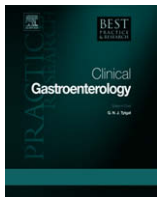
Best Practice & Research Clinical Gastroenterology 23 (2009) 505–515

Contents lists available at ScienceDirect

Best Practice & Research Clinical Gastroenterology



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Anal incontinence

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Keywords:
obstetric injury
rectal irrigation
dynamic graciloplasty
malone antegrade continent enema
sacral neuromodulation
artificial bowel sphincter

Anal incontinence is a life restricting condition that is sometimes challenging to treat. There is an equal gender prevalence, however women are more likely to present particularly early in life, as a result of obstetric injury. This is still one of the leading causes of anal incontinence and sphincter tears can be missed at the time of delivery. As a result, there is a heightened awareness for sphincter injury based on risk assessment, digital rectal examination and an endo-anal ultrasound. Surgical repair is still invaluable in the presence of disruption and salvage procedures for severe refractory incontinence such as the dynamic gracilloplasty and the artificial bowel sphincter continue to be perfected. Mini invasive procedures such as rectal irrigation and sacral neuromodulaton have had a successful outcome and we have had to depend less on the more invasive treatments. Above all there is a growing need to protect not only the baby but also the pelvic floor and anal sphincter from traumatic deliveries, through early risk assessment and research.

Introduction

Faecal incontinence presents a challenge to management since it causes considerable distress in patients and may have an adverse effect on lifestyle, work and inter-personal relationships. Faecal incontinence (FI) is defined as the involuntary loss of faecal material [1]. The prevalence of incontinence to solid or liquid faeces in adults living in the community is estimated at 1.4% [2,3], rising with age to approximately 6–7% in elderly people in the community and 10% of patients in elderly care homes [4,5]. Epidemiological data suggest that men and women are equally affected [2,6,7] which is surprising, given

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doi:10.1016/j.bpg.2009.06.001

that most treatment series comprise a considerable preponderance of women, and suggests that there may be a large number of symptomatic male patients who simply do not present to their medical practitioners. Despite its profoundly negative impact on quality of life, recent data suggest that even if taboo is overcome and consultation sought, knowledge of the causes and management of the problem in the wider medical community may be limited, further impeding early treatment [8]. Although the problem induces a feeling of hopelessness in many patients (and perhaps in their practitioners also), there are grounds for optimism. Simple measures can improve symptoms in a high proportion of patients and recently a number of novel therapeutic options have become available. In this chapter, the aetiology, assessment and management of faecal incontinence will be considered.

Causes of incontinence	
Congenital	Atresia, spina bifida
Inflammatory	Inflammatory bowel disease
Infectious	Bacterial: *Shigella*, *Salmonella*, *Campylobacter*, *Clostridium difficile* Viral: Human papiloma virus (anal warts), Miscellaneous infections e.g. cytomegalovirus, lymphogranuloma venereum, etc.
Trauma	Obstetric injury, post-surgical, injury, sexual abuse, involuntary anal intercourse
Neoplastic	Anal and rectal cancer, pre-malignant conditions e.g. Paget's disease of the anus, Bowen's disease, lichen sclerosus et atrophicus and anal intraepithelial neoplasia
Neurogenic	Spinal disc or cauda equine injury, arachnoiditis, multiple sclerosis, Parkinson's disease
Post-reconstructive	E.g. low anterior resection, pouch surgery
Miscellaneous	Rectal prolapse internal or external, diabetes mellitus, irritable bowel syndrome
Drugs	α- blockers, calcium channel blockers and nitric oxide donors e.g. glyceryl trinitrate, nicotine
Post-radiotherapy	

History and examination

The commonest cause seen in a surgical clinic is post-obstetric injury. When assessing a new patient, all the causes in the table need to be considered, but in most the history should provide indications for the cause. Post-obstetric injury may present early on after childbirth or in some cases after a considerable latent period. The reasons for the lag time are not fully understood but include deterioration of anorectal and pelvic floor function with age and withdrawal of hormonal input after the menopause, these all form part of the compensatory mechanisms that maintain continence.

