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Review

# Rectal Hyposensitivity

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Impaired or blunted rectal sensation, termed rectal hyposensitivity (RH), which is defined clinically as elevated sensory thresholds to rectal balloon distension, is associated with disorders of hindgut function, characterised primarily by symptoms of constipation and fecal incontinence. However, its role in symptom generation and the pathogenetic mechanisms underlying the sensory dysfunction remain incompletely understood, although there is evidence that RH may be due to 'primary' disruption of the afferent pathway, 'secondary' to abnormal rectal biomechanics, or to both. Nevertheless, correction of RH by various interventions (behavioural, neuromodulation, surgical) is associated with, and may be responsible for, symptomatic improvement. This review provides a contemporary overview of RH, focusing on diagnosis, clinical associations, pathophysiology, and treatment paradigms.
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**Key Words**
Constipation; Fecal incontinence; Rectal hyposensitivity

## Introduction

To date, investigation of hindgut dysfunction in patients with functional bowel disorders (primarily manifesting as symptoms of constipation, fecal incontinence, or both) has either focused on the assessment of potential motor (or morphological) abnormalities (transit studies, investigation of anorectal/rectosigmoid contractile activity and tests of evacuatory function etc) or, particularly with regard to the irritable bowel syndrome (IBS), possible alterations in visceral sensation, predominantly hypersensitivity (ie, heightened sensation).[1] By contrast, the study of blunted or impaired visceral sensation (hyposensitivity) has been relatively neglected. Furthermore, sensory and motor components of the gastrointestinal tract have generally been examined in isolation, leading to a paucity of research examining the complex interplay between afferent and efferent functions. This approach is illogical, as it is clear that intact sensation is fundamental to normal gut functions, and ultimately to normal defecation.[2]

In health, rectal evacuation requires a coordinated series of events that commences with the development of specific pre-defecatory colonic motor activities,[2] resulting in intermittent filling of the rectum that, in the setting of intact sensation and in the presence of sufficient stool, will trigger the perception of rectal fullness through rectal afferent pathways. This will result in relaxation of the internal anal sphincter as a result of the recto-anal inhibitory reflex, allowing 'sampling' of intraluminal contents[2] by the more sensitive anal mucosa, enabling discrimination between solid, liquid and gas. Defecation may then occur when socially acceptable. Normal rectal and anal sensory functions are thus es-

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sential to the process of defecation.[2] If rectal sensation is impaired, it therefore has the potential to compromise evacuatory function or continence, resulting in definable symptoms and clinical syndromes. Indeed, studies of patients with heightened rectal sensation have found significant association with a number of functional gastrointestinal disorders,[3-6] with rectal hypersensitivity being proposed as a hallmark of IBS.[7] Similar work has yet to be realised in patients with rectal hyposensitivity (RH), although it is an area receiving increasing attention.

RH can be defined as diminished sensation of the rectum to all modalities of stimuli. However, historically, and for the purposes of clinical investigation, it is generally defined as blunted sensation to mechanical balloon distension. RH was first described in 1951 in patients who had undergone parasympathetic block prior to surgery,[8] and was subsequently noted in patients with anorectal dysfunction secondary to supraconal spinal cord injuries.[9,10] Later it was clearly recognized in individuals with idiopathic constipation.[11,12] More recent work has shown that blunted sensation to rectal distension occurs in almost a quarter of adult patients with chronic idiopathic constipation,[11-13] and in up to two-thirds of idiopathic pediatric constipation.[14-16] It is also found in 10% of patients with fecal incontinence.[17] Despite occurring frequently, and often as the only discernible physiological abnormality,[17] little is known as to its pathogenesis or true clinical impact. This review will consider contemporary understanding of rectal hyposensitivity, particularly with reference to patients with intractable constipation.

