Sampling Reflex as a New Manometric Marker in the Diagnosis of Defecation Disorders - Systematic Review

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Abstract

Introduction Distension of the rectum wall and subsequent momentary relaxation of the internal anal sphincter (IAS) trigger a reflex called the rectoanal inhibitory reflex (RAIR). This same rectal distension causes a reflex contraction of the external anal sphincter (EAS), responsible for conscious continence called rectoanal excitatory reflex (RAER). This set of reflexes are named sampling reflex.

Objectives The sampling reflex is necessary to initiate defecation or flatulence. The objective of this study is to evaluate the sampling reflex and its practical applicability as a manometric marker of the main defecation disorders.

Methodology This review followed the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) items. The development method consisted of searching for articles in the research platforms BVS, PubMed, Cochrane Library, SciELO and ScienceDirect and for the selection of articles the Rayyan Platform was used. The articles resulting from the search strategies were added to the platform and five collaborators were invited for the blind selection. Finally, 6 articles were included in the final review.

Results An intact sampling reflex allows the individual to facilitate discrimination between flatus and stool and to choose whether to discharge or retain rectal contents. On the other hand, an impaired sampling reflex can predispose an individual to incontinence.

Therefore, it was observed that patients with defecation disorders had an impaired sampling reflex, since it was found that constipated patients have incomplete opening of the IAS, lower amplitude of RAIR and increase of RAER. Most incontinent patients present a failure in the recruitment of the EAS, a decrease in the RAER and an increase in the RAIR, in duration and amplitude.

Keywords

- manometry
- digestive System physiological phenomena
- reflex
- fecal incontinence
- constipation

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Conclusion The improvement of high-resolution anorectal manometric techniques was essential for understanding the pathophysiology of defecation disorders, as well as the physiological understanding and importance of RAIR and RAER.

Objective

Evaluate the sampling reflex and its practical applicability as a manometric marker of the main defecation disorders.

Introduction

The internal anal sphincter (IAS) and the external anal sphincter (EAS) act in response to continence and evacuation. The anal canal is usually closed by tonic contraction of the IAS and by partial contraction of the striated musculature of the EAS. Distention of the rectum wall and subsequent momentary relaxation of the internal anal sphincter (IAS) triggers a reflex called the rectoanal inhibitory reflex (RAIR). This same rectal distention causes a reflex contraction of the external anal sphincter (EAS), responsible for conscious continence called rectoanal excitatory reflex (RAER).[1] This set of reflexes are named sampling reflex.

In 1877, it was demonstrated that anal relaxation occurs in response to rectal distention. Later, in 1963, it was conceived that this anal relaxation allowed the rectal contents to meet the sensitive anal mucosa. This has been called the "sampling reflex" and is thought to represent the anal motor response to the sensory stimulus of rectal filling.[2]

The sampling reflex occurs via the sacroiliac pathway. This mechanism causes an increase in the diameter of the proximal portions of the anal canal and narrowing of the distal zones. Thus, small amounts of fecal material encounter sensory receptors in the upper anal canal (end bulbs of Krause, Golgi-Mazzoni bodies, and genital corpuscles) while a simultaneous narrowing of the lower anal canal occurs to prevent fecal leakage. Sensory recognition of contents in the rectal ampulla, be it stool or gas, is the determining mechanism for voluntary flatulence or defecation, and an imbalance in this mechanism could be a potential cause for triggering a defecation disorder.

Among the defecation disorders, the most common include fecal incontinence, chronic intestinal constipation, and outlet obstruction syndrome. Fecal incontinence is defined as the involuntary loss of fecal contents such as feces and gases through the anal canal due to the inability to contain the evacuation until it is socially convenient.[3] In general, constipation is defined by intestinal problems that include reduced frequency of bowel habits, hard stools, excessive use of force for defecation, sensation of anorectal blockage, anal typing and sensation of incomplete defecation after the act.[4,5]

