Manometric and ultrasonographic characteristics of patients with coexisting fecal incontinence and constipation

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Abstract

Background : **The treatment of fecal incontinence (FI) depends upon the dominant pathophysiology: impaired sphincter contractility or overflow due to pelvic floor dyssynergia and insufficient rectal emptying. In this study, we aimed to define the manometric and anorectal ultrasound characteristics in FI patients with and without constipation.**

Methods : **We did a retrospective study of 365 anal manometries, performed between October 2012 and July 2015, in patients with FI. Clinical information was obtained from questionnaires. In 220 of these patients an anorectal ultrasound was also available.**

Key results : **A high prevalence of self-reported constipation was seen in the total population of FI patients (66%). This number was lower (31%) when Rome IV criteria were applied. A very high percentage of manometric pelvic floor dyssynergia was seen in the total population with FI (81%). However, patients with FI and constipation did not show pelvic floor dyssynergia more often than patients without constipation. Anal resting pressure, squeeze pressure and anorectal pressure sensitivity were not different when comparing patients without and with constipation. The prevalence of a functional defecation disorder (FDD) in our study population of FI patients was 20%. Wexner score in this subgroup was lower compared with patients without FDD. Anal sphincter defects were more prevalent in women than men, and were associated with diminished sphincter contractility.**

Conclusion and inferences **: A very high percentage of FI patients showed manometric pelvic floor dyssynergia. The coexistence of fecal incontinence and constipation did not increase this percentage.**

Key messages **– Constipation is a frequent and underestimated cause of FI. A correct diagnosis has a major impact on treatment. – We aimed to characterize the manometric and transrectal ultrasound profile of FI patients with and without signs of coexisting constipation. – A very high percentage of incontinent patients showed pelvic floor dyssynergia, however no significant difference between the group with and the group without constipation was seen. Anal resting pressure, squeeze pressure and anorectal pressure sensitivity did not differ significantly either.**

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Introduction

Fecal incontinence (FI) can be defined as the recurrent uncontrolled passage of fecal material for at least 1 month's duration in an individual with a developmental age of at least 4 years (1). The reported prevalence estimates vary depending upon the definition used and the study population. Prevalence ranges from 7% to 15% in community-dwelling women and 18% to 33% in hospitals. The prevalence is either comparable or lower in men than in women (2). Most patients are reluctant to mention this condition to a healthcare provider, so it should be actively questioned by the treating physician and is presumably significantly underestimated.

FI is often multifactorial and occurs in conditions that cause diarrhea, impair colorectal storage capacity, and/or weaken the pelvic floor (3). Therefore, it is more appropriate to focus on associated conditions, especially when they precede the onset of FI, and on risk factors for FI (3). The contribution of obstetric sphincter damage is probably overestimated (4,5).

Most patients with FI have reduced anal sphincter resting and/or squeeze pressures, reflecting a motoric deficit (4). The contribution of sensory dysfunction is harder to determine and therefore probably underestimated. Rectal hypersensitivity may lead to urgency and therefore 'active incontinence'. Rectal hyposensitivity can lead to impaired defecation, fecal retention and 'overflow incontinence'. Excessive straining due to pelvic floor dyssynergia (i.e. paradoxical pelvic floor contraction during straining) may lead to pudendal nerve lesions by excessive perineal descent and thereby to sensorimotor disturbances.

The difference between FI due to anal sphincter weakness or pudendal neuropathy on the one hand and FI due to constipation ('overflow incontinence') on the other hand is not always easy to recognize. A correct differentiation has drastic effects on the therapeutic approach.

Patients with FI due to constipation and overflow benefit from regular emptying of the distal colorectum (e.g. daily osmotic laxatives, regular enemas, colonic retrograde irrigations) (3,6). Alternatively, biofeedback training can ameliorate sphincter relaxation during straining and improve rectal sensitivity, thereby enhancing rectal emptying. On the other hand, patients with sphincter weakness could benefit from medications (e.g. antidiarrheics) or interventions like biofeedback training, sacral nerve stimulation, injectable bulking agents or surgical therapy (e.g. sphincteroplasty, dynamic graciloplasty, artificial anal sphincter) (3,7,8,9).

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The aim of this retrospective study was to identify manometric and anorectal ultrasound parameters which could help to differentiate between FI with and without constipation.

