxane elastomer particles suspended in a bio-extractable carrier hydrogel of polyvinylpyrrolidone (povidone, PVP) the particles are highly textured and irregularly shaped, minimizing migration and attracting the deposition of host collagen biomaterial.	21(177-180, 186, 326, 332, 333, 335, 336, 338-348)	619
2. Durasphere ®	Durasphere®, carbon coated zirconium beads (Carbon Medical Technologies, St. Paul, Minnesota, USA), comprises of pyrolytic carbon-coated beads suspended in a water-based carrier gel containing beta-glucan. The beads size is 212-500 µm and theoretically cannot be absorbed by the body(333, 349)	7(181, 183, 184, 333, 337, 350, 351)	187
3. Coaptitle®	(*Coaptite*® by Bioform Medical, Inc) Synthetic calcium hydroxylapatite ceramic microspheres, normal constituent of bone and teeth. Non-allergenic.	2(352)	10

	The particles size ranging form 75-125 µm, limits the possibility of displacement(352)		
4. NASHA/Dx (Zuidex/Solesta)	NASHA™Dx (Solesta® or Deflux®) (Q-Med AB, Uppsala, Sweden). Dextranomer microspheres in stabilised hyaluronic acid-based gel of nonanimal origin (NASHA™ gel). Histopathologic data have shown fibrosis, i.e. collagen ingrowth and slight inflammatory reaction with no significant tissue changes or granuloma formation.The stabilized hyaluronic acid acts mainly as a carrier, leaving the dextranomer microspheres at the implant site. The implant is expected to be retained in situ for extended periods of time(353, 354)	4(177, 355-357)	56
5. Contigen	Glutaraldehyde cross-linked collagen (Bard, Covington, GA, USA). susceptible to *in vivo* degradation which limits its long term efficacy. It is also antigenic in 5% of patients so skin testing must be preformed 30 days prior to injection(349, 358)	2(182, 358)	90
6. Bulkamid	Bulkamid ™ (contura international A/S, Soeborg, Denmark). Synthetic non-particulate hydrogel consisting of 97.5% water and 2.5% cross-linked polyacrylamide. It is biocompatible but not biodegradeable, resistant to migration and cause mild reaction in the surrounding tissue(334, 349)	1(334)	5
7. Permacol®	Permacol® (Permacol, Tissue Science Laboratories, Aldershot, UK). Cross linked porcine dermal collagen matrix. Biocompatible and incorporated into host tissue with cell and microvascular ingrowth. None allergenic. Designed to resist breakdown by colllagenases.	3(334, 359, 360)	34
8. Teflon	Teflon (poly-tetra flouro-ethylene paste, Dupont, TX, USA). Was found to produce local and distant granulomas as the particles are small enough to be taken up by phagocytes(349)	1(361)	11
9. Autologous fat	Autologous fat. It has low efficacy and there are two reports of fat emboli following its use for urinary incontinence(362) and one of a stroke following injection into the face(363)	2(364, 365)	15
10. EVOH	Eight% Ethylene Vinyl Alcohol (EVOH) copolymer dissolved in dimethyl sulphoxide (DMSO). Upon	1(366)	21

	contact with polar physiologic fluid, the solvent diffuses away, resulting in solidification of the hydrophobic copolymer, which forms a spongy solid mass. It is biocompatible but not biodegradable and it has been used to treat stress urinary incontinence and gastro-oesophageal reflux in the past (STEPHENS 2010)		
11. Microballoons	Microballoons have been used to achieve the same effect of injectable bulkig agents, however this is not an injectable bulking agnet and the study was excluded from this systematic review	1(367)	6
12. Muscle stem cells	The technology of using stem cells to grow new tissue to treat incontinence, which is ideal for IAS related faecal incontinence, is in its early development. Although it has been used in urology studies, in patients with urinary incontinence(341, 368-370)	None	None

Table 5.1: Details of materials used as perianal bulking implants.

5.1.1.3.2 Technique of injection

Seven different techniques have been described in the literature. These are detailed in Figure 5.2. These techniques differ in two main aspects:

- The final site of implantation of the bulking material of which there are 3 locations: a) submucosal, b) intersphincteric or c) into the sphincteric defect itself.
- The route of insertion of the needle used to deliver the bulking material of which there are 3 options: a) transanal (transmucosal), b) transsphincteric, or c) intersphincteric.

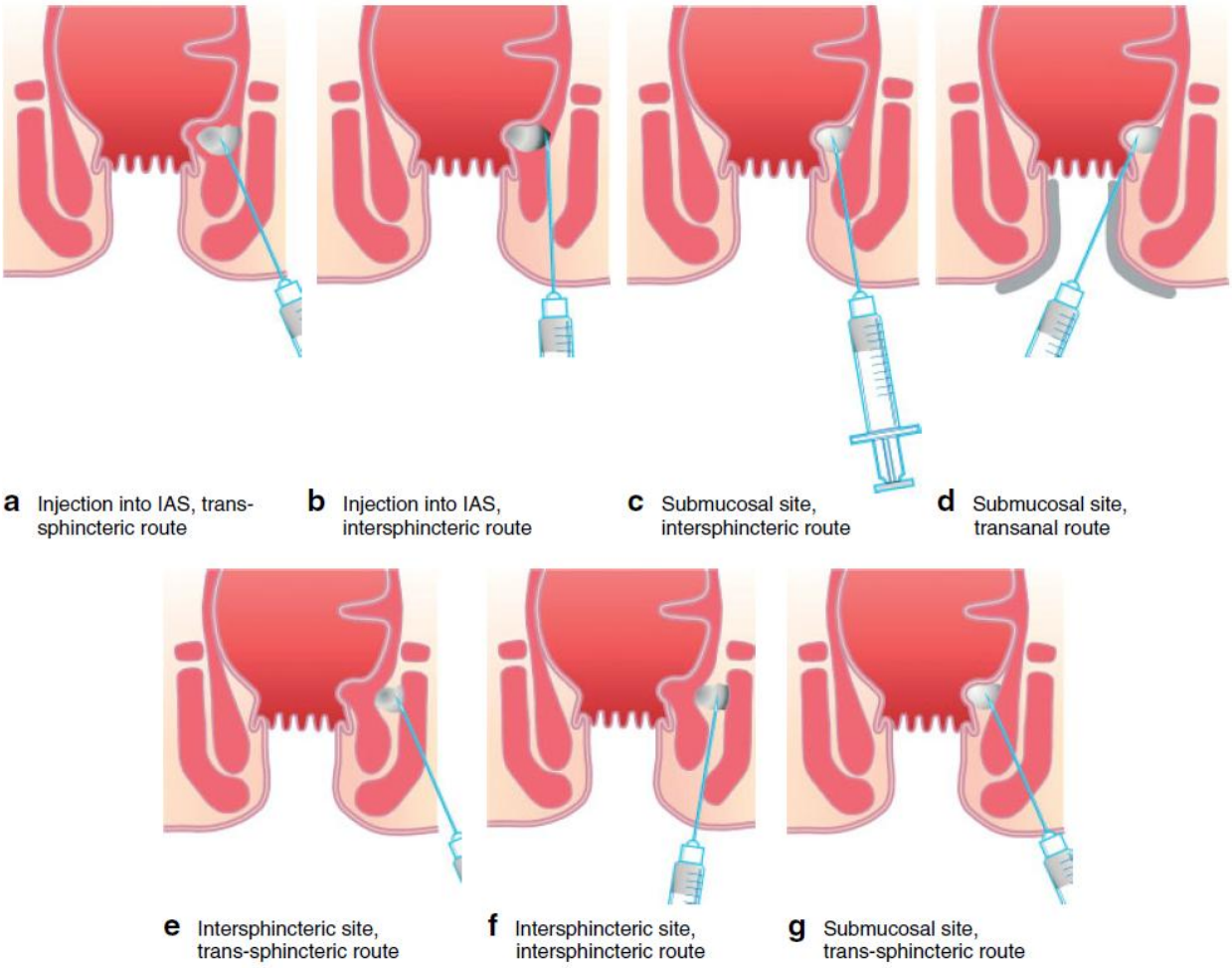


Figure 5.2: Injection sites and routes: **a** injection into internal anal sphincter (IAS) or IAS defect, trans-sphincteric route, **b** injection into IAS or IAS defect, intersphincteric route, **c** submucosal site, intersphincteric route, **d** submucosal site, transanal (transmucosal) route, **e** intersphincteric site, trans-sphincteric route, **f** intersphincteric site, intersphincteric route and **g** submucosal site, trans-sphincteric route

5.1.1.3.3 Antibiotic prophylaxis:

The use of pre- and post- operative antibiotics was highly variable. While some authors described pre-operative antibiotics followed by a course of oral antibiotics post-operatively, others did not use any antibiotic prophylaxis. In the middle of this spectrum, a single dose of pre-operative antibiotics or an oral course of antibiotics alone was used by other authors (Table 5.2).

Antibiotic prophylaxis	Pre-operative		No of Studies
• Single dose of antibiotic prophylaxis	• Cefuroxime & Metronidazole		3(333, 340, 365)
	• Cephalosporins		3(350) (361, 364)
	• Not mentioned		4(348, 359, 366)
• A course of oral antibiotic post-operatively	• Broad spectrum oral antibiotics		1(341)
• Pre-operative antibiotic followed by a course of oral antibiotic	Pre-operative	Post-operative	Reference
	• Gentamycin & metronidazole	Cefalexin & metronidazole	6(178, 180, 326, 338), (186, 339, 352)
	• Metronidazole	Metronidazole	2(332, 352)
	• Gentamycin	Oral Cefalosporin	1(180)
	• Cefuroxime & metronidazole	Augmentin	2(335, 336)
	• Cefuroxime	Cefuroxime	1(342)
	• Co-amoxiclav	Co-amoxiclav	1(183)
	• Not mentioned	Not mentioned	1(352)
No antibiotic prophylaxis	None		4(181, 355, 357, 358)
Not mentioned	Not mentioned		12(177, 182, 184, 337, 343-347, 351, 356, 360)

Table 5.2: various antibiotic regimes used with injectable bulking agents.

5.1.1.3.4 Enemas and Laxative:

Likewise, the use of preoperative enemas and postoperative laxatives was variable.

5.1.1.3.5 EAUS guidance/imaging

Several studies reported the use of endoanal ultrasound to facilitate the injection of bulking agents. The largest of these studies was conducted by Tjandra and colleagues who demonstrated in a randomised controlled study that intersphincteric injection of PTQ under ultrasound guidance was associated with significantly better short and long term results when compared with digital/manual guidance with a finger placed in the anal canal(335, 336) (table 5.3)

THE USE OF US GUIDENCE	No of Studies
USS Guidance not used	33(177-182, 184, 186, 326, 332-336, 338, 339, 341-343, 345, 347, 348, 350-352, 355-358, 364, 365, 371)
USS Guidance used	7 (180, 183, 333, 335-337, 340)
Not mentioned	5(344, 346, 359, 360, 366)

Table 5.3: The number of studies where USS guidance was used.

5.1.1.3.6 Anaesthesia

The type of anaesthetic used with injections of bulking agents was variable. In some studies injections were done without anaesthetic while in others they were done under general anaesthesia. However, the majority of injections were done under a local anaesthetic (table 5.4).

Type of anaesthesia	None	Local	Sedation	Local and sedation	G/A	Pudendal nerve block	Not mentio ned
Number of studies	6 (181, 182, 355-357, 361)	18 (177-180, 184, 186, 326, 332, 337, 338, 343-345, 348, 350-352, 366)	3(341, 342, 365)	4 (333, 335, 336, 340)	6(183, 326, 339, 358-360)	1 (364)	3(177, 346, 366)

Table 5.4: types of anaesthetics used during the injections of perianal bulking agents.

5.1.1.3.7 Patients' position

Patients were placed in a variety of positions to facilitate the injection of the bulking agents. The main positions used for injections included prone jack-knife, left lateral and lithotomy position (table 5.5).

Psoition	Prone Jack-knife	Left Lateral	Lithotomy	Supine	unknown
Number of studies	8(178, 180, 184, 186, 326, 334, 350, 352)	8(181, 182, 333, 335, 336, 340, 348, 357)	9(183, 339, 341, 342, 358, 361, 364, 365) (332)	1(343)	13(177, 337, 338, 344-347, 351, 355, 356, 359, 360, 366)

Table 5.5: Patients' positioning during the injection of perianal bulking agent.

5.1.1.3.8 Length of hospital stay

In the vast majority of patients the procedure was performed as a day case or in the outpatient setting. However, one study described an overnight stay in some patients following general anaesthesia, mainly because of unrelated co-morbidities(358) (table 5.6) .

Setting	Outpatient	Day Case	Inpatients	unknown
Number of studies	18 (179-181, 184, 326, 337, 341, 343, 348, 350-352, 355-357, 361, 364, 365)	12(178, 183, 333, 335, 336, 338-340, 358, 360, 366)	1(358)	8(177, 186, 342, 344-346, 352, 359)

Table 5.6: Length of hospital stay after the procedure.

5.1.1.4 Safety

The results from univariate analysis of factors affecting the development of compications are summarised in Table 5.7. Five variables (the agent used, the site of injection, use of postoperative antibiotics, type of anaesthesia and position of patient at time of injection) had impact on the likelihood of postoperative complications.

5.1.1.5 Efficacy

The results from univariate analysis of the above variables for short and longer term successes from treatment are summarised in Tables 5.8 and 5.9 respectively. Eight variables (the agent used, the site of injection, the route of injection, the use of preoperative and postoperative antibiotics, the use of postoperative laxatives, type of anaesthesia and position of patient at time of injection were found to impact on short-term efficacy. The same eight variables were found to have an impact on long-term efficacy.

Variable		No (% population)	Yes (% population)	*P*-value
Agent	PTQ	52.5	6.0	0.001
	Durasphere	13.6	4.4	
	Coaptite	1.9	0.0	
	NASHA-Dx	2.9	1.9	
	GAX Collagen	1.6	0.0	
	Contigen	7.0	0.0	
	Permacol	1.2	0.0	
	Teflon	1.1	0.0	
	Fat	1.3	0.0	
	EVOH	0.9	1.2	
	Saline	1.9	0.2	
	Bulkamid	0.5	0.0	
Route	Transanal	20.0	3.7	0.002
	Intersphincteric	2.5	1.2	
	Transphincteric	63.4	9.2	
Site	Defect	3.3	0.5	0.628
	Submucosal	31.9	5.7	
	Intersphincteric	51.0	7.6	
Imaging	No	63.6	8.9	0.355
	Yes	23.5	4.0	
Preop antibiotic	No	21.4	3.6	0.353
	Yes	66.2	8.9	
Postop antibiotic	No	28.4	5.8	0.005
	Yes	59.2	6.6	
Preop enema	No	34.0	4.5	0.648
	Yes	53.7	7.9	
Postop laxative	No	66.9	10.7	0.578
	Yes	19.7	2.7	
Anaesthetic	None	9.3	2.4	0.001
	Local	29.2	6.8	
	Sedation	32.8	3.2	
	General	15.0	1.4	
Position	Prone jack-knife	13.2	4.0	0.001
	Left lateral	38.9	4.8	
	Lithotomy	29.3	1.5	
	Others	7.1	1.2	

Table 5.7: Univariate analysis of variables which predict the development of complications

Variable		Failure (% population)	Success (% population)	*P*-value
Agent	PTQ	14.6	45.9	0.001
	Durasphere	6.3	7.2	
	Coaptite	0.4	1.7	
	NASHA-Dx	4.1	3.3	
	Permacol	1.3	6.1	
	Fat	0.0	3.1	
	Saline	3.5	1.3	
	Bulkamid	0.0	1.1	
Route	Transanal	10.3	10.6	0.002
	Intersphincteric	3.3	6.5	
	Transphincteric	17.9	51.5	
Site	Defect	1.7	2.1	0.025
	Submucosal	15.7	28.3	
	Intersphincteric	12.8	39.4	
Imaging	No	28.1	60.5	0.491
	Yes	3.0	8.4	
Preop antibiotic	No	7.3	25.1	0.016
	Yes	23.9	43.7	
Postop antibiotic	No	11.4	17.2	0.030
	Yes	19.8	51.6	
Preop enema	No	19.0	43.1	0.256
	Yes	14.2	23.7	
Postop laxative	No	22.0	28.6	0.007
	Yes	13.9	35.5	
Anaesthetic	None	5.2	4.0	0.001
	Local	17.5	30.4	
	Sedation	5.2	23.0	
	General	3.0	11.9	
Position	Prone jack- knife	6.9	20.8	0.001
	Left lateral	11.4	11.7	
	Lithotomy	3.6	32.2	
	Others	9.9.	3.3	

Table 5.8: Univariate analysis of variables which predict short term success from treatment

Variable		Failure (% population)	Success (% population)	P-value
Agent	PTQ	25.6	44.4	0.001
	Durasphere	4.2	3.1	
	Contigen	9.4	4.1	
	Bulkamid	0.9	0.0	
	Permacol	2.2	2.6	
	Teflon	0.0	0.9	
	Fat	0.0	2.6	
Route	Transanal	10.3	9.4	0.020
	Intersphincteric	0.0	0.0	
	Transphincteric	32.0	48.3	
Site	Defect	1.1	1.1	0.001
	Submucosal	18.4	14.4	
	Intersphincteric	22.8	42.2	
Imaging	No	34.8	44.2	0.120
	Yes	7.6	13.4	
Preop antibiotic	No	10.8	20.2	0.006
	Yes	33.2	35.8	
Postop antibiotic	No	14.8	11.6	0.001
	Yes	29.2	44.4	
Preop enema	No	15.0	22.5	0.363
	Yes	27.8	34.8	
Postop laxative	No	40.5	39.9	0.001
	Yes	2.2	17.4	
Anaesthetic	None	0.9	5.3	0.001
	Local	6.4	7.0	
	Sedation	17.7	37.6	
	General	17.3	7.7	
Position	Prone jack-knife	7.2	3.7	0.002
	Left lateral	20.4	27.8	
	Lithotomy	15.9	24.9	
	Others	0.0	0.0	

Table 5.9: Univariate analysis of variables which predict longer term success from treatment

5.1.1.6 Multivariate analysis

All significant variables on univariate analysis were entered into a logistic regression analysis model for multivariate analysis. Variables which remained significant on multivariate analysis were deemed to be true reasons for the observation of the studied effect.

