Gadallah *et al.*
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REVIEW

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Fecal incontinence: challenges in electrodiagnosis and rehabilitation

Naglaa A. Gadallah[1], Abeer K. El Zohiery[1*], Youssy S. Gergius[1] and Shaymaa A. Moussa[1]

Abstract

Background Pelvic floor disorders are a common, yet debatable medical challenge. The management of fecal incontinence (FI) has always been a puzzle as it is a multifactorial problem that needs a skilled specialized teamwork.

Main body of abstract FI has complex etiology including altered rectal sensibility, dysfunction of the pelvic floor muscles, and damage to the anal sphincter complex. The most valuable tests for the evaluation of FI are anorectal manometry, endoanal ultrasound, MRI with or without defecography, and neurophysiological studies. Neurophysiological tests of the pelvic floor muscles represent a valid method for studying the functional integrity of neural pathways, localizing a pathological process, and possibly revealing its mechanism and severity. These tests include assessment of conduction of the pudendal nerve, electromyography (EMG) of the sphincter as well as pelvic floor muscles, sacral reflexes, somatosensory-/motor-evoked responses, and perineal sympathetic skin response. Different approaches are available for the treatment of FI. These include conservative measures such as lifestyle and dietary modifications, medications, and pelvic floor rehabilitation which are considered the preferred lines to avoid the risk of interventions. However, more invasive approaches as the use of perianal injectable bulking agents, sacral nerve stimulation, or surgery are also present.

Conclusion Finally, management of FI is a true challenge that needs multidisciplinary approach. Integrated diagnostic work-up between the related subspecialities, as well as tailoring the management plan according to each case, would help to reach best outcome.

Keywords Biofeedback, Fecal incontinence, Rehabilitation, EMG

Background

Fecal incontinence (FI) is defined as the involuntary passage of fecal matter through anus or the inability to control the discharge of bowel contents. Its severity can range from an involuntary passage of flatus to complete evacuation of fecal matter. Depending on the severity of the disease, it has a significant impact on patient's quality of life [1]. The prevalence of FI is difficult to estimate because it is underreported due to social stigma. The overall reported prevalence ranges from 2 to 21% with a median of 7.7%. There is significant variation depending on age. The prevalence of FI is reported as 7% in women younger than 30 years which rises to 22% in their 7th decades. In geriatric patients, the prevalence is reported as high as 25 to 35% of nursing home residents and 10 to 25% of hospitalized patients. In fact, FI is considered the second leading cause of nursing home placement in the geriatric population [2, 3]. The mechanism of fecal continence relies on the coordinated function of the nervous system, gastrointestinal tract, anal sphincter, and pelvic floor musculature (Fig. 1). Stool is often transferred into the rectum by colonic high-amplitude-propagated contractions, which often occur after awakening or meals [4].

*Correspondence:
Abeer K. El Zohiery
dr.abeerzohiery@gmail.com; dr.abeerzohiery@med.asu.edu.eg
[1] Department of Physical Medicine, Rheumatology and Rehabilitation, Faculty of Medicine, Ain Shams University, Cairo 11591, Egypt