## Diagnosis of Rectal Hyposensitivity (See Table)

Generally, RH is detected clinically when sensory thresholds to simple balloon distension with a hand-held syringe are elevated beyond the normal ranges.[18] More exacting measurements can be made with a computer-controlled barostat, which has the added advantage of providing information as to the biomechanical properties of the gut wall, as well as examining sensory perception. The barostat is considered the gold-standard for assessment of sensory function.[19] There are 2 main techniques utilized: (1) sensory thresholds and (2) stimulus intensity assessments. A sensory threshold protocol involves gradual distension of the bowel with an infinitely compliant balloon using stepwise increases in pressure with time. The subject is asked to note when the first constant sensation, urge threshold and maximal tolerable intensity are reached, with hyposensitivity diagnosed as elevated pressure/volumes in comparison to the normal population.[18,20] By contrast, the stimulus intensity technique involves distension of the rectum to a random program of set pressures, with the subject asked to rate intensity experienced using a visual analog scale,[19,21,22] In this setting, hyposensitivity is diagnosed when the subject reports visual analog scale values below that of the normal range.[18]

Electrical stimulation of the rectum can also be used as a sensory stimulus to assess visceral afferent function.[23-25] While electrical stimulation is less physiological, it bypasses mucosal receptors and activates the nerve directly, thus avoiding confounding influences of bowel wall properties, while providing a precise reproducible stimulus. Furthermore, it can be used to produce a cortical evoked potential, providing an objective measurement of the afferent nerve pathway supplying the bowel.[26] Technology also exists to measure the sensitivity to noxious thermal stimuli.[27,28] This is an important modality as, in contrast to electrical stimulation, it relies on intact receptor function. This is currently only used for research purposes.[27] As with mechanical distension, RH

**Table.** Comparison of Techniques Used for the Diagnosis of Rectal Sensory Dysfunction

| Test | Advantages | Disadvantages |
|---|---|---|
| Latex balloon distension (clinical use) | Cheap and quick<br>Reproducible | Intrinsic elastic properties of the balloon limit assessment of rectal wall properties<br>Axial extension into sigmoid during distension possible |
| Barostat distension (clinical use) | Provides additional information on bowel wall biomechanical properties<br>Conforms to the outline of the visceral organ under study | More prolonged study required<br>Considerably more expensive than latex balloon |
| Electrical stimulation (predominantly research use) | Highly reproducible, precise stimulus<br>Problematic if rectal wall apposition is poor | Non physiological<br>Bypasses mucosal receptors |
| Thermal stimulation (research only) | Highly reproducible, precise stimuli<br>Requires intact mucosal receptors | Non physiological<br>Clinical utility not established |

to either electrical or thermal stimulation is diagnosed when recorded thresholds are elevated beyond the normal range.

### Summary

- RH is generally diagnosed clinically when sensory thresholds to simple volumetric balloon distension with a hand-held syringe are elevated.
- The gold standard for diagnosis of RH is using a computer controlled barostat.
- In the research setting, electrical and thermal sensitivity have also been used to examine specific elements of sensory function.

## Prevalence and Associated Conditions

RH has been found in up to 67% of patients with complete spinal cord injury and hindgut dysfunction, and in 6% of individuals with incomplete lesions.[10,29] Studies have also shown that patients with multiple sclerosis and diabetes have higher rectal sensory thresholds[30-32] than healthy individuals. In the absence of confirmed neurological dysfunction, RH is present in 23% of adult patients with constipation, 10% of patients with fecal incontinence (FI) and 27% of patients in whom these symptoms co-existent[17]; nevertheless, up to 63% of such individuals give a history that includes factors that could potentially disrupt the afferent pathway,[33] suggesting this may be the primary pathogenic mechanism. By way of example, in the largest published series of patients with RH to date, 38% had undergone prior pelvic surgery, 22% anal surgery and 13% described prior spinal trauma.[33] Approximately 30% of patients attributed the onset of their symptoms to these events. In addition, RH is found in up to 17% of patients with the IBS,[34] most commonly in those with constipation predominance who have lost the call to stool ('no urge' constipation).[35] Patients with hyposensitivity and IBS are also more likely to have obvious abdominal distension in association with the symptom of bloating,[36] whereas patients with normal or hypersensitivity report bloating in the absence of distension.