On logistic regression analysis, only one of five variables remained a significant predictor for the development of complications. Intersphincteric route of injections were associated with a greater likelihood of complications when compared with transphincteric or transanal routes of injections (Odds Ratio 3.4 (95% CI 1.6-7.1, *p*-value 0.001).

With regards to short-term efficacy, on logistic regression analysis, two of the eight variables remained significant predictors for a successful outcome. The use of either PTQ (Odds Ratio 5.9 (95%CI 2.2-16.1, p-value=0.001) or Coaptite agents (Odds Ratio 10.7 (95%CI 1.7-65.3, p-value=0.001) was associated with a greater likelihood of a successful outcome. Conversely, the use of local anaesthetic methods to administer the injectable bulking agents was associated with a lower likelihood of success (Odds Ratio 0.18 (95%CI 0.05-0.59, p-value=0.005).

Finally, with regards to longer-term efficacy, only one variable was found to be a significant predictor of a successful outcome. A failure to use laxatives in the postoperative period resulted in a poorer outcome from injectable bulking agents (Odds Ratio 0.13 (95%CI 0.06-0.25, p-value=0.001).

5.1.2 Discussion

There have been many publications on the use of injectable bulking agents for the treatment of faecal incontinence since it was first described in 1993 (361). There is however a lack of long-term comparative studies and randomised control trials. A wide variety of bulking agents and injection techniques have been employed. The variations in practice and lack of quality studies have made it difficult to draw firm conclusion about the safety and efficacy of this treatment. This systematic review attempted to identify common practices between studies and to extract important findings. It was found that route of injection may have an impact on the likelihood of postoperative complications. With regards to efficacy three factors were found to influence success, the type of bulking agent, the use of a general anaesthetic and the use of laxatives in the postoperative period.

The optimal injectable bulking agent should be non-biodegradable, biologically non-reactive, non-migratory and easy to inject(372). Studies have revealed that the solid content of these bulking agents should be at least 80 μm in diameter to prevent migration(349, 373). Experience from studies with old bulking agents like collagen (Contigen), Teflon or autologous fat injections demonstrated poor medium and long term results and reinjection was necessary in the follow-up period for efficacy to be maintained (361, 364, 365). Possible reasons for this observation were attributed to resorption and/or migration of the injected material(184). These materials are also potentially associated with significant local and systematic adverse event, whether used in the management of faecal incontinence of other conditions(349, 363) (table 5.1.)
The later generation of bulking agents such as Coaptite, NASHA/Dx, EVOH and PTQ were designed to have characteristics of "the optimal bulking agent". Results from injection with these modern injectable bulking agents were better on medium to long-term follow-up; however, in a proportion of patients treated with these newer agents, reinjection was subsequently required (332, 347, 357, 366).

This review suggests that the injections of bulking agents are best performed under general anaesthetic. This is likely related to the better exposure achieved for injection

during general anaesthetic. This may explain the poor short term results that were associated with injection of bulking agents under local anaesthetic.

Tjandra and colleagues demonstrated in a randomised controlled study that intersphincteric injection of PTQ under ultrasound guidance was associated with significantly better short and long term results when compared with digital/manual guidance with a finger placed in the anal canal (335, 336). However, we were unable to confirm superior results with injections that were performed with the use of ultrasound guidance when data was pooled in this systematic review. Additionally, studies done without the use of ultrasound imaging may not have suffered from a lack of exposure of the anal canal as the majority of investigator would have employed the use of anal retractors and/or proctoscope to achieve good exposure of the anal canal and ensure careful administration of the injections into the appropriate site.

Surprisingly the only predictive variable for longer-term efficacy was the use of laxatives postoperatively. Straining in the most vulnerable immediate postoperative period may cause significant displacement and/or leakage of injectable agents resulting in a large volume loss over a short period of time and a shorter period of symptomatic control. It seems that avoiding straining in the postoperative period by the use of laxatives may reduce the displacement and/or leakage and improve the medium term efficacy. Patients may therefore benefit form routine postoperative laxatives after the injection of bulking agents.

The increased risk of complications that is associated with inter-sphincteric route of injection is largely related to the puncture site/site of needle insertion. In transmucosal route of injection, the mucosal surface heals faster and demonstrates a diminished inflammatory reaction in response to trauma, like surgical wound. This has been shown both in animal and human models (374-378). Although these studies describe healing in oral mucosa, this may well applies to the rest of the gastrointestinal mucosa. For the transsphincteric route, the puncture site is about 3.5cm away from the anal verge through normal skin and therefore there is likely to be less risk of inoculation. In contrast the site of injection used for the intersphincteric route is closer to the anal canal and therefore potentially associated with a higher rate of inoculation. A further factor may be a high degree of vascularity in the intersphincteric space with susceptibility of

vessels to trauma during injection. This may lead to haematoma formation and subsequent infection.

There are numerous limitations to conducting a systematic review. Ideally, we would have chosen to perform a meta-analysis on this subject. However, a meta-analysis can only be conducted on randomised controlled studies. We chose not to exclude data from many other studies. Our conscious decision to include all published studies in our literature review has resulted in an inevitable heterogeneity of patients when analysis is performed. In addition, the primary endpoints differed significantly between individual studies. Consequently, studies designed to detect complications would have investigators that were more diligent about detecting and reporting complications. The purpose of multivariate analysis is to detect true differences within our study population. It is surprising to note that despite a very small sample size, the short-term outcomes seen in patients treated with Coapetite® injections (10 patients in total) appeared to influence our overall results. We have re-examined the data and it is difficult to determine if this observation is secondary to excellent results that were not obtained with other agents or if it merely an observation secondary to outlying results.

Since this systematic review was completed, few study evaluating the safety and efficacy of NASHA/Dx (Solesta) have been published (379-382). The largest of these was reported by Graf and *colleagues* (379) who recruited 206 patients. In their randomised, double-blind, sham-controlled trial, Graf and *colleagues* reported a 50% or more reduction in the number of incontinence episode in 52% of patients who received the treatment, compared with 31% of patients who received sham treatment (odds ratio 2·36, 95% CI 1·24–4·47, p=0·0089). There were 128 treatment-related adverse events, of which two were serious (1 rectal abscess and 1 prostatic abscess). Dodi and *colleagues* evaluated the outcome of NASHA/Dx injection in 86 patients in a multicentre study. Fifty percent reduction in the number of FI episodes from baseline was observed in 57.1% and 64.0% of patients at 6 and 12 months respectively. There was also significant improvements in the total number of both solid and loose FI episodes, FI free days, CCIS, and FIQoLS in all 4 domains. Ninety eight percent of the treatment-related adverse effects resolved spontaneously,

In conclusion, our systematic review of the published literature for injectable bulking agents has identified methodological variation between studies. In general, the technique is safe but complications can occur. The route of injection appears to influence the likelihood of complications. Seventy percent of patients have an early clinical response from injections but less than fifty percent of patients are able to maintain this response on maximum follow-up. The choice of material for injection is important and is likely to influence the outcome. The use of a general anaesthetic for the injection of bulking agents and the use of laxatives in the postoperative period is also associated with favourable outcomes.

5.2. Study-5- The use of Permacol® bulking agent for the treatment of faecal incontinence

5.2.1 Abstract

5.2.1.1 Objectives

Perianal bulking agents have been described for the treatment of faecal incontinence; however, numerous materials and techniques for injections of these agents have been described in the published literature. The aim of this study is to assess the safety and efficacy of Permacol® implant for the treatment of idiopathic faecal incontinence using a novel injection technique.

5.2.1.2 Methods

Patients with idiopathic passive faecal incontinence were selected for trans-submucosal injection of Permacol® after assessment by anorectal physiology, endoanal ultrasonography and pudendal nerve testing. Clinical assessment and St. Mark's incontinence score were used to evaluate efficacy before and at two time points (1 and 2 years) after treatment. Rockwood Score were also used to determine quality of life before and after treatment. The Friedman and Chi-Square test was used to compare continuous and categorical data respectively. A *p*-value of less than 0.05 was deemed significant.

5.2.1.3 Results

Thirty eight patients (24 female) with a median age of 66 (IQR 56-77) years were recruited. At maximum clinical follow-up (median of 9 months), response to Permacol® injections was categorised as excellent (complete/almost complete continence) in 12, good in 5 , fair in 4 and poor in 17 patients. Three patients who had initial improvement demonstrated a relapse during their final clinical assessment. St.

Mark's Incontinence Score improve in 72% and 63% of patients with idiopathic faecal incontinence following trans-submucosal Permacol® injection, at 1 and 2 years after treatment respectively. However a smaller proportion of patients (39% and 27% respectively) achieved a 50%, or more, improvement in Mark's Score during the same assessment periods. All four domains of Rockwood Quality of Life Score improved during the first year but only two domains, i.e. coping and embarrassment were statistically significant. Although all domains remained better at 2 years after treatment when compared with before treatment there was a subsequent decline in quality of life in these patients when compared with that at 1 year post treatment.

5.2.1.4 Conclusion

Permacol® injection improved symptoms by greater than 50 percent in 39% and 27% of patients on short and medium term follow-up respectively. The trans-submucosal technique for injection of Permacol® in this study was safe and no adverse outcomes were noted.

5.2.2 Introduction

Since the first report by Shafik and *colleagues* in 1993 (361) a variety of anal bulking materials and injection techniques have been described(383). The ideal method of injection has not yet been established (186), neither has the most effective injectable material.

The aim of this study was to assess the safety and efficacy of Permacol® implant (Tissue Science Laboratories, Aldershot, Hampshire, United Kingdom), which is designed to maintain a long standing increase in bulk, for the treatment of idiopathic faecal incontinence using a novel injection technique in a cohort of patients by a retrospective assessment of prospectively collected data . To our knowledge this is the largest series of patients treated with Permacol® injection for faecal incontinence. The only previous published study reported the efficacy of Permacol® in 5 patients (334).

5.2.3 Methods

5.2.3.1 Patients

Patients with passive faecal incontinence to solid or liquid stool who were classified as having idiopathic faecal incontinence according to the Leeds Classification of Faecal Incontinence(74) (table. 5.10) were considered for trans-submucosal Permacol® injection. All patients underwent anorectal physiology, endoanal ultrasound and pudendal nerve testing. Those with no evidence of sphincter defect or neuropathy were considered eligible for the study. Prior to Permacol® injection all eligible patients were seen in the out patient clinic by the senior author who is a Consultant Colorectal Surgeon with a specialist interest in faecal incontinence. The procedure was explained to the patient in detail and a patient information sheet was offered. No specific exclusion criteria were applied.

Classification Incontinence	score	Results of anorectal physiology
Continent	0	Any
TFI	>0	Sphincter defect, no neuropathy
CFI	>0	Sphincter defect, neuropathy
NFI	>0	Normal sphincters, neuropathy
IFI	>0	Normal sphincters, no neuropathy

Table 5.10: Leeds Classification of Faecal Incontinence TFI, traumatic faecal incontinence; CFI, combined faecal incontinence; NFI, neuropathic faecal incontinence; IFI, idiopathic faecal incontinence

5.2.3.1.1 Inclusion criteria

- Adult consenting patients with passive faecal incontinence to solid or liquid stool.

- Only patients classified as having idiopathic faecal incontinence according to the Leeds Classification of Faecal Incontinence. All patients underwent anorectal physiology, endoanal ultrasound and pudendal nerve testing. Those with no evidence of sphincter defect or neuropathy were considered eligible for the study

5.2.3.1.2 Exclusion criteria

- Patient with traumatic faecal incontinence, neuropathic faecal incontinence or combined faecal incontinence according to the Leeds Classification of Faecal Incontinence were excluded from the study.

5.2.3.2 Selection and follow-up periods

Eligible patients who underwent trans-submucosal Permacol® injection in the period from January 2007 to July 2010 were included in this study. Clinical follow–up was performed at a median of 12 weeks and 12 months. Follow-up with SMIS and Rockwood Quality of Life assessment was determined at 1 and 2 years following the procedure.

5.2.3.3.Ethical Consideration

This study was approved by the Research and Development Committee in York Teaching Hospital. It did not require approval under the Research Governance Framework for Health and Social Care as it was conducted in accordance with *IPG210 (Interventional procedure guidance 210) Injectable bulking agents for faecal incontinence, NICE guidance, Section 1.2.*

5.2.3.4. Preoperative assessment

Clinical assessement including a detailed obstetric history for female patients was performed. This included the recording of the number of vaginal deliveries, forceps deliveries, perineal tears, episiotomies and prolonged labour. Anal manometric variables were obtained using an eight-channelled solid-state transducer catheter (Flexilog 3000, Oakfield Instruments Ltd, Evensham, Oxon, UK) using a continuous "pull through" technique. Manometric data were analysed using commercial software (Flexisoft III, Oakfield Instruments Ltd, Evensham, Oxon, UK). This included calculation of the maximum mean resting pressure (MMRP), maximum mean squeeze pressure (MMSP) and vector volumetry (VV). EAUS was performed using a standard 2D 10 mHz probe (B&K, Denmark). Colonic imaging was also performed where indicated. Questionnaire were used to assess all patients pre and postoperatively. The St. Marks questionnaire is a faecal incontinence score(326) which assesses severity, where zero indicates complete continence and 24 represent the worst incontinence possible. The Rockwood Faecal Incontinence Quality of Life Score (FIQoLS)(264), is derived from a 29 item questionnaire comprising of four domains each one ranges from 1 to 4; with a 1 indicating a lower functional status of quality of life.

5.2.3.5.Material (Injectable Implant)

Permacol® (Tissue Science Laboratories, Aldershot, Hampshire, United Kingdom) is cross linked porcine dermal collagen. It has been designed to resist breakdown by collagenase in the body and maintain a long standing increase in bulk. The product is biocompatible and once injected is incorporated into host tissue, with associated cellular and microvascular ingrowth. There has been no evidence of irritancy or allergenicity(384, 385). The delivery system of Permacol® consists of two 3ml syringes (one of which is marked with a 3 cm scale with 1 mm increments) connected by a mixing adaptor. Each ml contains a cross linked porcine dermal collagen matrix in 60mg of saline. Before usage, the product is passed between the two syringes via the mixing adaptor several times so that the product is finally in the syringe labelled with the scale. This creates a homogenous suspension of Permacol® which is ready to inject.

