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Original Article

Do Age and Sex Influence Anorectal Manometry Parameters?

Gabrielle Jutras, MD, George Wahba, MD, Eloise Ayuso, MD, Elissaveta Neshkova, MSc, Mickael Bouin, MD, PhD

Centre Hospitalier Universitaire de l'Université de Montréal (CHUM), Montréal, Québec, Canada

Correspondence: Gabrielle Jutras, MD, Centre Hospitalier Universitaire de l'Université de Montréal (CHUM), 1051 Sanguinet Street, Montréal, Québec, H2X 3E4, Canada, e-mail: gabrielle.jutras@umontreal.ca

Abstract

Background: High-resolution anorectal manometry (HRM) is widely used in the evaluation of anal incontinence and constipation, which become increasingly prevalent with age. However, the impact of age and comorbidities on physiological digestive parameters remains poorly understood. In this study, we aimed to evaluate the effect of age on anorectal function.

Methods: We conducted a retrospective study on patients at our digestive motility clinic between January 2016 and May 2019. All patients with a normal HRM were included. Clinical data and HRM parameters were collected in a database. Multivariate regression analyses were performed to evaluate the effects of age, sex, medical comorbidities and obstetric history on anorectal HRM parameters.

Key Results: One hundred and forty-four patients were included (mean age: 53 ± 16 years, 72% females). The main indications for anorectal HRM were incontinence (44%), constipation (37%) and anorectal pain (9%). Age was significantly associated with higher maximum tolerable volume (β = +0.48 mL year^{-1}, P = 0.04) and higher rectal compliance (β = +0.04 mL year^{-1}, P = 0.01). Independently from age and medical comorbidities, female demonstrated significantly lower mean endurance squeeze pressure (β = −44.4 mmHg, P < 0.001), maximal squeeze pressure (β = −62.3 mmHg; P < 0.001), volume at first urge (β = −16.7 mL, P = 0.02) and maximum tolerable volume (β = −16.1 mL, P = 0.046). Vaginal birth was associated with lower tolerable maximum pressure (β = −39.4 mmHg, P = 0.046).

Conclusion: Age and sex are independent factors which influence anorectal HRM parameters. These findings should be taken into consideration when interpreting anorectal HRM.

Keywords: *Aging; Anorectal disorders; Constipation; Fecal incontinence; Manometry*

Introduction

The elderly population is undeniably increasing every year. Today, 8.5% (617 million people) of the world's population is over the age of 65 (1). Along with various medical diseases, gastrointestinal disorders of function and motility are very common in the elderly (2). The prevalence of constipation, incontinence and fecal impaction increases with age and respectively affects 40%, 9–25% and 6–19% of people over 65 years old (3).

Anorectal high-resolution manometry (HRM) remains the most widely used test to evaluate anorectal function and its physiological parameters. HRM has now replaced conventional manometry and is the new standard of care as it produces precise measurements and reliable results in three dimensions. It is a simple and standardized examination, and involves practically no risk to the patient. It allows measurement of anorectal pressures, rectal sensation and neural reflexes essential for continence and defecation (4,5).

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Anorectal HRM provides various parameters, the most frequent of which are listed in Table 1.

The influence of aging on manometric parameters remains debated. For example, some authors have stated that the mean resting pressure and maximum squeeze pressure decrease with age (6–8) while others have reported that age does not affect anorectal pressures (9). An increase in sensory thresholds associated with age was noted in a few studies (10) while it was non-significant in another one (9). Most of these studies were however performed more than fifteen years ago and were based on conventional manometry, instead of HRM. The results are therefore difficult to interpret, even more so as they all use different age categories with little clinical pertinence. To our knowledge, only two studies have been published using HRM. The first was solely performed on female subjects (11). An extended database from this first study, this time including both sexes, was recently published (12), but very few individuals over the age of 70 years old were included and patients were categorized in two groups with extremes of ages. Moreover, it excluded all patients with comorbidities, therefore making their results difficult to apply from a clinical point of view.