In patients with symptoms of evacuatory dysfunction, RH is more common in individuals with 'functional' obstructive features on proctography (eg, dyssynergic defecation; poor defecatory dynamics), rather than those with obstructive structural phenomena,[37,38] with recent studies showing that RH is not associated with mechanical obstruction as a result of either rectocoele[39] or intussusceptions.[38] In adult incontinent patients, RH is more frequently seen in conjunction with functional sphincter abnormalities (ie, incompetent, but structurally intact) and also increased prevalence of constipation symptoms,[37] suggesting that the incontinence may be a secondary phenomenon (as clearly recognised in both pediatric and geriatric populations). Incontinent patients with RH are also more likely to have impaired evacuation (ie, prolonged defecation or incomplete rectal emptying on proctography[37]). In pediatric patients, two-thirds of those with fecal retentive disorders have abnormal sensation thresholds on volumetric studies,[15] although more detailed barostat studies indicate that this is predominantly related to rectal wall biomechanical abnormalities such as megarectum or hypercompliance of the rectal wall.[40]

Clinically, it is also often noted anecdotally that patients with RH describe an attenuated, altered or absent call to stool.[35,41] Such patients more frequently describe lower abdominal pain or cramping as the stimulus for defecation in contrast to those with normal sensation, who appear to associate the call to stool with a sensation of rectal or suprapubic fullness. In a recent study,[42] where 50 patients with constipation and 21 healthy control subjects were asked to verbally describe their call to stool, and also pictorially represent the anatomical site of desire to defecate, 13% of patients reported a loss or absence of the call to stool vs only 3% of healthy controls ($P = 0.015$); in 87% of patients, the quality of sensation was volunteered using more varied descriptors than in health ($P < 0.01$); and there was a wider area of viscerosomatic referral in patients ($P < 0.001$).

### Summary

- RH is found most commonly in patients with spinal cord injury or clinically documented neuropathy; however it is also seen in patients without overt neurological compromise.
- RH is found in up to 23% of patients with constipation.
- RH is more common in patients with functional (ie, dyssynergic defecation) rather than structural (ie, rectocoele and intussusception) causes for their defecatory difficulties.
- Ten percent of patients with incontinence also have RH.

## Pathophysiology

### Rectal Innervation

The innervation of the rectum is more complex than that of the colon, as it is supplied by visceral afferents as well as somatic nerves arising from the pudendal nerve. This dual innervation

appears confined to the lower third of the rectum (< 7 cm from anal verge), as a pudendal nerve block has no effect on sensation to distension or thermal stimuli in the mid and upper rectum.[43]

The afferent component of the so called "brain-gut axis" involves visceral afferents of the enteric nervous system,[44] which are thought to be both chemosensitive and mechanosensitive and end as bare nerve fibers in the myenteric plexus within the gut wall.[45] They are generally unmyelinated C fibers, although some Aδ fibers are seen.[46] The enteric neurons communicate via interneurons with extrinsic sacral afferents, usually seen associated with blood vessels in the mesentery or serosa, but also extending further into the myenteric plexus or muscle layers.[45] Enteric afferents also directly communicate with enteric motor neurons to effect local reflexes.[44] The extrinsic spinal sensory fibers follow the path of the somatic and efferent autonomic nerves[47] to the spine, with cell bodies in the sacral dorsal root ganglia (S1-S2).[44] These then synapse with second order neurons in the spinothalamic and spinoreticular tracts of the spinal cord, ultimately projecting to the thalamus where they are relayed to higher centres (Figure).[45,47] Cortical perception of sensation is a critical component of the sensory pathway, as psychological profile and psychopathology have been shown to correlate with the response to visceral distension.[48-50] Theoretically, disruption of the afferent pathway from the rectum, at any level from receptor to cortex, could potentially lead to impaired perception of rectal stimuli.