The history details should include ascertaining whether the subjects experience passive soiling and whether they are aware of being incontinent. Passive soiling without awareness is suggestive of internal sphincter dysfunction that may follow the various causes outlined above. In minor cases there may simply be soiling of the underwear with associated anal itching and irritation. In more severe cases, there may be total evacuation of the bowel without any warning. This may be indicative of rectal prolapse. External sphincter defects or dysfunction in the presence of an intact sphincter are normally associated with urgency that leads to urge incontinence if the subject cannot reach a bathroom to evacuate. Patients should be asked about urgency that would suggest an external sphincter or alternatively a rectal motility disorder. A past history of surgery to the anus should alert the clinician to the possibility of anal sphincter damage. Anal sepsis and inflammatory bowel disease must be considered and abuse or sexual practice needs to be thought of, but probably not discussed at the first visit unless volunteered by the patient. Once again all of the diseases in the table should be considered when attempting to formulate therapeutic approaches.

Physical examination should comprise inspection of the anus at rest, during squeeze and during straining down as at defaecation. This will reveal characteristic descent seen in prolapse whether complete or incomplete. Sphincter gaping will be revealed by parting the anus and the reflex contraction in response to coughing 'anal wink' or its absence will tell the observer about the neurology. Sensory testing and eliciting the anal reflex will complement this. Digital examination should aim to assess internal anal sphincter (IAS) tone and length. Moreover, the behaviour of the IAS is variable with some patients who relax the muscle and others who appear to increase the tone involuntarily during examination. The force of contraction of the external anal sphincter (EAS) can then

be tested. During examination, defects or gaps may be palpated and there may be detectable variability of tone along the length of the sphincter complex. Finally, examination should continue with the subject bearing down. Complete inhibition with abnormal descent may suggest prolapse and this can be examined for. Abnormal contraction during straining suggests poor co-ordination and may indicate inefficient or failed evacuation that can be followed by post-defaecatory soiling. A procto-sigmoidoscopy should complete the examination to check for large haemorrhoids or major mucosal prolapse that may be prolapsing and causing soiling. It will also exclude major rectal disease and elicit varying degrees of prolapse or the solitary rectal ulcer syndrome and faecal overload.

Interpreting anorectal investigations

After a thorough history and examination, sometimes further investigations are warranted to develop a tailored management strategy. The next step would be in structural assessment using anal ultrasound (US) to document anal anatomical integrity. Magnetic resonance imaging (MRI) has the advantage of identifying muscular atrophy which US cannot accurately define, but a considerable amount of information can be obtained about the sphincter even with simple two dimensional US. Not only can the integrity of the IAS and EAS be studied but also some idea about muscle quality *can* be deduced.

The conditions in the table above should be considered to allow appropriate management.

The decision to proceed to colonoscopy is outside the scope of this article but management may proceed without further testing in many. If diarrhoea or stool frequency is a symptom, then titrating a very low daily dose of loperamide syrup starting with about 1 mg may give relief. If faecal loading is identified, then judicious laxative use with a trial of bulking agents together with glycerine suppositories or occasionally Bisocodyl suppositories will reduce leakage that is basically the consequence of overflow or post-defaecatory leakage. Rectal irrigation with a colostomy irrigation system or using the Peristeen Anal Irrigation System (Coloplast Ltd, Peterborough) can be used with excellent outcome [9]. If urgency is a problem, low dose Amitriptyline 10–20 mg at night time may help reduce the visceral hypersensitivity that accompanies this troublesome symptom [10].

With more complicated cases, anorectal physiology testing is helpful. If rectal prolapse is suspected, then the patient can be examined under anaesthesia. The author finds proctography less useful for diagnosing rectal prolapse predominantly because the prolapse can be missed especially if the subject is embarrassed or the technique is less than optimal. Others have also found it sub-optimal [11]. When examining under anaesthesia, the posterior wall of the rectum is grasped to assess if it is mobile. Normally it is fixed with very little mobility. In prolapse, the full thickness of the circumference of the rectum can be pulled out beyond the external anal verge. This is not seen in normal patients in whom the rectum is firmly fixed in place.