We believe that in order to be able to apply similar HRM demographic findings to a clinical population, it is necessary to have data on a large age range as well as a representative distribution of both sexes in a population sample representing the typically encountered comorbid population undergoing HRM. In addition, we believe that in order to properly assess the effect of age on anorectal function and manometric parameters, this factor must be assessed continuously and not categorically. Therefore, in our study, we aimed to determine the independent effect of age as well as sex and comorbidities on physiological HRM anorectal parameters in an unselected patient population referred for anorectal HRM.

Table 1. Description of anorectal manometric parameters used routinely in all patients

Manometric parameters	Description
Mean resting pressure	Represents the anal resting tone which is maintained by the internal anal sphincter, the external anal sphincter and by the hemorrhoidal plexus, respectively by 55%, 30% and 15%.
Maximum cough pressure	Represents the reflex contraction of the external anal sphincter induced by increased abdominal pressure.
Maximum squeeze pressure, mean endurance squeeze pressure and duration of endurance squeeze	Represents the strength of the external anal sphincter when the patient is asked to contract voluntarily.
Volume and pressure at first perception, volume and pressure at first defecation urge and maximum tolerable volume and pressure	Rectal distension is induced by inflating a balloon and enables measurements of the rectal sensation.
Recto-anal inhibitory and excitatory reflexes	Those reflexes are integral part of normal defecation. They are manifested as either an increase or a reduction in anal pressure during balloon distension.

METHODS

Study Design and Study Population

We performed a retrospective observational study at our digestive motility center at the Centre Hospitalier de l'Université de Montréal (CHUM), Canada. Anorectal HRM studies performed between January 2016 and May 2019 were reviewed. All patients aged 18 years or older with a normal HRM diagnosis were included in our study. The reference manometric values were determined based on the American Gastroenterological Association technical review on anorectal testing techniques (13). An abnormal manometric result was defined as either a result outside the normal values established for age (e.g., a maximum squeeze pressure of less than 60 mmHg was considered abnormal) or those in whom anorectal dyssynergia was demonstrated, defined as an increased anal pressure during attempted defecation. The final manometry result was determined by an experienced clinician, based on the various parameters studies during the procedure along with reliable reference values. Patients were excluded if the final diagnosis of the manometry was considered abnormal. All manometric parameters along with sociodemographic data were collected from medical records and compiled in a database. This study was approved by our institutional research ethics committee.

High-Resolution Manometry

All manometries were performed by a Medical Measurement Systems anorectal HRM (UniTip, UniSensor, Switzerland). The catheter contains eight equidistant directional sensors. Before the study is initiated, the catheter is submerged in water to prewet the sensors followed by a procedure to 'zero' them to atmospheric pressure. In order to ensure the rectal vault is empty, two enemas are given to the patient prior to the test. The patient is then placed in a left lateral position with knees and hips bent at a 90° angle. The probe is introduced into the rectum by a trained

nurse and a 5-minute run-in-period is taken. For each test, the following parameters are measured in a standardized way: anorectal pressures at rest (20 seconds), during a squeeze effort (average of 3 measures of maximal duration of 30 seconds), during a coughing effort and during simulated evacuation after distending a rectal balloon with up to 50 mL of saline. The rectoanal reflexes and rectal sensation are analyzed during progressive distension of the balloon. The technique was performed according to a standardized protocol based on the American College of Gastroenterology Guidelines for anorectal disorders (14). The software used to collect the manometric parameters was MMS Investigation & Diagnostic Software.

Data Collection

The electronic medical records of all included patients were reviewed. The following clinical variables were collected in a database: age at the time of the test, sex, body mass index (BMI), number of pregnancies, history of vaginal delivery, history of tobacco, alcohol or drug consumption, medical and surgical comorbidities, active medication and HRM indication. We collected all measured anorectal HRM parameters: mean resting pressure, maximum cough pressure, maximum squeeze pressure, mean endurance squeeze pressure, duration of endurance squeeze, volume and pressure at first perception, volume and pressure at first defecation urge, maximum tolerable volume and pressure, recto-anal inhibitory and excitatory reflexes and anal canal length.