RAIR has been shown to be impaired in patients with defecation disorders. Thus, in patients who suffer from difficulty with evacuation, there may be an incomplete opening of the IAS, which indicates that there is less contact between the contents of the rectum and the receptors in the anal canal, decreasing cortical perception. Concomitantly, there may be a significant change in the RAER, where the contractile response to rectal distention is increased, resulting in excessive contraction of the external anal sphincter, causing mechanical compression on the inferior anal sphincter, making it difficult to relax completely.[6]

Conversely, incontinent patients have greater IAS relaxation with rectal distension, and this relaxation increases with increasing rectal volumes when compared with constipated patients. This implies that, with progressive rectal filling with feces, incontinent patients may experience an exaggerated relaxation response with subsequent loss of rectal contents through an uninhibited proximal anal canal.[6]

Anorectal manometry is a test that allows an objective and quantitative assessment of the sphincter muscles and the reflexes. This exam provides detailed information on some parameters such as the maximum resting pressure of the anal sphincter, the maximum and mean pressures of voluntary contraction, the length of the functional anal canal, rectal sensation, and the presence of RAIR. Thus, it ends up becoming the ideal method for evaluating pelvic floor disorders, particularly for cases of incontinence and intestinal constipation. Thus, this systematic literature review was performed with the aim of evaluating the sampling reflex, in addition to its practical applicability as a manometric marker of the main defecation disorders.

Methods

This review followed the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) items. The development method consisted of searching for articles on the research platforms BVS, PubMed, Cochrane Library, SciELO and ScienceDirect to answer the following research questions: What is the practical applicability of the sampling reflex as a manometric marker of the main defecation disorders? Based on the PICO strategy (P: Patients with defecation disorders; I: sampling reflex analysis; C: Conventional screening; O: Applicability of this exam;), the following search terms (MeSH) were used: Manometry, Reflex, Digestive System Physiological Phenomena, as well as this free term: Sampling reflex which, associated with Boolean operators (OR and AND), structured the search strategy.

Research Bases

For this review, the broad search platforms BVS and PubMed, Cochrane reviews, SciELO, Science direct and UpToDate on 08/23/2022 were searched.

Research Strategy

Strategy 1–PubMed and SciELO

(("Manometry" [Mesh] OR Manometries OR Tonometry) AND "Digestive System Physiological Phenomena"[Mesh]

OR (Digestive Physiology) OR (Phenomenon, Digestive System) OR (Phenomena, Digestive System) OR (Physiology, Digestive System) OR (Processes, Digestive System) AND (Sampling Reflex)

Strategy 2–VHL
SAMPLING REFLEX AND MANOMETRY

Strategy 3–Cochrane Reviews
SAMPLING REFLEX AND MANOMETRY

Strategy 4–ScienceDirect
Manometry AND Digestive System Physiological Phenomena AND Sampling Reflex

Selection

For the selection, the Rayyan® Platform (https://www.rayyan.ai/) was used. The articles resulting from the search strategies were added to the platform and five collaborators were invited for the blind selection based on the reading of abstracts and titles. Conflict review was allowed for all employees. Once the conflicts were resolved, the articles included in the blind selection were read in full. Then, the final inclusion of articles was made.

Research Results

Initially, 41 articles were found through the platforms and after removing duplicates, 40 references were maintained. Of 40 studies, 32 were selected after reading the titles and of these, 26 articles were excluded after selection criteria were applied (8 articles were excluded due to an outcome incompatible with the purpose of the research and 18 excluded because they included pharyngeal manometry, esophageal or bladder analysis and deglutition or masticatory parameters, which are outside the scope of this review (►**Fig. 1**). Finally, 6 articles were included in the final review (►**Table 1**).

Results

Prisma® Flowchart

The anorectal reflex (a local reflex where a small amount of rectal distension causes transient contraction of the external anal sphincter) plays a role in continence.[7] Transient relaxation of the internal anal sphincter (IAS) allows small amounts of endorectal material to descend into the upper anal canal, coming into contact with specialized sensory organs such as Krause's terminal bulbs, Golgi-Mazzoni bodies, and genital corpuscles, and the sparse Meissner corpuscles and Pacinian corpuscles every 8–10 minute.[6] Rectal contents by this mechanism can be "sampled" to allow discrimination between flatus, fluid and stool. The amount of relaxation depends on the magnitude of strain. Greater rectal distention may prolong IAS relaxation, and less rectal distention may trigger only partial sphincter relaxation. As slow-wave activity in the distal part of the sphincter is associated with contraction of the external anal sphincter (EAS) and puborectalis muscle, the contents return to the rectum to prevent fecal leakage.