Physiological testing can take many forms but essentially, resting and squeeze pressures should confirm assessment by the educated clinician's digit. Rectal compliance can be assessed simply by balloon inflation with pressure measurement or by mano-volumetry using a barostat system which is probably more accurate, but may not be mandatory for all cases. Assessment of rectal motility is in the authors' opinion the most important component of the test. If the rectum is non-compliant with low distensibility and rapid pressure rises, this will explain urgency and urge incontinence. This is seen in inflammatory bowel disease, following surgery where the neo-rectum is non-compliant, and may follow radiotherapy. It may also result following autonomic nerve damage where the response to injury is smooth muscle hypertrophy that in turn leads to loss of rectal distensibility. On the other hand, if the volume of first sensation is high, the subject may be unaware of rectal filling until the rectum is full and ready to empty. This is seen in some cases of nerve injury and rectal denervation of unknown aetiology. It is also found in idiopathic mega-rectum and faecal impaction. Williams has devised various operations both to reduce rectal capacity and to augment it in extreme cases in order to try and improve anorectal function [12,13].

Pudendal nerve terminal latency measurement is unfortunately not particularly useful as the results are inconsistent and do not, in many studies, predict the outcome of various procedures. If the sphincter does not contract even in part when divided then it is likely that it does not have a satisfactory nerve supply. The problem with latency measurements is they assess and count the conduction of the fastest axons. Thus if some persist the latency will be normal even if the nerve supply is poor. This is analogous to an 8-cylinder automobile with only two cylinders working. The two may be satisfactory but the car does not drive! Thus too much sway should not be based on this test. The best test of neural integrity is

electromyography. Unfortunately, this is painful if needle electrodes are used and less informative when surface electrodes are employed. Moreover, it is time consuming with a test taking an hour to conduct.

Sensory testing is an indirect way of measuring the innervation of the anorectum by mucosal electrosensitivity [14,15]. Impaired thresholds suggest denervation of the rectum and anal canal. Caution should be exercised in the interpretation of impaired anal sensation in perineal descent, anorectal prolapse and haemorrhoids. Here the less sensitive rectal lining may give the false impression that the anus is denervated since the anal mucosa will lie below and outside the anal canal. Ultimately, the clinician needs to know whether or not the EAS contracts, which can be determined digitally, and whether the muscle is intact, which is determined by US.

Male incontinence

Males with incontinence represent a somewhat neglected group and frequently present a management challenge since they may have apparently normal sphincters and will often have soiling rather than involuntary evacuation. Wexner and colleagues recently reported a large cohort of males with FI [16]. Males represented 29% of their incontinent patients. They indicated that the causes vary with age. Prostate cancer, symptomatic haemorrhoids, perianal sepsis, rectal cancer and proctectomy/proctocolectomy with appropriate reconstructive surgery were associated conditions in patients of all ages. In younger patients, perineal injury, perianal sepsis, imperforate anus and anal cancer were significantly more common, whereas urological and neurological diseases were significantly more common in older patients [16].

Molloy and colleagues reported differences between males with leakage from those with frank faecal incontinence [17]. In the former, resting and squeeze pressures and anal ultrasonography were normal but in the latter were abnormal with sphincter defects in a small number in both groups. Rectal compliance was normal in both groups.

Two other studies have however focussed on FI and leakage in male patients [18,19]. Both studies reported that male patients with leakage/seepage had a significantly longer anal canal length. However, Parellada et al found that their patients displayed a significant increase in resting anal pressure compared with controls, whereas Sentovich et al noted that their 'leakers' had a reduced resting anal pressure which lay in between controls and those with true FI who showed a more significant reduction in resting anal pressure [18,19]. Many of their 'leakers' also displayed normal sensation and innervation. They postulated that leakage might occur through stool being trapped within a long, intermediate pressure sphincter; however, the anatomical or physiological findings of this study were not confirmed in Molloy's or in other studies [20,21]. Hoffmann et al [20] suggested that a delayed first rectal sensation but a normal relaxation reflex may result in FI from dyssynergy. An earlier report by Lubowski et al [21] presented similar findings in eight patients with FI who had normal physiology of the anal sphincters. Paradella et al suggested that patients with FI display an increase in rectal sensitivity in association with a smaller rectal capacity [19].