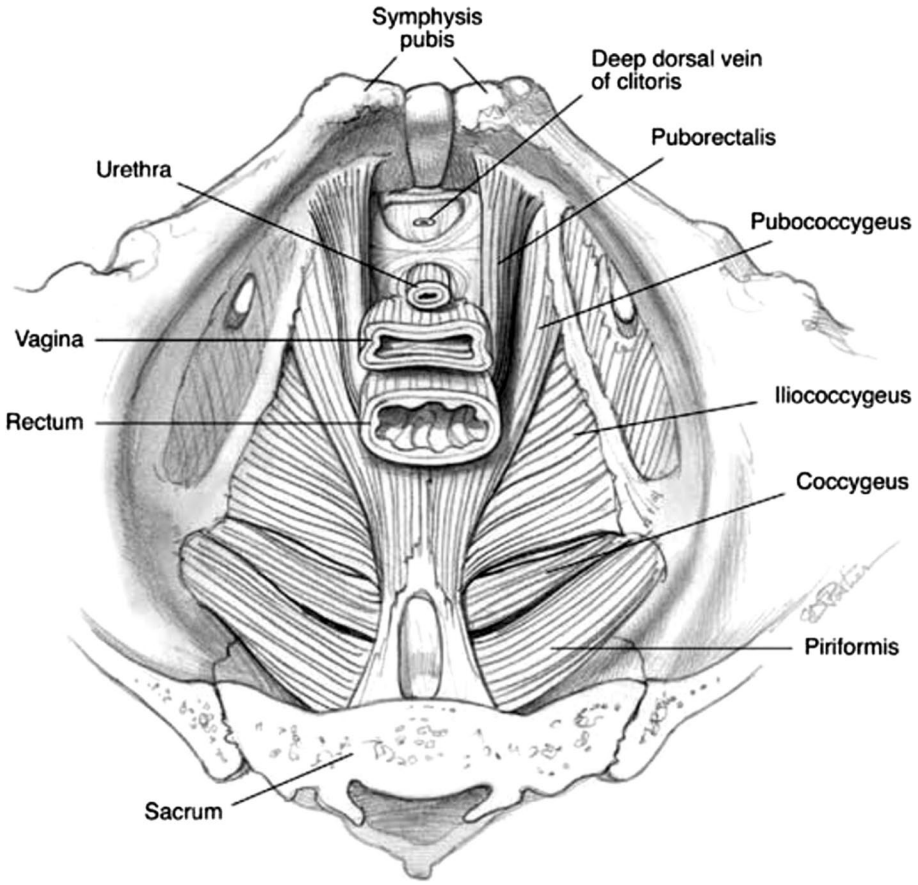

Fig. 1 Pelvic view of the levator ani demonstrating its four main components: puborectalis, pubococcygeus, iliococcygeus, and coccygeus [5]

Main text

As the fecal mass presents to the rectum, this causes distension. The sensation of rectal distension is transmitted by the parasympathetic nerves (S2–S4) which induces inhibition of the rectoanal inhibitory reflex and activation of the rectoanal contractile reflex. This causes rectal contraction and anal sphincter relaxation, facilitating evacuation. The pelvic floor, particularly the puborectalis, also generally relaxes during defecation as shown in Fig. 2. Simultaneous assessments of intrarectal pressures and pelvic floor activity reveal that increased intrarectal pressure and anal relaxation are required for normal defecation [5].

FI is a multifactorial problem including altered rectal sensibility, dysfunction of the pelvic floor, and damage to the anal sphincter complex. Patients with FI have an unintentional loss of liquid or solid stool. The etiology of the condition includes central or autonomic nervous system insults as cerebrovascular strokes, multiple sclerosis and spinal cord injury in addition to inflammatory bowel disease, irritable bowel syndrome, diabetes mellitus, previous anal surgery, and vaginal delivery. FI can also result from enlarged skin tags, poor hygiene, hemorrhoids, rectal prolapse, and perianal fistula. Other common causes include the use of laxatives and parasitic infections [1]. In children, FI is either due to functional or organic causes. The functional causes include constipation-associated FI and functional non-retentive FI, while organic causes include repaired anorectal malformations, post-surgical Hirschsprung disease, spinal dysraphism, spinal cord trauma/tumors, cerebral palsy, and myopathies affecting the pelvic floor and external anal sphincter [7]. Diagnostic testing is guided by whether incontinence is related to stool consistency or not. If diarrhea is suspected as a primary reason for incontinence, stool analysis for infection, osmolality, fat content, and pancreatic insufficiency is recommended together with evaluation of diabetes and thyroid disorder, evaluation for bacterial overgrowth, and lactose/fructose intolerance and colonoscopy to evaluate mucosal disease (IBD/colitis), mass, ulcer, and stricture. If incontinence is without any diarrhea, more specific testing should be conducted. The most valuable tests for the evaluation of FI are anorectal manometry, endoanal ultrasound, MRI with or without defecography, and

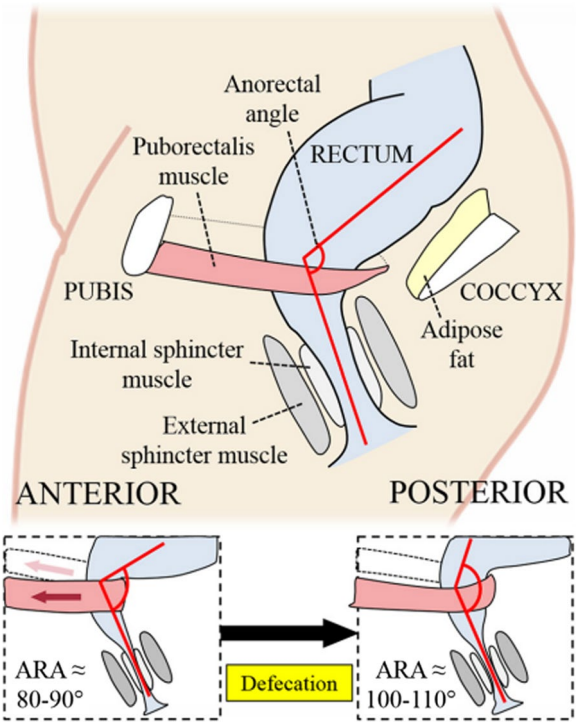

Fig. 2 Key components of the physiology of the defecatory system and their action [6]

neurophysiological studies [8, 9]. Anophysiology studies attempt to correlate the subjective complaints and clinical exam findings with objective parameters. However, the predictability of all tests remains a challenge [10]. Due to the limited usefulness of clinical examinations and anorectal manometric and imaging studies, clinical neurophysiologic methods continue to play an important role in determining whether anorectal disorders as FI have a neurogenic etiology [11].

