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NARRATIVE REVIEWS

The Clinical Utility of Anorectal Manometry: A Review of Current Practices

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Anorectal manometry (ARM) is a diagnostic test that utilizes pressure sensors to dynamically measure intraluminal anal and rectal pressures, thus providing an objective evaluation of anorectal functional parameters (tone, contractility, and relaxation), coordination and reflex activity, and sensation. ARM is a useful test for numerous indications including for the assessment and management of functional anorectal disorders such as fecal incontinence, functional defecatory disorders, and functional anorectal pain, preoperative assessment of anorectal function, and in facilitating/assessing response to biofeedback training. In addition, while many functional anorectal disorders present with overlapping symptoms (ie constipation, anorectal pain), ARM allows delineation of more specific disease processes and may guide treatment more effectively. In recent years the development of advanced manometric methodologies such as high-resolution anorectal manometry has also led to improved spatial resolution of data acquisition, further increasing the potential for the expansion of ARM. However, despite its ability to provide detailed information on anorectal and pelvic floor muscle function and synergy as well as the endorsements of several national and international organizations, ARM is still infrequently utilized in clinical practice. The purpose of this review is to address the current clinical applications and limitations of ARM for various disorders of the lower gastrointestinal tract. In so doing, we will provide clinicians with a framework for the use of ARM in clinical practice. This review will also discuss potential barriers to widespread adoption of ARM in clinical practice and propose possible solutions to these challenges.

Keywords: Anorectal Manometry; Biofeedback Therapy; Constipation; Defecatory Disorder; Fecal Incontinence

Introduction

Anorectal manometry (ARM) is a diagnostic test that provides an objective and dynamic assessment of anorectal sensation, pressure relationships, and functional parameters (ie tone, contractility, and relaxation), coordination and reflex activity, and rectal sensation.[1,2] ARM involves the placement of pressure-sensing catheters in the rectum to obtain multiple measures,[3] specifically: 1) contractility and tone of the internal and external anal sphincters, 2) rectal sensitivity and compliance, 3) the reflex relaxation of the internal anal sphincter in response to rectal distension (rectoanal inhibitory reflex or recto-anal inhibitory reflex [RAIR]), 4) the reflex contraction of the external anal sphincter in response to cough or Valsalva maneuver, and 5) the dynamic changes of rectal and anal pressures during simulated evacuation.[4]

As opposed to conventional ARM, which is still used at some institutions, high-resolution anorectal manometry (HR-ARM) and three-dimensional 3D-ARM have a higher number of recording sensors and can record and display detailed information simultaneously from the whole anal canal and distal rectum. Recorded data is displayed in color-contoured pressure topography plots.[2,3,5] Artificial intelligence systems are also now starting to be developed and validated to assist with interpretation of ARM.[6] Other tests are usually used and interpreted in conjunction with ARM, such as the rectal balloon expulsion test (BET) and the rectal sensory test (RST).[7] The rectal BET takes place during the simulated evacuation stage of ARM testing, for which patients are initially asked to bear down as if to defecate before and after inflation of the balloon with the goal to effectively expel the balloon from the rectum.[3] Rectal sensation and the RAIR are measured via distention of the balloon in 10 ml increments until the patient first reports a sensation, at which point the balloon is inflated in additional 20 ml increments to the maximum tolerated volume (maximum of 400 ml). Patients report additional sensations such as desire to defecate, urgency to defecate, and maximum tolerable sensation.[1,4]

Abbreviations used in this paper: **3D-ARM, three-dimentional anorectal manometry; ACG, American College of Gastroenterology; ANMS, American Neurogastroenterology and Motility Society; ARM, anorectal manometry; BET, balloon expulsion test; BMI, body mass index; DRE, digital rectal exam; ESNM, European Society of Gastroenterology and Motility; FDD, functional defecatory disorder; FI, fecal incontinence; HR-ARM, high-resolution anorectal manometry; IAPWG, International Anorectal Physiology Working Group; IBS-C, constipation-predominant irritable bowel syndrome; IPAA, ileal pouch-anal anastamosis; LAR, low anterior resection; LIS, lateral internal sphincterotomy; RAIR, recto-anal inhibitory reflex; RST, rectal sensory test.**

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Current guidelines recommend ARM in the assessment of fecal incontinence (FI) and assessment of constipation and functional defecatory disorders (FDDs) – the specific scenarios in which it should be utilized will be further discussed in this review. It has also traditionally been used in the management of these conditions to facilitate biofeedback therapy, a form of targeted pelvic floor therapy that consists of diaphragmatic muscle training in conjunction with manometric-guided pelvic floor relaxation followed by simulated defecation.[8–10] However, data supporting newer additional indications is emerging – including in the assessment of functional anorectal pain as well as in the preoperative assessment of anorectal function (Table 1).[2,13]

It has recently been proposed that up front ARM used to triage patients to appropriate therapy may even be more cost-effective compared to a combination of empiric prescription drugs and pelvic floor physical therapy.[14] However, the study had various limitations, including lack of consideration of the invaluable role of history taking and physical examination, including a complete digital rectal exam (DRE) in the diagnostic process. The DRE continue to be strongly recommended to screen for anorectal functional disorders and guide anorectal physiology testing, which can then help to characterize underlying structural and functional abnormalities more accurately.[15] While ARM is quite useful, it is also an uncomfortable procedure for patients to go through unnecessarily. The DRE assesses for the presence of stool, structural/anatomical issues, resting tone, and contraction of the anal sphincter and puborectalis muscle (when asking patient to bear down). Absence of contraction or failure to relax puborectalis and/or anal sphincter muscles should prompt

Table 1. Table Indicating When Functional Anorectal Testing (ARM, BET, RST) Is Helpful/Clinically Indicated, as Well as Most Common Findings on Functional Anorectal Testing