5.2.3.6. Permacol® injection technique

Trans-submucosal Permacol® injections were performed under general anaesthesia in Lloyd Davis position. Prophylactic antibiotics or bowel preparation were not used. The perianal skin was prepared with Povidone Iodine solution. An Eisenhammer rectal speculum was used to maximise exposure of the anal canal with care been taken not to stretch the internal anal sphincter. Under direct vision, 1.5 ml of Permacol® was injected at each of the four quadrants of the anal canal (anterior, posterior and both lateral quadrants) with an 18-gauge 1.5 inch needle (figure 5.3). The puncture site was the skin at the anal verge. The needle was then advanced proximally in the submucosal plane under vision, taking care not to breach the anal mucosa. When the needle tip was approximately 5 mm above the dentate line, the implant was injected into the submucosal layer (figure 5.4). A visible bulge at the injection site indicates correct placement of the implant in the submucosal space (figure 5.5). After injection the needle was retained *in situ* for few seconds before being slowly withdrawn. The technique is repeated for all four injection sites. The procedure was done as a day case and patients were discharged according to the Day Unit Discharge Protocol. There was no requirement for postoperative antibiotic or laxatives. The technique used to inject Permacol® was performed by a single surgeon and was the same for all patients.

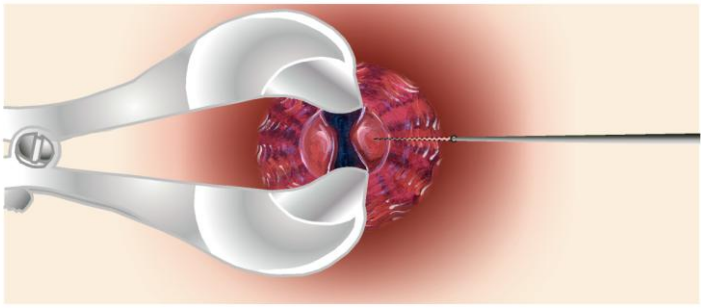


Figure 5.3: Eisenhammer rectal speculum used to maximise exposure of the anal canal. The puncture site is the skin at the anal verge. The needle is then advanced proximally in submucosal plane under vision.

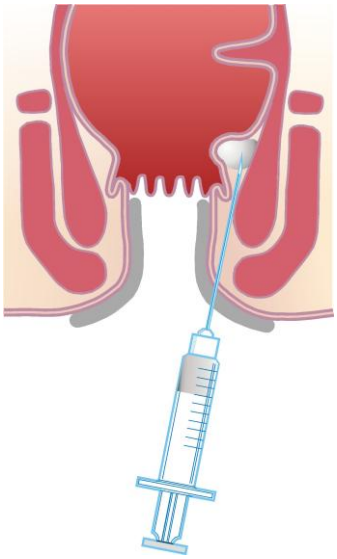


Figure 5.4: Schematic view of trans-submucosal Permacol injection. When the needle tip is 5 mm above dentate line, the implant is injected

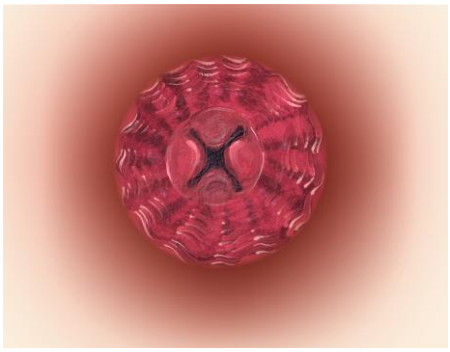


Figure 5.5: A visible bulge at the injection site indicates correct placement of the implant in the submucosal plane. 1.5 ml of Permacol_ was injected at the 3, 6, 9 and 12 o'clock positions

5.2.3.7.Follow-up

5.2.3.7.1. Clinical assessment

Clinical follow-up consisted of an early postoperative clinic appointment where all patients were reviewed by the senior author and categorised into 4 groups according to their subjective response to the treatment (table 5.11). A second clinical assessment was performed 1year postoperatively by an independent researcher using a similar approach.

Ranking	Details
Excellent	Complete or almost complete continence (no FI or ≤ 1 incident per month during the follow up Period)
Good	Significant reduction in frequency & volume of FI (the number of incidents of FI was reduced by 50% or more)
Fair	Some reduction in frequency & volume of FI (reduction in the number of incidents of FI is less than 50%)
No response	No improvement or worsening of FI

Table 5.11: Ranking of patients according to their clinical response. FI: faecal incontinence.

5.2.3.7.2 St. Mark's Incontinence Score and Rockwood Quality of Life assessments

St. Mark's Score and Rockwood Quality of Life Score (QoLS) were assessed at two time points, 1 and 2 years after Permacol® injection. An improvement of 50% or more in St. Marks Incontinence Score was considered a "successful outcome".

5.2.3.8. Data collection

Data were collected and entered into a password-protected Excel sheet, where they can only be identified by the assigned "identification code", by the principal investigator (ZH). The Excel sheet is stored on a password-protected NHS computer in York Teaching Hospital.

5.2.3.9. Data analysis

Data were assessed using Microsoft Excel Spreadsheet (Microsoft Corporation, Seattle, WA, USA) and statistical analysis was performed using SPSS v14.0 (SPSS Inc.,

Chicago, Illinois, USA). The Friedman test was performed for comparison of baseline St. Marks incontinence score and Rockwood quality of life scores with post-treatment scores. The Chi-Square test was used to compare categorical variables (sex, number of deliveries, perineal tear, long labour and episiotomy) and the Mann-Whitney U-test was used to compare continuous variables (age, VV, MMRP and MMSP). Univariate analysis was performed to identify predictors for a successful outcome . *P*-values of 0.05 or less was considered significant.

5.2.4 Results

Thirty eight patients (24 female) with a median age 66 (IQR 56-77) years with idiopathic passive faecal incontinence underwent treatment with Permacol® injection. Patient demographics and obstetric histories are detailed in table 5.12. Pre-treatment anorectal manometric values showed a median MMRP of 38 (IQR 28-58), a median MMSP of 61 (IQR 45-109), a median resting vector volume (RVV) 23,806 (IQR 15,315-44,926), a median Squeeze vector volume (SVV) 43,012 (IQR 28,954-95,553), a median resting asymmetry 10.8% (IQR 0.35-22.90%), and a median squeeze asymmetry of 7.05% (IQR 0.16-15.30%). All patients had intact internal anal sphincter (IAS) and external anal sphincter (EAS) on pre-treatment EAUS, although five patients had evidence of IAS degeneration. All patients who underwent treatment did so as a day case procedure and all were discharged on the same day. There were no immediate complications or adverse events.

Gender	Number		Vaginal delivery	Forceps Delivery	Prolonged labour	Episiotomy	Perineal tear
Female	24	Yes	21	2	15	11	5
		No	3	22	9	13	19
Male	14		N/A	N/A	N/A	N/A	N/A

Table 5.12: Patients demographics and obstetrical history

5.2.4.1 Clinical assessment

First clinical follow-up was at a median of 12 weeks (IQR 9 - 16 weeks). None of the patients experienced pain or sepsis following treatment; however, one patient reported leakage of the implant 10 days following the procedure. Patient responses are shown in table 5.13. Second clinical assessment was at a median of 12 months (IQR 11-15) post treatment. At maximum follow-up of all patients, 12 patients were ranked excellent, 5 good, 4 fair and 17 poor, in terms of their clinical response to Permacol® injection. Three patients who had initial improvement (2 excellent, 1 good) during the first clinical assessment demonstrated a relapse during the second assessment (1 fair and 2 poor) in a median of 19 (IQR 14-27) months following the procedure (table 5.13).

Ranking	Excellent	Good	Fair	Poor
1st Assessment	14	6	3	15
2nd Assessment	12	5	4	17

Table 5.13.: Clinical assessment at 12 weeks and 12 months following Permacol® injection.

5.2.4.2 St Mark's Incontinence Score

St Mark's Incontinence Score were assessed at two time points, one and two years, after the procedure. At one year St Marks Incontinence Score significantly improved compared to baseline, 8 (IQR 5-12) vs. 13 (IQR 9.5 – 18) ($p < 0.001$). Although the median St Marks Incontinence Score remain improved at 2 years, (median score 10 (IQR 6.5 – 14) when compared with baseline, this had declined when compared with scores at 1 year (table 5.14).

Improvement by 50% or more was only seen in 39% patients at 1 year. This declined to 27% of patients at 2 years.

Preoperative, median (IQR)	1 year follow-up, Median (IQR)	2 years follow-up, median (IQR)
13.00 (9.5–18.0)	8.0 (5.0–12.0)	10.00 (6.5–14.0)

Table 5.14: St. Mark's Incontinence Score before, 1 year, and 2 years after the procedure.

5.2.4.3 Rockwood Quality of Life Score

The Life Style Scale of the Rockwood Quality of Life Score improved from a median of 3.4 (IQR 2.6 – 3.8) to 3.8 (IQR 3.0 – 4.0) and 3.5 (IQR 2.5 – 4.0) at one and two years follow-up respectively (p = 0.248). The median Coping Score was 2.6 (IQR 2.1 – 3.0) at baseline and significantly improved at one year to 3.0 (IQR 2.6 – 3.7) and at two years to 2.7 (IQR 2.1 – 3.5) (p = 0.003). Depression Scale also improved from a median of 3.0 (IQR 2.2 – 3.7) to a median of 3.4 (IQR 2.6 – 3.9) at one year and 3.2 (IQR 2.5 – 3.6) at two years (p = 0.09). Finally the Embarrassment Scale demonstrated a significant improvement from a median of 2.3 (IQR 2.0 – 2.7) to 3.0 (IQR 2.2-3.8) and 2.4 (IQR 2.0 to 3.4) at one and two years follow-up respectively (p = 0.02) (table 5.15).

	Scale 1: Life style	Scale 2: coping	Scale 3: Depression	Scale 4: Embarrassment
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)
Preop	3.4 (2.6-3.8)	2.6 (2.1-3.0)	3.0 (2.2-3.7)	2.3 (2.0-2.7)
One year follow up	3.8 (3.0-4.0)	3.0 (2.6-3.7)	3.4 (2.6-3.9)	3.0(2.2-3.8)
Two years follow up	3.5(2.5-4.0)	2.7(2.1-3.5)	3.2(2.5-3.6)	2.3(2.0-3.5)
P-value	0.248	0.003	0.09	0.002

Table 5.15: Rockwood Faecal Incontinence Quality of Life Scales before, 1 year, and 2 years after the procedure.

5.2.4.4 Predictors of a successful outcome

There were no predictors of a successful outcome (such as age , gender, MMRP, MMSP, RVV, SVV, resting asymmetry, squeeze asymmetry, history of prolonged labour, perineal tear or episiotomy) for assessments at 1 and 2 years.

5.2.5 Discussion

This study showed that St. Mark's Incontinence Score improved in 72% and 63% of patients with idiopathic faecal incontinence following trans-submucosal Permacol® injection, at short and medium term follow-up respectively. However only 39% of patients achieve a 50%, or more, improvement in St. Mark's Score in the short term. The percentage falls to 27% at medium term follow-up. On the other hand, at longest clinical follow-up (median of 9 months) 45% of patients were ranked excellent or good.

The current success rate and durability of symptomatic control after Permacol® injection make it an acceptable option for managing idiopathic faecal incontinence owing to the simplicity, minimal invasiveness, safety and low cost. This treatment provides symptomatic improvement in faecal incontinence in patients with idiopathic faecal incontinence. Alternative treatments exist but the majority of options are invasive. Results of postanal repair or total pelvic floor repair are variable (386, 387). Replacement of damaged or non-functioning anal sphincter complex by dynamic graciloplasty(6) or artificial bowel sphincter(7) have resulted in an improvement in continence in more than 50% of patients, but such surgery has significant morbidity(8). Sacral neuromodulation has shown promising results, however, it is costly and only available in specialised centres(8)

At longest follow-up most of the patients, who had an initially successful outcome following Permacol® injection, maintained their response. Therefore the effect of Permacol® implant seems to be maintained in the medium-term and that is consistent with the finding from the pilot study by the St. Mark's group(334). However the continued improvement in continence over the first 6 months after injection that was

described with PTQ by some authors(333, 341) was not demonstrated in this study with Permacol®.

It is not clear which group of patients respond to injection of bulking agents. Previous studies used variable criteria for patient selection. While some authors strictly included patients with IAS defect on pre-operative endoanal ultrasonography (186, 343), others excluded any patient with a sphincteric defect(184). Within this spectrum lie many patients(183, 184, 333) who had various degrees of sphincteric degeneration. In this study no patients were found to have sphincteric or pudendal nerve abnormalities and treatments were therefore administered to a cohort of patients who we felt had idiopathic faecal incontinence. This may partially explain the significant difference in response to treatment between patients.

Several injection techniques have been described in literature (179-182, 335, 388). To date there is no evidence that one technique is superior. In this series, complications such as, perianal sepsis, allergic reaction or persistent anal pain were not encountered; furthermore pre-procedure testing of the injectable material was not required.

The rationale of using the Eisenhammer rectal speculum and performing the injection of Permacol® under general anaesthetic was to achieve good exposure of the anal canal in order to place the implant in the intended site above the dentate line, under direct vision, and avoid inadvertent breaching of the anal mucosa whilst advancing the needle in the submucosal plane. The reason for choosing 4 sites of injection was to create a greater degree of closure in the anal canal by the circumferential and symmetric tissue expansion caused by the bulges of the implants. In our experience a total volume of 6 ml of Permacol® was usually sufficient to create the adequate tissue expansion. The puncture site at the skin of the anal verge, which is about 3-4 cm away from the site of the implant placement, minimises the chance of leakage of the implant and seems to be associated with minimal risk of infection.

This technique differed substantially from those described in previous papers. St. Mark's group used a trans-sphincteric injection into the anal cushions(179, 180). Other authors injected bulking agents directly into the submucosal space through the anal mucosa(181, 182, 355, 358). Chan and *colleagues* believed that both previous

techniques may increase the risk of sepsis and erosion of implants(340) and adapted the technique described previously by the same group which is a trans-sphincteric injection of the implant material into the inter-sphincteric space(333, 335). Aigner and *colleagues* and Beggs and *colleagues* inserted the needle through the inter-sphincteric groove and delivered the implant into the submucosal plane and inter-sphincteric space respectively(181, 182, 355, 358). In all of the above techniques the procedure was covered with prophylactic antibiotics.

The role of prophylactic antibiotics described by many authors(178-180, 183, 186, 326, 332, 334, 335, 339-342, 350, 352, 361) is not clear. In this study we did not use any antibiotics and there was no incidence of sepsis or perianal abscess in any of the patients in this series. This approach has been advocated by others (181, 182, 355, 357, 358).

Apart from one previously published pilot study of 5 patients treated with perianal Permacol® injection (334), this is the only study that describe the used of Permacol® for the treatment of faecal incontinence. However this study was limited by its retrospective nature. Some patients have been followed for longer periods than others which might have led to variability in outcomes. In addition the first clinical assessment was carried out by the senior author who initially preformed the procedure, which could create a potential bias.

Trans-submucosal injection of Permacol® for the treatment of faecal incontinence is a safe technique that allows adequate exposure of the anal canal with a reasonable success rate and minimal risk of leakage of injectable material. It is a good option in managing patients with idiopathic faecal incontinence who are particularly difficult to treat, especially those with associated co-morbidity who might not be suitable for more invasive form of management.

A larger and well powered randomised control trial is required to verify the best bulking agent and the most effective injection technique for the treatment of faecal incontinence.