Material and Methods

Data extraction

Data were collected based on the anal manometry records performed between October 2012 and July 2015 in our institution (604 examinations). Prior to the examination, all patients received a questionnaire scoring several clinical parameters: presence of FI (Wexner score), stool frequency, presence of urgency, sense of incomplete rectal emptying, digital manoeuvres etc. Patients in whom there was no information concerning the Wexner score or in whom there was no information concerning stool frequency, sense of incomplete rectal emptying or digital maneuvers were excluded from further analysis. A cutoff Wexner score of at least 3 points was adopted to classify patients as being 'clinically significant fecal incontinent'. In a majority of patients, an anorectal ultrasound was also available.

To make the comparison between patients with 'overflow' FI on the one hand and patients with FI due to other etiologies on the other hand, we first divided the population in 2 groups, based on the presence of functional constipation according to an adaptation of the Rome IV criteria for functional constipation and using the data retrieved from the questionnaire. Patients were included in the functional constipation group if they met at least two of the following three criteria: stool frequency lower than 3 times/week, need for digital fecal evacuation efforts (weekly or daily) and sensation of incomplete rectal emptying (weekly or daily). Because of the retrospective design of our study, we didn't have information about the presence of fecalomas (digital rectal examination).

We then categorized patients as having a 'functional defecation disorder' (FDD) if they met the criteria for functional constipation and at least two of the following criteria: (a) failed balloon expulsion test, (b) impaired relaxation or paradoxical contraction of the anal sphincter or absent or reversed anorectal pressure gradient and (3) impaired rectal evacuation on MR defecography. These criteria were based on the Rome IV criteria for FDD. Patients with FDD were compared with patients without FDD.

Finally, we divided our population in two groups, based on sphincter strength (pressure measured during voluntary contraction of the anal sphincter by anal manometry recording). We defined a normal sphincter strength as a pressure rise of at least 60 mmHg above baseline. Patient characteristics of patients with and without a normal sphincter strength were compared.

Ethics

The study protocol was approved by the institutional ethics committee.

Anal manometry

An 8-channel water-perfused anorectal manometry setup was used (MMS, the Netherlands). The examinations were executed by trained nurses under supervision of one specialized neurogastroenterologist. Normal thresholds for anorectal sensitivity were set at an intrarectal balloon volume of 5-10 mL for 'first sensation' and 20-40 mL for 'first desire to defecate' using a phasic distension protocol. In the continuous distention protocol, a volume of 30-50 mL for 'first sensation' and a volume of 70-150 mL for 'first desire to defecate' were normal thresholds for anorectal sensitivity. A normal resting sphincter tone was situated between 60 and 100 mmHg. A normal sphincter contraction was defined as a pressure rise between 60 and 100 mmHg, while a low sphincter contraction was defined as a maximal pressure rise of < 60 mmHg. Upon straining, normally a short increase in sphincter pressure is noted followed by a relaxation of at least 1/3 of the resting pressure. Absence of relaxation or the presence of pressure rise during straining was categorized as paradoxical contraction.

Anorectal ultrasound

Ultrasound examinations were performed with a rigid linear endorectal probe (Hitachi, Japan), in the left lateral position. A water-filled balloon at the top of the probe served as an acoustic window for the ultrasound waves. The frequency of the ultrasound waves was 5-7 MHz. Defects of the anal sphincter were identified if present. A rectocele was defined as a ventral displacement of the rectal wall over a distance of at least 1 cm during straining to defecate, in comparison with the resting state (10).

Statistical analysis

Data were processed with IBM SPSS Statistics 23. Continuous variables are expressed as mean standard error if they have a Gaussian distribution and as medians with percentiles if otherwise. When interaction between two factors was studied, the non-parametric Mann-Whitney U test was used. The interaction between categorical variables was studied using crosstab analysis completed by a Pearson Chi-square analysis. In all cases a p-value <0.05 was considered statistically significant.