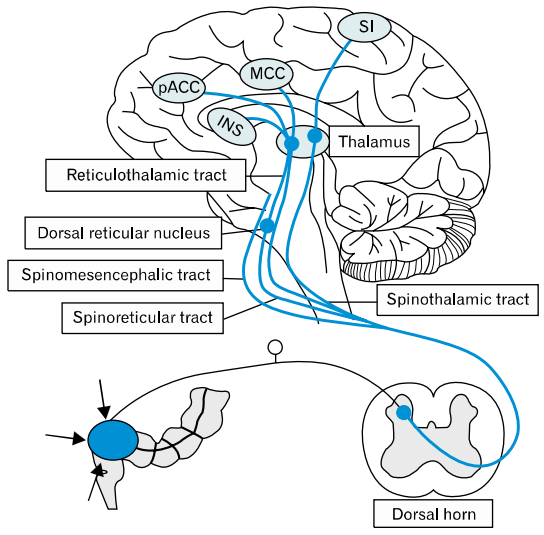


**Figure.** Sensory pathways from the rectum to the higher cortical centers (reproduced from Sharma et al with permission: Sharma A, Lelic D, Brock C, Paine P, Aziz Q. New technologies to investigate the brain gut axis. World J Gastroenterol 2009;15:182-191). pACC, perigenual anterior cingulate cortex; MCC, mid cingulate cortex; INS, insular; SI, somatosensory cortex. Arrows indicate visceral distension.

## Pathophysiology of Rectal Hyposensitivity

Although RH is generally diagnosed on the basis of elevation of sensory thresholds to rectal distension, recent studies involving complementary modalities (barostat, electrical and thermal stimulation, and fluoroscopic screening during distension studies[13,21,51]) have allowed subdivision of RH into "primary" RH (thought due to direct disruption/dysfunction of the afferent pathway); "secondary" RH (proposed to be due to altered rectal biomechanical properties, such as an enlarged [mega] rectum, or increased compliance/stretch of the rectal wall, thus requiring elevated distension volumes to induce the same sensory stimulus); or both. Primary RH is elevation of thresholds to all modalities of stimulation in the presence of normal rectal biomechanical properties. In the largest series of patients with RH to have undergone comprehensive physiological assessment, one-third were found to have primary RH, 42% secondary RH, and 25% had both.[13] Unfortunately, the majority of other studies to date have not made such a distinction between groups. The ability to accurately phenotype such patients is becoming increasingly relevant, as new pharmaceutical and surgical treatments become available, the effectiveness of which may well depend on accurate diagnosis.

In patients in whom there is documented disruption of the afferent pathway (eg, due to pelvic nerve damage or spinal cord injury), the cause-effect relationship to the development of RH appears clear cut. However the role that sub-clinical systemic neuronal dysfunction plays in the development of RH is less clear. Landmark studies in patients with FI suggest that RH and sphincter dysfunction is a marker for occult spinal cord injury (with up to 10% of patients affected),[52,53] and in another study, up to 30% of patients with constipation were found to have incidental lower spinal dysraphism[12] (unfortunately, rectal sensory status was unknown). Damage to the pelvic nerves either during childbirth,[54] due to chronic straining at stool,[55] or due to pelvic surgery (particularly hysterectomy) has also been postulated as a cause.[33,56] Nevertheless, the level at which neuronal pathway dysfunction occurs in individuals with RH remains to be elucidated. Interestingly, such patients appear to have intact spinal reflexes. When the recto-anal inhibitory reflex, rectoanal contractile response and sensorimotor response are tested, although patients with RH require higher volumes of rectal distension to induce reflexive responses than healthy individuals, those reflexes are preserved.[57] This suggests any potential abnormality may be above the level of the reflex arc. Furthermore, early evidence

(from studies of esophageal pain and in patients with IBS) suggests that visceral sensory function may also be influenced by personality profile, autonomic nervous system function and psychological phenotype;[58-62] however this has yet to be examined directly in patients with rectal hyposensitivity.