6. Discussion

Management options in faecal incontinence are varied, ranging from conservative management with dietary modification, medications and behavioural interventions(5) to supplementation of damaged or non-functioning anal sphincter complexes by means of a dynamic graciloplasty(6) or artificial bowel sphincter(7). A recent systematic review of faecal incontinence reported a trend favouring conservative management, such as biofeedback and less invasive surgical procedures, amongst which the more promising are sacral neuromodulation, the SECCA procedure, posterior tibial nerve stimulation and injectable bulking agents. Most of these treatment modalities have been discussed in details in previous literature, however, notable advances have been a change in perspective when treating faecal incontinence, from a rather blinkered concern about a local abnormality such as sphincter defect to a more holistic approach involving the pelvic floor, rectum, colonic transit and, most importantly, psychological wellbeing(8). To the best of our knowledge, no previous study has addressed the influence of providing a seamless multidisciplinary care to patients with faecal incontinence in a timely fashion, by mean of clinical pathway model, on the overall patient care and clinical outcome and that was the focus of this thesis.

When patients managed in the IRAT Pathway were compared to the Standard Care Pathway, there was no significant difference in overall quality of care which, in addition to a non-significantly different outcome measures (FIQoLS, CCIS and SMIS), indicated that the introduction of the IRAT Pathway did not have a major impact on clinical outcomes. In spite of the insignificant difference in outcome measures, patients' satisfaction seemed to increase with the use of the IRAT pathway. Patients in the IRAT Pathway also had a stronger agreement that all aspects of their problem were addressed. This could reflect the support and thorough education that patients in this group received along with the interaction with the pelvic floor and biofeedback therapists, both in clinic and in laboratory. It seems that the multidisciplinary and systematic approach to investigation and treatment and the presence of clear management plan, which encouraged patients to take an active role in their own management, all helped to achieve a better patients' satisfaction.

The success of integrated services in delivering high quality care stresses the crucial role of systematically establishing infrastructure and actively developing champions, teams and staff (389). The provision of high-quality care for incontinence appears to be dependent upon well-organised services with personnel who have the appropriate training and skills to deliver the care. However, many of the organisational characteristics, such as implementing evidence-based clinical practice guidelines, identifying guideline champions and providing regular feedback on performance measures to providers, to enhance the delivery of care in their settings, are not necessarily structural, but where well-organised services exist, it is more likely that these factors become ingrained into service provision(390).

In The IRAT pathway, patients had regular, predetermined encounters with various members of a multidisciplinary team in a non-time-pressured environment and had the opportunity to discuss various aspects of their problem. Throughout, they were provided with advices, solutions and explanations, which eventually helped them to set realistic and achievable expectations. This approach can be introduced to any clinic that manages patients with faecal incontinence without imposing the stringent timetable of a clinical pathway. The possible financial implications and increased organisational burden, required to support various components of a clinical pathway, can thus be minimised whilst maintaining the same quality of care and patients' satisfaction.

Currently, few clinical and economic evaluations of treatment options for faecal incontinence exist; randomised controlled comparisons present formidable ethical and practical problems when placing a patient into a treatment modality that may not be the most suitable for his particular condition(391). Also comparisons in such studies would be between completely different set of complications (391), rate of recovery and follow-up requirements. Comprehensive evaluation requires a clearly defined perspective, a sufficiently long time horizon, *appropriate measures of health outcome, assessment of quality of life* and detailed measures of short-term and projected resource utilization. Although unfamiliar to many clinicians, these complex issues require increasing attention by those wishing to demonstrate the true value of new interventions for faecal incontinence(391). Therefore, to be able to measure the value of implementing the IRAT pathway we needed to select accurate assessment tools, with acceptable validity and reliability, to measure health outcomes and quality of life. The

lack of standardised assessment tools in faecal incontinence makes it a rather difficult task to perform such assessment.

Avery and *colleagues* (249) indicate in their systematic review on questionnaires used to assess urinary and faecal incontinence, at best, a grade C recommendation for the SMIS and CCIS. This means that these scores are in the early stages of development and further study is required and encouraged. No questionnaire used in the assessment of FI was identified as meeting the grade A criteria (highly recommended: validity, reliability and responsiveness established with rigor) and only three attained a grade B status, including the FIQoLS (127), the Manchester Health Questionnaire (237) and the Birmingham Bowel and Urinary Symptoms Questionnaire(255).

St Mark's Incontinence Scores (SMIS) and Cleveland Clinic Incontinence Scores (CCIS) are used to assess the severity of faecal incontinence, while Rockwood Quality of Life Scales (FIQoLS) is used to assess condition-specific quality of life. These assessment tools are among the most widely used assessment tools in current literature, and indeed in our unit. In order to assess the reliability of these assessment tools in measuring the clinical outcomes and quality of life we conducted our second study in this thesis; the test-retest reliability of FI severity and quality of life assessment tools.

Test-retest reliability is the most relevant evaluation of reliability in the setting of clinical medicine because the constructs we attempt to measure are heterogeneous. In addition, **intra-observer** test-retest reliability analysis can determine whether these questionnaires reflect the global disease burden over a defined period of time or whether daily variation in symptomatology and the lack of consistency in the construct of these instruments influence their score to an extent that renders them meaningless when used to compare different modalities of managements or measure the success rate of a certain treatment. On the other hand, **inter-observer** test-retest reliability analysis is a good measure of variation in outcomes of these questionnaires when completed by different assessors and whether they correlate well when compared to self-completed questionnaires.

This study showed that CCIS, SMIS and FIQoLS all have good test-retest reliability and adequately reflect the global disease burden. Therefore, they are appropriate tools to objectively measure symptoms and compare various management modalities.

The fundamental reason for the less than satisfactory results usually achieved when managing FI is likely to be our failure to fully understand the continence mechanism and how this is affected in patients with faecal incontinence. Anorectal physiology studies were developed to assess faecal incontinence and sometimes used in the evaluation of chronic constipation. It involves endoanal ultrasound, manometry and pudendal nerve studies and provides quantitative measurements of the anatomy and function of the muscles and nerves of the anal sphincter complex(292) in an attempt to diagnose the underlying defect in continence mechanism and assist in choosing the right treatment option. However, several problems with anorctal investigation have been identified, such as the lack of standardization and the issue of reproducibility of these tests(327). In addition, many treatment strategies that have been gaining an increasing popularity such as SNS, PTNS, TENS and IBA are of uncertain mechanism. There have been conflicting reports about how would these interventions influence anorectal physiology studies.

In previous studies, anorectal manometery and EAUS findings in various group of patients, for example continent Vs incontinent, were measured and reported as a percentage of normal and abnormal results in each group(392). However, the lack of standardization and the absence of normative data from significant numbers of normal patients(327) make it rather difficult to determine what “normal values” are for a particular age, sex and other patient characteristics.

Other studies measured the changes in anoretal manometric values after various interventions. The use of IBA did not seem to influence anoretal manometric measures, even in the presence of a significant symptomatic improvement(1, 179, 326). While some studies showed minimal or no change in resting pressure and increased squeeze pressure following SNS implantation, others showed no significant changes in both resting and squeeze pressures with stimulation(137, 393, 394). Similarly conflicting observations were reported with other interventions, such as overlapping sphinctroplasty. Variables such as MMSP, MMRP, VV, RAI, SAI, rectal volumes and

pudendal nerve studies have been shown to significantly change following this procedure in some studies, while others failed to replicate these findings(120, 395-398).

Even a significant endosonographic abnormalitis such as anal sphincter defect, previously considered as an exclusion criteria from undergoing SNS, has now been shown to be indeterminate finding and an interesting success rate with SNS in this group of patients has been demonstrated without doing anything to the damaged sphincter(396, 397).

In our third study; the correlation between anorectal physiology studies and patients' symptoms, we assessed the correlation between the anorectal physiological measurements and the severity of faecal incontinence, measured by St Mark's Faecal Incontinence Score (SMIS), and compared these measurements in patients with & without faecal incontinence, and among three subgroups of incontinent patients ***at baseline,*** i.e. at the stage of management when decisions about the treatment modality of choice is made, rather than merely reporting changes after various intervention, and thus directly influencing patient care and outcome.

In stead of reporting a percentage of normal and abnormal results in each group, we attempted to measure the correlation between the absolute values of these studies and the patients' symptoms and whether these values vary significantly among the different groups of patients.

This study showed weak correlation between anorectal physiology studies and the severity of FI. This weak correlation was only significant when mean rectal pressures, vector volumes and asymmetry index were measured. Of all anorectal studies, only four manometric parameters, namely the MMRP, MMSP, rVV and sVV, demonstrated consistently significant variations when measurements were compared between the different groups of patients in this study, i.e. incontinent patients versus continent patients and among the three subgroups of incontinent patients.

Several problems with anorctal investigation have been identified previously (327). However, the weak correlation of anorectal investigation parameters with patients'

symptoms represents another serious problem and raises the question of the value of performing many of these tests.

It is uncertain to what extent these studies are required to plan patients' management and how it would affect the choice of treatment. Moreover, it is not clear what group of patients would respond to a particular treatment based on the results of these investigations. Moy *and colleagues* found that SNS was equally effective independent of the aetiology, the manometric results and the endosonographic findings(397). Even when some enthusiasts advocated the important influence of anorectal physiology on the management of incontinent patients (328-330) the outcome of treatment has not been shown to be influenced by performing these tests. At the present, it seems more logical to rely on thorough clinical assessment when evaluating patients' requirements, choice of treatment and response.

As for any other condition for which several treatment options are available, choosing the appropriate procedure for treating FI, when patients failed to respond to conservative management, is a complicated process that depends on several factors including patient-related comorbidities, procedure-specific risks, and the underlying cause of FI. This also means that there is no gold standard in the management of FI as yet.

Once conservative and medical management options have been exhausted, minimally invasive intervention such as SNS, IBA, PTNS and TENS should be considered. Alternative treatments exist but the majority of options are invasive. Results of postanal repair or total pelvic floor repair are variable(386, 387). Replacement of damaged or non-functioning anal sphincter complex by dynamic graciloplasty(6) or artificial bowel sphincter(7) have resulted in an improvement in continence in no more than 50% of patients and are associated with significant morbidity(8). Unfortunately, the results of these surgical options are, in general, rarely good, with many adverse outcomes (138, 399-403). A significant advance in the management of FI has been the development of conservative therapies and minimally invasive procedures which have considerably reduced morbidity. Clearly it is more appropriate to attempt the simpler and less disfiguring interventions in the first instance.

Patients which FI are frequently in poor general health with significant comorbidities and may be poor surgical candidates. These patients may benefit most from the least invasive procedure, which is the injection of a bulking agent. The Secca procedure and SNS are also considered minimally invasive, but they are costly, performed in a monitored setting under some form of anaesthesia, and require sophisticated instrumentation, only available in specialised centres(8).

Faecal incontinence makes major demands on healthcare resources. At a time of increasing pressure on health budgets, there is a growing requirement to demonstrate the clinical effectiveness and cost-effectiveness of new treatment options in order to make the best use of resources and improve care(391).

A systematic review on SNS has shown that 75–100 per cent of incontinent patients are improved, with 41–75 per cent becoming completely continent at 1–99 months(404). However, like artificial anal sphincter and stimulated graciloplasty, SNS is extremely high-maintenance procedure that mandate that the patients have complete appreciation of the complexity of the hardware, basic knowledge in pelvic and anorectal anatomy, and full commitment to daily operation and maintenance of the devices; they should also be aware of complication rate, be able to recognize the early signs of failure, and be mentally prepared for re-operations(405).

Conversely, injectable bulking agents do not require any maintenance or routine follow-up and thus may be more suitable for elderly patients, patients with comorbidities and those who have impaired mental capacity(405). Therapeutic strategies are dependent on local expertise and available facilities(8), therefore IBA is an attractive option in units with limited resources and infrastructure, making a potential treatment of FI more widely available at an affordable budget and contributing to the overall improvement in the quality of care provided.

In our unit, we offer trsns-submucosal Permacol® injection to patients with idiopathic faecal incontinence who failed to respond to conservative and medical management. In our **fourth study**, we conducted a systematic review to investigate the various injectable agents and techniques used for the treatment of faecal incontinence and assessed the safety and efficacy of these techniques, while in the **fifth study** of this

thesis we reported the safety and efficacy of Permacol® implant for the treatment of idiopathic faecal incontinence using a new injection technique. The current success rate and durability of symptomatic control after Permacol® injection make it an acceptable option owing to the simplicity, minimal invasiveness, safety and low cost.

It is not clear which group of patients respond best to injection of bulking agents. Previous studies used variable criteria for patient selection. While some authors strictly included patients with IAS defect on pre-operative endoanal ultrasonography (186, 343), others excluded any patient with a sphincteric defect(184). Within this spectrum lie many patients(183, 184, 333) who had various degrees of sphincteric degeneration. In our study, no patient was found to have sphincteric or pudendal nerve abnormalities and treatments were therefore administered to a cohort of patients who we felt had idiopathic faecal incontinence.

Various materials and techniques for injection of these bulking agents have been described in the literature. Therefore, we conducted a systematic review to investigate the various injectable agents and techniques used, and assess their safety and efficacy. Our systematic review of the published literature on injectable bulking agents has identified methodological variation between studies. In general, the technique is safe but complications can occur. The route of injection appears to influence the likelihood of complications. Seventy percent of patients have an early clinical response from injections but less than fifty percent of patients are able to maintain this response on maximum follow-up. The choice of material for injection is important and is likely to influence the outcome. The use of a general anaesthetic for the injection of bulking agents and the use of laxatives in the postoperative period is also associated with favourable outcomes.

PTNS and TENS are relatively new techniques with promising results, however, the literature available on these interventions is rather limited and larger well designed studies are required, not only to assess the efficacy of PTNS and TENS, but also to determine the optimum technique, such as stimulatory strength, timings and length of treatment. Magnetic anal sphincter(409) and transcutaneous sacral nerve stimulation(410) are two novel techniques in the management faecal incontinence. Thye are calamined to be easy to implement, affordable and requiring minmal follow-

up. However, they are still in the early stages of development and it would be interesting to see some large studies with adequate follow-up period to evaluate their safety and efficacy.

In summary, a well-organised service with systematic multidisciplinary approach to patient management, implementing evidence-based clinical practice, is the first step to delivering a high quality care. Comprehensive patient evaluation requires the use of appropriate and reliable measures of health outcome and quality of life. Investigations of continence mechanism should focus on the measures that truly reflect patient's underlying problems and influence their management. The extensive use of investigations that poorly relate to patient's clinical condition may cause an unnecessarily anxiety and discomfort, in addition to the unwise use of available resources. A holistic and patient oriented approach to management is a paramount. Several factors influence the choice of the most appropriate treatment. These include patient factors, procedure complexity and efficacy, available resources and infrastructure and local expertise.