Results

General population characteristics

A total of 493 anal manometry records was studied. Patients in whom there was no information concerning

Table 1. — **Comparison between fecal incontinence patients with and without clinical constipation**

		Without constipation	With constipation	p value
Sex	Female Male n	190 (75.7%) 61 (24.3%) 251	95 (83.3%) 19 (16.7%) 114	P= 0.102
Self-reported constipation	No Yes n	95 (38.4%) 152 (61.5%) 247	27 (23.7%) 87 (76.3%) 114	P< 0.05*
Sphincter defects (ultrasound)	No Yes N	121 (79.6%) 31 (20.4%) 152	49 (72.0%) 19 (27.9%) 68	P= 0.436
Rectocele (ultrasound)	No Yes n	100 (66.2%) 51 (33.8%) 151	40 (59.7%) 27 (40.3%) 67	P = 0.633
Balloon expulsion test	Unsuccesfull Succesfull n	150 (84.8%) 27 (15.2%) 177	65 (75.6%) 21 (24.4%) 86	P= 0.071
Pelvic floor dyssynergia (manometry)	No Yes N	39 (16.4%) 199 (83.6%) 238	25 (22.7%) 85 (77.3%) 110	P= 0.156
Absent/reversed pressure gradient (manometry)	No Yes n	133 (56.1%) 104 (43.9%) 237	55 (50.0%) 55 (50.0%) 110	P= 0.287
Wexner score (points)	Median (Q1-Q3) n	8 (5-12) 251	8 (4-12) 114	P=0.379
Age (years)	Median (Q1-Q3) n	58 (45.5-69) 251	56.5 (46-68) 114	P= 0.742
Sphincter resting pressure, manometry (mmHg)	Median (Q1-Q3) n	64.5 (46-82) 250	63 (44-80) 112	P= 0.539
Sphincter strength, manometry (mmHg)	Median (Q1-Q3) n	53 (33-82) 250	58 (32-87) 114	P= 0.809
Duration of contraction, manometry (sec)	Median (Q1-Q3) n	12.5 (5-28) 128	21 (7.5-28) 71	P= 0.314
1st sensation, phasic protocol manometry (ml)	Median (Q1-Q3) n	10 (5-15) 232	10 (5-15) 101	P= 0.640
Stool urge, phasic protocol manometry (ml)	Median (Q1-Q3) n	32.5 (20-50) 224	35 (25-50) 98	P= 0.431
1st sensation, continuous protocol manometry (ml)	Median (Q1-Q3) n	46 (24-65) 141	48 (29-75) 74	P= 0.411
Stool urge, continuous protocol manometry (ml)	Median (Q1-Q3) n	74 (50-100) 143	81.5 (55.5-104.5) 72	P= 0.377

Interaction between categorical variables was studied using Pearson Chi Square analysis. For continuous variables, the Mann Whitney U test was used. P value < 0,05 was considered to be statistically significant (*).

the Wexner score (n = 16) or in whom there was no information concerning stool frequency, sense of incomplete rectal emptying or digital maneuvers (n = 96) were excluded from further analysis. A cutoff Wexner score of at least 3 points was adopted to classify patients as having 'clinically significant FI' (365 of 493 patients). These 365 patients with FI were included in the final analysis. In 220 of these patients, an anorectal ultrasound was also available. In 64 patients an MR defecopraphy was available. Seventy-eight % of our 365 patients was female, 22 % was male. The median age of the total population with FI was 58 years. The median Wexner score was 8 points (4-12). When patients were asked about the presence of constipation, 66% of patients mentioned to have constipation problems 'now and then' or 'often'.

Fecal incontinence in patients with or without coexisting constipation

Thirty-one % of the FI patients was classified as having functional constipation, while 69% of the patients didn't fullfill our criteria. These two groups of patients were compared for various clinical, manometric and ultrasonographic features (Table 1). Median Wexner score was comparable between the two groups. Patients with coexisting functional constipation were more often female than patients without functional constipation, but this difference was not statistically significant (p = 0.10). Anal resting pressure and squeeze pressure were not different when comparing patients without and with functional constipation. Likewise, anorectal pressure sensitivity did not differ between the two groups,

Table 2. — **Comparison between fecal incontinence patients with and without functional defecation disorder (FDD)**