Electrodiagnosis of pelvic floor and sphincters

The impetus to develop electrophysiological techniques for the purpose of investigating sphincter function in order to determine the cause of FI came from the work of Beersiek and his colleagues in 1979 [12]. They identified histological changes in the anal sphincter, showing evidence of denervation of the muscle. The standard electrodiagnostic tests used elsewhere in the body were somehow adapted for studying the external anal sphincter (EAS) and pelvic floor muscles. These tests have offered a comprehensive knowledge of the pathophysiology of incontinence and pelvic floor disorders [13]. Electrodiagnostic tests of the pelvic floor muscles represent a valid method for studying the functional integrity of neural pathways, localizing a pathological process, and possibly revealing its mechanism and severity [14–16].

Neurophysiological assessment of the pelvic floor includes assessment of conduction of the pudendal nerve, electromyography (EMG) of the sphincter as well as pelvic floor muscles, sacral reflexes, somatosensory/motor evoked responses, and perineal sympathetic skin response.

Pudendal nerve terminal motor latency (PNTML)

Weakness of the external anal sphincter due to pudendal nerve damage may occur in 2 ways: a direct stretch-induced injury as during vaginal delivery and chronic straining. In addition, damage to the pelvic nerves causing perineal descent which in turn leads to pudendal nerve stretch, thus causing abnormal pudendal nerve motor latency [12]. Pudendal nerve conduction studies (NCS) are the most commonly reported electrodiagnostic (EDX) tests done on the pelvic floor. A pudendal electrode, also known commonly as "St. Mark's electrode," (Fig. 3) consists of a stimulating cathode and anode and two recording electrodes, which can be attached to a gloved index finger. The stimulating electrodes are positioned on the tip of the index finger, while the recording electrodes are placed at the base. Then, the pudendal nerve is stimulated at the ischial spine level (Fig. 4). If stimulation is applied transrectally, the recording electrodes are located at the external anal sphincter. Since PNTML is evaluating conduction speed, it is considered an assessment for the faster conduction nervous fibers, and accordingly, it is not a good guide about muscular denervation [17].

In women, it is preferable to stimulate the pudendal nerve using a transvaginal approach with surface electrodes placed over the external anal sphincter (EAS) at the 3 and 9 o'clock positions with the patient in dorsal lithotomy or left lateral position. Older age, more vaginal deliveries, and a wide genital hiatus were associated with longer pudendal and perineal nerve terminal motor latencies. Normative data for pudendal nerve studies are illustrated in Table 1.

Pudendal and perineal nerve conduction studies have established a link between pudendal neuropathy and fecal incontinence. Prolongation of PNTML suggests pudendal neuropathy, and bilateral, not unilateral, neuropathy has been associated with diminished sphincter function and higher incontinence scores [19, 20]. The test of pudendal nerve has been found to be relatively insensitive to axonal lesion, because amplitude of response is variable between control subjects (particularly due to technical reasons), and conduction may remain normal in partial lesions [21]. The pudendal nerve study assesses the large, myelinated, fastest-conducting fibers in a nerve, and hence, loss of the slower-conducting fibers may be missed. PNTML has been used in different clinical