Indication:	Is ARM helpful?	When to order ARM?	ARM findings:
Fecal incontinence (FI)	Yes, identifies patients appropriate for surgical anal sphincter repair as well as in conjunction with biofeedback therapy	For all patients with clinical evidence of FI who fail to respond to conservative measures (strong recommendation, moderate quality of evidence)[11]	• Significantly lower anal resting (hypotonia) and squeeze pressure (hypocontractility) • Anorectal hyposensitivity more common (although hypersensitivity has been noted as well)
Functional defecatory disorder (FDD)	Yes, identifies patients appropriate for biofeedback therapy and may help target specific exercises	Per current guidelines,[11,12] after failing empiric medical management of chronic constipation with laxatives	• Evidence of dyssynergic defecation patterns • Rectal hyposensitivity • Rectal hypersensitivity in IBS-C
Functional anorectal pain	Not for diagnosis, but helpful for guiding biofeedback training	In conjunction with biofeedback therapy	• Elevated anal sphincter pressures • Evidence of dyssynergic defecation patterns • Rectal hypersensitivity
Preoperative management	Yes, predicts outcomes	Prior to LAR, LIS, fistula-in-ano surgery, rectal prolapse repair	• Lower resting pressures associated with postop incontinence
Biofeedback therapy	Yes, can guide specifics of both biomechanical and neuromuscular biofeedback therapy	To guide specific exercises and provide patient education, live feedback and coaching regarding the following: • Rectal sensitivity training → for example, a rectal balloon may be repeatedly distended with air or water and the patient is taught to feel the distension at either progressively lower volumes (for rectal hyposensitivity) or to tolerate progressively larger volumes (for urgency/hypersensitivity) • Training to relax pelvic floor muscles when straining • Enhancing the push effort • Improving anorectal muscle coordination and strength	• Findings of several of the above conditions should ideally improve with biofeedback training

IBS-C, Constipation-predominant IBS; LAR, low anterior resection; LIS, lateral internal sphincterotomy; OASI, obstetric anal sphincter injury.

suspicion of underlying anorectal functional pathology. Notably, DRE by an experienced provider has been shown to be sufficient in daily clinical practice to measure resting tone and detect dyssynergia.[16–18] DRE was found in a recent meta-analysis to have a sensitivity of 71.3% and a specificity of 76% in predicting findings of dyssynergia defecation on high resolution ARM.[19]

ARM should ideally be utilized after the conservative measures for FDD and FI fail.[15] Complete assessment of anorectal function also often requires additional analysis such as physiological function testing, rectal compliance assessment, and structural assessments by anal ultrasound or magnetic resonance imaging defecography[20] – all of which are complement findings of ARM. However, despite its ability to provide detailed information on anorectal and pelvic floor muscle function and synergy, ARM is infrequently utilized in clinical practice for various reasons. This review will, therefore, address the current literature regarding the clinical applications of ARM for various disorders of the lower gastrointestinal tract and discuss its limitations and potential solutions, in order to provide clinicians with a framework for the use of ARM in clinical practice.

Methods

A preliminary search of the literature was performed using electronic databases PubMed and Google Scholar using the terms “anorectal manometry,” or “high-resolution anorectal manometry,” AND “clinical indications,” or “limitations”. A secondary search of the literature was performed after initial search using more specific terms identified during the preliminary search such as “fecal incontinence,” “functional defecation disorder,” “functional anorectal pain,” “preoperative assessment”. Inclusion criteria were articles written in English published between January 1980 and April 2024 and that discussed the topic of interest, clinical indications, and limitations of ARM. Exclusion criteria were articles written in languages other than English, those that were published prior to 1980, and those that did not focus on the topic of interest.

Fecal Incontinence

FI is a debilitating and highly prevalent medical disorder with significant social implications. Prevalence increases with age,[21] but FI does affect a younger population as well — most frequently patients with inflammatory bowel disease and postpartum women.[22] It is also more common in patients with celiac disease and irritable bowel syndrome — both thought secondary to frequent diarrhea associated with the disease process,[23] as well as in patients with diabetes[23] thought secondary to neuropathy associated with reduced rectal sensitivity. 24

Maintaining continence is a complex process that relies on the integrity of anal sphincter and puborectalis muscle function, as well as multiple anorectal sensorimotor mechanisms.[25] FI is generally classified into urge FI (lack of voluntary control, related to external anal sphincter dysfunction) and passive FI (related to impairment of internal anal sphincter) based on clinical symptoms.[25–27] One common (and frequently underreported) cause of anal sphincter damage is obstetric injury[28–30] – although damage to the sphincters for any reason can result in FI. Compared to healthy patients, patients with FI have significantly lower anal resting tone (representative of internal anal sphincter function) and squeeze pressure (representative of external anal sphincter function) on ARM.[31] Interestingly, one of the proposed mechanisms of this hypocontractility in FI is actually constipation that may lead to pelvic floor denervation from chronic straining.[32]

Both increased and decreased rectal sensitivity also have been noted on ARM in FI patients.[2,26,31] It is thought that attenuated rectal sensitivity, especially if anal sphincter function is already compromised, may contribute to passive FI by reflex inhibition of the internal anal sphincter before the patient perceives stool in the rectum.[33] In contrast, rectal hypersensitivity appears to be more associated with urge FI, and may occur secondary to issues with rectal compliance, sensitization of pain pathways, and/or hypervigilance in the setting of behavioral processes.[25]

Based on most recent clinical practice recommendations from the American College of Gastroenterology (ACG), ARM, BET, and RST are indicated for all patients with clinical evidence of FI who fail to respond to conservative measures (strong recommendation, moderate quality of evidence).[11] In the evaluation of FI, these tests are most helpful for identification and quantification of impaired anal sphincter function as well as abnormal rectal sensitivity.[2] Ultimately, patients with demonstrated anal hypotonia/hypocontractility may benefit from anal sphincter repair, whereas those without will likely not. In the former case, ARM is critical to establish the degree of hypotonia and/or hypocontractility and will help delineate those who may benefit from surgical management.[34]

If not undergoing surgery, biofeedback therapy is often performed,[8,35–37] as multiple randomized controlled trials have shown significant benefit.[22,38–40] However, specific targeted exercises differ depending on specific patient-specific pathology. Three main modalities of biofeedback therapy have been described in the management of FI: 1) rectal sensitivity training (during which a rectal balloon is repeatedly distended with air or water and the patient is taught to feel the distension at either progressively lower volumes (for rectal hyposensitivity) or to tolerate progressively larger volumes (for urgency/hypersensitivity)), 2) anal sphincter strength training if not undergoing surgical repair, and 3) coordination training (teaching patients to counteract the RAIR with a voluntary anal squeeze).[22] As such, ARM is quite helpful to guide specific therapeutic exercises.

ARM has been shown to be an accurate test for diagnosing FI; in a meta-analysis of 7 (majority retrospective) studies, Yeap et al noted the sensitivity and specificity of ARM as a whole for FI to each is about 80%.[41] However, they were unable to establish the diagnostic accuracy of individual ARM measures as they relate to FI. Pehl et al also

noted that while ARM demonstrated an excellent sensitivity (91.4%) and accuracy (85.8%) for FI, the overall specificity was only moderate (62.5%). Notably, manometric pressure data showed higher sensitivity and accuracy for FI than RST data, supporting that hypocontractility is likely more strongly correlated with FI than hyposensitivity.[31] Ultimately, further research, in particular randomized control trials and longer-term prospective studies, is needed to further elucidate the clinical significance of each of these ARM findings with respect to patient outcomes. This will allow for the improvement of ARM protocols and interpretation guidelines (further discussed below) in the management of FI.