A recent study in 11 healthy volunteers and 13 patients with constipation and RH looked at the location of the proposed afferent pathway defect in more detail.[63] Using evoked potential recording and inverse modeling techniques of cortical dipoles, a temporal delay in afferent transmission in patients in comparison to volunteers was found (142 ± 24 vs 116 ± 15 ms; $P = 0.004$), although there was no difference in the location of cortical processing. Rectal electrical stimulation (as used to induce the evoked potential) is known to bypass end-organ receptors and directly stimulate the surrounding neuronal axons, and therefore any changes seen in evoked potential latencies are not an effect simply of aberrant receptor function. This suggests that the defect may lie within the spinal cord or peripheral nerves. This is important clinically, as, unlike patients with IBS, who have been shown to have altered cortical processing on inverse modeling studies,[64,65] RH patients may be less likely to benefit from psychoemotional therapy designed to influence cortical function.

Constipated patients have also been shown to have altered autonomic function,[66,67] small sensory fiber dysfunction[68,69] and also anal sensory hyposensitivity.[70] Unfortunately such studies were not stratified by rectal sensory status, with one notable exception by Vasudevan et al,[70] who examined anal sensation and found that although anal hyposensitivity is associated with constipation per se, it is not associated with the presence of RH, suggesting that different etiopathological processes are involved in the impairment of anal sensation (somatic) and rectal (visceral) sensation.[70] It is thus unclear whether the sensory abnormalities seen in RH are an isolated visceral phenomenon or simply a feature of a more generalized neuropathic disorder.

The influences that altered central processing/descending inhibition or psychological profile have on the presence of RH are also unclear. A small number of studies in patients with inflammatory bowel disease have found that although during periods of active inflammation there is rectal hypersensitivity,[71,72] during quiescence rectal sensory thresholds are increased.[73] This has been postulated to be due to descending inhibition of sacral dorsal horn neurons in response to chronic inflammation.[73,74] Furthermore, a number of studies have shown that experimental stress is associated with changes in visceral sensitivity (generally towards the development of hypersensitivity[75-77]), although such studies have not been focused to RH. There is also evidence that a past history of trauma such as sexual abuse appears to be associated with the presence of elevated sensory thresholds to distension.[78,79]

Other work in animal models suggests that the luminal contents of the bowel can influence rectal sensitivity; one such study showed that mice developed RH after undergoing colonic infusion of fecal supernatants from patients with inflammatory bowel disease. By way of contrast, mice who received infusion from patients with the IBS developed hypersensitivity. This response appears to be mediated by protease-activated receptors (PARs), particularly the antinociceptive PAR-4 and PAR-2.[80]

### Summary

- RH may be sub-categorized into primary RH thought to be due to direct disruption/dysfunction of the afferent pathway or secondary, due to altered rectal biomechanical properties (ie, megarectum or increased rectal wall compliance), or both.
- Rectal evoked potential studies indicate altered transmission of afferent information in patients with RH.
- The level at which afferent neuronal dysfunction occurs is yet to be confirmed.
- It is not clear whether the sensory abnormalities seen in RH are an isolated visceral phenomenon or a feature of a generalized neuropathic disorder.

## Role of Rectal Hyposensitivity in the Development of Hindgut Dysfunction

Ultimately, whether RH contributes to, or is instead a manifestation of hindgut dysfunction (ie, is simply an epiphenomenon) is not clear.