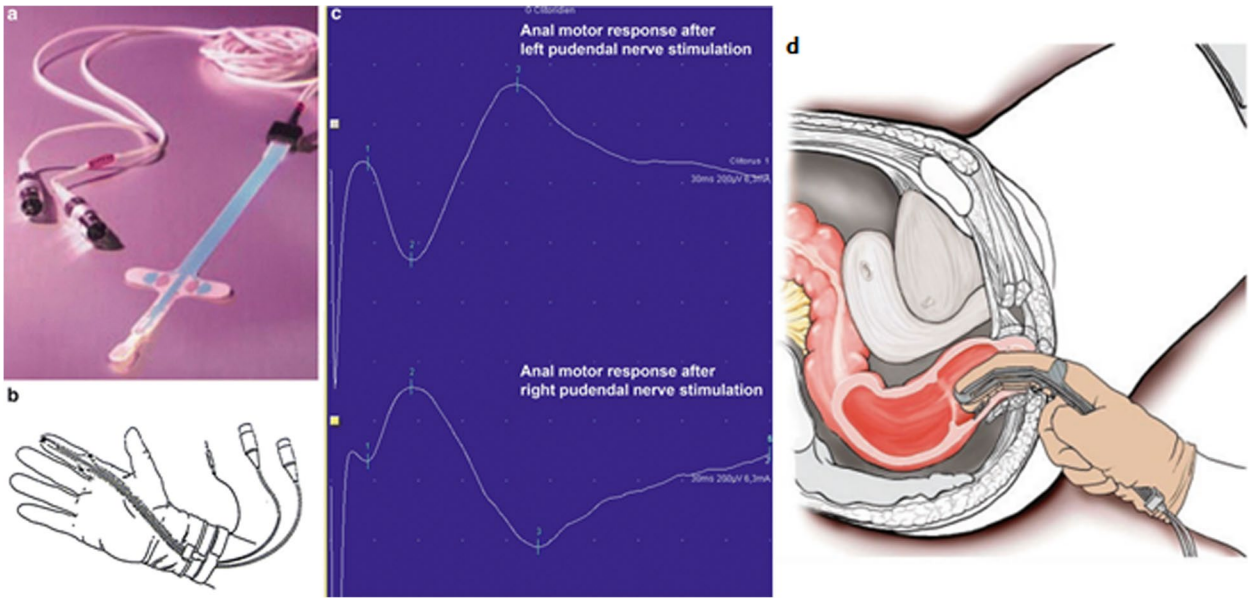

Fig. 3 **a** Pudendal electrode. **b** A bipolar-stimulating electrode is mounted on the tip of the gloved index finger, which is inserted into the rectum. **c** Recording electrodes located 3 cm proximally at the base of the finger pick up the contraction response of the anal sphincter. **d** Application of pudendal electrode transrectally [10]

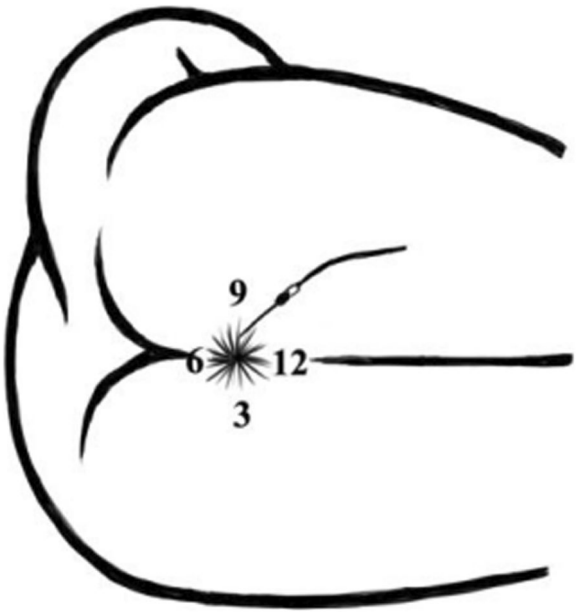

Fig. 4 Position of needle insertion in external anal sphincter EMG [18]

Table 1 Normative pudendal nerve conduction values [6]

Latency (msec) + SD	Amplitude (uV) + SD
1.94 (1.55–2.54)	101 (20–260)

conditions, but its clinical value has been questioned because the reproducibility, sensitivity, and specificity are still uncertain. It should not be used in isolation from other EDX tests when evaluating pelvic floor injuries. Generally, EMG follows NCSs since EMG is more sensitive for detecting neuropathic injury [22].

Electromyography (EMG)

Electromyography (EMG) is the recording and analysis of electrical activity from striated muscles and can be used to distinguish between normal, denervated, and reinnervated muscle. EMG aims at analyzing the motor units by means of either painless but imprecise surface electrodes or through precise but painful needle electrodes (Fig. 4). EMG may also play a role in confirming paradoxical puborectalis contraction in patients with obstructed defecation [23]. Voluntary electrical activity is recorded as motor unit action potentials (MUAP), which represent the summation of activity from multiple motor units. Insertional activity is the electrical activity detected by the concentric needle electrode as it passes through the muscle at rest (Fig. 5). When the electrode is in healthy muscle, the insertional activity will return to baseline in 300 ms. Decreased insertional activity indicates that the electrode is not in muscle, or that the muscle has undergone severe atrophy and has been replaced by electrically inactive tissue as in cases of postsurgical fibrosis [23]. Spontaneous activity is