Statistical Analysis

All statistical analyses were performed using R software. All continuous variables are presented as mean ± standard derivation and categorical variables are reported as frequencies. Linear multivariate analyses were performed to investigate associations between various demographic variables and anorectal manometric parameters. In our first model, we tested associations between each manometric parameter and age, sex, history of irritable bowel syndrome, inflammatory bowel disease, rectocele, diabetes, hypothyroidism, anorectal surgery, ileocolic surgery and manometry indications (incontinence, constipation and anorectal pain). In the second model, associations between each manometric parameter and age, number of deliveries and history of vaginal delivery were tested in female patients only. We performed backward stepwise variable selection based on the Akaike Information Criteria. A *P*-value inferior to 0.05 was considered statistically significant in all analyses.

RESULTS

Sociodemographic Characteristics

A total of 618 patients were referred to our center for an anorectal HRM during the study period. Eighty-four patient HRM records (14%) were excluded as they were incomplete or lost due to errors in data transferal from the HRM recording program to the digital patient's file. We excluded 390 (63%) patients as their HRM was abnormal. The remaining 144 (23%) patients were included in our study. The demographic information of included patients is given in Table 2. The mean age at the time of HRM was 53 years (range 19–92) and females made up 72% (103/144) of the study population. Of the 55 females for whom information was available, the average number of pregnancies was 1.3 ± 1.3 and 86% of females who had given birth had a history of vaginal delivery. The most frequent comorbidities in our population were gastrointestinal medical conditions (39%), previous gastrointestinal tract surgery (17%) and hypothyroidism (17%). Thirty-one patients (36%) were under laxative pharmacotherapy. The most common indications for HRM were fecal incontinence (44%) and constipation (37%) (Figure 1).

Effect of Age, Sex and Comorbidities on Anorectal Physiological Parameters

We found that increasing age was independently associated with maximum tolerable volume ($\beta = 0.48$ mL year^{-1}; $P = 0.03$) and rectal compliance ($\beta = 0.04$ mL mmHg^{-1} year^{-1}; $P = 0.01$). There was a tendency toward higher volume at first defecation urge with age ($\beta = 0.39$ mL year^{-1}; $P = 0.05$; Table 3).

We also found that sex was a significant independent predictor of multiple HRM parameters. Female demonstrated statistically lower maximum squeeze pressure ($\beta = -61.8$ mmHg; $P < 0.001$) and mean endurance squeeze pressure ($\beta = -44.2$ mmHg; $P < 0.001$). There was a tendency toward lower maximum cough pressure in females as well ($\beta = -17.9$ mmHg; $P = 0.04$; Figure 2). When the effect of sex on anorectal sensation was analyzed, female independently demonstrated statistically lower volume at first defection urge ($\beta = -16.7$ mL; $P = 0.02$) and lower maximum tolerable volume ($\beta = 16.1$ mL; $P = 0.046$; Figure 3).

Hypothyroidism was associated with an increase in rectal compliance ($\beta = 1.53$ mmHg; $P = 0.04$). Patients with a history of rectocele had a significantly lower duration of contraction endurance ($\beta = -2.61$ seconds; $P = 0.02$), a higher pressure at the urge to defecate ($\beta = 55.9$ mmHg; $P = 0.002$) and lower maximum tolerable pressure ($\beta = 55.2$ mmHg; $P = 0.03$). A history of ileocolic surgery was associated with decreased duration of enduration squeeze ($\beta = -2.76$ seconds; $P = 0.002$). We did not detect any multicollinearity (Table 3).