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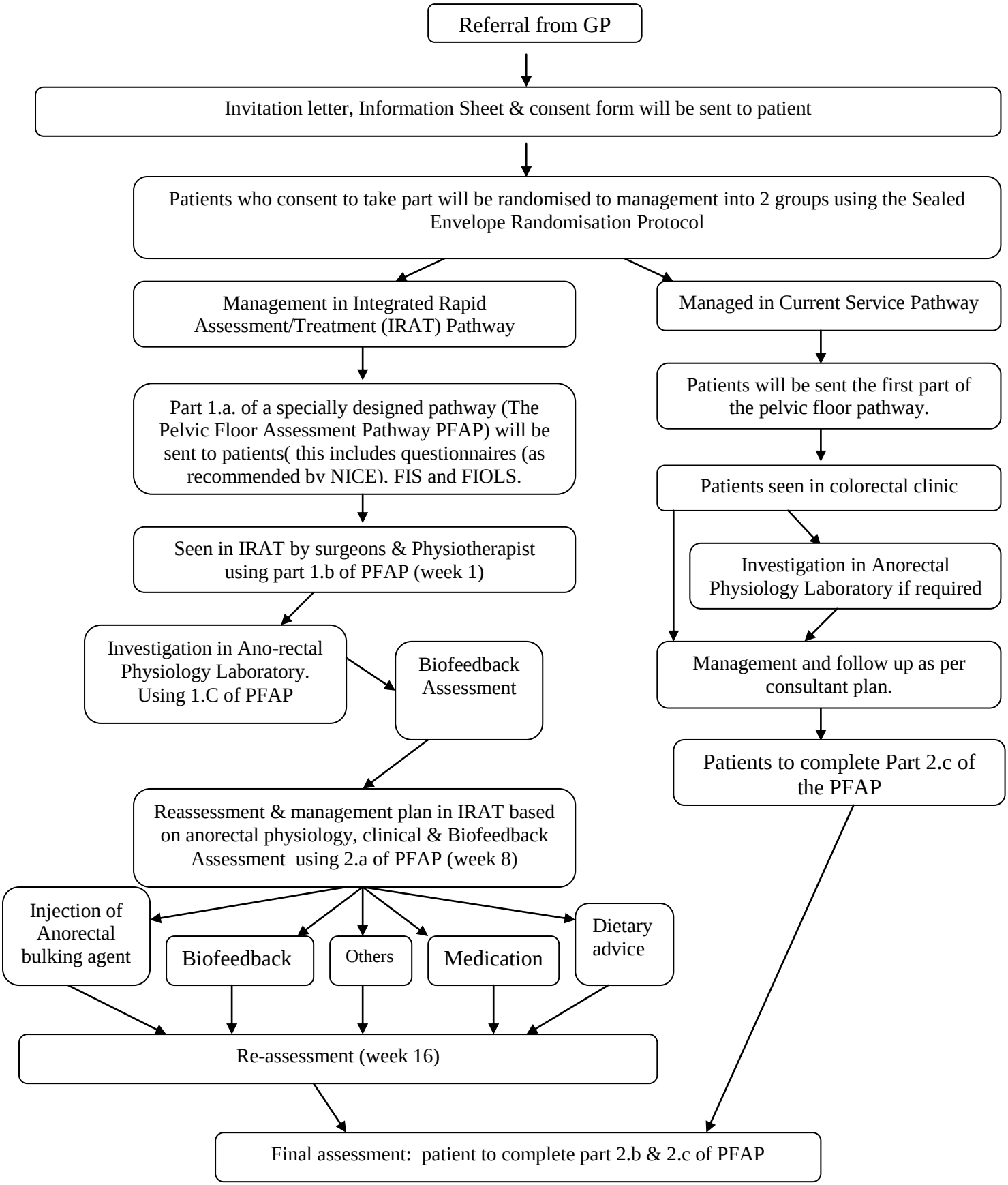
Appendices

Appendix 2.2: Patient's Satisfaction and Feedback Form

2.c Patient's Feedback

Please rate your degree of satisfaction with each of the following aspect	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
6. The waiting time from seeing your GP until been seen at York hospital was acceptable.	❑	❑	❑	❑	❑
7. The waiting time from being seen at York Hospital until completing your treatment was	❑	❑	❑	❑	❑
8. The questions you were asked to complete were relevant to your problem?	❑	❑	❑	❑	❑
9. The questions you were asked to complete were clear and easy to answer?	❑	❑	❑	❑	❑
10. The questions you were asked to complete covered all aspect of your problem?	❑	❑	❑	❑	❑
11. You were supported and given clear advices/instructions throughout management.	❑	❑	❑	❑	❑
12. You were given enough time to explain your problem/concerns	❑	❑	❑	❑	❑
13. Your privacy and dignity were respected throughout management.	❑	❑	❑	❑	❑
14. The over all quality of care you received was high.	❑	❑	❑	❑	❑
Comments:					

Appendix 2.3: The algorithm of events in both IRAT study groups



Appendix 3.1: Descriptive faecal incontinence assessment systems

Author	Grading and Score
Parks(406)	1 = normal 2 = difficult control of flatus and diarrhea 3 = no control of diarrhea 4 = no control of solid stool
Kelly(231)	0 = 50% accidents, always soiling, absent sphincters 1 = occasional accidents, occasional soiling, weak sphincters 2 = no accidents, no soiling, strong sphincters Points 0-2= poor; 2-4= fair; 5-6= good
BROWNING (407) AND PARKS normal c	Category A: continence of solid and liquid stools and flatus **(i.e.** ontinence) Category B: continence of solid and usually liquid stools but not flatus Category C: partial return of function (following surgery) with acceptable continence for solid stool but no control over liquid stool or flatus: Category D: continued faecal leakage and indicated failure of the surgery.
Lane(233)	True incontinence = loss of faeces without knowledge or control Partial incontinence = passage of flatus or mucus under same conditions Overflow incontinence = result of rectal distension without sphincter relaxation

Rudd(234)	1 = continence
	2 = minor leak
	3 = acceptable leak
	4 -- unsatisfactory major leak
	5 = total failure
Holschneider(408)	Continence (resting tone at manometry > 16 mm Hg)
	Partial continence (resting tone at manometry 9-15)
	Incontinence (resting tone at manometry < 8)
Keighley and Fielding(232)	Minor = faecal leakage once a month or less, to diarrhoea
	Moderate -- incontinence once a week to solid stool
	Severe = incontinence in most days, perineal pad
Corman(241)	Excellent = continent at all time
	Good = continent but may require enemas
	Fair = incontinent for liquid stool
	Poor -- incontinent for solid stool
Hiltunen(239)	Continent, partially continent, totally incontinent
Broden (240)	1 = none
	2 = medium
	3 = severe incontinence
Womackl (242)	A = continence
	B = incontinence for liquid stool
	C = incontinence to flatus and diarrhea
	D = totally incontinent
Rainey (243)	A = continence
	B = incontinence to liquid stool
	C = incontinence to solid stool

Reilly(229)	Faecal incontinence survey
	It consists of 70 questions, grouped by specificity: general bowel habits (16 questions); faecal incontinence (13 questions); urinary symptoms (13 questions); anal-rectal diseases and surgical history (12 questions); medical care utilization (4 questions) and potential contributing medical disorders (5 questions). The instrument was originally developed to be self-applicable and does not allow for the calculation of scores.
Miller(247)	Grade I: incontinence less frequent than once a month Grade II: between once a month and once a week Grade III: more than once a week Score: flatus 1-3, fluid 4-6, solid 7-9

Appendix 5.1: Extensive search in EMBASE & MEDLINE (including all synonyms of each known bulking agent used for the treatment of faecal incontinence).

1. EMBASE; PTQ.ti,ab; 20 results. 2. EMBASE; exp BIOMATERIAL/; 12818 results. 3. EMBASE; exp SILICONE/; 7276 results. 4. EMBASE; 1 OR 2 OR 3; 19791 results. 5. EMBASE; contigen.ti,ab; 26 results. 6. EMBASE; exp COLLAGEN/; 73363 results. 7. EMBASE; (glutaraldehyde AND cross-lined AND collagen).ti,ab; 1 results. 8. EMBASE; exp GLUTARALDEHYDE/; 5567 results. 9. EMBASE; 5 OR 6 OR 7 OR 8; 78511 results. 10. EMBASE; exp DURASPHERE/; 0 results. 11. EMBASE; durasphere.ti,ab; 22 results. 12. EMBASE; (carbon AND coated AND beads).ti,ab; 41 results. 13. EMBASE; exp BULKING AGENT/; 34925 results. 14. EMBASE; 10 OR 11 OR 12 OR 13; 34964 results. 15. EMBASE; coaptite.ti,ab; 7 results. 16. EMBASE; exp HYDROXYAPATITE/; 9719 results. 17. EMBASE; (ceramic AND microspheres).ti,ab; 35 results. 18. EMBASE; exp MICROSPHERE/; 10327 results. 19. EMBASE; 15 OR 16 OR 17 OR 18; 19938 results. 20. EMBASE; zuidex.ti,ab; 20 results. 21. EMBASE; dextranomer.ti,ab; 220 results. 22. EMBASE; 20 OR 21; 229 results. 23. EMBASE; exp ELASTOMER/; 1085 results. 24. EMBASE; elastomer.ti,ab; 1023 results. 25. EMBASE; 23 OR 24; 1706 results. 26. EMBASE; permacol.ti,ab; 48 results. 27. EMBASE; (autologous AND fat).ti,ab; 748 results. 28. EMBASE; polytetrafluoroethylene.ti,ab; 4387 results. 29. EMBASE; exp POLITEF/; 8498 results. 30. EMBASE; 28 OR 29; 9914 results. 31. EMBASE; bulkamid.ti,ab; 1 results. 32. EMBASE; polytef.ti,ab; 81 results. 33. EMBASE; exp POLITEF/; 8498 results. 34. EMBASE; teflon.ti,ab; 3604 results. 35. EMBASE; 32 OR 33 OR 34; 10707 results. 36. EMBASE; (stem AND cells).ti,ab; 65771 results. 37. EMBASE; exp STEM CELL/; 75993 results. 38. EMBASE; 36 OR 37; 102182 results. 39. EMBASE; EVOH.ti,ab; 44 results. 40. EMBASE; exp ETHYLENE VINYL ALCOHOL COPOLYMER/; 344 results. 41. EMBASE; solesta.ti,ab; 0 results. 42. EMBASE; exp NON ANIMAL STABILIZED HYALURONIC ACID/; 0 results. 43. EMBASE; dextranomer.ti,ab; 220 results. 44. EMBASE; exp DEXTRANOMER/; 468 results. 45. EMBASE; 43 OR 44; 504 results. 46. EMBASE; 4 OR 9 OR 14 OR 19 OR 22 OR 25 OR 26 OR 27 OR 30 OR 31 OR 35 OR 38 OR 39 OR 40 OR 45; 259857 results. 47. EMBASE; "f*ecal incontinence".ti,ab; 2038 results. 48. EMBASE; exp FECES INCONTINENCE/; 6589 results. 49. EMBASE; 47 OR 48; 6885 results. 50. EMBASE; 46 AND 49; 170 results. .	51. MEDLINE; PTQ.ti,ab; 29 results. 52. MEDLINE; exp BIOMATERIAL/; 51572 results. 53. MEDLINE; exp SILICONE/; 18931 results. 54. MEDLINE; 51 OR 52 OR 53; 68978 results. 55. MEDLINE; contigen.ti,ab; 26 results. 56. MEDLINE; exp COLLAGEN/; 81626 results. 57. MEDLINE; (glutaraldehyde AND cross-lined AND collagen).ti,ab; 1 results 58. MEDLINE; exp GLUTARALDEHYDE/; 5632 results. 59. MEDLINE; 55 OR 56 OR 57 OR 58; 86998 results. 60. MEDLINE; exp DURASPHERE/; 0 results. 61. MEDLINE; durasphere.ti,ab; 20 results. 62. MEDLINE; (carbon AND coated AND beads).ti,ab; 39 results. 63. MEDLINE; exp BULKING AGENT/; 0 results. 64. MEDLINE; 60 OR 61 OR 62 OR 63; 56 results. 65. MEDLINE; coaptite.ti,ab; 9 results. 66. MEDLINE; exp HYDROXYAPATITE/; 8283 results. 67. MEDLINE; (ceramic AND microspheres).ti,ab; 38 results. 68. MEDLINE; exp MICROSPHERE/; 18340 results. 69. MEDLINE; 65 OR 66 OR 67 OR 68; 26539 results. 70. MEDLINE; zuidex.ti,ab; 15 results. 71. MEDLINE; dextranomer.ti,ab; 217 results. 72. MEDLINE; 70 OR 71; 220 results. 73. MEDLINE; exp ELASTOMER/; 25397 results. 74. MEDLINE; elastomer.ti,ab; 1400 results. 75. MEDLINE; 73 OR 74; 26154 results. 76. MEDLINE; permacol.ti,ab; 57 results. 77. MEDLINE; (autologous AND fat).ti,ab; 804 results. 78. MEDLINE; polytetrafluoroethylene.ti,ab; 5064 results. 79. MEDLINE; exp POLITEF/; 8982 results. 80. MEDLINE; 78 OR 79; 10554 results. 81. MEDLINE; bulkamid.ti,ab; 1 results. 82. MEDLINE; polytef.ti,ab; 104 results. 83. MEDLINE; exp POLITEF/; 8982 results. 84. MEDLINE; teflon.ti,ab; 4517 results. 85. MEDLINE; 82 OR 83 OR 84; 12123 results. 86. MEDLINE; (stem AND cells).ti,ab; 73955 results. 87. MEDLINE; exp STEM CELL/; 166300 results. 88. MEDLINE; 86 OR 87; 200648 results. 89. MEDLINE; EVOH.ti,ab; 35 results. 90. MEDLINE; exp ETHYLENE VINYL ALCOHOL COPOLYMER/; 0 results. 91. MEDLINE; solesta.ti,ab; 0 results. 92. MEDLINE; exp NON ANIMAL STABILIZED HYALURONIC ACID/; 0 results. 93. MEDLINE; dextranomer.ti,ab; 217 results. 94. MEDLINE; exp DEXTRANOMER/; 0 results. 95. MEDLINE; 93 OR 94; 217 results. 96. MEDLINE; 54 OR 59 OR 64 OR 69 OR 72 OR 75 OR 76 OR 77 OR 80 OR 81 OR 85 OR 88 OR 89 OR 90 OR 95; 384192 results. 97. MEDLINE; "f*ecal incontinence".ti,ab; 2281 results. 98. MEDLINE; exp FECAL INCONTINENCE/; 6358 results. 99. MEDLINE; 97 OR 98; 7029 results. 100. MEDLINE; 96 AND 99; 77 results. 101. MEDLINE; exp ETHYLENES/; 3975 results. 102. MEDLINE; exp BIOCOMPATIBLE MATERIALS/; 51572 results. 103. MEDLINE; exp HYALURONIC ACID/; 11956 results. 104. MEDLINE; 54 OR 59 OR 61 OR 62 OR 69 OR 72 OR 75 OR 76 OR 77 OR 80 OR 81 OR 85 OR 88 OR 89 OR 93 OR 101 OR 102 OR 103; 397395 results. 105. MEDLINE; 99 AND 104; 77 results.

Appendix 5.2: Reclassification of data of efficacy in every included paper into success/failure.

Papers	Original outcomes	Final outcomes	
		Failure	Success
1. Maeda Y 2007(326)	Improved, same	Same	Improvement
2. de la Portilla F 2008(178)	Poor, fair, very good, good	Poor, fair	very good, good
3. Malouf A 2001(180)	Complete, marked, minor, nil.	Nil, minor.	Complete, marked.
4. Aigner F 2009(184)	Improvement, symptoms unchanged	symptoms unchanged	Improvement
5. Ganio E 2008(352)	Marked improvement, no improvement	No improvement	Marked improvement
6. Davis K 2003(181)	No improvement, improvement	No improvement	Improvement
7. Tjandra JJ 2009(333)	50 percent improvement in continence score	< 50 percent	>50 percent
8. Oliviera 2009(186)	Overall improvement, No improvement	No improvement	Overall improvement
9. Soerensen 2009(339)	Major improvement, failed	Failed	major improvement
10. Tjandra JJ 2004(335)	50 percent improvement in continence score	< 50 percent	>50 percent
11. Chan 2006(340)	Symptomatic improvement. 50% improvement in FI scores	not improved < 50 percent	Improved >50 percent
12. Altomare 2008(350)	Improved, not improved	not improved	Improved
Bartlett L 2009(341)	Fully continent, improved, no improvement.	not improved	Fully continent, improved
13. Dehli 2007(355)	Improved, no improvement	Not improvement	Improved
14. LA Torre F 2008(177)	CCIS <1	CCIS > 1	CCIS <1
15. Zoler L. Mitchel 2007(337)	Much better, little better, same.	Little better, same.	Much better.
16. Kumar D 1998(182)	Significant, minimal and no improvement	Minimal, no improvement.	Significant improvement.
17. Stojkovic S G 2006(358)	Improved, transient improvement, no effect.	Transient improvement, no effect	Improved
18. Maeda Y 2008(334)	Improved, worse.	Worse	Improved
19. van der Hagen 2007(343)	Complete continence, partial response, no response.	Partial response, no response.	Complete continence
20. De La Portilla 2009(338)	50 percent improvement in continence score	< 50 percent	>50 percent
Shafik A 1993(371)	Grade I, II & III	Grade III	Grade I & II

Shafik A 1995(364)	Score 1, 2 & 3	Score 3	Score 1 & 2
21. Bernardi C 1998(365)	Fully continent	Incontinent	Fully continent
22. Beggs AD 2009(183)	Subjective improvement, no improvement	No improvement	Improvement
23. Danielson J 2009(357)	Excellent, good, acceptable , poor	acceptable , poor	Excellent, good
Lindsey I 2004(344)	Improvement in continence score	No improvement	improvement
George I M 2004(345)	Symptomatic improvement, no improvement	No improvement	Improvement
24. Wiess E 2002(351)	Subjective improvement	The same	improved
Gett(346)	Improved, no change, worse.	No change, worse.	Improved
Tan JJ(347)	Improved, not improved.	Not improved.	Improved
25. Siproudhis(332)	Cured, markedly improved, improved, not improved.	not improved	Cured, markedly improved, improved
Tjandra 2006(336)†	50 percent improvement in continence score	< 50 percent	>50 percent
26. Chattopadhyay(360)	improvement, no improvement.	Not improved.	Improved
27. Stephens 2010(366)	50 percent improvement in continence score	< 50 percent	>50 percent
28. Guerra F(348)	Good results, no improvement	no improvement	Good results
29. Smart(359)	Asymptomatic, symptomatic improvement and unchanged.	Unchanged.	Asymptomatic, symptomatic improvement.