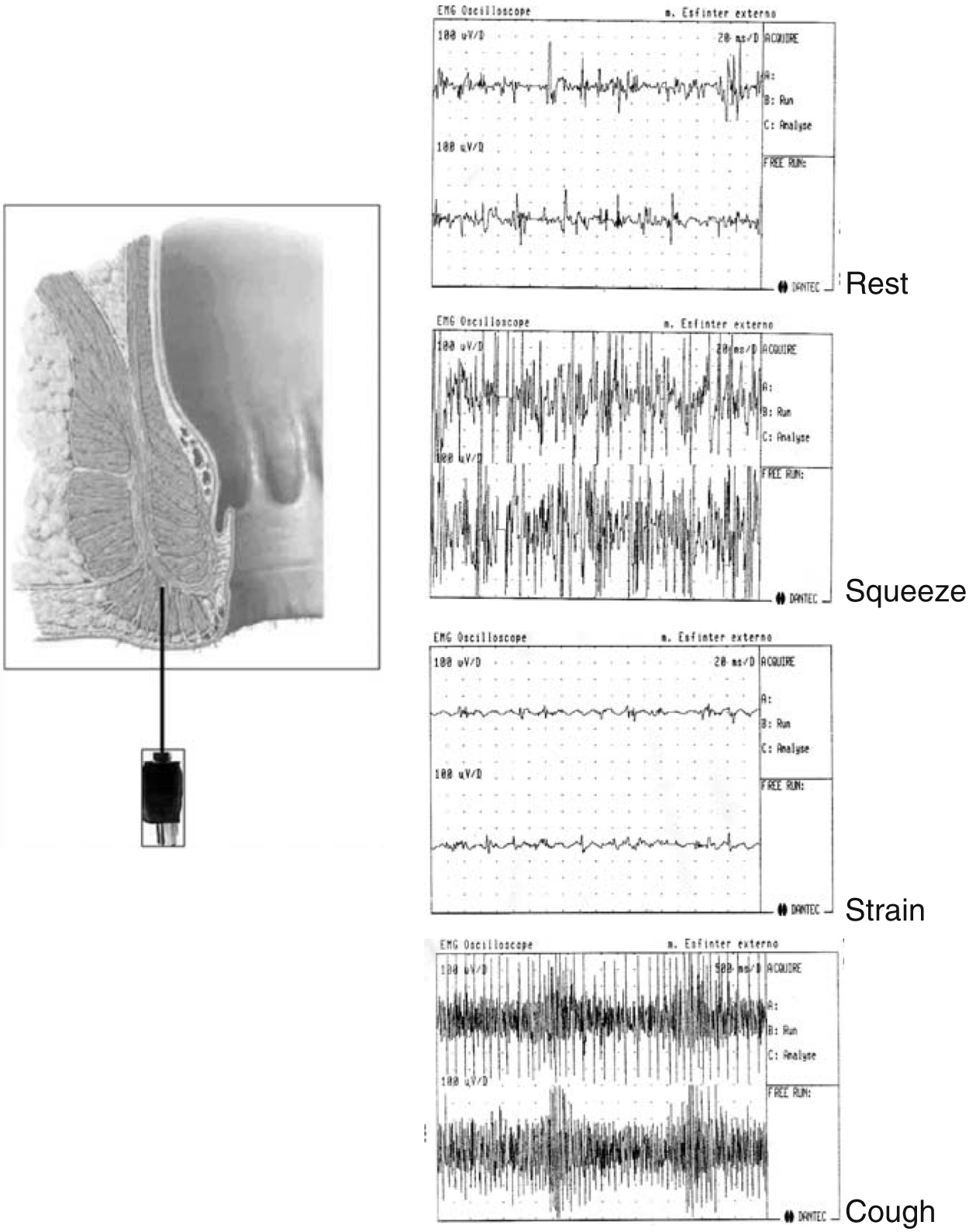

Fig. 5 Needle electrode recording in EAS for rest, squeeze, strain, and cough [24]

persistent electrical activity after the needle is inserted and results from marked membrane instability of the muscle or neuron innervating it. Unlike most skeletal muscles, which are electrically silent at rest, the pelvic floor muscles have baseline tonic electrical activity assessed and named as resting tone, making it more difficult to detect spontaneous activity. The most common form of spontaneous activity in skeletal muscles is the presence of positive sharp waves or fibrillation potentials [15]. The commonest type of abnormal spontaneous activity reported in pelvic floor muscles is complex repetitive discharges (CRD). Even though CRDs are nonspecific findings, their presence usually suggests ongoing chronic denervation and reinnervation in the muscle [21].

Motor unit recruitment refers to the pattern in which motor units are recruited by the spinal cord. Muscle increases force by increasing the frequency and number of individual firing motor units. Sphincter muscles' EMG recordings are performed at rest and during squeezing, coughing, and straining that simulates rectal evacuation. Therefore, as voluntary effort is increased, an increased number and frequency of MUAPs should be seen (tested and analyzed as minimum squeeze power). At maximum effort (usually named maximum squeeze power), so many motor units are firing that individual MUAPs cannot be distinguished, resulting in an interference pattern [25]. Since sphincter MUAPs are smaller than other striated muscles, it is important to know the commonly used settings. Amplifier gain is typically reduced to 50 μV, and filter settings are set at 10 Hz and 10 kHz with a sweep speed of 10 ms/div [23]. The normative data for mean values of EAS motor units action potentials are shown in Table 2.

Quantitative EMG (QEMG) of the EAS with automated analysis of MUAPs is the most widely used method in clinical practice. A set of three MUAP parameters with the highest predictive power for neuropathic signs is proposed (i.e., area, duration and number of turns) [16].

Table 2 Normative data for mean values of individual MUAP parameters [26]

MUAP parameter	Mean + SD
Amplitude (μV)	609 ± 93
Duration (ms)	5.55 ± 1.12
Area (μVms)	356 ± 135
Phases	3.02 ± 0.36
Turns	2.87 ± 0.50
Spike duration (ms)	2.90 ± 0.55

In multiple system atrophy (MSA) studies, MUP duration together with percentage of polyphasic MUPs is the two main electromyographic parameters considered. EMG of the EAS muscle, especially use of the single MUP technique with inclusion of late components for measuring MUP duration, shows neurogenic MUP changes in MSA patients compared with controls, with an abnormality rate of more than 70% [16].