### Constipation

It is hypothesized that RH leads to constipation via a number of mechanisms. Firstly, hyposensitivity either secondary to rectal wall biomechanical dysfunction or to true afferent dysfunction, may lead to fecal retention and impaction (and likely further dilation of the rectum), due to failure of the development of an urge to defecate. With time, the fecal matter desiccates producing a large hard stool, which is painful and difficult to pass. Secondarily, RH may underscore rectal evacuatory dysfunction (RED) in a significant proportion of patients. A number of studies[17,33,37] have now shown RH to be associated with a 'functional' RED,

manifest as abnormal defecatory dynamics in up to 32%,[33] most commonly poor expulsive effort, failure of the anal canal to relax, or development of a hyperacute anorectal angle with straining (ie, pelvic floor dyssynergia),[81] all of which result in inadequate rectal emptying. This indicates that intact sensation is critical to appropriate recto-anal and pelvic floor co-ordination.[56] Furthermore, patients with RH have reduced rectal wall contractility (ie, co-incident or corresponding efferent dysfunction) in response to distension, which likely contributes to evacuatory failure.[82] Thirdly, RH may lead to the development of constipation by influencing colonic motility. Delayed colonic transit, which is an indirect measure of colonic contractile functions,[83] is found in up to one-third of patients with RH.[33] Although this delay may reflect a true primary colonic dysmotility, it may alternately be secondary to rectal stasis as a consequence of RH (ie, due to inhibitory feedback mechanisms).[84-86]

### Incontinence

Generally, RH is thought to contribute to the development of FI via its association with functional constipation.[87,88] Indeed, RH is most commonly found in patients with coexistent constipation and incontinence, where the latter is predominantly passive in nature[17]; this suggests the fecal leakage is secondary to fecal impaction or impaired evacuation.[87] An inability to adequately empty the rectum may result in liquid feces or mucus seeping around an impacted bolus of intrarectal stool (otherwise termed "overflow").[89] The cause of impaction may be secondary to pelvic floor dysfunction[90] or inadequate attention to the urge to defecate. Even in the absence of rectal impaction, RH may contribute to the development of FI via impairment of the reflexive or conscious contraction of the anal sphincters; patients with RH have reflexive relaxation of the internal anal sphincter at volumes lower than that required to induce rectal sensation,[91,92] and thus conscious deferral of defecation may not be possible.[87] They are also likely to have a functional sphincter defects (ie, reduced manometric pressures in the absence of structural sphincter damage) and pelvic floor dyssynergia.[33,37] Finally, RH may contribute to FI through its association with pelvic floor weakness and sphincter incompetence, perhaps related to pelvic nerve damage (see above).[87]

### Summary

- RH may lead to constipation via:

(1) Development of fecal retention due to lack of urge

(2) Its association with a functional RED

(3) Influencing colonic motility though inhibitory feedback mechanisms triggered as a result of rectal stasis.

- RH may lead to incontinence via:

(1) Its association with functional constipation, where fecal leakage is secondary to fecal impaction or impaired evacuation, ie, "fecal overflow"

(2) Impairment of the reflexive or conscious contraction of the anal sphincters

(3) An association with pelvic floor weakness.

## Treatment Options

Currently there is no definitive treatment for functional bowel disorders (particularly constipation) associated with rectal hyposensitivity. This is in part because the true clinical role has yet to be substantiated. Several studies have shown, however, that correction of sensory impairment is associated with an improvement in bowel symptoms.[93-96]

### Bowel Retraining Therapy/Biofeedback

Bowel retraining therapy, often incorporating sensory biofeedback is frequently used for the management of constipation and RED.[56,85,97,98] Enhancement of sensory perception is one of the primary aims of therapy.[98] However, evidence of targeted therapy to RH is lacking, with no randomized controlled trials available,[84,96,97,99] and only limited patient numbers (largest study [n = 26][96]). The basis of sensory re-training involves inflating a balloon or barostat in the rectum until urge threshold is reached. With repeated inflations, the patient learns to associate a given sensory intensity with the inflated volume. Over time, the balloon is inflated with decreasing volumes and the patient is asked to closely monitor and attend to sensations experienced. Eventually, new sensory thresholds may be established. Biofeedback has been shown to both objectively (up to 92% of patients show a significant improvement in sensory thresholds following treatment[96,97,99]) and subjectively improve symptoms of constipation[84,96,97] and incontinence,[99,100] with sustained improvement for at least 12 months.[101]

### Medical Therapy

Unlike rectal hypersensitivity, where a number of medications aimed at correcting sensory dysfunction[102-106] have been trialled, there is currently no established medical therapy for treating visceral hyposensitivity.