Recently, significant progress has been made in revealing the nature of inhibitory neurotransmission in the IAS that may be of relevance to our understanding of the mechanisms for passive leakage as the result of internal anal sphincter dysfunction. In a recent review, Rattan reported that although nitric oxide (NO) plays a major role in inhibiting the IAS, complete inhibitory neurotransmission involves interaction between multiple neurotransmitters including NO, vasoactive intestinal polypeptide (VIP) and carbon monoxide (CO) [22]. Recent studies suggest that neurohumoral substances such as angiotensin II (Ang II) and prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) also play a role in the maintenance of sphincteric tone. However, the basic intracellular mechanisms responsible for the basal tone in the IAS smooth muscle remain poorly understood.

Obstetric injury

Classification of tears

The anal canal is surrounded by the smooth muscle of the IAS and surrounding it is the striated EAS muscle. A first-degree tear is confined to the vaginal epithelium or perineal skin only. A second-degree tear extends to disrupt perineal muscles. Third-degree tears involve the anal sphincter and are divided into (a) less than 50% of the EAS injured and (b) more than 50% of EAS thickness torn and (c) IAS

disrupted. A fourth degree tear involves both sphincter muscles in addition to the rectal mucosa or anal epithelium. Obstetric sphincter injury is now recognised to be far more common than was formerly believed. In the past, only primarily recognised tears were recorded: for example, Venkatesh et al found that 3rd or 4th degree tears were sustained in 5% of 20,500 vaginal deliveries [23]. Of the cases that were primarily repaired, 10% broke down and required further repair. In the USA, midline posterior episiotomy was common and was considered to be associated with a higher incidence of tears. On the other hand, it has been argued that postero-lateral episiotomy, which is considered by its protagonists to reduce sphincter injury, may produce much more complex and severe injuries to the sphincter because of the pattern of extension of the episiotomy. Hartmann reported on seven randomised trials involving 5001 patients in the USA [24]. Thirty-five percent (varying between 10 and 50%) of deliveries had an episiotomy. Episiotomy was associated with a reduction in perineal muscular strength but made no difference to the incidence of faecal incontinence, though there was a small increase in anterior vaginal tears. It was concluded that there was no benefit associated with routine episiotomy.

Sultan et al carried out a prospective anal ultrasound examination after delivery and found that 35.4% (28 of 79) primaparous women had an anal sphincter defect on US after vaginal delivery [25]. Nineteen (39·6%) of 48 multiparous women had an anal sphincter defect before delivery and 21 after the index delivery; thus the incidence of de novo defects in multiparous females was two (4·2%) of 48. If an injury was identified, then on careful questioning, 20.4% admitted to some impairment of anal continence, varying between incontinence to flatus and more incapacitating forms of faecal incontinence. Finally, 33.3% of these patients experienced significant urgency to defaecate. One (1·3%) of 78 women in the study complained of faecal incontinence after delivery, but no anal sphincter defect was observed. None of 23 women who underwent caesarean section had a new anal sphincter defect after delivery.

Wexner attempted to quantify the incidence of obstetric sphincter tears by carrying out a meta-analysis of 717 vaginal deliveries from five separate studies [26]. This revealed a 26·9% incidence of anal sphincter defects in primiparous mothers; in the multiparous group, 8·5% developed new sphincter defects. Of the patients with defects, 29.7% were symptomatic. Thus at least two-thirds of these post-partum anal sphincter defects were asymptomatic. On the other hand, however, the probability that postpartum faecal incontinence is associated with an anal sphincter defect is between 76.8 and 82.8%.