Neurophysiologic tests for children suffering from FI following transanal endo rectal pull-through operation (for Hirschsprung's disease) showed a statistically significant lower resting tone, a significant prolongation of MUAP duration with higher mean of polyphasicity when compared to controls [27]. Comparing male and female patients with FI suggests that female patients tend to have worse sphincter function than men. Both groups had similar EMG alterations, suggesting a common neurogenic injury as etiology [28]. Prior to the more widespread use of anal ultrasound, investigators would utilize EMG to "map" the location of functioning anal sphincter muscle.

Sacral reflex testing

Reflex contractions of pelvic floor muscles occur after stimulation of certain pelvic floor sites resulting in sacral reflexes. Those reflexes are mediated through afferent and efferent connections between sacral spinal segments and the muscles through the pudendal nerve. Sacral reflexes are altered in few patients with suprasacral lesions, and they are not useful for evaluating spinal cord damage. They can be recordable following mechanical or electrical stimulations over the penis while recording directly from the bulbocavernosus muscle using a concentric or monopolar needle. Different forms of sacral reflexes have been described, and the ones chiefly employed in pelvic floor evaluation are the urethral-anal reflex, the bladder-anal reflex, and the clitoral/penile-anal reflex. Sacral reflex studies have a greater sensitivity than the clinical elicitation of the reflex [15]. Electrical stimulation over the penis/clitoris will elicit a monosynaptic reflex response (R1) at around 30 ms and a polysynaptic late response (R2) at around 60 ms. The R1 is a direct response and exhibits no habituation to repeated electrical stimulations. A prolonged latency or absent response is considered as abnormal. They are an important tool to evaluate the integrity of sensory and motor components of the pudendal nerve [16]. There was a statistically significant higher mean latencies of sacral reflex in patients suffering from FI. The cutoff value of the pudendo-anal reflex was 40.88 ms [27]. Increased latency or non-elicitable responses are the most frequent abnormal findings. Needle EMG examination together with

bulbocavernosus reflex study will increase the yield of detecting cauda equina and conus medullaris lesions to over 95% [16, 29].

Pudendal somatosensory-evoked potentials (pSEPs)

Unlike the basic sensory nerve conduction studies, the pelvic region sensory nerves are inaccessible for electrical stimulation. Hence, the nerve is stimulated peripherally while recording its response from the somatosensory cortex of the brain using surface scalp electrodes. The pudendal somatosensory-evoked potential study is a well-established test and the most commonly performed evoked potential study in the pelvic region [30]. Evaluation of pSEPs provides information about the integrity of the somatosensory afferent pathways from the pudendal nerve to the parietal cortex. Pudendal somatosensory-evoked potential is easily recorded using a similar technique to that which is used for recording the tibial-evoked potential but with stimuli applied to the dorsal nerve of the penis or clitoris. The response has a similar waveform and even latency to that of the tibial-evoked response—the slower conduction being due to the composition of the penile nerve being sensory only and lacking the fast-conducting muscle afferent fibers of the tibial nerve. Pudendal nerve cortical somatosensory-evoked potentials are used to assess suprasegmental pathways. It was mentioned by Benson (1996) that measuring the pudenda-anal reflex and the pudendal-evoked potential allows examination of both segmental and suprasegmental neural pathways to the sacral cord [31].

Nevertheless, the pudendal SEPs have few limitations due to technical and anatomical factors. The cortical amplitudes are relatively lower than those recorded from mixed nerves as the posterior tibial nerve. This could be due to the absence of large diameter sensory fibers in the dorsal nerve of the penile/clitoris. Owing to the low cortical potentials, it is challenging to determine amplitude asymmetry. Pudendal responses are recorded mainly from S2 to S4. Hence, partial lesions affecting only some of the roots may be missed during studying pudendal SEP. Moreover, the faster unaffected dorsal root fibers convey the signals to the cortex with normal latency. Finally, the supramaximal stimulation on one side (especially at the penis base in males) may result in co-stimulation of the contralateral nerve. Due to these limitations, it may not be possible to provide a precise localization when lateralized sacral root injury is suspected which limits the clinical utility of recording pudendal SEPs [32]. Lately, the dermatomal somatosensory-evoked potentials (DSEP) measurement may assist in overcoming some of these limitations. Recording technique for DSEPs is similar to pudendal SEPs; however, individual dermatomes are stimulated rather a nerve branch of a sensory nerve [33].

Pudendal magnetic-evoked potentials (pMEPs)

Transcranial magnetic stimulation can be used to test the motor efferent to the pelvic floor muscles. Studies investigating the diagnostic role of pMEPs in patients with neurological disorders are sparse and heterogeneous. Some reported good reliability of pMEPs in discriminating patients with central nervous system disorders from healthy subjects. On the other hand, some healthy subjects may show absent response to cortical stimulation due to the difficulty of stimulating deep cortical structures, hence limiting the clinical value of this method [16].