FDDs: Chronic Constipation and Constipation-Predominant Irritable Bowel Syndrome

Chronic constipation is commonly classified as slow transit constipation or outlet dysfunction, the latter of which includes FDDs and structural disorders such as rectocele or rectal prolapse – both of which will typically fail conservative measures for chronic constipation such as bulking agents and osmotic laxatives.[20,42] FDDs in particular are characterized by 1) paradoxical contraction or inadequate relaxation of the pelvic floor muscles during attempted defecation (dyssynergic defecation), and/or 2) inadequate propulsive forces during attempted defecation. Dyssynergic defecation is generally considered to be an acquired behavioral evacuation disorder[43]; interestingly, there is significant overlap amongst patients between dyssynergic defecation and slow transit constipation, possibly reflecting acquired incorrect defecation patterns in the setting of prolonged constipation and laxative dependence.[1]

In the evaluation of FDDs, ARM is useful in to identify and quantify abnormalities of anorectal strength and coordination and rectal sensitivity (via RST).[1,2] In healthy patients, defecation should show a pattern of increased intrarectal pressure associated with anal relaxation on manometry.[20] Dyssynergic defecation may be evidenced by features of impaired evacuation on ARM (inappropriate contraction of the pelvic floor as measured by manometry in the setting of adequate propulsive forces, and abnormal BET). In contrast, inadequate propulsive forces as measured by manometry (with or without inappropriate contraction of the anal sphincter and/or pelvic floor muscles) are classified as a separate subset of FDD.[20]

ARM can also be useful to evaluate rectal sensitivity in patients with chronic functional constipation – most commonly rectal hyposensitivity is noted in this population. While it has been proposed that rectal hyposensitivity in certain patients may be important in the pathophysiology of constipation (as it is often the only demonstrable abnormality on ARM testing in up to half of patients reporting constipation,[44,45] it has also been proposed that rectal hyposensitivity may instead be a result of longstanding functional constipation rather than a cause of it, possibly secondary to denervation related to chronic straining.[1,46] In contrast to rectal hyposensitivity more often noted in patients with chronic functional constipation, patients with constipation-predominant irritable bowel syndrome (IBS-C) are interestingly more likely to have rectal hypersensitivity (characterized by first sensation reported at decreased pressure and volume thresholds as well as reported pain).[47–49] IBS-C patients have also been shown to have higher rates of dyssynergic defecation noted on ARM compared to functional constipation patients, while functional constipation patients have been shown to have higher rates of inadequate defecatory propulsion compared to IBS-C patients.[47]

Ultimately, diagnosis of FDD according to ROME IV criteria (a set of consensus criteria developed by the Rome Foundation, an independent, not for profit organization dedicated to the diagnosis and management of disorders of brain-gut interaction) is based on both the presence of symptoms as well as objective data via both abnormal ARM and BET.[11,20,47] Current ACG guidelines notably state that 2 abnormal anorectal tests (ARM, BET) in combination with clinical history of chronic constipation are required to diagnose a defecation disorder.[11] This is because while FDDs are often associated with symptoms of excessive straining and sense of incomplete evacuation,[43] symptoms alone do not discriminate between a defecation disorder and other causes of constipation (such as slow transit).[20] The American Gastroenterological Association recommends anorectal function testing with ARM and BET in all patients with chronic constipation that do not respond to laxatives.[50]

Multiple randomized controlled trials have also demonstrated clear symptom-benefit from ARM-guided biofeedback therapy for FDD patients (between 70% and 80% of patients reporting improvement).[51–55] Rectal hyposensitivity has also been shown to significantly improve with biofeedback therapy in up to 92% of patients.[8,35,36,56] Biofeedback therapy, specifically sensory adaptation training, has also been shown to be more effective in treating rectal hypersensitivity than medical management with escitalopram.[37] However, biofeedback therapy is ineffective for patients with functional constipation without FDD.[52,57] and it is unclear if biofeedback is as effective for inadequate propulsive defecation as it is for dyssynergic defecation.[20] There also appears to be no significant effect of the specific dyssynergia pattern on clinical outcomes associated with dyssynergia therapy.[58]

One important limitation of ARM specific to FDDs is that abnormal anorectal pressures during evacuation and evidence of dyssynergic defecation on anorectal function testing have also been noted in asymptomatic healthy patients.[43,47,59,60] It remains unclear whether these patients tend to develop symptoms of FDDs in the future. Therefore, it is uncertain if this is indicative of the technical limitations of ARM (further discussed below) leading to an overestimation of true abnormalities vs the possibility that certain individuals may be currently asymptomatic but have underlying mechanical features of FDDs. We favor the later sentiment – that there likely exists a certain population of patients who are unaware of their defecatory dysfunction (a limitation of history-taking) and may benefit from empiric biofeedback/pelvic floor therapy to prevent the development of symptoms in the future.

Regardless, additional prospective, long-term studies are needed to understand whether particular abnormal findings in asymptomatic patients could be a predictor of future development of symptomatic constipation, and if empiric management strategies have any impact on patient outcomes.[3]

Emerging and Lesser Known Indications for ARM

Significant evidence is emerging supporting the diagnostic and therapeutic utility of ARM in other conditions, 2 of which are discussed further here.