Dandolu and colleagues reported a large study of 258,507 vaginal deliveries from Pennsylvania in which they analysed the risk of a subsequent tear after an initial sphincter injury [27]. The rate of sphincter tear was 7.31%. 16,152 patients with prior tears were delivered of babies, of which 1162 were by caesarean section. Of the remaining 14,990 subsequent vaginal deliveries 864 (5.76%) had a recurrence of third or fourth degree tears. Thus one may infer that recommending routine caesarian section to mothers who have sustained a tear with their first delivery is unnecessary unless there are compelling obstetric reasons.

It is clear that many tears are missed by obstetric and midwifery staff. Sultan and colleagues studied 254 women having their first vaginal delivery over a 12-month period in his hospital [28]. 24.5% of women sustained clinically recognisable and occult obstetric anal sphincter injuries (OASIS). The prevalence of OASIS rose from 11 to 24.5% when women were re-examined by an expert. In total 30 sustained OASIS, but only 4 (13%) were correctly identified by the midwife. On the other hand, midwives classified eight as OASIS and only four were confirmed by medical staff. All 30 women with OASIS had the diagnosis confirmed either by the on-call specialist registrar or consultant and their anal sphincter was then repaired in the operating theatre according to a standardized protocol. The authors concluded that the majority of midwives and junior doctors were failing to identify OASIS and suggested that a majority of practicing doctors and midwives were inadequately trained in diagnosing and repairing perineal trauma. They concluded that their findings were not unique to local practice, but probably reflected a more widespread phenomenon. This was supported by quoted data from Queen Charlotte's Hospital, known as one of the centres of excellence in obstetric practice, where a clinical research fellow examined women who had sustained perineal trauma and found that 40% of OASIS were being missed. The unavoidable conclusion reached was that almost all sphincter injuries previously described as 'occult' probably represented missed tears. In this study clinical examination at the time of delivery was the cornerstone of diagnosis of sphincter damage, with the research fellow performing a rectal examination to exclude rectal or anal sphincter injury. This involved visual inspection together with palpation between the index finger in the rectum and the thumb over the anal sphincter. They went on ''unfortunately, although most midwifery and obstetric textbooks recommend that

a rectal examination should be performed after perineal repair, very few indicate the need for rectal examination before repair". It went on to state that injuries classified as occult do have clinical relevance as many of these patients thus injured go on to develop faecal incontinence after subsequent deliveries. They feel that training should be focused and become more intensive to identify these tears.

From the above it appears that even in units offering high class obstetric care it is extremely common for midwives to miss obstetric injury. There have been relatively few audits on the outcome of primary obstetric sphincter repair. Sultan et al reported that following a repair in the labour ward 65% had persisting defects on an endo-anal ultrasound scanning [29]. A study by Starck et al showed that when an endo-anal ultrasound scan was carried out 2–7 days after a primary repair of third or fourth degree obstetric injuries, 90% had persisting defects [30]. These authors have further studied the outcome of tears in a report in 2006. They showed that after immediate repair defects not only persisted in large numbers but also with follow-up, became worse [31]. This suggests that immediate repair does not lead to good anatomic outcomes.

It can be seen from the above that there is considerable controversy over the outcome of early repair in the immediate postpartum period. Thus there may be some benefit in considering delayed repairs of these sphincter injuries possibly by an expert colorectal surgeon or by gynaecologists with special expertise in repair. Recently Nordenstam et al addressed this issue by randomizing 165 women with third to fourth degree perineal tears to immediate or delayed (8- to 12-h delay) end-to-end repair [32]. Immediate repair was carried out by the obstetrician on call whilst delayed repair was carried out by a member of the study team, comprising three obstetricians and three colorectal surgeons. There was no difference in anal incontinence at one-year follow-up between the groups.