An intact sampling reflex allows the individual to facilitate discrimination between flatus and stool and to choose whether to discharge or retain rectal contents. On the other hand, an impaired sampling reflex can predispose an individual to incontinence. Thus, its functional purpose is the fine adjustment of the continence barrier.[6] The frequency of these reflexes is highly variable in normal individuals, but they occur on average seven times per hour and predominantly after meals and at night.

Anorectal manometry is an exam that allows identifying sampling reflexes and is an important test to confirm pathological conditions such as chronic constipation and fecal incontinence.[7]

In their study, Kumar, D. et al. observed that the sampling phenomenon is more frequent during the day than at night and suggested that transient relaxation in the upper anal canal may be related to contractile events in the rectosigmoid or proximal colon. This is supported by the spontaneous occurrence of sampling in the absence of evident changes in rectal pressure.[2]

Zbar, AP et al. demonstrated that maximal inhibitory pressures were higher in constipated patients compared with healthy volunteers and incontinent patients at all sphincter levels. The same effect was observed with measurements of inhibitory slope calculated between the point of initiation of inhibition below baseline pressure and the point of maximum inhibition.[8]

Planimetric measurement of AUICs (area under the pressure/time inhibitory curve, AUIC) showed a progressive difference between incontinent patients, healthy volunteers and constipated patients and between the proximal, intermediate and distal sphincters, further suggesting coordinated recovery from IAS as part of rectal distension. It was assumed that higher pressures initially recorded in constipated patients may contribute in absolute terms to larger planimetric areas and larger inhibitory curves, resulting in slower overall recovery in this group. However, this does not fully explain the differential recovery observed at various sphincter levels.[8]

Differences in rectal compliance have been a contributing factor between patient groups, particularly in cases of constipation where there is slow recovery of inhibition and exaggerated inhibitory reflex reaction. In incontinent patients, minimal excitation was evident in the intermediate sphincter.[8] It has further been suggested that the speed and coordination of EAS recovery may play an important role in preventing leakage in those individuals in whom EAS recruitment may fail since no significant differences were found in distal excitation between patient groups.

Pucciani et al. showed that 86.2% of patients with a functional defecation disorder had an impaired sampling reflex. The manometric reports of patients with functional defecation disorder (FDD) identified RAIR and RAER alterations that correlated positively with the stress test and defecographic data. These changes also showed high rates of sensitivity, specificity, PPV and NPV.[3]

In patients with FDD, RAIR is characterized by the absence of a dose-dependent response, a shorter duration and