Effect of Pregnancy and Vaginal Delivery on Anorectal Physiological Parameters

In a sub-cohort of our study population of solely female, the effect of pregnancy and vaginal birth was evaluated. In a multivariate analysis, while controlling for age and parity, female with a history of vaginal delivery had lower maximum tolerable pressure ($\beta = 39.4$ mmHg, $P = 0.046$) versus female

Table 2. Demographic characteristics, comorbidities and medication of patients who have had an anorectal manometry at our digestive motility center from January 2016 to May 2019

Baseline characteristics		Total
		n = 144
Age (years)	Mean (range)	53 (19–92)
Females	*n* (%)	103 (72)
BMI	Mean (range)	26 (15–54) (*n* = 57)
Pregnancy		
Parity	Mean (range)	1 (0–5) (*n* = 55)
Vaginal delivery	*n* (%)	31 (86) (*n* = 36)
Lifestyle habits		
Current smoking	*n* (%)	13 (14)
Alcohol	*n* (%)	2 (2)
Drugs	*n* (%)	4 (4) (*n* = 96)
Comorbidities		
GI condition	*n* (%)	45 (39)
IBS	*n* (%)	17 (38)
IBD	*n* (%)	13 (28)
Rectocele	*n* (%)	5 (11)
Microscopic colitis	*n* (%)	4 (8)
Esophageal disorder	*n* (%)	4 (8)
Celiac disease	*n* (%)	3 (7)
Past GI surgery	*n* (%)	20 (17)
Anorectal tract	*n* (%)	11 (55)
Ileocecal resection	*n* (%)	7 (35)
Gastro-esophageal tract	*n* (%)	2 (10)
Hypothyroidism	*n* (%)	20 (17)
Neurological condition	*n* (%)	9 (8)
Diabetes	*n* (%)	8 (7)
Myopathy	*n* (%)	3 (3) (*n* = 117)
Medication		
Laxatives	*n* (%)	36 (31)
Anticholinergics	*n* (%)	9 (8)
Opioids	*n* (%)	7 (6)
Antidiarrheals	*n* (%)	7 (6)
Prokinetics	*n* (%)	4 (3) (*n* = 118)

IBS, Irritable bowel syndrome; IBD, Inflammatory bowel disease.

who never experienced vaginal delivery. In this analysis of solely female, age was only associated with rectal compliance ($\beta = 0.05$ mL mmHg^{-1} year^{-1}; $P = 0.002$) but not the volume at first defecation urge or the maximum tolerable volume (Table 3).

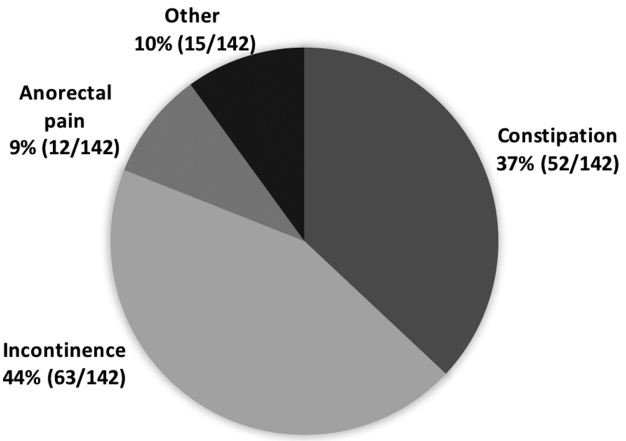

Figure 1. Distribution (in %) of indications of anorectal manometry performed by high-resolution manometry (HRM) at our digestive motility clinic from January 2016 to May 2019.

Effect of Manometry Indications on Anorectal Physiological Parameters

Indications of manometry were correlated with certain physiological parameters. Patients referred for incontinence had lower maximum squeeze pressure ($\beta = -39.2$ mmHg, $P = 0.001$) while still presenting a manometric result defined as normal versus individuals who endured an anorectal manometry for another indication. Incontinence was also associated with lower compliance ($\beta = -1.9$ mL mmHg^{-1} year^{-1}, $P = 0.04$). The patients suffering from constipation at the time of the manometry presented, while remaining within the normal values, a higher mean endurance squeeze pressure ($\beta = 16.4$ mmHg, $P = 0.06$) than the others (Table 3).