		Without FDD	With FDD	p value
Sex	Female Male n	203 (76.9%) 61 (23.1%) 264	43 (78.2%) 12 (21.8%) 55	P=0.836
Self-reported constipation	No Yes n	96 (36,9%) 164 (63.1%) 260	14 (25.4%) 41 (74.5%) 55	P=0.105
Sphincter defects (ultrasound)	No Yes n	127 (78.9%) 34 (21.1%) 161	22 (75.9%) 7 (24.1%) 29	P=0.494
Wexner score (points)	Median (Q1-Q3) n	8 (5-12) 264	6 (4-11) 55	P<0.05*
Age (years)	Median (Q1-Q3) n	58 (46-69) 264	52 (46-65.5) 55	P= 0.106
Sphincter resting pressure, manometry (mmHg)	Median (Q1-Q3) n	64 (45-82) 262	64 (44-79) 54	P=0.606
Sphincter strength, manometry (mmHg)	Median (Q1-Q3) n	54 (33.5-82.5) 263	58 (33-87.5) 55	P=0.882
Duration of contraction, manometry (sec)	Median (Q1-Q3) n	13 (5-27) 137	21 (5.5-29) 43	P=0.368
1st sensation, phasic protocol manometry (ml)	Median (Q1-Q3) n	10 (5-15) 243	10 (5-10) 49	P=0.389
Stool urge, phasic protocol manometry (ml)	Median (Q1-Q3) n	35 (20-50) 235	30 (20-50) 47	P=0.764
1st sensation, continuous protocol manometry (ml)	Median (Q1-Q3) n	45.5 (24-67) 150	42 (25-65.5) 43	P=0.895
Stool urge, continuous protocol manometry (ml)	Median (Q1-Q3) n	74 (50-100) 151	81.5 (55-118) 42	P=0.471

Interaction between categorical variables was studied using Pearson Chi Square analysis. For continuous variables, the Mann Whitney U test was used. P value < 0,05 was considered to be statistically significant (*).

neither for first sensation of rectal filling (continuous distention), nor for the desire to defecate.

Patients with coexisting functional constipation did not show impaired anal sphincter relaxation upon a straining effort more often compared to patients without it (Table 1). It should be noted that the presence of pelvic floor dyssynergia in the total FI population was very high (81%). The same high percentage was seen with the balloon expulsion test, which was unsuccessful in more than 81% of FI patients. There was no significant difference in the presence of rectocele between patients without and with functional constipation, not on anorectal ultrasound nor on MRI (Table 1). There was no significant difference in the presence of anal sphincter defects, examined with anorectal ultrasound (Table 1).

Fecal incontinence in patients with and without a functional defecation disorder

The study group was then divided in two groups, based on the presence of a Functional Defecation Disorder (FDD), derived from the Rome IV criteria for FDD, as cited above. Fifty-five patients fulfilled these criteria, so the prevalence of FDD in our functional constipation group was 48 % (55 of 114 patients); the prevalence in the total FI population was 15 % (55 of 365 patients). It is important, however, that there was no balloon expulsion test available in 102 patients, and in 6 patients there was no information concerning anorectal pressure gradient nor pelvic floor contraction pattern. Furthermore, MR defecography results were only available in 64 patients, limiting the number of patients fulfilling the criteria. When only patients were included with results of at least two (of the three) defining examinations, the prevalence of FDD rose to 20% (55 of 274 patients). When only patients were included with results of all three defining examinations, the prevalence of FDD rose to 30% (15 of 49 patients). Patients with FDD had a lower Wexner score compared with patients without FDD (median score 6 points (4-11) vs. 8 points (5-12), $p<0.05$). When we compared constipated FI patients with and without FDD, we observed that patients with FDD were significantly younger than the patients without FDD (median age 52 years (46-65.5) vs. 64 years (57-73), $p < 0.05$).

Fecal incontinence in patients with or without normal sphincter contractility

Patients with FI were divided in two groups based on external anal sphincter strength (pressure increase measured during voluntary contraction of the anal

Table 3. — **Comparison between fecal incontinence patients with and without sphincter insufficiency**

		Without sphincter insufficiency	With Sphincter insufficiency	p value
Sex	Female Male n	105 (64.4%) 58 (35.6%) 163	180 (89.5%) 21 (10.5%) 201	P< 0.05*
Self-reported constipation	No Yes n	51 (31.7%) 110 (68.3%) 161	70 (35.2%) 129 (64.8%) 199	P= 0.339
Clinical constipation	No Yes n	109 (66.9%) 54 (33.1%) 163	141 (70.1%) 60 (29.8%) 201	P= 0.502
Sphincter defects (ultrasound)	No Yes n	86 (89.6%) 10 (10.4%) 96	83 (67.5%) 40 (32.5%) 123	P< 0.05*
Balloon expulsion test	Unsuccesfull Succesfull n	101 (84.2%) 19 (15.8%) 120	113 (79.6%) 29 (30.4%) 142	P= 0.339
Pelvic floor dyssynergia (manometry)	No Yes n	31 (19.7%) 126 (80.2%) 157	33 (17.4%) 157 (82.6%) 190	P= 0.570
Absent/reversed pressure gradient (manometry)	No Yes n	76 (40.1%) 83 (53.2%) 159	112 (59.9%) 75 (47.8%) 187	P< 0.05*
Age (years)	Median (Q1-Q3) n	56 (44-67) 163	59 (47-70) 201	P= 0.087
Sphincer resting pressure, manometry (mmHg)	Median (Q1-Q3) n	67 (51-87) 162	61 (41-79.5) 199	P< 0.05*