† Both references represent data from the same study. Thus data from the older publication were not included in analysis.
‡ Data from the control patients of the study is not published yet.

List of abbreviations

ABS	-	artificial bowel sphincter
AME	-	anal mucosal electrosensitivity
AMS	-	American medical system
ARP	-	anorectal physiology
ASA	-	American society of anaesthesiologists
BBUSQ-22	-	Birmingham Bowel and Urinary Symptoms Questionnaire
BMRP	-	basal mean resting pressure
BSE	-	bovine spongiform encephalopathy
CCIS	-	Cleveland Clinic Incontinence Score
CP	-	clinical pathway
EAS	-	external anal sphincter
EAUS	-	endoanal ultrasound
FI	-	faecal incontinence
FIQoLS	-	Rockwood Faecal Incontinence Quality of Life Scale
FISI	-	Faecal incontinence severity index
IAS	-	internal anal sphincter
IBA	-	injectable bulking agent
IFI	-	idiopathic faecal incontinence
IQR	-	inter quartile range
IRAT	-	Integrated Rapid Assessment and Treatment Pathway
FIS	-	Faecal incontinence score
LMF	-	longitudinal muscles fibres
LOS	-	length of stay

mA	-	milliamps
mHz	-	millihertz
MHz	-	megahertz
mmHg	-	millimetres of mercury
mmH_2O	-	millimetres of water
MMRP	-	maximum mean resting pressure
MMSP	-	maximum mean squeeze pressure
MTV	-	maximum tolerated volume
mV	-	millivolts
NO	-	nitrous oxide
PFAP	-	pelvic floor assessment pathway form
PNTML	-	pudendal nerve terminal motor latency
PTNS	-	Posterior tibial nerve stimulation
RAIR	-	rectoanal inhibitory reflex
RPG	-	resting pressure gradient
rVV	-	resting vector volume
SMIS	-	St Marks Incontinence Score
SPSS	-	statistical package for the social sciences
sVV	-	squeeze vector volume
TENS	-	transcutaneous electric nerve stimulation

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1.a) Pelvic Floor Assessment Pathway

This document is confidential and is to remain filed within the patients notes at all times, with the exception of the initial filling in exercise, which the patient will perform prior to their appointment

HOW TO USE THE PELVIC FLOOR ASSESSMENT PATHWAY
AREA HEADED BY BLUE - TO BE COMPLETED BY PATIENTS
AREAS SHADED WITH RED - TO BE COMPLETED BY PHYSICIANS
PLEASE MARK ONLY ONE BOX ❑ FOR EACH QUESTION Please use a "cross" (i.e. X) as a mark in the boxes
Larger Prints are available if required (please contact 01904 726694)

Date of Referral		
Date of 1st Anorectal Clinic		
Date of Physiology Lab:		
Height:	Weight:	BMI:

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About Your Bowel Habit
(To be completed by the patient)

1	Your bowel habit is ***usually***:	Regular ❑	Erratic/Irregular ❑	Recently changed ❑	A1
2	Are you able to tell the difference between when you are about to pass wind or a stool?	Yes, always ❑	Sometimes ❑	No, never ❑	A2
3	If you are about to pass wind, can you control this wind?	Yes, always ❑	Sometimes ❑	No, never ❑	A3
4	Are you able to delay emptying your bowels?	Yes, always ❑	Sometimes ❑	No, never ❑	A4
5	If you are able to delay emptying your bowels, for how long can you do that?	< 5 Min ❑	<15 Min ❑	15 Min State how long ____ ❑	A5
6	Do you ever need to rush to empty your bowel?	Yes, always ❑	Sometimes ❑	No, never ❑	A6
7	Do you experience abdominal pain before passing a bowel motion?	Yes, always ❑	Sometimes ❑	No, never ❑	A7
8	Do you experience bloating before passing a bowel motion?	Yes, always ❑	Sometimes ❑	No, never ❑	A8
9	When you open your bowel, do you have to strain?	Yes, always ❑	Sometimes ❑	No, never ❑	A9
10	Do you ever feel you haven't emptied completely?	Yes, always ❑	Sometimes ❑	No, never ❑	A10
11	Do you ever have to assist the passage of stool with your finger?	Yes, always ❑	Sometimes ❑	No, never ❑	A11

In females

12	Do you ever feels like the area between your anus and vagina is swollen?	Yes, always ❑	Sometimes ❑	No, never ❑	A12
13	Do you ever feel your bowel is pushing against the vagina?	Yes, always ❑	Sometimes ❑	No, never ❑	A13
14	Do you ever need to apply pressure on the area between your anus and vagina to empty bowel?	Yes, always ❑	Sometimes ❑	No, never ❑	A14

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What is the usual consistency of your stools (bowel motions)?

15 **Your stool is usually which type** *(please refer to the table below)* **……** **A15**

Type 1: Stools appear in separate, hard lumps, similar to nuts.

Type 2: Stools are sausage-like in appearance but lumpy.

Type 3 (Normal): Stools come out similar to a sausage but with cracks in the surface.

Type 4 (Normal): Stools are smooth and soft in the form of a sausage or snake.

Type 5: Stools form soft blobs with clear-cut edges, and easily pass. (Soft diarrhoea)

Type 6: Stools have fluffy pieces with ragged edges. Considered mushy stools (diarrhoea)

Type 7: Stool is mostly liquid with no solid pieces.

Type 8: Stool has a mucus-like consistency, with bubbles and a foul odour (sprayed out)

16 Do the stools vary in consistency? Yes ❑ No ❑ **A16**

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Your urinary tract (the water works):

17	Do you ever rush to pass water?	Yes, always ❑	Sometimes ❑	No never ❑	**A17**
18	Do you ever leak urine if you cough or sneeze?	Yes, always ❑	Sometimes ❑	No never ❑	**A18**
19	Do you ever not make it in time to pass urine?	Yes, always ❑	Sometimes ❑	No never ❑	**A19**

About faecal incontinence

20	How often does faecal incontinence happen?	Never ❑	Monthly ❑	Weekly ❑	Daily ❑	More than once daily ❑	**A20**

21	Do you ever leak stools without being aware of it?	Yes ❑	No ❑	**A21**
22	Do you get the sensation of the need to empty your bowels before you leak?	Yes ❑	No ❑	**A22**
23	When soiling occurs, you only notice it when you change your underwear or go to toilet.	Yes ❑	No ❑	**A23**
24	When soiling occurs, you need to change your underwear immediately.	Yes ❑	No ❑	**A24**
25	When soiling occurs, you need to change your underwear and clothes immediately.	Yes ❑	No ❑	**A25**
26	Does soiling occur after a bowel motion has been passed?	Yes ❑	No ❑	**A26**
27	Do you use pads or plugs for faecal incontinence?	Yes ❑	No ❑	**A27**
28	If so, are they effective in preventing soiling of clothes/ surroundings/ furnishing?	Yes ❑	No ❑	**A28**
29	Is faecal incontinence affecting your lifestyle?	Yes ❑	No ❑	**A29**

Mobility:

30	Do you need help to go to toilet?	Yes ❑	No ❑	**A30**
31	Are you able to clean yourself after passing stools	Yes ❑	No ❑	**A31**
32	Do you need help to get dressed?	Yes ❑	No ❑	**A32**

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Parity (History of childbirth)

Age at delivery	Mode of delivery		Difficult labour		Were you cut during delivery (*episiotomy*)		Did you suffer tears that required stitches (*perineal tears*)	
	Normal vaginal delivery ❑ Forceps vaginal delivery ❑ Caesarean section ❑	B1	Yes ❑ No ❑	B7	Yes ❑ No ❑	B13	Yes ❑ No ❑	B19
	Normal vaginal delivery ❑ Forceps delivery ❑ Caesarean section ❑	B2	Yes ❑ No ❑	B8	Yes ❑ No ❑	B14	Yes ❑ No ❑	B20
	Normal vaginal delivery ❑ Forceps delivery ❑ Caesarean section ❑	B3	Yes ❑ No ❑	B9	Yes ❑ No ❑	B15	Yes ❑ No ❑	B21
	Normal vaginal delivery ❑ Forceps delivery ❑ Caesarean section ❑	B4	Yes ❑ No ❑	B10	Yes ❑ No ❑	B16	Yes ❑ No ❑	B22
	Normal vaginal delivery ❑ Forceps delivery ❑ Caesarean section ❑	B5	Yes ❑ No ❑	B11	Yes ❑ No ❑	B17	Yes ❑ No ❑	B23
	Normal vaginal delivery ❑ Forceps delivery ❑ Caesarean section ❑	B6	Yes ❑ No ❑	B12	Yes ❑ No ❑	B18	Yes ❑ No ❑	B24

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Medication Check List	Tick (✓)	
Is the patient taking the following?	**Yes**	**No**
Oral Medication		
Oral Steroids in previous 12 months (give details)		
H.R.T / Oral Contraceptive Pill		
Eye / Ear / Nasal Preparations		
Inhalation Devices		
Topical Preparations (e.g. creams / patches)		
Rectal / Vaginal Preparations		
Purchased Medication		
Injections (e.g. daily / weekly / monthly)		
Herbal / Homeopathy Preparations		
Clinical Trial Medication		
Intra Uterine Device (IUD)		

Drug Allergies / Sensitivities

Name or nil known

Please document all medication Patient is currently taking, and recent changes to medication. Please include brands (if known) and specific instructions. Also include strengths of all preparations (e.g. eye drops) and type of preparation (e.g. turbohaler / rotahaler).

Was patient medication compliant prior admission? Yes ❑ No ❑

Please list all your medication here or *attach a copy of* your Prescription (to be completed by the patient) (please include brands, if known & preparation type e.g. tablet / capsule/ slow release etc)	**Dose / Instructions** (please include units)	**Frequency** (please be specific e.g. mane, prn)

Additional Information (e.g. oxygen, TPN, PEG feeding, dialysis, tunnelled / non-tunnelled line):

Have there been any recent changes to your medications?

Pharmacy Use Only

Medication checked correct Amendments documented
Name: .....
Source of medication history: .....
Date: .....

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Please complete the **incontinence scores** *below* **:** **(Please *circle* one score only on each line)**					
	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

How to use the incontinence scoring system above?	
Never:	no episodes in the last 4 weeks
Rarely	1 episode in the past 4 weeks
Sometimes	>1 episode a week in the past 4 weeks but <1 a day
Weekly	1 or more episodes a week but < 1 a day
Daily	1 or more episodes a day
Please circle one score only on each line!	

To be completed by Doctor	
CCIS	/20
To be completed by Doctor	
St. Marks IS	/24

Please indicate, which of the following symptoms is *most concerning* to you			
Mark from 1-6; **1** being the most concerning and **6** the least concerning, using each number only once	If the problem does not apply to you please ***circle*** *N/A*		
Incontinence for solid stool:		N/A	**C1**
Incontinence for liquid stool:		N/A	**C2**
Incontinence for gas:		N/A	**C3**
Alteration in lifestyle:		N/A	**C4**
Need to wear a pad or plug:		N/A	**C5**
Lack of ability to defer defecation:		N/A	**C6**
Others:		N/A	**C7**

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Please complete the **quality of life scores** *below*:

Q1 In general, would you say your health is (**please *circle***):

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor

Q2 *For each of the items, please indicate how much of the time the issue is a concern for you due to accidental bowel leak (if there is another cause please check the Box under not apply(N/A).)*

Due to accidental bowel leak	Most of the time	Some of the time	A little of the time	None of the time	N/A
a. I am afraid to go out	1	2	3	4	❑
b. I avoid visiting friends	1	2	3	4	❑
c. I avoid staying overnight away from home	1	2	3	4	❑
d. It is difficult for me to get out and do things like going to a movie or to church	1	2	3	4	❑
e. I cut down on how much I eat before I go out	1	2	3	4	❑
f. Whenever I am away from home, I try to stay near a bathroom as much as possible	1	2	3	4	❑
g. It is important to plan my schedule (daily activities) around my bowel pattern	1	2	3	4	❑
h. I avoid travelling	1	2	3	4	❑
i. I worry about not being able to get to the toilet on time	1	2	3	4	❑
j. I feel I have no control over my bowels	1	2	3	4	❑
k. I can not hold my bowel movement long enough to get to the bathroom	1	2	3	4	❑
l. I leak stool without even knowing it	1	2	3	4	❑
m. I try to prevent bowel accident by staying very near a bathroom	1	2	3	4	❑

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Q3	Due to accidental bowel leak, *indicate the extent to which you AGREE OR DISAGREE with each of the following items (if it is a concern to you for reason other than accidental bowel leak then check the Box under not apply, (N/A).)*

Due to accidental bowel leak	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	N/A
n. I feel ashamed	1	2	3	4	❑
o. I can not do many of the things I want to do	1	2	3	4	❑
p. I worry about bowel accidents	1	2	3	4	❑
q. I feel depressed	1	2	3	4	❑
r. I worry about others smelling stool on me	1	2	3	4	❑
s. I feel like I am not a healthy person	1	2	3	4	❑
t. I enjoy life less	1	2	3	4	❑
u. I have sex less often than I would like to	1	2	3	4	❑
v. I am afraid to have sex	1	2	3	4	❑
w. I feel different from other people	1	2	3	4	❑
x. The possibility of a bowel accident is always on my mind	1	2	3	4	❑
y. I avoid travelling by train or plane	1	2	3	4	❑
z. I avoid going out to eat	1	2	3	4	❑
aa. Whenever I go to somewhere new, I specifically locate where the bathrooms are	1	2	3	4	❑

Q4	During the past month, have you felt so sad, discouraged, hopeless, or had so many problems that you wondered if anything was worthwhile? (please *circle*):

1 Extremely So - To the point that I have just about given up

2 Very Much So

3 Quite a Bit

4 Some - Enough to bother me

5 A Little Bit

6 Not At All

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To be completed by DOCTOR			
Scale 1		Scale 3	
Scale 2		Scale 4	

Scale Scoring

Scales range from 1 to 4. Scales scores are the average (mean) response to all items in the scale (e.g. add the responses to all questions in a scale together and then divide by the number of items in the scale). (Not apply is coded as a missing value in the analysis for all questions.)

Scale 1. Lifestyle, ten items. " Q2A Q2B Q2C Q2D Q2E Q2G Q2H Q3B Q3L Q3M
Scale 2. Coping/Behaviour, nine items." Q2F Q2I Q2J Q2K Q2M Q3C Q3H Q3J Q3N
Scale 3. Depression/Self Perception, seven items." Q1 Q3D Q3F Q3G Q3I Q3K Q4, (Question 1 is reverse coded.)
Scale 4. Embarrassment, three items." Q2L Q3A Q3E

By placing a tick in one box in each group below. Please indicate which statements best describe you health state today.