What we do know is that many women sustain tears that are missed as evidenced by the above studies. Moreover, some are initially asymptomatic but then present at varying periods following delivery with incontinence. Endo-anal ultrasound scans will show that defects are present and on the basis of evidence it is clear that these defects were sustained during delivery. It is often stated that the majority of women fare well after a repair in the immediate aftermath of a tear. Samarasekera et al carried out long-term evaluations of women who had sustained third or fourth degree tears over 10 years after delivery and found that 53% were significantly affected by faecal incontinence [33]. This suggests that the results of repair in the long term are not especially good.

Isolated repair of the IAS has proved to be impossible [34]. Defects of the IAS lead to passive faecal soiling. There is also debate about whether it is possible to repair the IAS in the labour ward with claims of successful outcomes. The problem lies in defining what injury has occurred after delivery. Unless scans are carried out before and after delivery, it is difficult in the absence of a fourth degree tear to be certain the IAS has actually torn. Moreover the interpretation of US in the labour ward may be difficult. In any case, even with properly identified IAS tears, the probability of success from delayed repair has been shown to be extremely poor. Thus, from the above, one must question how successful obstetric IAS repair may be.

Risk factors for anal sphincter injury

The risk factors that are recognised are forceps, a large head circumference and birth weight of greater than 4 kg together with an abnormal presentation for example breech or the occiput-posterior position (OP). Forceps delivery is associated with new symptoms of fecal incontinence in up to 59% of women [35]. The actual reported incidence of third-degree tears following forceps delivery has varied from 13% to 83% in different studies [36–38].

Benavides found that 35% of women who had forceps deliveries developed third or fourth degree tears [39]. OP positions were associated with an incidence of tears of 51.5% while the occiput anterior tear frequency was much lower at 32.9%. Only 11.6% of this forceps assisted group was OP. In a logistic regression model that controlled for occiput-posterior position, maternal body mass index, race, length of second stage, episiotomy, birth weight, and rotational forceps, they calculated that the OP head position was 3.1 (CI: 1.6–6.2) times more likely to be associated with anal sphincter injury than OA head position.

The use of epidural anaesthesia in labour is also the subject of controversy. Whilst the analgesic benefits are beyond doubt, there is evidence that it prolongs the second stage of labour [40] and such prolongation may lead to higher instrumental rates with consequently increased risk of sphincter trauma [41–43].

It has been reported that one-third of women who have a second stage lasting more than 4 h will sustain a clinically identified third or fourth degree tear [44]. These authors reported rising rates of

caesarean section, operative vaginal delivery, and perineal trauma associated with a second stage of over 1 h. In multivariate analysis, the group with second stage of over 4 h had higher caesarean rates (odds ratio, 5.65; $P < 0.001$), operative vaginal deliveries (odds ratio, 2.83; $P < 0.001$), and 3rd or 4th degree perineal lacerations (odds ratio, 1.33; $P = 0.009$). They concluded that although the length of the second stage of labour was not associated with poor neonatal outcomes, a prolonged second stage was associated with increased maternal morbidity and operative delivery rates. Dudding and colleagues opined that the evidence regarding the incidence of EAS lacerations in those undergoing vacuum extraction was conflicting. They considered that episiotomies and foetal position tended to confound the data [45].

Treatment

An empty rectum is less likely to leak. Therefore suppositories and/or rectal irrigation are helpful so long as the patient is co-operative [9]. Loperamide particularly low doses titrated to keep the stools firm may help. Fibre may be added judiciously. In some symptoms are made worse whereas others are aided by bulking agents. Biofeedback may be tried and may help those with inappropriate sphincter contraction and anismus but the authors have been unimpressed by their own experiences with patients who are rarely helped significantly.