Discussion

The aim of this study was to investigate the effect of age on anal physiological parameters measured in HRM on a large cohort of patients with a wide age spectrum and comorbidities. Here, we have shown that age has a significant impact on physiological digestive parameters. The main analysis of this study also supports that rectal sensation and rectal compliance are modified with age.

We chose to exclude all patients with abnormal HRM in order to minimize the effect of pathological anomalies and therefore increase the focus on physiological anorectal variations. Parity, vaginal delivery and medical and surgical comorbidities were carefully reviewed and controlled for as those factors have been shown to have a potential effect on anorectal motility (3). Since the patients included in this study were not asymptomatic volunteers, this differs from other studies on the subject. We believe that this approach makes our results more easily applicable from a clinical point of view, since the general population undergoing HRM generally exhibits gastrointestinal

Table 3. Effect of age, sex and comorbidities on anorectal pressures, rectal sensory thresholds and rectal compliance

Parameter	Age	Female sex	IBS	IBD	Rectocele	Anorectal surgery	Diabetes	Hypothyroidism	Incontinence	Constipation	Rectal pain	Overall model
MRP	-[‡]	-[‡]	β= −8.3 P = 0.12	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	--[‡]	-[‡]	F (1,114) = 2.5Adj. R^2 = 0.012 P = 0.12
MCP	-[‡]	β= −17.9P = 0.06	β=24.8 P=0.07	-[‡]	-[‡]	-[‡]	-[‡]	β= −20.0P = 0.09	-[‡]	-[‡]	-[‡]	F (3,101) = 3.7Adj. R^2 = 0.073 P = 0.01
MSP	-[‡]	β= −61.8P < 0.001	-[‡]	-[‡]	β= −41.2P = 0.16	-[‡]	-[‡]	β= −27.6P = 0.08	β= −39.2P = 0.001	-[‡]	-[‡]	F (4,109) = 10.4Adj. R^2 = 0.25 P < 0.001
MESP	-[‡]	β= −44.2P < 0.001	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	β= −18.0P = 0.11	-[‡]	β= 16.4P = 0.06	β= 21.9P = 0.12	F (4,112) =9.0Adj. R^2 = 0.22 P < 0.001
DES	-[‡]	β= 1.39P = 0.004	-[‡]	-[‡]	β= −2.48P = 0.04	-[‡]	β= −2.54P = 0.003	-[‡]	β= 1.5P = 0.04	β= 1.6P = 0.03	β= 2.0P = 0.04	F (6,105) = 5.2Adj. R^2 = 0.18 P < 0.001
VFP	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	Adj. R^2 = 0
PFP	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	Adj. R^2 = 0
VFD	β= 0.39P = 0.05	β= −16.7P = 0.02	-[‡]	-[‡]	-[‡]	-[‡]	β= -18.8P = 0.13	-[‡]	-[‡]	-[‡]	-[‡]	F (3,112) =3.9Adj. R^2 = 0.07 P = 0.01
PFD	-[‡]	-[‡]	-[‡]	-[‡]	β= 55.9P = 0.002	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	F (1,104) =10.4 Adj. R^2 = 0.08 P = 0.002
MTV	β= 0.48P = 0.043	β= −16.1P = 0.046	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	F (2,111) = 4.4Adj. R^2 = 0.06 P = 0.02
MTP	-[‡]	-[‡]	-[‡]	-[‡]	β= 61.3P = 0.01	β= −20.9P = 0.15	-[‡]	β= −17.2P = 0.12			β= 28.5P = 0.03	F (4,99) = 3.8Adj. R^2 = 0.10 P = 0.007
Compliance	β= 0.04P = 0.02	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	-[‡]	β= 1.65P = 0.03	β= −1.9P = 0.04	β= −1.6P = 0.1	β= −2.1P = 0.07	F (5,98) = 3.7Adj. R^2 = 0.12 P = 0.004

DES, Duration of endurance squeeze; MCP, Maximum cough pressure; MESP, Mean endurance squeeze pressure; MRP, Mean resting pressure; MSP, Maximum squeeze pressure; MTV, Maximum tolerable volume; MTP, Maximum tolerable pressure; PFP, Pressure at first perception; PFD, Pressure at first defecation urge; VFD, Volume at first defecation urge; VFP, Volume at first perception.