1. Mobility	
I have no problems in walking about	❑
I have some problems in walking about	❑
I am confined to bed	❑
2. Self-Care	
I have no problems with self-care	❑
I have some problems washing or dressing myself	❑
I am unable to wash or dress myself	❑
3. Usual Activities (*e.g. work, study, housework, family or leisure activities*)	
I have no problems with performing my usual activities	❑
I have some problems with performing my usual activities	❑
I am unable to perform my usual activities	❑
4. Pain/Discomfort	
I have no pain or discomfort	❑
I have moderate pain or discomfort	❑
I have extreme pain or discomfort	❑
5. Anxiety/Depression	
I am not anxious or depressed	❑
I am moderately anxious or depressed	❑
I am extremely anxious or depressed	❑

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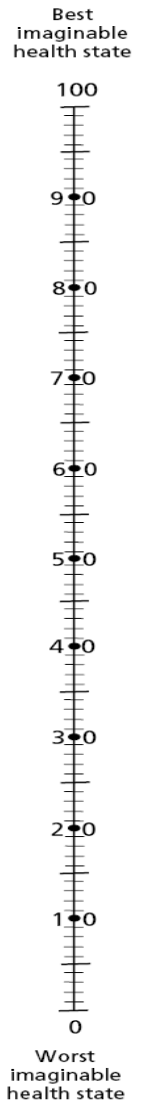
EQ VAS

To help people say how good or bad a health state is, we have drawn a scale (rather like a thermometer) on which the best state you can imagine is marked 100 and the worst state you can imagine is marked 0.
We would like you to indicate on this scale how good or bad your own health is today, in your opinion. Please do this by drawing a line from the box below to whichever point on the scale indicates how good or bad your health state is today.

Your own health state today



Comments by DOCTOR

1. Incontinence scores completed? (Y / N)
2. Quality of life scores completed? (Y/ N)
3. Comments:

With reference to
Consensus of NICE Guidelines, Rockwood FIQoLS & Cleveland clinic IS

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1.b) Pelvic Floor Assessment Pathway

On Arrival to Incontinence clinic
The patient is not required to fill in this part

Incontinence scores (to be completed by DOCTOR)					
	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

How to use the incontinence scoring system above?	
Never:	no episodes in the last 4 weeks
Rarely	1 episode in the past 4 weeks
Sometimes	>1 episode a week in the past 4 weeks but <1 a day
Weekly	1 or more episodes a week but < 1 a day
Daily	1 or more episodes a day
Please circle one score only on each line!	

CCIS	/24
St Mark's IS	/24

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Please affix a copy of the GP referral letter

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Previous medical history			
Neurological disorder(s) (ex. Spina bifida? Multiple sclerosis? Motor neuron disease? Stroke? Parkinsonism …etc)	Yes ❑	No ❑	C1
Previous spinal surgery/injury?	Yes ❑	No ❑	C2
History of pelvic floor/anal surgery	Yes ❑	No ❑	C3
History of bowel surgery	Yes ❑	No ❑	C4

Other illnesses: (please list) e.g. Diabetes, Parkinsons disease etc.	C5	1. 2. 3. 4. 5. 6. 7.

Drug History To be completed by DOCTOR	
Drug class (*list all relevant medication according to their classes*)	Drug name
Drugs altering sphincter tone ❑	Nitrates
	Calcium channel antagonists
	Beta-blockers
	Sildenafil
	Selective serotonin reuptake inhibitors
Antibiotic ❑	Cephalosporin's
	Penicillin's
	Erythromycin
Topical drugs applied to anus ❑	GTN ointment
	Diltiazem gel
	Bethanechol cream
	Botulinum toxin A injection
Drugs causing profuse loose stools ❑	Laxatives
	Metformin
	Orlistat
	Magnesium-containing antacids
	Digoxin
Constipating drugs ❑	Aluminium-containing antacids
	Loperamide
	Opioid's
	Tricyclic antidepressants
	Codeine
Tranquillisers or hypnotics ❑	Benzodiazepines
	Anti-depressant: indicate type
	Anti-psychotics

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1	Faecal Incontinence clinic
Physician	Date:
Comment:	Plan:

2	Faecal Incontinence clinic
Physiotherapist	Date
Comment:	Plan:

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Please affix 1st incontinence clinic letter

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Patient ID Label

1.c) Pelvic Floor Assessment Pathway

before you attend your pelvic floor tests

Date the form completed:

Please complete the **incontinence scores** *below* **:**
(Please *circle* one score only on each line)

	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

How to use the incontinence scoring system above?	
Never:	no episodes in the last 4 weeks
Rarely	1 episode in the past 4 weeks
Sometimes	>1 episode a week in the past 4 weeks but <1 a day
Weekly	1 or more episodes a week but < 1 a day
Daily	1 or more episodes a day
Please circle one score only on each line!	

o be completed by Doctor	
CCIS	/20
To be completed by Doctor	
St. Marks IS	/24

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Please complete the **quality of life scores** *below*:

Q1 In general, would you say your health is (**please *circle***):

6. Excellent
7. Very good
8. Good
9. Fair
10. Poor

Q2 *For each of the items, please indicate how much of the time the issue is a concern for you due to accidental bowel leak (if there is another cause please check the Box under not apply(N/A).)*

Due to accidental bowel leak	Most of the time	Some of the time	A little of the time	None of the time	N/A
n. I am afraid to go out	1	2	3	4	❑
o. I avoid visiting friends	1	2	3	4	❑
p. I avoid staying overnight away from home	1	2	3	4	❑
q. It is difficult for me to get out and do things like going to a movie or to church	1	2	3	4	❑
r. I cut down on how much I eat before I go out	1	2	3	4	❑
s. Whenever I am away from home, I try to stay near a bathroom as much as possible	1	2	3	4	❑
t. It is important to plan my schedule (daily activities) around my bowel pattern	1	2	3	4	❑
u. I avoid travelling	1	2	3	4	❑
v. I worry about not being able to get to the toilet on time	1	2	3	4	❑
w. I feel I have no control over my bowels	1	2	3	4	❑
x. I can not hold my bowel movement long enough to get to the bathroom	1	2	3	4	❑
y. I leak stool without even knowing it	1	2	3	4	❑
z. I try to prevent bowel accident by staying very near a bathroom	1	2	3	4	❑

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Q3	Due to accidental bowel leak, *indicate the extent to which you AGREE OR DISAGREE with each of the following items (if it is a concern to you for reason other than accidental bowel leak then check the Box under not apply,(N/A).)*

Due to accidental bowel leak	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	N/A
bb. I feel ashamed	1	2	3	4	❑
cc. I can not do many of the things I want to do	1	2	3	4	❑
dd. I worry about bowel accidents	1	2	3	4	❑
ee. I feel depressed	1	2	3	4	❑
ff. I worry about others smelling stool on me	1	2	3	4	❑
gg. I feel like I am not a healthy person	1	2	3	4	❑
hh. I enjoy life less	1	2	3	4	❑
ii. I have sex less often than I would like to	1	2	3	4	❑
jj. I am afraid to have sex	1	2	3	4	❑
kk. I feel different from other people	1	2	3	4	❑
ll. The possibility of a bowel accident is always on my mind	1	2	3	4	❑
mm. I avoid travelling by train or plane	1	2	3	4	❑
nn. I avoid going out to eat	1	2	3	4	❑
oo. Whenever I go to somewhere new, I specifically locate where the bathrooms are	1	2	3	4	❑

Q4	During the past month, have you felt so sad, discouraged, hopeless, or had so many problems that you wondered if anything was worthwhile? (**please *circle***):

1 Extremely So - To the point that I have just about given up
2 Very Much So
3 Quite a Bit
4 Some - Enough to bother me
5 A Little Bit
6 Not At All

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To be completed by DOCTOR			
Scale 1		Scale 3	
Scale 2		Scale 4	

Scale Scoring

Scales range from 1 to 4. Scales scores are the average (mean) response to all items in the scale (e.g. add the responses to all questions in a scale together and then divide by the number of items in the scale). (Not apply is coded as a missing value in the analysis for all questions.)

Scale 1. Lifestyle, ten items. " Q2A Q2B Q2C Q2D Q2E Q2G Q2H Q3B Q3L Q3M
Scale 2. Coping/Behaviour, nine items." Q2F Q2I Q2J Q2K Q2M Q3C Q3H Q3J Q3N
Scale 3. Depression/Self Perception, seven items." Q1 Q3D Q3F Q3G Q3I Q3K Q4, (Question 1 is reverse coded.)
Scale 4. Embarrassment, three items." Q2L Q3A Q3E

Comments by DOCTOR

4. Incontinence scores completed? (Y / N)
5. Quality of life scores completed? (Y/ N)
6. Comments:

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1.d) Pelvic Floor Assessment Pathway

On arrival to Anorectal physiology lab.

Incontinence scores (to be completed by NURSE)					
	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

How to use the incontinence scoring system above?	
Never:	no episodes in the last 4 weeks
Rarely	1 episode in the past 4 weeks
Sometimes	>1 episode a week in the past 4 weeks but <1 a day
Weekly	1 or more episodes a week but < 1 a day
Daily	1 or more episodes a day
Please circle one score only on each line!	

CCIS	/24
St Mark's IS	/24

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ANO-RECTAL PHYSIOLOGY
(to be completed by physician)

VECTORGRAMS:		
Maximum mean resting pressure: *(40 – 88)*		**Comment:**
Maximum mean squeeze pressure: (*60 – 140)*		
Resting vector volume:		
Squeeze vector volume:		
Resting asymmetry:		
Squeeze asymmetry:		

Please attach the diagrams

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Patient ID Label

ANO-RECTAL PHYSIOLOGY
(to be completed by physician)

ENDO-ANAL USS:

EAS (*Normal* / *Abnormal*) **IAS** (*Normal* / *Abnormal*)

Comment:

Please attach the diagrams

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Patient ID Label

ANO-RECTAL PHYSIOLOGY (to be completed by physician)		
RECTOANAL INHIBITORY REFLEX:		
Threshold rectal volume: *(40 – 100)*	mls	**Comment:**
Maximum tolerated volume: *(100 – 300)*	mls	

ANO-RECTAL PHYSIOLOGY (to be completed by physician)		
ANORECTAL ELECTROSENSITIVITY		
Distal anal canal: 1. 2. 3. Average:	Proximal anal canal: 1. 2. 3. Average:	Distal rectum: 1. 2. 3. Average:

Comments by DOCTOR

7. Incontinence scores completed? (Y / N)
8. Quality of life scores completed? (Y/ N)
9. Date completed:
10. Comments:

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Please affix the Anorectal Physiology Report

With reference to
Consensus of NICE Guidelines, Rockwood FIQoLS & Cleveland clinic IS

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Pelvic Floor Assessment Pathway (part 2)

This document is confidential and is to remain filed within the patients notes at all times, with the exception of the initial filling in exercise, which the patient will perform prior to their appointment

HOW TO USE PART 2 OF THE PELVIC FLOOR ASSESSMENT PATHWAY
(**2.a**) ***Diagnosis & Management:*** 2nd Incontinence Clinic & subsequent management (surgical intervention, biofeedback..etc)
(2.b) Eight weeks follow up: only following surgical intervention
(2.c) Re-assessment: 3rd incontinence Clinic

Date of 2nd Incontinence Clinic		
Date of 3rd Incontinence Clinic		
Date of any further follow up		
Date of discharge		
Height:	Weight:	BMI:

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2.a) Diagnosis & Management

Type of incontinence	
Traumatic Incontinence ❑	IAS ❑ EAS ❑ Combined ❑
Neuropathic incontinence ❑	
Combined Incontinence ❑	
Idiopathic incontinence ❑	

From Pelvic Floor Assessment Pathway, the MOST likely cause of Faecal incontinence is:	
Altered Stool Consistency ❑ IBS IBD Infectious diarrhea Laxative abuse Malabsorption Syndromes Short gut syndrome Radiation enteritis	**Inadequate reservoir** ❑ IBD Absent reservoir (pouch, coloanal etc.) Collagen vascular disease Rectal CA Extrinsic compression
Inadequate rectal sensation ❑ Neurological conditions Dementia CVA Multiple sclerosis Brain Tumour Sensory Neuropathy Injuries (brain, spinal cord & cauda equina)	**Overflow incontinence** ❑ Faecal impaction Encopresis Psychotropic drugs Antimotility drugs
Abnormal sphincter defect ❑ Anatomical sphincter defect Obstetric Trauma Iatrogenic/surgical trauma	**Pelvic floor denervation** ❑ Primary neurogenic Pudendal neuropathy Descending perineum syndrome
Idiopathic ❑	

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Management

Please record all encounters with patient after anorectal physiology clinic

Management plan *following Anorectal physiology results:*
1- Biofeedback 2- Altering medication 3- Dietary advise 4- Injection of bulking agent (Please complete page 7 of part 3) 5- Other surgery 6- Referred to a tertiary centre for SNS. 7- No treatment required 8- Others :

1	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

2	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

3	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

4	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

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Patient ID Label

5	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

6	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

7	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

8	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

9	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

10	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

Patient ID Label

11	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

12	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

13	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

14	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

15	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

16	Date:	Event (Clinic/theatre/biofeedback/others):
Management received *(ex: session 1 of Biofeedback)*:		
Plan:		Comment:

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Please affix 2nd incontinence clinic letter

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Injection of Bulking agent

Date:	Anaesthesia: G/A ❑ Local ❑	Position:

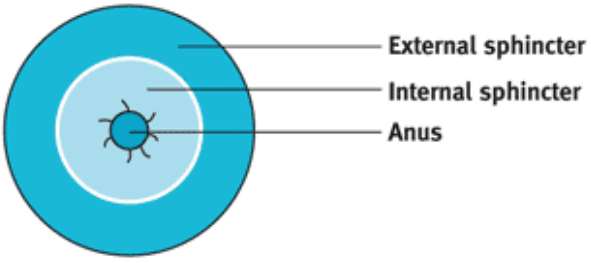
Bulking Agent Used:

Technique: Submucosal ❑ Trans-sphincteric ❑ Others ❑:
Details:

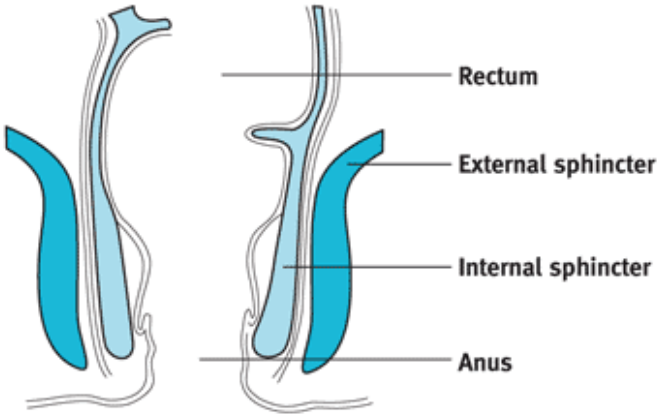
Antibiotics: No Antibiotics ❑ On induction ❑: Post operative ❑:

Operation notes
(in Writing and on diagram)

Position (O' clock) **Dose (ml)**



View across – 'rings of muscle'



Side view

Intra-operative complications: Bleeding ❑ Leakage of bulking agent ❑ Others ❑

Post-operative complications: Infection ❑ Leakage of bulking agent ❑ Others ❑

With reference to
Consensus of NICE Guidelines, Rockwood FIQoLS & Cleveland clinic IS

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2.b) Re-assessment

Please complete the **incontinence scores** *below* **:** **(Please *circle* one score only on each line)**					
	Never	*Rarely*	*Sometimes*	*Weekly*	*Daily*
Incontinence for solid stool	0	1	2	3	4
Incontinence for liquid stool	0	1	2	3	4
Incontinence for gas	0	1	2	3	4
Alteration in lifestyle	0	1	2	3	4
Need to wear a pad or plug	0	1	2	3	4

	No	*Yes*
Taking constipating medicines	0	2
Lack of ability to defer defecation for 15 minutes	0	4

How to use the incontinence scoring system above?	
Never:	no episodes in the last 4 weeks
Rarely	1 episode in the past 4 weeks
Sometimes	>1 episode a week in the past 4 weeks but <1 a day
Weekly	1 or more episodes a week but < 1 a day
Daily	1 or more episodes a day
Please circle one score only on each line!	