Interaction between categorical variables was studied using Pearson Chi Square analysis. For continuous variables, the Mann Whitney U test was used. P value < 0,05 was considered to be statistically significant (*).

Table 4. — **Comparison between fecal incontinence patients with and without sphincter defects (diagnosed by anorectal ultrasound)**

		Without sphincter defect	With sphincter defect	p value
Sex	Female Male n	123 (71.1%) 47 (100%) 170	50 (28.9%) 0 (0.0%) 50	P< 0.05*
Childbirth	No Yes n	29 (96.7%) 92 (65.2%) 121	1 (3.3%) 49 (34.7%) 50	P< 0.05*
Wexner score (points)	Median (Q1-Q3) n	7.5 (4-11) 170	11.5 (8-15) 50	P< 0.05*

Interaction between categorical variables was studied using Pearson Chi Square analysis. For continuous variables, the Mann Whitney U test was used. P value < 0,05 was considered to be statistically significant (*).

sphincter). In patients with normal sphincter strength, the prevalence of 'functional constipation' was 33.1%. Male FI patients more often had normal sphincter strength compared to female patients (Table 3). When we looked at significant anal sphincter defects on anorectal ultrasound, we saw a higher prevalence of sphincter defects in the patient group with a diminished sphincter strength (32% compared to 10% of patients, p = 0.001). There is an obvious association between the presence of significant anal sphincter defects and gender; in 28.9% of women, a sphincter defect was seen, while none was seen in the male subjects. We also observed that childbirth is a risk factor for anal sphincter defects (p = 0.002). No correlation was seen between sphincter defects and the number of childbirths. The presence of a sphincter defect is associated with more severe FI, manifesting as a higher Wexner score (Table 4). Older age seems to be a risk factor for diminished sphincter strength (p = 0.087); the median age of patients with normal sphincter strength was 59 years (47-70), the median age of patients with a diminished sphincter strength was 56 years (44-67). Patients with a normal sphincter strength more often had an inadequate anorectal pressure gradient (absent or reversed gradient) on anorectal manometry during straining (52% vs. 40% in patients with a diminished sphincter strength, p = 0.024).

Discussion

Traditionally the pathophysiology of FI patients is attributed to sphincter insufficiency, and treatment is focused at restoring sphincter strength. An important subgroup of FI patients however has normal sphincter contractility (44.8% in our series). Especially in these patients the coexistence of constipation and/or a defecation disorder should be looked for, as overflow incontinence could be the real problem. In our

series, 33.1% of FI patients had coexisting functional constipation (according to our adapted criteria). FI due to constipation requires a distinct medical and physiotherapeutic approach, where the goal is to optimize rectal emptying, thereby reducing overflow and involuntary loss of stool (11). The exact prevalence of overflow incontinence is unclear, as the phenomenon is underrecognized by primary care physicians and even gastroenterologists. In the general adult population, the coexistence of constipation and FI is unknown, though given their overall prevalence (~15% and 4-9%, respectively) overlap is likely considerable (12). There is a lack of guidelines to establish the diagnosis and to guide therapy.

Our study population was created by collecting the anal manometry records of patients with a Wexner score > = 3. The presence of overflow incontinence was suspected when patients had clinical features of coexisting constipation according to the aforementioned criteria derived from the Rome IV criteria for functional constipation. When FI patients were asked about the presence of 'constipation', up to 66% of them reported to have it 'now and then' or 'often'. When applying our criteria for functional constipation, this number fell to 31%, which is probably still an underestimate due to the retrospective nature of the study.