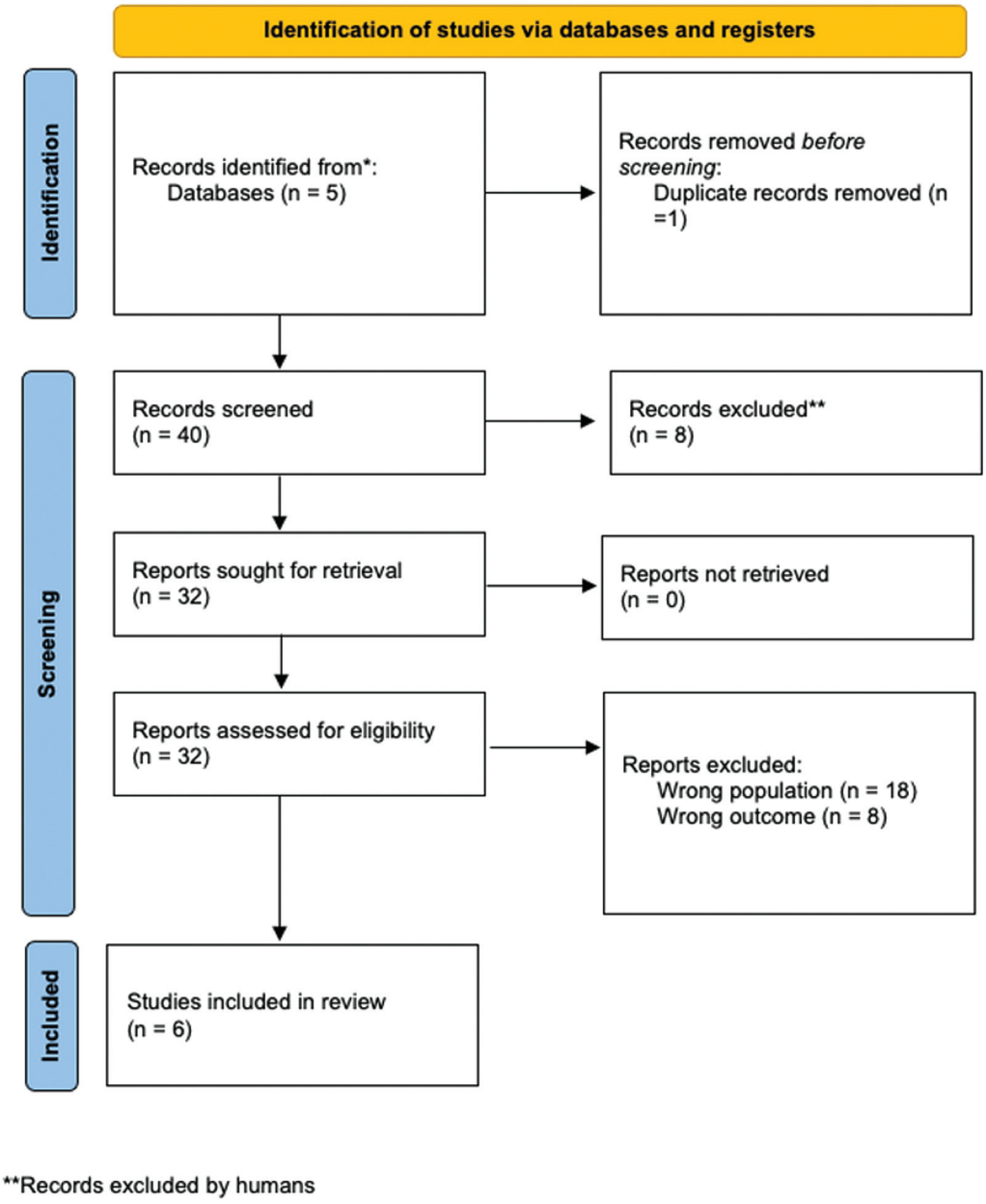

Fig. 1 Process of articles selection flowchart.

incomplete relaxation with high residual pressure at the lowest point of the reflex curve compared with healthy volunteers. This RAIR deficiency corresponds to an incomplete opening of the IAS, which induces less contact between the rectal contents and the receptors in the anal canal and interferes with cortical perception.[3]

Furthermore, Pucciani et al. suggest that RAIR impairment is not due to alterations in sensory perception, but due to muscle malfunction, since the RAIR threshold in patients resembled controls. Indeed, the contractile response to rectal distention is increased, which indicates that RAIR impairment is combined with a change in RAER. Excessive RAER would explain the impaired sampling reflex, and the latter may explain the impairment of the RAIR, as the excess contraction of the EAS can prevent the IAS from relaxing.[3]

It is important to point out that in their study, Yates, G. et al. demonstrated that general anesthesia (nitrous oxide, halothane, altesin, phenoperidine, droperidol, propofol and trimiprazine), usually administered to children to perform anorectal manometry, inhibits IAS, and reduces resting pressure, but seems to have no effect on qualitative relaxation of the anal sphincter in response to rectal distention when examining the RAIR. This effect has also been demonstrated after administration of inhalational anesthetic agents such as sodium pentothal or nitrous oxide. However, no significant differences were found at rest due to pressure, when using ketamine or awake anorectal manometry.[4]

In the pediatric context, indications for the use of anorectal manometry remain variable, with limited guidance on when it should be performed. Yates, G. et al. highlight the