Functional Anorectal Pain

Anorectal pain syndromes are functional disorders of the pelvic floor muscles that present with recurrent and persistent pain in the anus without detectable organic pathology. The prevalence is estimated to range between 8% and 18% of the general population.[3] While the etiology is not fully understood, it is thought to be most likely secondary to intermittent pelvic floor muscle spasm.[61] Functional anorectal pain syndromes can be categorized into 3 subtypes based on clinical symptoms. Proctalgia fugax consists of fleeting pain that lasts for seconds to minutes, while in levator ani syndrome (LAS) and unspecified anorectal pain the pain lasts for greater than 30 minutes. In LAS, there is notable puborectalis tenderness.[20]

Initial evaluation of functional anorectal pain often includes endoscopy, ultrasonography, and pelvic imaging to rule out alternative etiologies for the pain.[20] The diagnosis of functional anorectal pain is almost entirely clinical; however, evidence is emerging regarding the utility of ARM in diagnosis and guiding therapy for functional anorectal pain. Some studies using conventional ARM have noted elevated anal sphincter pressures and evidence of dyssynergic defecation patterns.[62,63] In addition, patients with functional anorectal pain are frequently noted to have rectal hypersensitivity, possibly secondary to altered pain perception by the central nervous system.[64]

Ultimately, biofeedback therapy (with ARM-guidance) has been shown to improve symptoms of functional anorectal pain, supporting the clinical use of ARM in this condition. One randomized controlled trial of 157 patients with LAS found that biofeedback therapy was superior to electrogalvanic stimulation and massage (87%, 45%, and 22% reporting adequate relief, respectively).[65] Heah et al also found that biofeedback therapy improved symptoms in LAS.[61] Documentation of baseline anorectal functional parameters and subsequent parameters after therapy can be helpful in guiding treatment.[63,65]

Preoperative Assessment of Anorectal Function

ARM has also been shown to help predict surgical outcomes, and thus allows physicians to better educate and advise their patients regarding the risk of developing postoperative FI prior to certain abdominal and pelvic surgeries. Specifically, ARM for preoperative assessment of anorectal function is sometimes done prior to procedures such as low anterior resection (LAR), ileal pouch-anal anastomosis (IPAA), fistulotomy, fistulectomy, lateral sphincterotomy and rectopexy.

An increasing number of patients with malignant rectal tumors undergo sphincter-preserving resections.[64] Surgeons often create a temporary diverting stoma to prevent anastomotic leakage and subsequent complications with plans for future stoma reversal. However, between 14% and 35% of patients ultimately do not undergo stoma reversal for a myriad of reasons.[64] In patients undergoing such surgeries, low maximum squeeze pressure measured by ARM was found to be an independent risk factor for stoma nonreversal.[64] Preoperative assessment of such risk factors is important for surgical planning and stoma site selection.

LAR is a common sphincter-preserving surgery for rectal tumors that does not involve creating a diverting stoma. Following LAR, 70%–90% of patients suffer from a variety of bowel symptoms including anal or FI, bowel urgency, incomplete evacuation and constipation[66]; this bowel dysfunction is commonly known as LAR syndrome. The etiology of LARS is believed to be secondary to colonic dysmotility, neorectal reservoir dysfunction and/or anal sphincter damage.[67] Preoperative ARM can be used to aid in predicting which patients will develop postoperative FI. One study reported significant correlation between rectal maximum tolerance value and length of high-pressure zone and postoperative defecatory function,[68] while other authors have reported that preoperative maximum resting pressure can predict postoperative FI.[69] Preoperative prediction of such function is valuable as this allows proper counseling of patients and consideration of alternate surgical approaches.

IPAA is the preferred surgical approach for most patients with ulcerative colitis requiring colectomy.[70] Approximately, 25%–30% of patients will experience FI postoperatively.[70] ARM is sometimes used for preoperative assessment of anorectal function in patients planning to undergo IPAA. Some authors have demonstrated that preoperative ARM can predict postoperative function and quality of life. Preoperative low resting anal sphincter pressures are associated with increased rates of incontinence postoperatively, while higher resting anal sphincter pressures are associated with better function and quality of life.[70] It has also been proposed that ARM results could guide surgical approach, as stapled anastomoses have been shown to result in less incontinence than hand-sewn anastomoses.[71] Further, if a patient has preoperative FI, a continent ileostomy can be considered instead. In addition, low preoperative resting and squeeze pressures have been shown to be an independent risk factor for pouch failure.[72]

An anal fissure is a superficial tear in the squamous epithelium of the anus distal to the dentate line.[73] They are commonly caused by constipation, chronic diarrhea, sexually transmitted infections, inflammatory bowel disease and anal injury, among other causes. The tears can sometimes

extend deep enough to expose the sphincter muscle. Internal sphincter spasms and exposure of sphincter muscle cause significant pain with bowel movements. High anal canal pressure can result in regional ischemia and delayed healing of fissures.[73] Internal sphincter spasm is thought to contribute to increased pressure and impaired healing. Roughly 40% of patients who develop acute anal fissures will progress to chronic anal fissures.[73] These are usually managed conservatively with topical medications (nitrates, calcium channel blockers) as well as other more novel treatments such as botulinum toxin. However, conservative management of chronic anal fissures ultimately does sometimes fail; in this case, salvage treatment is lateral internal sphincterotomy.[73,74] Unfortunately, anal and FI occur in 45% following lateral internal sphincterotomy.[73] Some authors recommend a calibrated or tailored sphincterotomy: this entails determining the length of sphincterotomy based on preoperative measured anal resting pressure (via ARM) and sphincter length. This results in significantly reduced incontinence with reported rates of 2.5%–3.8%.[74,75]

Fistula-in-ano is a tract connecting the anal canal to the perianal skin and most often develops from anorectal abscesses.[76] Most anal fistulas require surgical treatment. Surgery for anal fistulas is associated with significant risk of incontinence, with trans-sphincteric and supra-sphincteric fistulas carrying the greatest risk. The incidence of anal or FI following anal fistula surgery ranges from 8% to 52% depending on type of fistula and surgical approach.[77] Multiple studies have shown that preoperative low anal resting pressures are associated with postoperative incontinence.[78–80] Preoperative ARM has been shown to significantly reduce rates of postoperative incontinence, as more conservative surgical approaches are taken in patients with pre-existing low anal pressures.[81]

Rectal prolapse is full-thickness protrusion of the rectum through the anus. It can present with a variety of symptoms including constipation and FI. Most patients with symptomatic rectal prolapse require surgical repair, of which there are several approaches. The surgical technique must be individualized for each patient based on their etiology, symptoms, and anatomy.[82] Preoperative ARM is sometimes performed in patients with concomitant constipation and incontinence to guide the decision on surgical technique, as different approaches are associated with different effects on continence.[82] In addition, patients with anal sphincter dysfunction at baseline can be referred for biofeedback therapy to improve long-term continence.