If surgical intervention is to be undertaken it is essential that the expected results are discussed openly with the patient, particularly with regard to the long-term durability of certain interventions. For example, as discussed above, continence deteriorates with time after anterior sphincter repair. Selection of patients for surgery is based on clinical assessment aided by selected anatomical and physiological investigations. In general, the first question to answer is whether the anal sphincter is intact. Endo-anal ultrasound (EUS) is usually the investigation of choice, though depending on local availability MRI may be preferred. EUS has high sensitivity for the detection of both external and internal anal sphincter defects [46,47]. As already discussed, additional tests of anorectal function including defecography, colonic transit studies, manometry and electromyography may be indicated in selected cases. Surgical repair of damaged sphincters can be contemplated but the EAS must be contractile otherwise even if the anatomic defect is corrected the muscle will not contract because it has not got an adequate nerve supply. The IAS can rarely be repaired so soiling and incontinence to gas will persist. Thus if this is the predominant complaint, surgery should probably be avoided. Patients who do not demonstrate a sphincter contraction are currently considered for sacral nerve stimulation. Although SNS has shown promise in patients with disrupted sphincters, there may be a case for repair of the sphincters in those patients who do not achieve an optimal response to SNS, followed by repeat testing once the sphincters have been repaired.

Sphincter repair

Patients with an external sphincter defect of 90° or more should be considered for elective repair using an overlapping technique. The majority of cases result from sphincter damage at childbirth with the remainder due to surgical intervention for anal fistula or fissure. Primary repair is usually performed within 24 h of delivery and the majority of obstetricians carry out an end-to-end repair. In cases of missed sphincter damage or failed primary repair, elective secondary repair is indicated after a minimum interval of 3 months. This is usually performed by colorectal surgeons using an overlapping technique in which the sphincter ends are mobilised and repaired with interrupted mattress sutures. Although the short-term results of sphincter repair after obstetric injury are satisfactory, the results deteriorate in the medium to long term. Furthermore, patients are rarely made continent to gas and urgency may only improve minimally. Best results are obtained in those incontinent to solid stool. Passive incontinence due to internal sphincter disruption is not improved.

Long-term outcome of delayed sphincter repair

Early results are often excellent but with longer follow-up frequently deteriorate such that most are left with significantly impaired control. In the study by Bravo Gutierrez et al, patients at ten years follow-up after sphincteroplasty, 6% had no incontinence, 16% were incontinent of gas only, 19% had

soiling only, and 57% were incontinent of solid stool [48]. The results worsened significantly between assessments at three and ten years. Other studies have reported similar deterioration with time [49–53]. In the author's experience, while continence to solid stool was reasonably well preserved, urgency remained a problem and incontinence to gas was not improved [54].

A repeat procedure for patients who remain symptomatic with a residual sphincter defect may be undertaken with acceptable results [55] but there is limited benefit in more than two attempts. Vaizey analysed the long-term outcome following repeat anterior anal sphincter repair for obstetric trauma in twenty-three patients who had undergone a repeat repair and compared the analysis to one undertaken at 20 months follow-up, at which time 13 patients (65%) felt 50% or greater improvement compared with their preoperative status. Reassessment at a median of 5 years identified one patient who was fully continent and 12 with symptom improvement of over 50%. In contradistinction to follow-up after primary surgical repair, there was no significant deterioration of continence and early results of repeat repair were sustained [56].

Pelvic floor repair

A number of procedures have been described to attempt to plicate the levator muscles and external sphincter in order to increase the length of the anal canal and/or restore the normal recto-anal angle, including anterior levatorplasty, post-anal repair, and total pelvic floor repair. Unfortunately mid-term results were poor, leading to the procedure being largely abandoned as sphincter repair was undertaken in preference [57]. Since the intervention was undertaken during a time preceding accurate evaluation of the anal sphincter it is likely that many of the patients selected had occult sphincter defects. However, now that the limited durability of sphincter repair is known the longer-term results of the two procedures may not be all that different.

Sacral neuromodulation is dealt with in detail in a separate chapter in this supplement but its success for treating faecal incontinence has been reported as 75–95%, this includes those with the presence of a disrupted sphincter and certainly has led to less reliance on invasive surgery. Its exact mechanism of action remains unclear.

Neosphincter implantation

Patients in whom SNS has failed or those with a substantial morphological defect may be offered a neosphincter in the form of a dynamic graciloplasty or artificial anal sphincter. Both interventions are associated with considerable morbidity. Patients need to be highly motivated and aware of the possibility of failure due to evacuatory problems or recurrent sepsis, ultimately necessitating a permanent colostomy.