Perineal sympathetic skin response (SSR)

Clinical neurophysiological investigations such as nerve conduction studies, electromyography, and evoked potential studies are helpful to assess somatic afferent and efferent nerve pathways. Sympathetic skin response test is helpful to assess sympathetic pathways [33]. The SSR is used to test sympathetic sudomotor activity by assessing conductance changes across the skin as a response to peripheral nerve electrical stimulation. It is mediated through myelinated somatosensory afferent fibers, a central autonomic network, and sympathetic cholinergic efferent fibers controlled by complex supraspinal signals. The distribution of eccrine glands is not uniform over the body, and their density is greatest over the palms and soles [34] and more thinly distributed over the thighs and back. SSR response recorded from the perineal skin is therefore of much smaller amplitude compared to palms and soles. Moreover, the responses are affected by a temperature, stimulus strength, habituation, and patient relaxation. Thus, the examiner should be aware of the physiological and environmental factors when interpreting the SSR. Due to the marked variability in SSR amplitude, just the presence of a clear response is sufficient to document a normal study [33]. Finally, no statistically significant difference in SSR data could be reported between patients with FI and controls in literature [27].

Pelvic floor rehabilitation

Different approaches are available for the treatment of FI. Conservative measures are usually considered the preferred first line of treatment. However, more invasive procedures are available on individual basis [35]. A stepwise approach to treatment is usually advocated to minimize injury to patients [36]. Pelvic floor rehabilitation (PFR) is a broad-spectrum entity that constitutes different techniques including bowel management

education and retraining, EMG biofeedback-guided pelvic floor muscle training (PFMT), biofeedback therapy (BFT), the use of electrical stimulation, and manual myofascial release techniques. Biofeedback therapy is the broad general term referring to recording different biomechanical or physiological parameters with a feedback in the form of visual and/or auditory signals. EMG biofeedback implies recording muscles activity, and this is the most commonly used technique in pelvic floor dysfunction rehabilitation. This could be achieved using surface electrodes, intrarectal or intravaginal probes. Other types as manometry biofeedback are also used. These various rehabilitative techniques are usually used in combination to produce the maximum benefit for the patient. The principal aim of all forms of pelvic floor rehabilitation is to improve pelvic floor and anal sphincter muscle strength, tone, endurance, and coordination to achieve better function. PFR also works on increasing the patient's awareness of their own muscles and improving rectal sensitivity allowing improved muscle function [37, 38].

Lifestyle and diet modifications

PFR lifestyle education and diet modifications incorporation in the management of patients with FI are of great importance [35]. These might include but not limited to instructions to optimize fluid intake and dietary adjustments [39]. Regulating dairy, gluten, and fiber contents in diet is a crucial component [40]. Fiber supplementation was found to significantly reduce the rate of FI with recommended daily supplementary fiber intake of 2–6 g per day [41, 42]. Behavior modifications include creating a scheduled time for bowel evacuation in a trial to limit incontinent episodes. Teaching the proper defecation posture to avoid straining, together with fecal urge suppression techniques, is also key measures [39, 43]. Weight reduction is typically encouraged, as obesity is a well-documented risk factor for the development of FI [44].

Medications

Some medications have been used in managing FI. Loperamide is a synthetic opioid which was found beneficial in reducing urgency FI. It works on inhibiting intestinal peristalsis, thus increasing oral-cecal transit time. It also increases resting anal sphincter tone, thus improving rectal perception and rectal compliance [45]. Anticholinergic medications, such as hyoscyamine, can help decrease postprandial leak if taken before meals. Also, amitriptyline has been shown to increase colon transit time by decreasing rectal contractions in patients with idiopathic FI [42]. Cholestyramine is helpful in patients with bile salt malabsorption. Low-dose clonidine, an α-adrenergic agent, also can be used to reduce rectal sensation and urgency [46, 47]. Phenylephrine gel applied directly to the sphincter was shown to increase internal anal sphincter (IAS) tone, possibly beneficial for patients with intact IAS but low-resting pressure [47, 48].

Pelvic floor muscle exercise training (PFMT)

PFMT typically consists of verbally guided instruction for pelvic floor and sphincter contractions (Kegel contractions) [49]. It was introduced for the treatment of FI in the 1970s [50]. Contractions could be done in various ways as maximal voluntary sustained sphincter contractions, submaximal sustained contractions, or fast-twitch or "quick-flick" contractions [51, 52]. It aims to improve muscle tone and sphincter strength, thus leading to an increased patient's ability to delay defecation. Moreover, it has been hypothesized that training all core muscles would be more beneficial than merely focusing on the pelvic floor muscles alone [51]. A study showed that all patients who underwent pelvic floor exercises with either biofeedback with anal manometry, biofeedback with transanal ultrasound, or with feedback from digital examination all experienced highly significant improvements [53].