Technical Limitations of ARM and Barriers to More Widespread Adoption in Clinical Practice

There are significant limitations with respect to the use and interpretation of ARM in clinical practice that differ based

Table 2. Table Indicating Limitations of ARM and Barriers to More Widespread Adoption in Clinical Practice as Well as Potential Solutions to Each

Limitation/barrier	Potential solution(s)
Subjectivity of testing and variability of protocols across institutions	• Use of a standardized protocol (IAPWG or ANMS/ESMN) • Further evidence-based studies to improve these protocols: - Provide technique- and equipment-specific normal values - Improve understanding of which cutoffs to use (currently there are many sources with varying degrees of supporting demographic-matched normative data) - Improve accuracy of measurements for pressure and coordination during simulated defecation - Provide guidance on potential follow-up testing based on findings
Interpretation guidelines are lacking	• Need additional normal values further delineated by age, sex, parity, BMI, and ethnicity • Determine which individual aspects of ARM predict responsiveness to biofeedback therapy • Provide evidence-based rationale for major and minor disorder classifications • Need consensus guidelines on how to define sensory abnormalities on RST • Improve user-friendliness of protocols
Lack of education/training of health-care providers	• Improve educational access and availability of hands-on training via: - Develop courses and CME opportunities in ARM procedure and interpretation for community gastroenterology providers - Implementing a mandatory curriculum on ARM procedure/interpretation during fellowship training - Including more ARM-related topics on board examinations to increase fellow motivation to learn this information - Developing away rotations for fellows who do not have motility testing at their institution - Utilizing the ANMS clinical training program for gastroenterology fellows
Lack of staffing for and facilities at which to perform the procedure	• Utilize (if given appropriate training) APPs to perform diagnostic ARM procedures • Develop a higher number of physical motility laboratories in the community • Clarify billing procedures for community providers
Miscellaneous	• Additional consensus guideline-based recommendations are needed regarding the use of ARM as a screening tool for other less common indications, such as in functional anorectal pain and preoperative management/prognostication

APP, advanced practice practitioner; CME, continuing medical education.

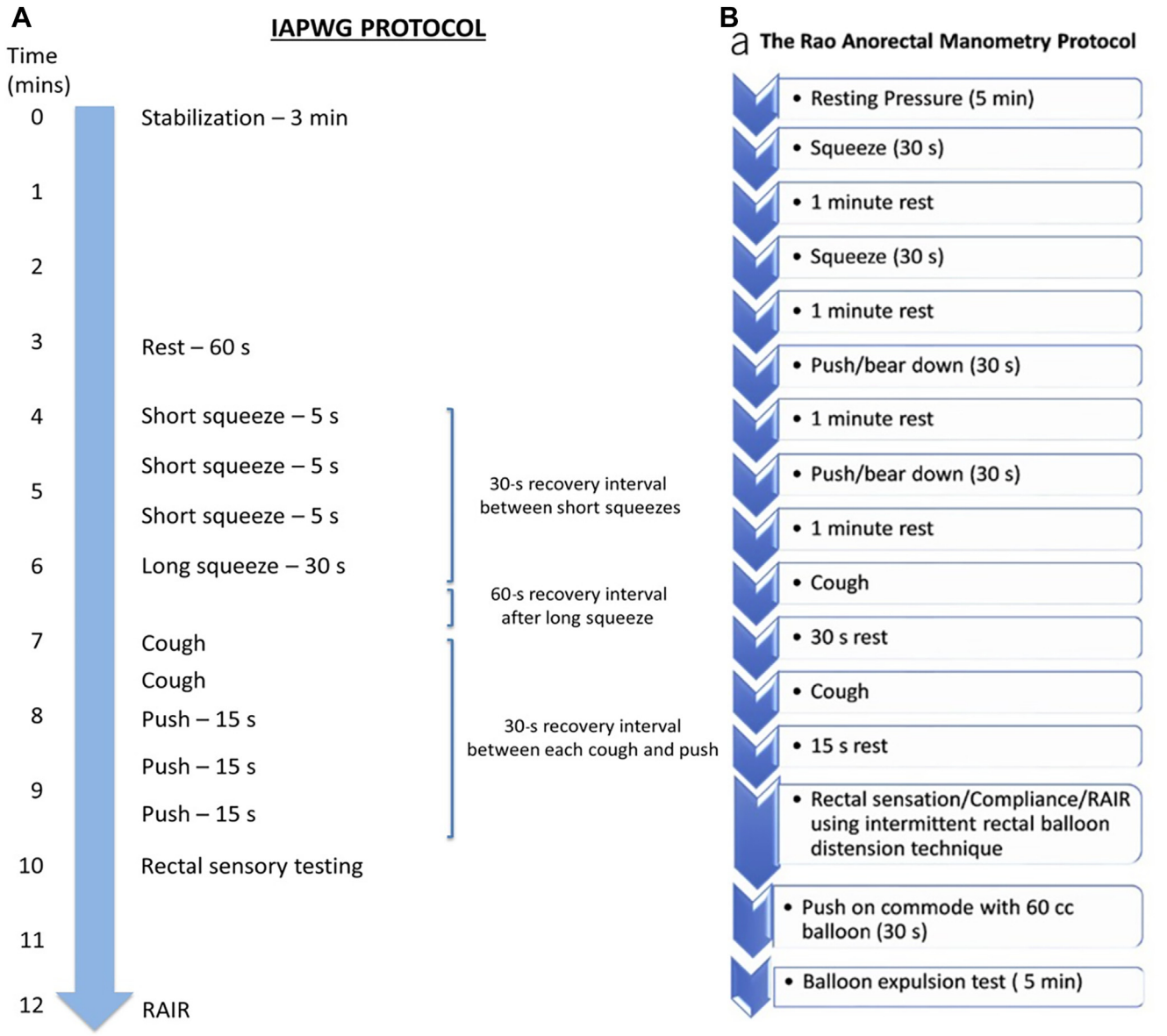

Figure 1. IAPWG Protocol for high-resolution anorectal manometry and rectal sensory testing. BET is performed either immediately before or after this protocol. (Image and caption reproduced from Carrington et al.[7]). (B) A summary of the anorectal manometry (ARM) protocol recommended by the American and European Societies of Neurogastroenterology and Motility (ANMS and ESNM).[11] IAPWG, International Anorectal Physiology Working Group.

on specific indication, discussed above. In addition, ARM is inherently limited due to a lack of evidence-based standardization of the technology itself, procedures, and interpretation of results (Table 2) – all of which will be discussed here.