To be completed by Doctor	
CCIS	/20
To be completed by Doctor	
St. Marks IS	/24

Please indicate, which of the following symptoms is *most concerning* to you			
Mark from 1-6; **1** being the most concerning and **6** the least concerning, using each number only once	If the problem does not apply to you please ***circle*** *N/A*		
Incontinence for solid stool:		N/A	**C1**
Incontinence for liquid stool:		N/A	**C2**
Incontinence for gas:		N/A	**C3**
Alteration in lifestyle:		N/A	**C4**
Need to wear a pad or plug:		N/A	**C5**
Lack of ability to defer defecation:		N/A	**C6**

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Patient ID Label	
Others:	N/A **C7**

Please complete the **quality of life scores** *below*:	
Q1	In general, would you say your health is (**please *circle***):

11. Excellent
12. Very good
13. Good
14. Fair
15. Poor

Q2	*For each of the items, please indicate how much of the time the issue is a concern for you due to accidental bowel leak (if there is another cause please check the Box under not apply(N/A).)*

Due to accidental bowel leak	Most of the time	Some of the time	A little of the time	None of the time	N/A
aa. I am afraid to go out	1	2	3	4	❑
bb. I avoid visiting friends	1	2	3	4	❑
cc. I avoid staying overnight away from home	1	2	3	4	❑
dd. It is difficult for me to get out and do things like going to a movie or to church	1	2	3	4	❑
ee. I cut down on how much I eat before I go out	1	2	3	4	❑
ff. Whenever I am away from home, I try to stay near a bathroom as much as possible	1	2	3	4	❑
gg. It is important to plan my schedule (daily activities) around my bowel pattern	1	2	3	4	❑
hh. I avoid travelling	1	2	3	4	❑
ii. I worry about not being able to get to the toilet on time	1	2	3	4	❑
jj. I feel I have no control over my bowels	1	2	3	4	❑
kk. I can not hold my bowel movement long enough to get to the bathroom	1	2	3	4	❑
ll. I leak stool without even knowing it	1	2	3	4	❑
mm. I try to prevent bowel accident by staying very near a bathroom	1	2	3	4	❑

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Q3	Due to accidental bowel leak, *indicate the extent to which you AGREE OR DISAGREE with each of the following items (if it is a concern to you for reason other than accidental bowel leak then check the Box under not apply, (N/A).)*

Due to accidental bowel leak	Strongly agree	Somewhat agree	Somewhat disagree	Strongly disagree	N/A
pp. I feel ashamed	1	2	3	4	❑
qq. I can not do many of the things I want to do	1	2	3	4	❑
rr. I worry about bowel accidents	1	2	3	4	❑
ss. I feel depressed	1	2	3	4	❑
tt. I worry about others smelling stool on me	1	2	3	4	❑
uu. I feel like I am not a healthy person	1	2	3	4	❑
vv. I enjoy life less	1	2	3	4	❑
ww. I have sex less often than I would like to	1	2	3	4	❑
xx. I am afraid to have sex	1	2	3	4	❑
yy. I feel different from other people	1	2	3	4	❑
zz. The possibility of a bowel accident is always on my mind	1	2	3	4	❑
aaa. I avoid travelling by train or plane	1	2	3	4	❑
bbb. I avoid going out to eat	1	2	3	4	❑
ccc. Whenever I go to somewhere new, I specifically locate where the bathrooms are	1	2	3	4	❑

Q4	During the past month, have you felt so sad, discouraged, hopeless, or had so many problems that you wondered if anything was worthwhile? (please *circle*):

1 Extremely So - To the point that I have just about given up
2 Very Much So
3 Quite a Bit
4 Some - Enough to bother me
5 A Little Bit

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Patient ID Label

6 Not At All

To be completed by DOCTOR			
Scale 1		**Scale 3**	
Scale 2		**Scale 4**	

Scale Scoring

Scales range from 1 to 4. Scales scores are the average (mean) response to all items in the scale (e.g. add the responses to all questions in a scale together and then divide by the number of items in the scale). (Not apply is coded as a missing value in the analysis for all questions.)

Scale 1. Lifestyle, ten items. " Q2A Q2B Q2C Q2D Q2E Q2G Q2H Q3B Q3L Q3M
Scale 2. Coping/Behaviour, nine items." Q2F Q2I Q2J Q2K Q2M Q3C Q3H Q3J Q3N
Scale 3. Depression/Self Perception, seven items." Q1 Q3D Q3F Q3G Q3I Q3K Q4, (Question 1 is reverse coded.)
Scale 4. Embarrassment, three items." Q2L Q3A Q3E

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Patient ID Label

Comments by DOCTOR

11. Incontinence scores completed? (Y / N)
12. Quality of life scores completed? (Y/ N)
13. Date completed:
14. Comments:

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Patient ID Label

Please affix 3rd incontinence clinic letter

With reference to
Consensus of NICE Guidelines, Rockwood FIQoLS & Cleveland clinic IS

Appendix 5.3: Papers and abstract included in study 5.1

Author	Paper/ abstract	Type of study	No of patients	Material used	FI score	QoLS	Clinically		Follow up Period
1. Maeda Y 2007[15]	paper	Cohort	6	PTQ	St mark's Baseline: 11 (9-20) End of f/u: 13 (9-19) P = 0.127	Rockwood	1 improved 1 slight improvement 4 no change	1- passive FI 2-Failed conservative treatment. 3- If history of anal repair: EAS intact on Endoanal USS	61 months
1. de la Portilla F 2008[16]	Paper	Cohort	20	PTQ	CCIS Baseline: 13.5 (5-20) End of f/u: 9.4 (1-20) P value: 0.127		60% Improvement	1- Passive FI. 2- Failed antidiarrhoeals 3- Psychologically stable	24 months
5. Malouf A 2001[17]	Paper	Cohort	10	PTQ	-		2 markedly improved 1 minor improvement 7 no change	1- Passive FI. 2- Failed antidiarrhoeals 3- Psychologically stable	6 months
6. Aigner F 2009[18]	Paper	Cohort	11	Durasphere	CCIS Baseline: 12.27(97) End of f/u: 4.91 (0.87) P value		6 improved 5 no improvement	1- Idiopathic FI 2- Failed conservative management 3- Most of patients with symptoms of urgency	26 months
10. Ganio E 2008[19]	Paper	Cohort	10	Coaptite	FISS score Baseline: 85.6 (9.4) End of f/u: 28.0 (29.0) P value 0.008		80% improvement	1- Passive faecal incontinence due to IAS dysfunction. 2- Failed conservative management	12 months
14. Davis K 2003[20]	Paper	Cohort	18	Durasphere	CCIS Baseline: 11.89(5.1) End of f/u: 8.50(3.65) P = 0.002 (at 12 month f/u)		-	1- Faecal Incontinence 2- Failed conservative management	28.5 months
18. Tjandra JJ	Paper	RCT	20		CCIS		90% improvements	1- Passive FI	12 months

2009[21]		PTQ VS Durasphere		PTQ	Baseline	End of f/u		(had >50% improvement in CCIS)	2- IAS dysfunction. 3- failed conservative management (at least 6 months)	
					11.45 (2.63)	3.80(2.76)				
					P value <0.0001			35% improvement (had >50% improvement in CCIS)		
			20	Durasphere	Baseline	End of f/u				
					11.45 (2.35)	7 (2.77)				
					P value <0.0001					
					P = 0.001 (difference between 2 group)					
26. Oliviera 2009[14]	Paper	Cohort	35	PTQ	CCIS			32 overall improvement 3 no improvement	1- mild-moderate faecal incontinence related to simple or multiple IAS defects	12 months
					Baseline	End of f/u				
					11.3	3.6				
					P value <0.001					
30. Soerensen 2009[22]	Paper	Cohort	33	PTQ	CCIS			Oval all modest improvement (only 6 had major improvement)	1- incontinence to solid & liquid 2- IAS or EAS dysfunction 3- Failed conservative management	12.9 months
					Baseline	End of f/u				
					12.7 (6-18)	10.4 (2-17)				
					P = 0.01					
34. Tjandra JJ 2004[23]	Paper	RCT US Vs no US	42	PTQ guided by EAUS)	CCIS			69% had >50% improvement in CCIS	1- Severe FI for solid & liquid. 2- IAS dysfunction 3- Failed conservative management	12 months
					Baseline	End of f/u				
					14.5 (10-20)	3 (1-12)				
					P < 0.001					
			40	PTQ (guided by palpation	Baseline	End of f/u		40% had >50% improvement in CCIS		
					14.5 (11-20)	11 (2-10)				
					P = 0.5					
					P = 0.014 (difference between 2 group)					
42. Chan 2006[3]	Paper	Cohort	7	PTQ	CCIS			yes	1- Passive FI following haemorrhoidectomy	
					Baseline	End of f/u		Symptoms improved in all patients		14 months
					12 (9-14)	2 (1-5)				

					P value P= 0.016				
46. Altomare 2008[24]	Paper	Cohort	33	Durasphere	CCIS Baseline: 12 / End of f/u: 8 P value < 0.001		11 improved 22 no improvement	1-passive FI of minor to medium severity of at least 1 year 2- Failed conservative treatment	20.8 months
50. Bartlett L 2009[25]	Paper	Cohort	74	PTQ	CCIS Baseline: 10 (6.8-15) / End of f/u: 1.0 (0-2.0) P value <0.001		52 were fully continent on final f/u	1- Passive & urge FI 2- Failed conservative management	28 months
54. Dehli 2007[26]	Paper	Cohort	4	Zuidex (NASHA/DX	St Mark's Baseline: 19 / End of f/u: 15.5 P value --		3 out of 4 improved	1- Severe FI	5 moths
58. LA Torre F 2008[27]	Paper	Cohort	21	PTQ	21: CCIS Baseline: 7.05 / End of f/u: 1		improvement in CCIS in 19 patients	-	24 months
	---	Ongoing study	6	Solesta	Baseline: 8 / End of f/u: 3		--	--	3 months
63. Zoler L. Mitchel 2007[28]	Paper	RCT	77	Durasphere	CCIS Baseline: 12.7 (49 patients) / End of f/u: 8.3 (49 patients) P value: --		In 49 patients at 6 month follow up: 41%: much better. 29% little bit better 22% same 8% worse.	-	12 months
67. Kumar D 1998[29]	paper	Cohort	17	GAX Collagen	-		11 improvement 3 minimal improvement 3 no change	1- Grade 2-3 FI (Incontinence to flatus & fluid) 2- Failed conservative treatment	8 months
68. Kenefick N J 2002[8] (withdrawn in 2006 due to significant error)									
69. Stojkovic S	Paper	Cohort	73	Contigen	CCIS Baseline / End of f/u		30% improved 42% transient	1- Faecal incontinence	12 months

G 2006[30]					10 (6-16) / P < 0.001	6 (3-10)		improvement, 27% no effect		
73. Maeda Y 2008[31]	Paper	RCT	5	Bulkamid	St, Marl's Baseline: 15(12-17) End of f/u: 12 (6-18) P value: --			4 improved 1 worse	1- Passive FI to solid or liquid 2- due to IAS dysfunction 3- Failed conservative treatment	19 months (however the post-injection scoring was done at 6 months)
			5	Permacol	Baseline: 16 (11-24) End of f/u: 15 (8-22) P value: --			1 improved 2 no change 1 worse 1 uncontactable		
80. Gaj F 2007[32]	Paper	Cohort	16	PTQ	AMS score Baseline: 107 (101-119) End of f/u: 64 (61-94) P = 0.001			--	1- Faecal Incontinence with 2- IAS dysfunction 3- Low anal pressure due to previous pelvic surgery 4- Failed conservative treatment	12 months
84. van der Hagen 2007[33]	Paper	Cohort	24	PTQ	St Mark's Baseline: 4.2 (0-8) End of f/u: 2.1(0-6) P value <0.001			5 fully continent 11 Partial response 8 no response	1- Faecal soiling. 2- Keyhole defect of anal sphincter on USS, but otherwise normal anorectal physiology	12 months
88. De La Portilla 2009[34]	Paper	Cohort	15	PTQ	CCIS Baseline: 14.07 (4.7) End of f/u: 8.2 (5.5) P value = 0.002			CCIS improved > 50% in 6 patients	-	24 months
92. Shafik A 1993[35]	Paper	Cohort	11	Teflon	--			5 fully continent 4 improved 2 no change	1- Partial FI (Flatus & fluid) 2- Failed conservative treatment.	12 months (18 if 2nd injection)
93. Shafik A 1995[36]	Paper	Cohort	14	Autologous fat	--			All continent (11 patients after 2nd session of injection)	-	6-9 months after each injection
94. Bernardi C 1998[37]	Paper	Case report	1	autologous fat	--			Fully continen	-	8 months

95. Raval M J 2009[38]	Paper	Cohort	12	Solesta	St Marks (??) Baseline: 14 (10–18) End of f/u: 9 (1 to 18) P value = 0.003		--	1- Predefined threshold of faecal incontinence severity 2-Failed conservative treatment.	6 month
99. Beggs AD 2009[39]	Paper	Cohort	21	Durasphere	St Marks Baseline: 18.7 (2.16) End of f/u: 10.9 (4.5) P value < 0.01		15/21 demonstrated subjective improvement in initial clinic visit	1- Passive FI 2-Failed conservative treatment.	12 months
103. Danielson J 2009[40]	Paper	Cohort	34	NASHA-Dx	Miller's Baseline: 14 (6-18) End of f/u: 11(1-16) P value = 0.0078	-	4 excellent 11 good 13 acceptable 6 poor	1- Faecal Incontinence of at least 1 incidence/week (ailed conservative 2- Failed conservative management.	12 months
107. Lindsey I 2004[41]	Abstract	Cohort	10	Silicone	-	-	8 out of 10 improved	1- passive FI 2- Low MRP and abnormal IAS 4- Failed conservative treatment	Short term
108. George I M 2004[42]	Abstract	Cohort	12	PTQ	CCIS Baseline: 16.4 (5.1) End of f/u: 8.2 (4.6) P = 0.05		75% improved	1- Faecal incontinence with history of previous anorectal surgery.	6 weeks
112. Wiess E 2002[43]	Abstract	Cohort	7	Durasphere	CCIS Baseline: 13.3 End of f/u: 9.6 P value < 0.012		Subjective improvement in 55%	1- Faecal incontinence 2- EAS intact on EAUS	3 months
116. Gett[44]	Abstract	Cohort	37	PTQ	-		25 improved 7 no change 5 worse	-	9 months
117. Tan JJ[45]	Abstract	Cohort	16	PTQ	CCIS Baseline: 13 End of f/u: 9 P value: --		7 out of 14 improved.	1- Patients with FI who had initial good response (for 6 months) after 1st injection	6 months following 2nd injection

121. Ganio E 2004	*Abstract*	Cohort	10	Coaptite	CCIS Baseline: End of f/u 8.9: 2.7 P value		8 out of 10 improved	1- Faecal incontinence 2- IAS thickness < 1.2 mm or discrete IAS defect	3 months
125. Siproudhis[46]	paper	Cohort	22	Elastomer (silicone)	CCIS Baseline: End of f/u 14.2 (2.3): 11.6 (4.6) P = 0.001		Successful in 23% Successful in 27% P = 0.73 (difference between 2 group)	1- Sever passive FI with CCIS of 9-20. 2- IAS defect, disruption or degeneration 3- Failed conservative management	3 months
			22	Saline	Baseline: End of f/u 14.6 (3): 11.4 (5) P= 0.001 P value = 0.79 (difference between 2 group)				
133. Tjandra 2006[47]	*Abstract*	RCT (us vs no us)	114	PTQ (with US)			63 % had >50% improvement in CCIS		24 months
			111	PTQ (no US)			41 % had >50% improvement in CCIS p=0.01		
136. Chattopadhyay[48]	abstract	Cohort	22	Permacol	St Mark's Baseline: End of f/u 13..7: 5.57 P value < 0.001	-	61% of patients improved		14 months
140. Stephens 2010[49]	Paper	Cohort	21	EVOH	CCIS Baseline: End of f/u 11: 6.9 P = 0.002		47% had >= 50% improvement of CCFIS	1- Faecal incontinence for 6 Months or more 2- EAS is intact 3- CCIS >4 & <15 4-Failed conservative management	12 months
144. Guerra F[50]	Paper	Cohort	16	PTQ	CCIS Baseline: End of f/u 10,4 (6-14): 5.6 P value --		--	1- Moderate FI(CCIS <15) 2-Failed conservative management	24 months

148. Smart[51]	Abstract	Cohort	7	Permacol	-		Asymptomatic 2 Improved: 4 N change: 1		5 months (13 months if required re-injection)