Table 1 Main results presented by the studies included in the review

Study	Year	Methodology	Main results
IOVINO, P.	2021	Ten studies were collected in a non-systematic method and the research and study selection methods were not standardized or explicit.	- In patients with functional defecation disorder (FDD) RAIR is characterized by dose-dependent unresponsiveness, shorter duration and incomplete relaxation with high residual pressure at the lowest point of the reflex curve when compared with healthy volunteers. - There is incomplete opening of the IAS, which alters cortical perception. - RAIR impairment also occurs due to muscle malfunction, as in patients with FDD RAIR impairment is combined with an increased contractile response to RAER rectal distention. - Excessive contraction of the IAS can prevent complete relaxation of the IAS.
YATES, G.	2020	A systematic review was conducted using a*norectal* manometry (ARM) with a pediatric sample. The total number of included studies was 227.	- General anesthesia and inhalational anesthetic agents usually administered to children to perform anorectal manometry inhibit IAS and reduce resting pressure but seem to have no effect on RAIR. - No significant differences were found at rest due to pressure, when using ketamine or awake anorectal manometry. - There is a lack of standardization in the use of anorectal manometry in pediatrics and guidelines must be established to harmonize the use of manometry in clinical practice.
PUCCIANI, F.	2020	Prospective cohort study performed in 58 patients with obstructed defecation syndrome (ODS) with FDD (functional defecation disorder). All 58 patients and 20 controls were evaluated with anorectal manometry to study the sampling reflex.	- Functional defecation disorder (FDD) was diagnosed in 37.6% of patients with obstructed defecation syndrome and 50 (86.2%) of them had an impaired sampling reflex. - Alterations in the RAIR and RAER that correlated positively with the exercise test and defecographic data were identified. - RAIR in patients demonstrated incomplete opening of the IAS which limits cortical perception - The RAIR threshold in patients was not different from controls, so there is no cortical perception fault. - There is a significant change in the RAER where the contractile response to rectal distention is increased and the over-contraction of the EAS prevents complete relaxation of the IAS. - No correlation was found between RAIR impairment and anal resting pressures.
ZBAR, AP	1998	42 patients were evaluated through anorectal manometry.	- There were no significant differences in distal excitation between patient groups. - Maximal inhibitory pressures were higher in constipated patients compared with healthy volunteers and incontinent patients at all sphincter levels. - In incontinent patients, minimal excitation was evident in the intermediate sphincter.
JORGE, JM	1993	Fifty-five studies were collected in a non-systematic way and the research and study selection methods were not standardized or explicit.	- Anorectal manometry is a widely recognized test for detecting conditions such as chronic constipation and fecal incontinence. - Can be used to compare the integrity of anorectal physiology after treatments - Despite being important to determine defecation phenomena, anorectal physiology depends on other factors such as fecal consistency, anorectal angle, anal sensation, integrity of the muscles involved and sensory circuits that must be considered when performing the exam.
KUMAR, D.	nineteen ninety	14 patients were evaluated using synchronized and prolonged recordings of anorectal pressures and electromyogram (EMG) of the external anal sphincter.	- Sampling reflex was observed in all subjects. - There was a significant increase in the reflex after meals compared with fasting and this was greater in relation to periods of sleep.

variation and lack of standardization in the use of ARM in pediatrics and point to the need to establish guidelines to ensure the optimization of the use of high-definition anorectal manometry in clinical practice.[4]

Discussion

The development of diagnostic methods has provided a better understanding of anorectal physiology and functional defecation disorders, with more effective therapeutic approaches. Among these, high-resolution anorectal manometry is an important exam in the elucidation of the mechanisms of defecation, since it captures the measurement of pressures in the anal canal, at rest, contraction and during muscle relaxation of the sphincters, in addition to the main reflexes involved in continence fecal and physiological evacuation.