First, a variety of systems (equipment + software) are currently used to perform ARM which differ in numerous ways, including but not limited to the type and number of pressure sensors, the number and spatial distribution of pressure sensors on the catheter, and the display.[4] The introduction of high-resolution manometry has even further increased the potential for variability in equipment and protocols for ARM across institutions. Because existing ARM systems differ in both design and computing methods for pressures, it is important to use catheter-specific normal values for comparison.[4] However, for some, normal values are unavailable or have not been assessed in an adequate number of people,[4] which limits user ability to interpret data when using these systems. To increase the precision of HR-ARM, the development of a larger database of technique-specific normal values is needed.[4]

An international survey also found significant institutional variations in ARM protocols,[83] which have historically impacted the ability to interpret research in the realm of anorectal dysfunction.[83] In recent years, various protocols have been created by international societies aiming to standardize the procedure of ARM, in particular including the International Anorectal Physiology Working Group [IAPWG] protocol (Figure 1A),[7] and a similar but slightly

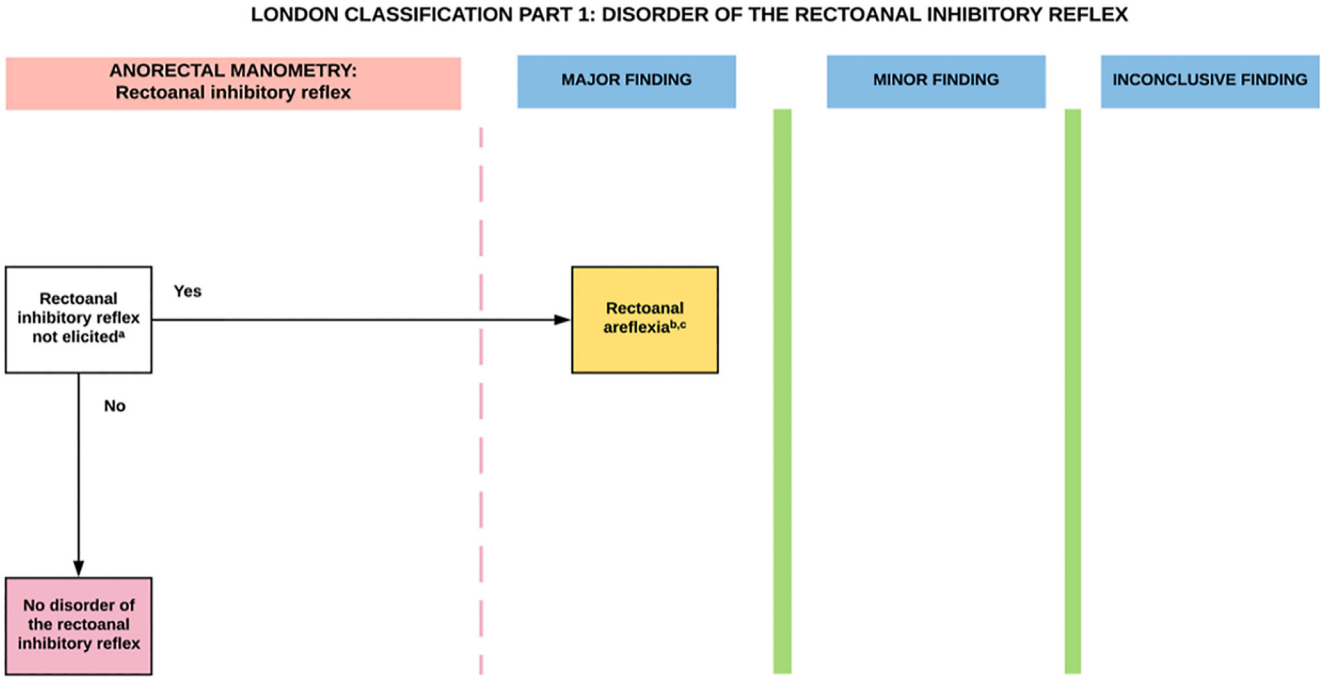

Figure 2. Part 1: Disorder of the rectoanal inhibitory reflex. White boxes represent manometric findings or decision points; yellow boxes represent the resultant diagnosis; and pink boxes represent a "negative/normal study." All results to be interpreted in the context of adjunctive testing. (Image and caption reproduced from Carrington et al.[7]). [a]Minimum volume required to elicit reflex not established in the literature: failure to elicit a RAIR may be seen with low distending volumes in a large capacity rectum. [b]RAIR not elicited is a pattern not seen in healthy patients, but may be found in asymptomatic patients following rectal resection/ileal pouch anal anastamosis, anal hypotonia, faecal loading, or megarectum. [c]May indicate the need for further investigation to exclude aganglionosis expecially in paediatric populations and adult patients with coexistent megarectum/megacolon.

more detailed consensus protocol from the American and European Societies of Neurogasteroenterology (ANMS and ESNM) (Figure 1B).[13] However, these protocols are based solely on expert opinion[4]; and the algorithms have not been tested or validated clinically. Some have also broadcasted concern about possible redundancy in the IAPWG protocol in particular.[84] Given this, further evidence-based studies are needed to further improve these protocols for the standardized conduction and analysis of ARM. Regardless, for now we continue to recommend utilization of these protocols to improve rates of protocol standardization across institutions. In particular, rectal sensation testing is a more subjective component of anorectal function testing, which may lead to an even higher variation in measurements.[13,41] Following standardized protocols is one way to minimize this subjectivity.

Guidelines for the interpretation of ARM can also be improved significantly.[85] With respect to interpretation, the London Classification currently divides anorectal function testing into 4 parts: Part 1, disorders of the rectoanal inhibitory reflex (RAIR) (Figure 2); Part 2, disorders of anal tone and contractility (Figure 3); Part 3, disorders of anorectal coordination (Figure 4); and Part 4, disorders of rectal sensation (Figure 5). Much like the Chicago Classification for esophageal motility disorders, the London Classification then categorizes anorectal testing results into major findings (patterns not seen in control subjects, likely to represent a physiological change associated with generation of symptoms), minor findings (patterns seen in patients with anorectal symptoms but may also be seen in control subjects; may represent a physiological change associated with generation of symptoms), and/or inconclusive findings (patterns seen in both patients with anorectal symptoms but also in control subjects).[7] However, these major and minor disorder classifications are again not evidence-based (based on expert opinion); thus, further research is needed to provide more evidence-based rationale for these classifications. In addition, this classification system could be improved by the development of age/sex/party/BMI/ethnicity-specific normal values as well as consensus guidelines on how to define sensory abnormalities and those abnormalities that warrant additional assessment. Treatment recommendations based on dyssynergic defecation category should also be included for providers.[85]

Although ARM is recommended by several national organizations in the diagnosis and/or management of various lower gastrointestinal conditions, it is often under-utilized in clinical practice for various reasons (Table 2). All of the above limitations, as well as a lack of education regarding the indications and clinical utility of ARM and a lack of training in how to actually perform the procedure (then resulting in a lack of staff to perform the procedure) are