When comparing FI patients with and without constipation, no manometric differences were found in sphincter strength between both groups. Lifetime excessive straining during defecation can provoke pudendal neuropathy and pelvic floor weakness, finally resulting in FI. Indeed, Tantiphlachiva et al identified sphincter weakness in 38% of patients with dyssynergic defecation (13). This could provide a rationale for the combination of dyssynergic defecation and sphincter weakness, and explain the frequency of motoric insufficiency in our group of constipated patients.

We detected no significant difference in anorectal pressure sensitivity between patients with and without constipation. Both rectal hypo-and hypersensitivity have been reported in patients with FI (14). This observation could be related to the coexistence of different etiological factors in FI (e.g. sphincter weakness versus overflow incontinence), and the lack of prospective data in our study. An additional explanation could be that all sensory stimuli in our protocols were provided by isovolumetric distension of an intrarectal balloon. Although a traditional method, the variability in rectal volumes between patients is negated using this method. This is of importance, as a subset of patients with dyschezia will develop a megarectum and will hence require greater balloon volumes to elicit a similar stimulus. Ideally, isobaric rather than isovolumetric distensions are performed using a Barostat® device, which was not available during the observation period.

Pelvic floor dyssynergia, where the anal sphincter fails to relax or even contracts during straining, provokes incomplete rectal evacuation, fecal retention and potentially overflow incontinence (15). In our study, patients with coexisting FI and functional constipation did not show pelvic floor dyssynergia more often compared to FI patients without constipation. 81% of the total study population (including patients without constipation) showed pelvic floor dyssynergia. An equally high percentage of failed BET was seen here (81%), but no significant difference between the two groups could be demonstrated. An explanation could be the fact that straining during a manometric exam is performed in the left lateral position rather than in the more natural sitting position, which makes a representative straining maneuver challenging even for people with normal defecation. Indeed, more than 20 % of normal subjects will show a paradoxical contraction during manometry performed in the left lateral position (16). Moreover, many FI patients with sphincter insufficiency will automatically contract their sphincter during a straining effort in an exam room, for fear of fecal spilling in the presence of the examiner. Finally, the BET is a useful screening test for FDD, but it does not define the mechanism of disordered defecation. After all, the balloon does not reliably mimic the patients' stool (3). In summary, manometric straining does not always reflect the patient's normal defecation process and should always be interpreted with caution and in combination with other techniques.

In a second analysis we divided our study population in two groups, based on the presence of a FDD. Since symptoms do not consistently distinguish patients with FDD from those without, the Rome IV criteria for FDD rely on both symptoms and physiological testing (3). The prevalence of FDD in our total FI population was 20%. This number is probably an underestimation as well, because of patient selection criteria (vide infra). Furthermore, a significant part of the study population underwent only one of the three required tests. The Wexner score in patients with FDD was significantly lower than in those without FDD (two points), suggesting that fecal loss in overflow incontinence occurs less frequently than in patients with sphincter insufficiency. Finally, we saw that constipated FI patients with FDD were significantly younger than constipated FI patients not fulfilling criteria for FDD.

In a third analysis FI patients were classified according to external anal sphincter strength. A cutoff of 60 mmHg was considered as 'normal' sphincter strength. Since the external anal sphincter represents (along with the puborectal muscle) the voluntary component of fecal continence (17), patients with insufficient sphincter strength probably reflect an 'active incontinence' problem. In the rest of FI patients, there could be more arguments for coexisting constipation and 'overflow incontinence', though this seems to be an oversimplification. Indeed, we didn't find a significant correlation between sphincter strength and self-reporting of constipation symptoms nor between sphincter strength and our definition of functional constipation or FDD.

We observed that childbirth is a risk factor for anal sphincter defects. An important observation was also that the presence of a sphincter defect was associated with more severe FI, as evidenced by as a higher Wexner score. In line with this observation, a higher prevalence of sphincter defects (diagnosed by anorectal ultrasound) was seen in the patient group with a lower sphincter strength.

The retrospective nature of our study implies several important weaknesses. In clinical practice, a careful anamnesis and physical examination are of major importance tackling a problem of fecal incontinence. In our study we could only take three of the six defining criteria of the Rome IV criteria for functional constipation into account, which could explain some of the observations we made. In addition, since a significant part of our study population was referred from other hospitals, information about medication use (laxatives, enemas) and systematic results about a digital rectal examination (DRE) were not available. Nonetheless, the latter can be a very useful screening test, assessing sphincter control and rectal filling status.