## Neuromodulation

Neuromodulation therapy involves modulation of the extrinsic neural control of the pelvic floor via continuous low amplitude stimulation of the sacral nerve roots or via direct stimulation of the organ of interest (ie, anal canal). Currently, neuromodulation research has focussed on end-organ outcomes and hence little is understood as to the true physiological mechanism of action,[107] although one plausible hypothesis is that its effects are mediated predominantly via changes in afferent neuronal function.[108] A number of different methods and techniques of neuromodulation exist; however, it is possible that the mechanism of action is common to all.

**Sacral nerve stimulation**

Sacral nerve stimulation (SNS) involves the placement of stimulating electrodes alongside the S3 sacral nerve; these are then attached to an implantable stimulator. Whilst neuromodulation with SNS has been shown to be effective in patients with fecal incontinence,[107,109,110] its role in the treatment of constipation remains controversial,[111] although promising.[111,112] Only one small mechanistic study has examined the effects of SNS with particular reference to RH and constipation,[113] this found normalization of rectal sensory thresholds with treatment, associated with both an increase in the number of successful bowel actions, and also improved constipation symptom scores.[113] This suggests a possible mechanistic effect of RH. Larger studies of SNS in constipation have also shown changes in sensory function, with a reduction in urge and maximal tolerable thresholds.[112] Unfortunately, the majority of studies performed have examined absolute change in rectal sensation (ie, both hyposensitive and hypersensitive patients have been analysed together), rather than by stratifying patients on the basis of sensory status.[114-118]

**Electrical stimulation**

Less invasive electrical stimulation techniques than SNS have also been used in the treatment of constipation and are likewise found to influence rectal sensory status.[119,120] Anal canal electrical stimulation has been shown to be associated with an improvement in both symptoms of constipation as well as a reduction in rectal sensory thresholds,[120] although its use has yet been generally accepted. More recently, transcutaneous abdominal electrical stimulation and dorsal genital nerve stimulation have been trialed in children and adults respectively, with an improvement in constipation symptoms and rectal perception again shown.[121,122] The latter study[122] found this was coincident with a reduction in rectal diameter.

**Magnetic stimulation of the lumbosacral nerves**

There is also emerging evidence that extracorporeal lumbosacral magnetic stimulation is effective in treating patients with hindgut dysfunction.[94,123,124] Magnetic stimulation has been shown to decrease colonic transit times,[124] decrease rectal sensory threshold volumes, and increase anal pressures[125] in healthy controls, patients with neuropathic hindgut dysfunction and patients with slow colonic transit.[94] This is associated with a decrease in constipation symptom scores,[124] an increase in frequency of defecation, and decreased laxative use.[94] There appears to be symptomatic benefit for at least 3 months,[123,124] but no longer term studies have been performed to date. In one important study, symptomatic benefit was associated with a significant decrease in rectal sensory volumes to urge to defecate and maximal toleration.[94] The responders, as a group, also had significantly higher baseline sensory thresholds (maximal tolerable volume 296 mL vs 143 mL)[94] in comparison to the non-responders, suggesting one mechanism of action is via alteration of afferent function.