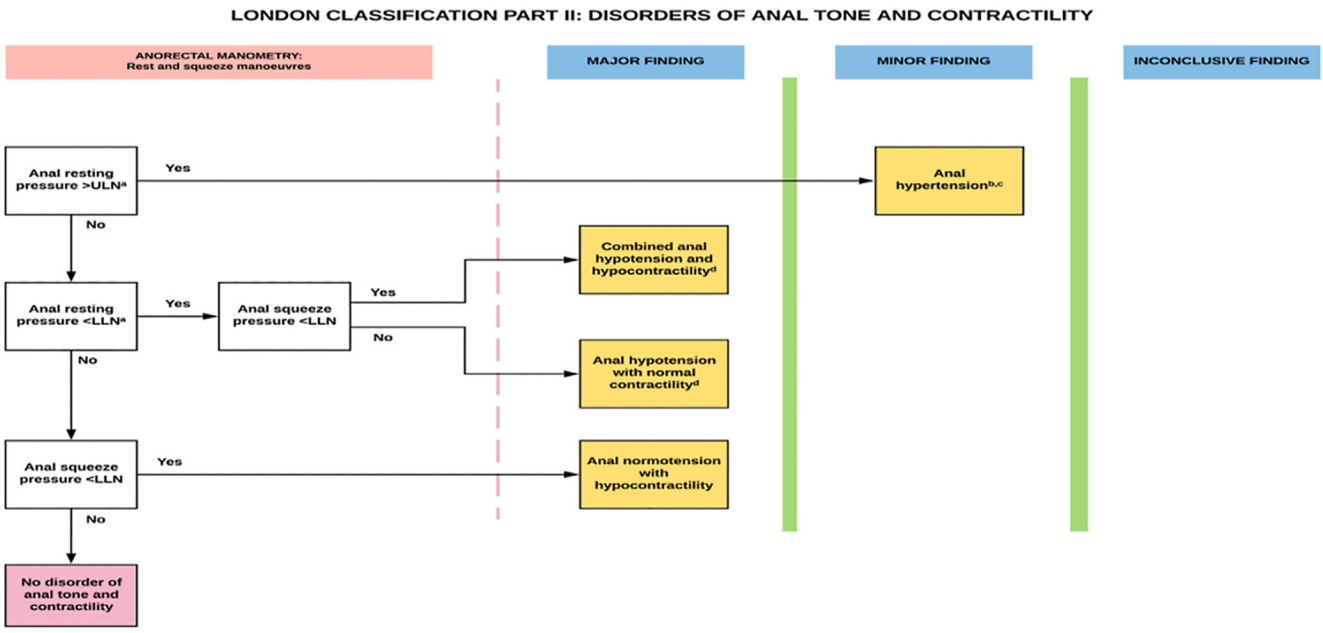

Figure 3. Part 2: Disorders of anal tone and contractility. White boxes represent manometric findings or decision points; yellow boxes represent the resultant diagnosis; and pink boxes represent a "negative/normal study." All results to be interpreted in context of adjunctive testing. LLN: lower limit of normal, ULN: upper limit of normal. (Image and caption reproduced from Carrington et al.[7]). [a]The functional anal canal length may be measured, as a short anal canal can be associated with anal hypotonia, but its use as a diagnostic criterion in isolation is unproven. [b]May be associated with slow and/or ultraslow waves; however, the clinical significance of these has not been established. [c]This finding may have greater clinical significance in certain patient groups (eg chronic anal fissure, levator ani syndrome, or proctalgia fugax). [d]Addition of an abnormal cough response may indicate a more severe phenotype (whereas preservation may suggest a target for biofeedback), but its use as a diagnostic criterion is unproven.

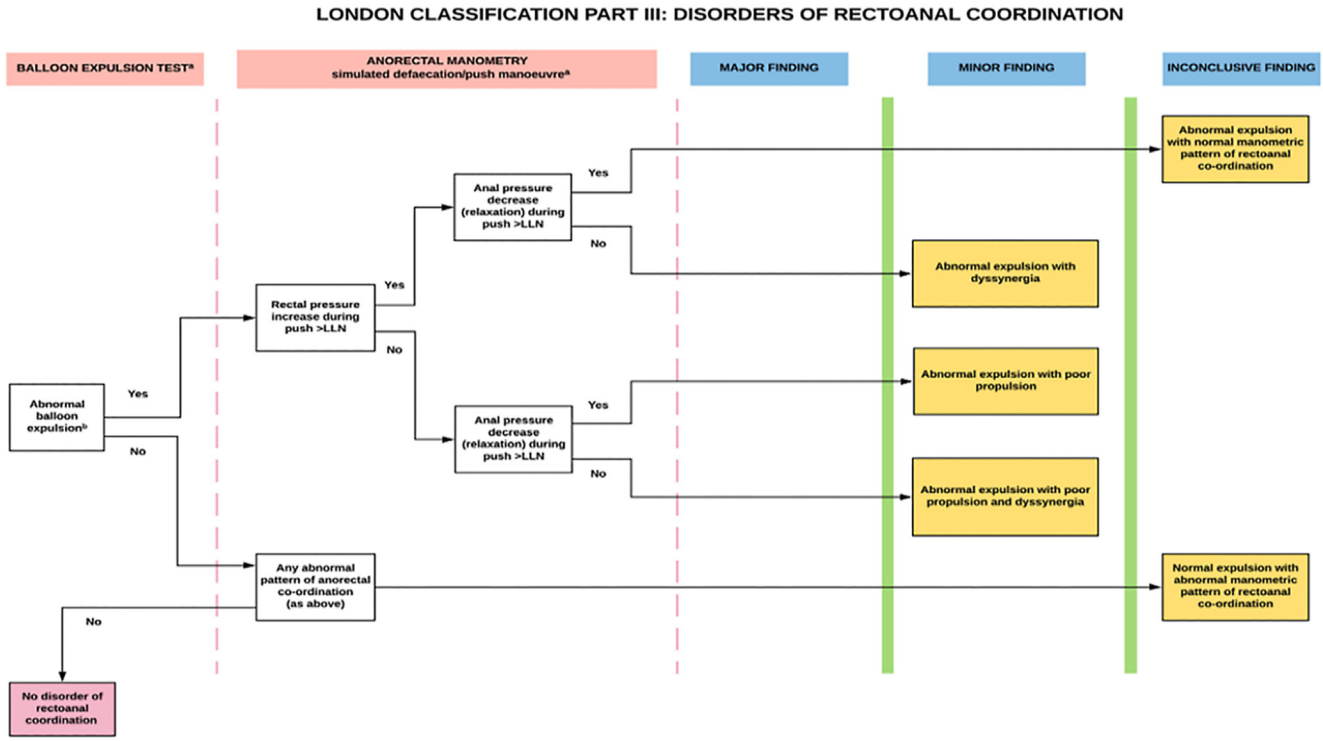

Figure 4. Part 3: Disorders of anorectal coordination. White boxes represent manometric findings or decision points; yellow boxes represent the resultant diagnosis; and pink boxes represent a "negative/normal study." All results to be interpreted in context of adjunctive testing. MR, magnetic resonance. (Image and caption reproduced from Carrington et al[7].). [a]Requires the use of both balloon expulsion test and anorectal manometry. [b]Or impaired evacuation of contrast medium (prolonged evacuation end time and/or reduced percentage of contrast emptied) on alternative testing, for example, barium or MR defecography.