Dynamic graciloplasty (DGP)

Chetwood first described substituting the anal sphincter with the gluteus maximus muscle over 100 years ago [58]. The technique has since been modified and refined to use the gracilis muscle, which unlike the glutei has a negligible role in movement and posture. In order to convert the type II fast twitch fibres of skeletal muscle to the slow twitch fatigue-resistant fibres of the anal sphincter, conditioning with constant low-frequency electrical current is applied via an implanted stimulator. The gracilis muscle is mobilised preserving its proximal neurovascular pedicle and repositioned to encircle the anal canal with its distal tendon anchored to the contralateral ischial tuberosity. After 8 weeks of conditioning the patient can control continence using an external magnet to switch the stimulator on and off to allow evacuation as required.

The procedure is technically challenging and the complication rate is high, with infection being the most frequent early problem [59]. Revisional surgery is common. The Dynamic Graciloplasty Therapy Study Group has compiled prospective multinational data to show that after 2 years, 60% of patients had significant improvement in continence and quality of life [60]. These figures were replicated by Tiffin et al, who reported improved quality of life and continence in two-thirds of patients two years after DGP; two-thirds were continent all or most of the time [61]. In the author's experience (DCCB) 13 of 16 patients were improved or fully continent at a mean 20 months follow-up, though many required

readmission or correction of technical problems [62]. Similar results are reported from other centres [63]. There is some evidence that results are less favourable after longer-term follow-up, and obstructed defecation may become more problematic with time [64]. The procedure deserves consideration in the severely affected patient who is highly motivated. The operation has also been undertaken to avoid permanent colostomy in young patients after abdominoperineal excision for rectal cancer [65] and in patients with congenital anorectal malformation [66].

Malone antegrade continent enema (MACE)

Malone first introduced the procedure in 1990 to treat faecal incontinence in children. A non-refluxing channel is created to allow antegrade administration of enemas to empty the colon and hence prevent faecal leakage. An appendicostomy concealed in the umbilicus is simplest method but if the appendix has been removed ileal or colonic conduits can be fashioned. The procedure should be considered in patients where FI is associated with constipation due impaired rectal evacuation or colonic dysmotility. Results are good in 50–60% of cases [67,68]. Unlike neosphincter procedures, the surgery involved in MACE is relatively simple; the difficulty lies in maintaining patient compliance for administration of enemas and daily stoma catheterisation (necessary to avoid stenosis). Patients have to be highly motivated and involved in formulating their own care plans. Good stoma nurse support is essential. Recently the procedure has been reported in association with perineal colostomy in younger patients requiring abdominoperineal resection for rectal cancer as an alternative to abdominal colostomy, with good results [69,70].

Colostomy

A colostomy may be the option of last resort for the patient in whom all other options have failed. Although a stoma has the apparent advantage of simplicity, stomas have considerable physical and emotional impact and are associated with progressive long-term problems including parastomal herniation. Even after colostomy formation, patients may be incontinent of rectal mucus or suffer defunction proctitis. Nevertheless, for some patients a colostomy is a positive advance in comparison to the social isolation of FI [71].

In summary, there is much to offer the incontinent patient even though the management is complex and demands a multidisciplinary and skilled approach.

Practice points

- Unless there is a clear history of trauma, most cases of FI are multifactorial.
- A great deal of information can be obtained from careful clinical examination in combination with an endo-anal ultrasound to assess sphincter integrity.
- Examination under anaesthetic is useful to assess rectal mobility if internal or external prolapse is suspected.
- Overlapping sphincteroplasty is indicated in patients with an external anal sphincter defect of 90° or more; best results are obtained in those with incontinence to solid stool. There must be active contraction of the pelvic floor otherwise there is little point in repair of the divided muscles.
- Many studies have shown that there is deterioration in results after 5 years.

Research agenda

- Prevention of obstetric injury and early and accurate detection of such injuries should be of major importance.
- Randomised trials of Caesarean section versus instrumental delivery are needed.

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