In conclusion, we observed that a considerable percentage of patients with FI had clinical arguments for constipation, which could provoke incomplete rectal evacuation, fecal retention and overflow incontinence. More than 80% of incontinent patients showed pelvic floor dyssynergia on anorectal manometry irrespective of the presence of constipation. The median Wexner score in patients with FDD is lower than in patients without FDD. Finally, the presence of a sphincter defect on anorectal ultrasound was associated with more severe FI, manifesting as a higher Wexner score.

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Author contribution

CP en KVM performed the data extraction. MS en WV analyzed the data. MS and HDS designed the study and analyzed the results. MS en HDS wrote the paper. All authors read, commented and approved the final version of this paper

References

1. WHITEHEAD W.E., WALD A., NORTON N.J. Treatment options for fecal incontinence. *Dis. Colon. Rectum*, 2001, **44** : 131-142 ; discussion 142-144.
2. RAO S.S.C. Advances in diagnostic assessment of fecal incontinence and dyssynergic defecation. *Clin. Gastroenterol. Hepatol*., 2010, **8** : 910-919.
3. RAO S.S.C., BHARUCHA A.E., CHIARIONI G., *et al.* Anorectal Disorders. *Gastroenterology*, 2016, **150** : 1430-1442.
4. BHARUCHA. Management of fecal incontinence. *Gastroenterol. Hepatol. (NY)*, 2008 Nov, **4**(11) : 807-817.
5. MELVILLE J.L., FAN M.Y., NEWTON K. Fecal incontinence in US women: a population-based study. *Am. J. Obstet. Gynecol*., 2005, **193** : 2071-2076.
6. KOCH S.M.P., RIETVELD M.P., GOVAERT B., *et al*. Retrograde colonic irrigation for faecal incontinence after low anterior resection. *Int. J. Colorectal Dis*., (2009) **24** : 1019-1022.
7. HEYMEN S., SCARLET Y., JONES K., *et al*. Randomized controlled trial shows biofeedback to be superior to alternative treatments for patients with pelvic floor dyssynergia-type constipation. *Dis. Colon. Rectum*, 2007, **50** : 428-441.
8. MOWATT G., GLAZENER C., JARRETT M. Sacral nerve stimulation for fecal incontinence and constipation in adults: a short version Cochrane review. *Neurourol. Urodyn*., 2008, **27** : 155-165.
9. RAO S.S.C. Current and Emerging Treatment Options for Fecal Incontinence. *J. Clin. Gastroenterol*., 2014, **48** : 752-764.
10. VAN OUTRYVE S.M., VAN OUTRYVE M.J., DE WINTER B.Y., *et al.* Is anorectal endosonography valuable in dyschesia? *Gut*, 2002, **51** : 695-700.
11. QURESHI M.S., RAO M.M., SASAPU K.K., *et al.* Male faecal incontinence presents as two separate entities with implications for management. *Int. J. Colorectal. Dis*., 2011, **26** : 1589-1594.
12. NURKO S., SCOTT S.M. Coexistence of constipation and fecal incontinence in children and adults. *Best Pract. Res. Clin. Gastroenterol*., 2011, **25**(1) : 29-41.
13. TANTIPHLACHIVA K., RAO P., ATTALURI A., *et al*. Digital rectal examination is a useful tool for identifying patients with dyssynergia. *Clin. Gastroenterol. Hepatol*., 2010, **8** : 955-960.
14. SCOTT S.M., VAN DEN BERG M.M., BENNINGA M.A. Rectal sensorimotor dysfunction in constipation. *Best Pract. Res. Clin. Gastroenterol*., 2011, **25** : 103-118.
15. CROWELL M.D., LACY B.E., SCHETTLER V.A., *et al.* Subtypes of anal incontinence associated with bowel dysfunction : clinical, physiologic, and psychosocial characterization. *Dis. Colon. Rectum*, 2004, **47** : 1627-1635.
16. VODERHOLZER W.A., NEUHAUS D.A., KLAUSER A.G., *et al*. Paradoxical sphincter contraction is rarely indicative of anismus. *Gut*, 1997, **41** : 258-262.
17. SUN W.M., READ N.W., MINER P.B. Relation between rectal sensation and anal function in normal subjects and patients with fecal incontinence. *Gut,* 1990 , **31** : 1056.