[‡]Eliminated by variable selection process.

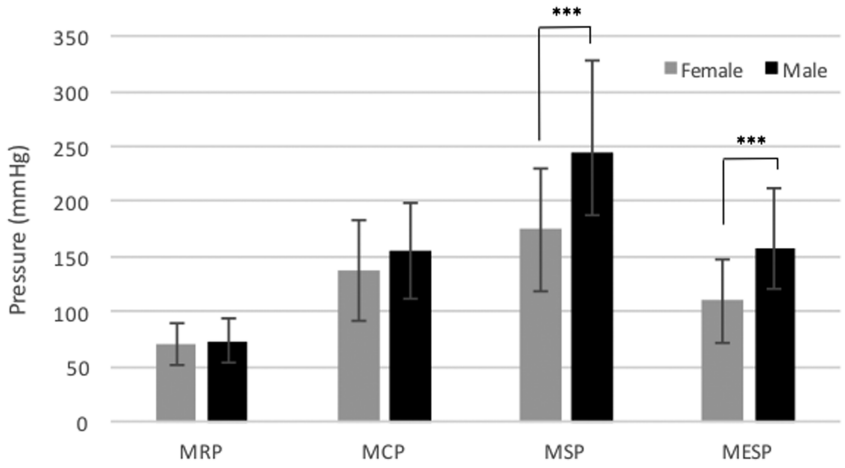

Figure 2. Median values for mean resting pressure (MRP), maximum cough pressure (MCP), maximum squeeze pressure (MSP) and mean endurance squeeze pressure (MESP) in male versus female patients. ***$P < 0.001$.

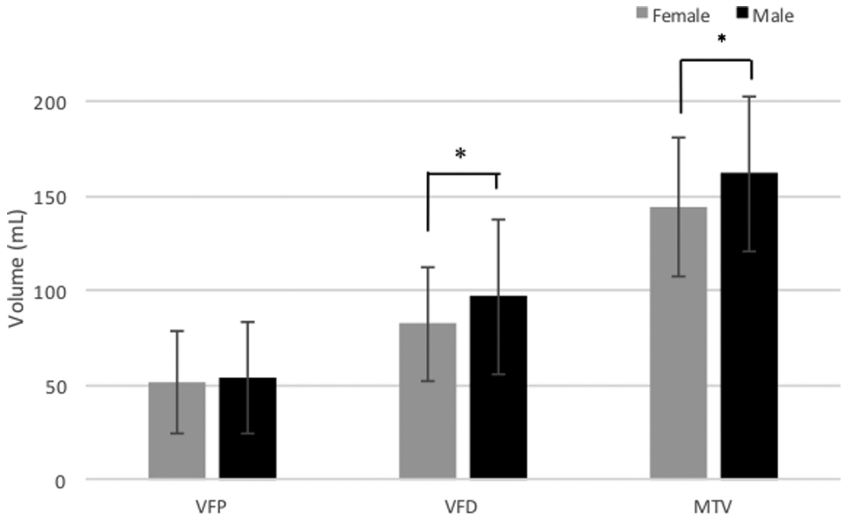

Figure 3. Mean values for volume at first perception (VFP), volume at first urge of defecation (VFD) and maximum tolerable volume (MTV) in male versus female patients. *$P < 0.05$.

symptoms and multiple medical comorbidities. Some might argue that these patients might still have different manometric parameters values than the general asymptomatic population. The indications of manometry indeed modified to a certain extent the manometric parameters, as patients who were referred for incontinence had lower maximum squeeze pressure and patients with constipation had higher mean endurance squeeze pressure while still remaining within the values considered normal for these manometric parameters. However, by including the manometric indications in the analysis model, this impact on physiological anorectal parameters was controlled for and allowed to isolate more precisely the effect of age, sex and the various comorbidities on anorectal manometry parameters.