## Surgery

In highly selected patients with RH secondary to increased rectal compliance/dimensions (particularly idiopathic megarectum), surgery may be a therapeutic option. A number of surgical procedures exist, and this is reviewed elsewhere.[126] The majority of procedures involve resection of the rectum and/or sigmoid colon, with either coloanal anastomosis or fecal diversion via colostomy. Although effective (~70%-80% success rate, depending of type of procedure),[126] surgery is generally considered a last resort due to its invasive, frequently irreversible nature and high morbidity (6%-50%).[127] One particular operative technique called vertical reduction rectoplasty,[95] which was specifically designed to correct rectal biomechanical abnormalities, has been shown to have clinical benefit and sustained physiological (diameter, compliance and sensory function) improvement in at least the medium term (60 months).[128]

## Summary

- There is currently no definitive treatment targeted to RH in functional bowel disorders.
- However, bowel retraining therapy incorporating sensory biofeedback has been shown to result in a reduction in rectal sensory thresholds to balloon distension. This is associated with a subjective improvement in symptoms.
- There is some evidence that neuromodulation techniques, such as with SNS or extracorporeal magnetic/electrical

stimulation may be an effective treatment for patients with functional bowel disorders associated with RH.

- Surgery can be considered in highly selected patients where RH is secondary to increased rectal dimensions.

## Clinical Research Implications

The underlying cause for the finding of RH has not been unequivocally established, but is almost certainly multifactorial, involving neuroanatomical, psychological and biomechanical factors. In particular, the site or the extent of any disruption to the afferent nerve pathway has not been accurately defined. Likewise, the pathology leading to rectal wall biomechanical changes has yet to be determined. It therefore remains unclear whether RH is itself causative or indeed secondary to hindgut dysfunction, ie, does a true cause and effect relationship exist, or is RH simply an epiphenomenon. There is growing evidence that constipation starting in childhood (associated with altered sensory thresholds) may persist into adulthood, with 40%-50%[129,130] of paediatric patients not responding to treatment on long-term follow-up. The relationship between childhood-onset constipation and constipation associated with RH and biomechanical dysfunction in adulthood certainly warrants further research.

Furthermore, it is not known whether any afferent pathway defect represents an isolated visceral sensory neuropathic process, or reflects a more generalized neuropathy also affecting efferent and/or autonomic function. Although previous work has demonstrated concurrent systemic small fiber sensory dysfunction and autonomic dysfunction in patients with constipation,[66,69] the relationship to rectal sensory status was not documented. Such a study is currently underway.

Most importantly, the clinical impact of the presence of RH needs to be fully appreciated. Akin to the association between visceral hypersensitvity and the IBS, an association between RH and RED has been firmly established,[33] and there certainly appears to be a strong link between RH and an altered 'call to stool',[35,41,42] and also an effect on other physiological functions (eg, colonic transit[33] and rectal evacuation[17]). However, whether correction of RH is the responsible mechanism for concurrent symptomatic improvement seen with a number of different interventions[84,94,96,97,99,113,120] remains unclear, though results to date appear promising. Further controlled studies with larger numbers are an absolute requirement to substantiate this.

## Summary

- The underlying causes (be that neurological or biomechanical) for RH need to be unequivocally established.
- It remains to be confirmed whether RH is causative or, alternatively, is secondary (ie, an epiphenomenon) to hindgut dysfunction.
- The clinical impact of RH still needs to be better defined.

## Conclusion

RH is commonly found in patients with hindgut dysfunction, and is often the only pathophysiological abnormality identified in these individuals. In terms of etiopathogenesis, it can be subdivided into two main groups (of which there is likely considerable overlap), namely primary afferent nerve dysfunction or secondary to biomechanical changes of the rectal wall. However the mechanism by which it exerts its effects in relation to symptom generation remains to be fully elucidated. Furthermore, whether there is a clear clinical phenotype associated with the finding of RH has still to be confirmed. Nevertheless, normalization of RH has been shown through a variety of interventions (behavioral, neuromodulation and surgery) to be associated with clinical benefit. Ultimately, appreciation of the mechanisms responsible for RH has potentially important and wide-ranging implications for the management of functional hindgut disorders, as new and evolving therapies targeted to correcting sensory function become available.

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