In their study, Jorge, JM et al demonstrated that maintenance of continence is not only a function of anal pressure but is a complex and dynamic interaction of the anal canal, rectum, and pelvic floor musculature. Anorectal physiology depends on factors such as fecal continence, anorectal angle, anal sensation, integrity of involved muscles and sensory circuits.[1]

The manometry method using high resolution has led to an understanding of anal sphincter activity during various physiological functions. They demonstrated the degree of interaction between rectal and anal activity, in time and space, with more reliable reconstruction of volume vectors, in addition to better visualization of sampling reflexes. The rectoanal contractile reflex precedes the rectoanal inhibitory reflex depending on the intensity and speed of rectal distension and evacuation dysfunction (►**Figs. 2**, **3** and **4**).

The sampling reflex is an indispensable mechanism for controlling continence and triggering evacuation. Both the RAIR, mediated by the relaxation of the internal anal sphincter, and the RAER mediated by the contraction of the external anal sphincter, allow the individual to perceive the fecal material and prepare to inhibit or allow the fecal exoneration.[3] Greater rectal distension causes a greater prolongation of IAS relaxation. Slow-wave activity in the distal part of the sphincter is associated with contraction of the external anal sphincter (EAS) and the puborectalis muscle, which results in the return of contents to the rectum to prevent fecal leakage.

Thus, the role of studying the sampling reflex can have remarkable therapeutic implications, as it can be easily identified in high-resolution anorectal manometry. After stimulating air instillation into the rectal ampulla, anal pressure drops abruptly or equalizes with rectal pressure. Rectal pressure, in turn, may increase or remain unchanged.

The sampling reflex occurs on average seven times per hour and predominantly after meals and at night.[6] In contrast, in their study, Kumar, D. et al. observed that the sampling phenomenon is more frequent during the day than

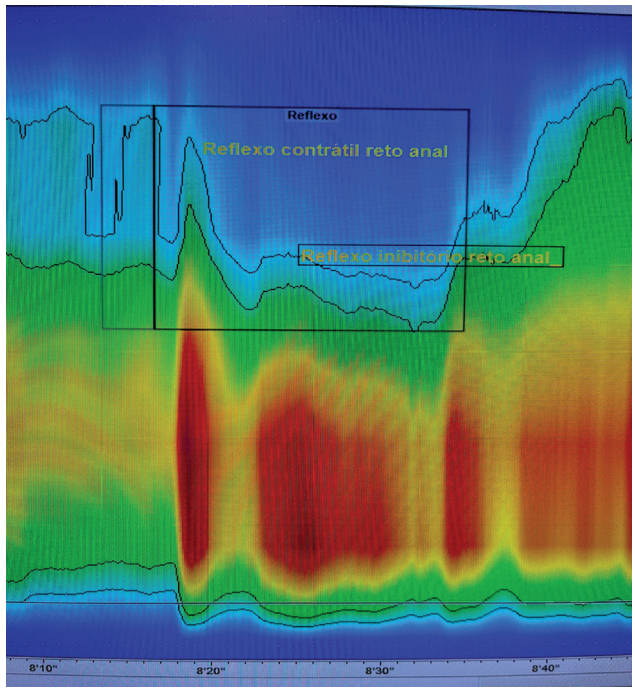

Fig. 3 RAER preceded by a long rectoanal inhibitory relaxation in a constipated patient with outlet obstruction subtype.

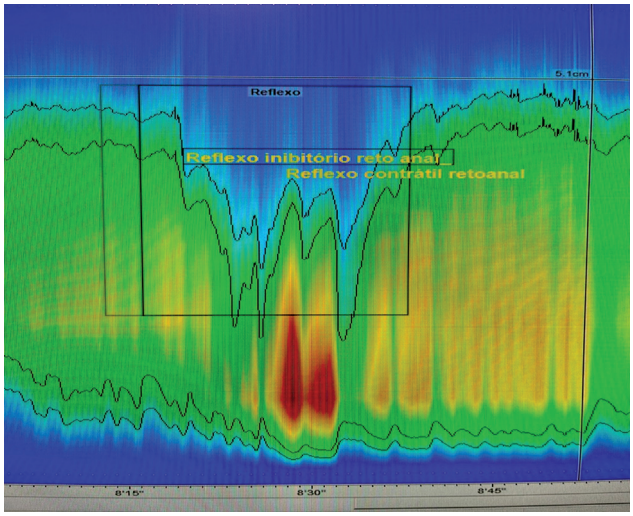

Fig. 2 Rectoanal inhibitory reflex followed by a long rectoanal contractile reflex in a patient with fecal incontinence.