The HRM indications in our study were similar to what has been previously described in the literature (9,15) further confirming the external validity of our study. Indeed, more than 80% of the patients in our study underwent HRM to evaluate a history of constipation and incontinence.

Aging modified rectal sensory thresholds in our study; a positive correlation was demonstrated between age and maximum tolerable volume and there was a nearly significant relationship between age and volume at first urge of defecation, even when adjusting for sex and history of hypothyroidism, past gastrointestinal medical or surgical history. It has been previously demonstrated that anal sensation appears to be impaired with age (16,17) and Lagier et al. even compared rectal sensory thresholds between two extreme age groups and found a statistical difference (18). Our finding of increased volume at first urge of defecation and increased maximum tolerable volume in the elderly can probably be attributed to reduced rectal sensation and decreased perception of distension with age. Age-associated alterations in neuronal pathways and a

possible reduction in the enteral neuronal population in the digestive tract with increasing age are likely pathophysiological mechanisms which underlie these relationships, as has been previously demonstrated (3,19,20). Koch et al. demonstrated in a study on anorectal inhibitory innervation an age-related decrease in inhibitory junction potentials, and therefore a potential modification in the inhibitory pathway of the smooth anorectal muscle membrane (20). Thus, the elderly patient may not recognize the need for defecation and is therefore potentially predisposed to fecal impaction and fecal incontinence by overflow.

Age was also associated with higher rectal compliance. The existing literature has reported conflicting results concerning the impact of age on this manometric parameter. Rao et al. demonstrated that in healthy adults, rectal compliance was not associated with age (9) while Bannister et al. reported that age was associated with lower rectal compliance (10). The latter hypothesized that rectal compliance was impaired with age due to possible loss of tissue elasticity and fibrosis occurring in the elderly. Although fibrotic changes may occur with age, the effect described above on damage to the nerve fibers could potentially explain the increase in tolerable volume and therefore an increase in rectal compliance. This discrepancy between our study and Bannister et al.'s can potentially be explained by the HRM technique used; Bannister et al.'s study was performed with conventional HRM which potentially has more difficulty assessing rectal sensation as precisely. Nonetheless, in our study, age was associated with higher rectal compliance and this could potentially explain an increased tendency for fecaloma formation in the elderly, since more volume is tolerated with the same rectal pressure.

The effect of sex on anorectal physiological parameters was also analyzed. Interestingly, female had lower maximal and mean endurance squeeze pressures than men. The coughing pressure was also lower in female. These findings confirm previous findings (10,11). The squeeze pressure represents the strength of the external anal sphincter muscle which is mainly constituted of striated muscle; it has been hypothesized that males have higher squeeze pressures because of the positive effect of testosterone on the striated muscle (7). We can thus hypothesize that hormonal factors may play a role in modulating these sexual differences.

In our study, sex also had an effect on rectal sensation; female had a lower first urge of defecation volume and a lower maximum tolerable volume. Data regarding sexual differences in anorectal sensation parameters are sparse. The majority of publications to date suggest no differences between sexes (2,18) but these studies had very small sample sizes. One study however, Sun et al. (21), reported that males tolerated higher volumes until urgency occurred as did our study. It is however difficult to interpret those results as balloon distension can produce very variable results, depending on the type and speed of inflation as well as the shape and type of balloon (22). However, this impairment could be a potential explanation for the increased prevalence of fecal incontinence in older females (22).

When analyzing the effect of sex on manometric parameters, an evaluation of the impact of parity and vaginal delivery is necessary as these may contribute to observed sexual differences. Our study found that a history of vaginal birth is significantly associated with a lower tolerable maximum pressure. To our knowledge, the effect of vaginal birth on anorectal function has not yet been formally studied in anorectal HRM. Ryhammer et al. demonstrated that parity contributes to increase perineal descent during strain (8) but no other study has specifically looked at the functional impairment caused by vaginal trauma. We hypothesize that this functional impairment is likely secondary to damage caused by vaginal delivery to the neurological pathways associated with anorectal sensation and motor function (23). One might argue that these results must be interpreted with caution, given the potential bias coming from the fact that information on parity and vaginal delivery had potentially been more questioned in women with fecal incontinence than in participants referred for another indication. However, the inclusion of manometry indications in the statistical model makes it possible to control for this potential bias.