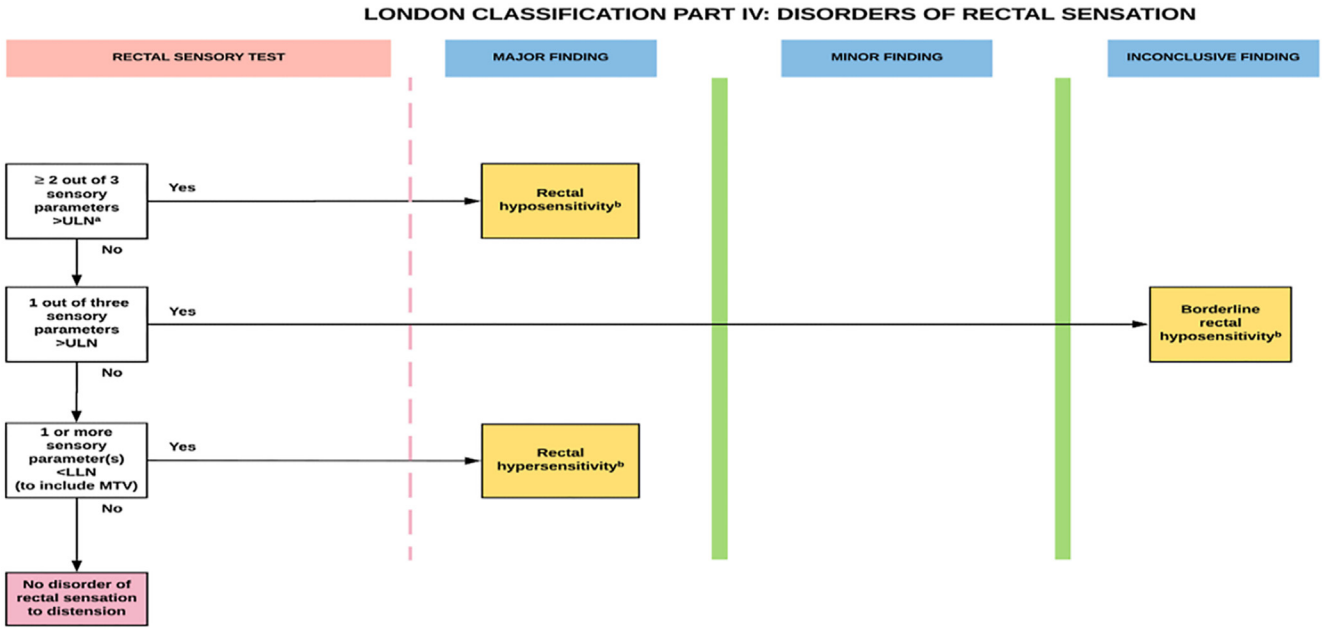

Figure 5. Part 4: Disorders of rectal sensation. White boxes represent manometric findings or decision points; yellow boxes represent the resultant diagnosis; and pink boxes represent a "negative/normal study." [a]ULN, upper limit of normal; [b]diagnosis of rectal hypo or hypersentitivity.

important barriers to the more widespread adoption of ARM.[85] Notably, no standardized protocol for training in ARM currently exists.[13] Ideally, training in ARM technique and interpretation should include hands-on experience learning under an experienced provider.[13] Potential solutions to the current gap in available training opportunities include developing away rotations for fellows who do not have motility testing at their institutions, as well as implementing a mandatory curriculum on ARM procedure/interpretation during fellowship training (and potentially including these topics on board examinations to increase fellow motivation to learn these topics). In addition, courses and continuing medical education opportunities in ARM procedure/interpretation may be developed for fellows and gastroenterology physicians and advanced practice providers in the community. Currently, the ANMS clinical training program offers an apprenticeship-based learning program for gastroenterology fellows.[86] A recent article also proposed a stepwise approach on how to set-up a motility laboratory in the community.[87] Challenges proposed included a lack of physical facilities and staffing as well as confusion over billing practices; this article proposes utilizing advanced practice practitioners to perform diagnostic procedures if given appropriate training.[87] Regardless, the development of a greater number of motility laboratories, especially in the community where they are particularly lacking, would also reach a greater audience of health-care providers in education and training in ARM technique – and as such allow for more widespread adoption in clinical practice.

Conclusion

ARM is a useful test for numerous indications (Table 1). Notably, while many functional anorectal disorders present with overlapping symptoms (ie constipation, anorectal pain), ARM allows delineation of more specific disease processes and may guide treatment more effectively. Its clinical usefulness has been endorsed by several national organizations such as the American Gastroenterological Association (AGA)[12] and the ACG.[11] It is required for the clinical diagnosis of FDD,[11] and is strongly recommended in the evaluation of FI not responsive to initial conservative measures.[11] In addition, it has been shown to be very helpful in the treatment of anorectal pain syndromes[61,63,65] as well as preoperatively to guide surgical management.[64,69,75,81,82]

The development of high-resolution technology has resulted in an expansion of the use of ARM in clinical practice and has also provided an opportunity for more accurate pressure and sensation readings. However, widespread adoption of ARM in clinical practice has been limited secondary to a lack of health-care provider knowledge regarding the clinical utility and availability of ARM, a lack of training education, and a lack of evidence-based protocols. These barriers can be overcome in various ways, including with the implementation of a curriculum in ARM procedure and interpretation during gastroenterology fellowship, the development of away rotations and courses for gastroenterology fellows, physicians and advanced practice practitioners, as well as working on increasing motility lab infrastructure in the community. Further studies are needed to improve current protocols and to provide more evidence-based standardization, as well as to develop databases of technique and device-specific normal values for HR-ARM for comparison and improved interpretation.

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