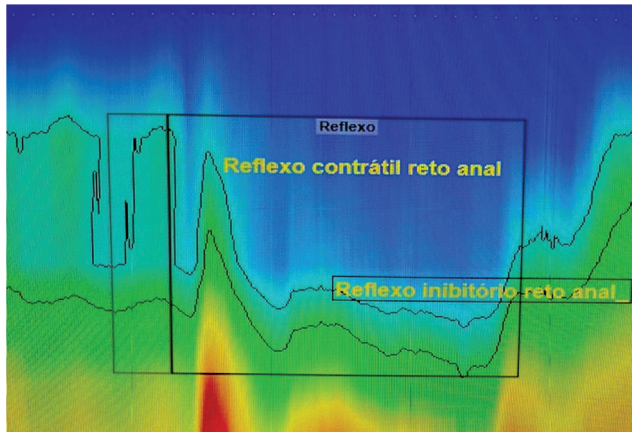

Fig. 4 RAER with great amplitude making it difficult to expose the fecal material to the sensory mechanisms of IAS in the middle anal canal.

at night and suggested that transient relaxation in the upper anal canal may be related to contractile events in the rectosigmoid or proximal colon. This is supported by the spontaneous occurrence of sampling in the absence of evident changes in rectal pressure.[2]

Pathological states of the anus can influence sampling rates. Pucciani et al. showed that 86.2% of patients with functional defecation disorder (FDD) had an impaired sampling reflex, where manometric studies of patients with FDD showed changes in the RAIR, in addition to the absence of a dose-dependent response, a shorter duration and an incomplete relaxation with high residual pressure at the lowest point of the reflex curve, corresponding to an incomplete opening of the IAS, less contact between the contents of the rectum and the receptors in the anal canal and a consequent change in cortical perception. This commitment is probably due to a muscle malfunction, considering that the RAIR threshold was like the exams of control patients. However, as the contractile response to distension is increased, it is inferred that there is also an alteration in the RAER, which in excess, in addition to explaining the altered sampling reflex, also justifies the alteration in the RAIR, since the excess contraction of the EAS prevents IAS relaxation.[3,9]

Furthermore, the planimetric measurement of AUICs (area under the pressure/time inhibitory curve) showed that there is a progressive difference between incontinent patients and constipated patients and between the proximal, intermediate, and distal sphincters, suggesting an uncoordinated recovery of the IAS as part of the strain. rectal. Thus, it is concluded that the functional purpose of the sampling reflex is the fine adjustment of the continence barrier.[6,8]

Conclusion

Sensory recognition of content in the rectal ampulla is the determining mechanism for community life and has allowed us to advance in the social development of the human species. The reflection by sampling is an important determinant of this evolution and in life in society. An intact neurological pathway and a pelvic floor with functional musculature is an intrinsic condition for coordination, control, and freedom of the evacuation act.

This systematic review came to prove that changes in the sampling reflex contribute as one of the causes of evacuation disorders present in our environment. In incontinent patients, there is a tendency toward a decrease in the RAER reflex and an increase in the RAIR, allowing for an increased risk of active and passive fecal losses, and a great deal of social embarrassment. In chronic constipated patients, especially in patients with the outlet obstruction subtype, there is an increase in the RAER in time, duration, and amplitude, generating inability in the sensory perception of the material due to the short time it spends in contact with the IAS. The RAIR, in turn, has a shorter duration and amplitude, both in the relaxation phase and in the reflex recovery phase. These facts inhibit the desire to evacuate, and, over time, patients lose the perception of fecal material and the desire to exonerate the stool in a perpetual chair cycle.

With this, it is concluded that the functional purpose of the sampling reflex is the fine adjustment of the continence barrier and the evacuation desire and should be evaluated and measured routinely in high-resolution anorectal manometric exams.

Conflict of Interest
None.

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