In the particular subgroup of women that was created in order to analyze the effect of pregnancy, age was not associated with volume at first defecation urge and maximum tolerable volume. It is unclear why these relationships were not seen in female patients; it may reflect a lack of statistical power given the smaller sample size of this subgroup.

Regarding gastro-intestinal comorbidities, patients with a prior history of rectocele had statistically different manometric parameters than others. With other variables controlled for, patients with this condition presented with higher rectal pressure at first defecation urge and maximum tolerable sensation. Few studies have been published on the impact of rectocele on HRM parameters. Rotholz et al. described that, retrospectively, patients with rectocele had higher first sensation volume and higher compliance (24). Our study also confirms what has been previously stated in a prospective study performed on male subjects, demonstrating that higher resting pressures were present in patients with rectocele (25). A possible explanation would be non-relaxation and dysfunction of the puborectalis muscle.

It is known that thyroid imbalance can cause gastrointestinal dysfunction (26), but the effect of disordered thyroid metabolism on anorectal function is poorly understood. In our study, hypothyroid patients, when controlling for age, sex and gastrointestinal comorbidities, demonstrated higher rectal compliance. This result is in agreement with a study published two

decades ago evaluating anorectal manometric parameters in hypothyroid females. Indeed, Deen et al. demonstrated that the threshold sensation for impending evacuation in hypothyroid patients was significantly higher than controls, which could potentially be extrapolated as greater rectal compliance (27). The mechanisms underlying this relationship remain unclear since we assume that patients with a history of hypothyroidism were, at the time of the manometry, on a supplementation therapy for their thyroid gland. Alterations in the brain-gut axis caused by dysthyroidism have been suggested as a possible explanation by previous authors (27), and further studies are needed to determine whether the possible alteration induced by this hormone on anorectal function is actually perpetuated even when hypothyroidism is resolved.

Certain limitations were inevitable in this study. Inherent to the fact that this study is retrospective, several sociodemographical and clinical variables were missing when reviewing medical files, therefore limiting the analyses that could be done. Furthermore, all patients included in this study presented to a certain extent gastrointestinal symptoms which led to a referral for an anorectal HRM. Some may question whether our findings represent a true physiological 'normalcy' for these parameters. Manometric indications indeed modified some manometric parameters as noted above but the influence of incontinence, constipation or anorectal pain in our patients on the various manometric parameters was controlled for and allowed to minimize this potential bias. In addition, we believe that this makes our results much more applicable to a clinical reality in which anorectal manometries are rarely performed in asymptomatic volunteers. We also tried to minimize this effect by controlling for different medical conditions and past anorectal trauma. A highlight of this study is our large sample size of patients and very broad age spectrum. We were also able to evaluate a considerable number of manometric variables in relation to pertinent factors, some of which, like vaginal birth, had never been specifically studied before.

In summary, these findings establish that age influences anorectal physiological parameters measured by HRM in both men and female. Age is independently associated with altered rectal sensation and compliance. Sex also seems to influence anorectal function and sensation. These alterations occurring with aging may explain the increased prevalence of fecal incontinence in female and in the elderly. Vaginal birth also seems to impair the anorectal function. These results are applicable in clinical practice and should be taken into consideration when interpreting HRM in the elderly. Further studies are needed to standardize the HRM technique and establish references according to age and sex-related values.

Conflict Of Interest

All of the authors have no interest to disclose.

Author Contributions

G.J. and M.B. designed the research study; E.N. performed anorectal manometries; E.A. and G.J. collected data; G.J., G.W. and M.B. performed statistical analysis; G.J., G.W. and M.B. wrote the manuscript.

Data Availability

The sociodemographic, clinical data and manometric parameters compiled in a database to support this study are in possession of the main author and are available upon request.

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