Biofeedback therapy

Biofeedback is defined primarily as using tools to enable a person to get control on some subconscious body processes by making them perceptible [54]. EMG BFT, which was first introduced in 1979, is considered the most common type of biofeedback used for pelvic floor rehabilitation purposes [55]. BFT help patients to correctly identify and isolate the muscles to enable them to effectively contract them. There are three main approaches in how biofeedback is useful as a part of pelvic floor rehabilitation for FI [37]. The most common one is for strength and endurance training for the pelvic floor and/or anal sphincter. The second treatment modality is to use BFT to improve rectal sensitivity or compliance, allowing the patient to detect smaller volumes of stool at an earlier time, and enabling patients to reach the restroom before accidents occur [56]. The third approach deals with anal sphincter coordination training. Patient is taught to do a voluntary external sphincter contraction to counteract the involuntary relaxation of the internal sphincter [37, 57]. Biofeedback was found more beneficial in patients with urgency FI, post sphincteroplasty, or anal repair. However, severe FI, pudendal neuropathy, and underlying neurological problems have been associated with worse outcomes [37].

Electrical stimulation

Electrical stimulation targeting the external anal sphincter is another modality that has been proposed for the rehabilitative treatment of FI. Electrical stimulation has been shown to transform fast-twitch muscle fibers to slow-twitch muscle fibers, thus improving endurance [58]. It also increases capillary density, allowing more blood flow to the oxidative slow-twitch fibers [59]. Electrical stimulations can be delivered to the pelvic floor and anal sphincter in different ways, as surface electrodes or intrarectal probes [60]. A study held by Schwandner group reported that patients with sphincter damage and neuropathic anal incontinence responded better to a combination treatment termed triple target treatment or 3 T, which consisted of amplitude modulated-medium frequency (AM-MF) stimulation, EMG-triggered AM-MF stimulation, and EMG biofeedback training, than to EMG biofeedback alone [61].

Percutaneous tibial nerve stimulation (PTNS)

PTNS is a minimally invasive outpatient technique with almost no associated morbidity and a success rate of up to 60%. PTNS takes place through inserting a 34-gauge needle electrode (or surface electrode) to stimulate the posterior tibial nerve near the medial malleolus to achieve effects via L4–S3 nerve roots. It was initially used in treatment of overactive bladder, and it is now gaining ground as a treatment for FI [62].

Sacral nerve stimulation (SNS)

SNS was first introduced as a minimally invasive surgical option for refractory FI in 1995 in Europe in cases of conservative treatments failure. FDA approved this technique in the USA in April 2011 [45, 63]. SNS uses electrical stimulation of the sacral nerves, thus modulating the lower bowel, anal sphincter, and pelvic floor [64]. Patients usually undertake a test stimulation period. Patients who show significant benefit, at least a 50% reduction in FI episodes, undergo implantation of the definitive pulse generator [65].

Injectables

Injection of a bulking agent into the submucosal or intersphincteric space to augment the closure of the proximal anal canal was first introduced in 1993 [66]. It is considered a simple and a minimally invasive technique. According to the American Society of Colon and Rectal Surgeons practice, this method is most beneficial when FI is primarily due to internal anal sphincter dysfunction; however, its long-term efficacy and definite protocol have yet to be defined [67].

Secca® procedure

The Secca® procedure, an application of a temperature-controlled radiofrequency (RF) energy to the IAS in order to induce collagen deposition causing tightening of the sphincter, was approved by the FDA for treatment of refractory FI in 2002 [68].

Although conservative treatment of FI is effective in more than half of all patients, a proportion with persistent severe incontinence require more intensive treatment and direct surgical interventions which are beyond the scope of this article.

Conclusion

Finally, management of FI is a true challenge that needs multidisciplinary approach. Integrated diagnostic work-up between the related subspecialities, as well as tailoring the management plan according to each case, would help to reach best outcome.

Abbreviations

AM-MF	Amplitude modulated-medium frequency
BFT	Biofeedback training
CRD	Complex repetitive discharge
DSEPs	Dermatomal somatosensory-evoked potentials
EAS	External anal sphincter
EDX	Electrodiagnostic
EMG	Electromyography
FDA	Food and Drug Administration
FI	Fecal incontinence
IAS	Internal anal sphincter
IBD	Inflammatory bowel disease
MRI	Magnetic resonant imaging
MSA	Multiple system atrophy
MUAP	Motor unit action potential
MUP	Motor unit potential
NCS	Nerve conduction study
PFMT	Biofeedback-guided pelvic floor muscle training
PFR	Pelvic floor rehabilitation
PNTML	Pudendal nerve terminal motor latency
PSEPs	Pudendal somatosensory-evoked potentials
PTNS	Peripheral tibial nerve stimulation
QEMG	Quantitative electromyography
RF	Radiofrequency
SEP	Somatosensory-evoked potentials
SNS	Sacral nerve stimulation
SSR	Sympathetic skin response

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