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ORIGINAL ARTICLE

Frequency, spectrum, and factors associated with fecal evacuation disorders among patients with chronic constipation referred to a tertiary care center in northern India

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Abstract
Background Data on fecal evacuation disorder (FED) causing chronic constipation (CC) is scanty in India.
Methods Prospectively maintained data of 249 consecutive patients with CC (Rome III) referred for investigations were retrospectively analyzed.
Results Of 249 patients (43.7 ± 16.2 years, 174 males), 135/242 (55.8 %), 57/249 (22.9 %), and 83/136 (61.0 %) had abnormal balloon expulsion test (>200 g), anorectal manometry [>100 mmHg resting pressure ($n = 4$), >167 mmHg squeeze pressure ($n = 46$), and both ($n = 7$)], and defecography (anorectal angle not opening by >15° during defecation, perineal descent ≥4 cm, and/or rectocele), respectively. Though 181/249 (72.6 %) had one test abnormality, 86/249 (34 %) had FED (greater than or equal to two abnormalities), 44/65 (67.6 %) of whom had a defecation index ≤1.4. Rome III criteria for irritable bowel syndrome were equally fulfilled by patients with and without FED [74/83 (89 %) vs. 117/144 (81.2 %); p = ns]. On univariate analysis, straining duration, prolonged straining [≥30 min; 21/39 (53.8 %) vs. 15/65 (23.1 %); $p = 0.002$], incomplete evacuation [75/77 (97.4 %) vs. 95/114 (83.3 %); $p = 0.004$], and >3 stools/week [60/75 (80 %) vs. 76/128 (60 %); $p = 0.004$] were commoner among the FED patients though age, gender, symptom duration, mucus, manual evacuation, and stool forms were comparable. Resting and squeeze pressures and balloon volume at maximum tolerable limit were higher, and the sphincter tended to be shorter in FED. Prolonged straining, incomplete evacuation, and squeeze pressure were significant on multivariate analysis. Manometry and defecography abnormalities were commoner among the female FED patients.
Conclusion FED is not uncommon, which fulfills the Rome III criteria for IBS, and prolonged straining may be suggestive; abnormal defecography and manometry are commoner in female.

Keywords Anorectal manometry · Chronic constipation · Functional gastrointestinal disorders · Irritable bowel syndrome

Introduction

Chronic constipation was reported to affect 12 % to 30 % of the population in community surveys [1–5] and is also a common condition in gastroenterology practice. Though lifestyle, dietary, and systemic factors may be associated with chronic constipation in primary care setting, in tertiary care practice, complex physiological factors may cause constipation [6, 7]. These factors include slow colonic transit, puborectal dyssynergia, reduced propulsive activity and hyposensitivity of the rectum, and anatomical defects like rectocele [8]. Recognizing such pathophysiological mechanisms helps to guide the management of constipation [9, 10]. Moreover, with the upcoming Rome IV algorithm for the management of chronic constipation, recognition of multidimensional clinical profile (MDCP) of these patients including fecal evacuation disorder (FED) and slow colonic transit is important [11]. Approximately 50 % of the patients referred to tertiary care centers for constipation in the West have FED [7, 12, 13]. A single study that is reported to date from a referral center in

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Mumbai, India, showed a high frequency of FED [14]. More studies from India are needed on this issue.

Most studies on FED focused on a female population [15] mainly because it has been thought that FED might not be common among the males [16]. However, there is a need to study FED among the male patients and whether they differ from female patients. Interestingly, a large proportion of patients with functional bowel disorders in India are male [17]. This provided us a unique opportunity to evaluate FED among the male patients in our current study.

A diagnosis of FED requires specialized investigations such as anorectal manometry, balloon expulsion test (BET), and defecography (either conventional barium or magnetic resonance-based techniques) [8, 9]. Whereas BET is an easily performed screening tool, anorectal manometry (to study the sphincter pressures, rectal sensation, recto-anal inhibitory reflex, rectal compliance, and defecation index) and defecography (to evaluate the defecation mechanism in a dynamic fashion) are complex techniques that are not widely available [18]. Hence, it is important to know whether there are clinical predictors suggesting the possibility of FED among the patients with chronic constipation so that physicians can decide which patients to be referred for specialized investigations to the centers where gastrointestinal (GI) physiological investigations are available. Unfortunately, there are limited data on this issue globally [19, 20] and none from India.

Accordingly, we undertook this retrospective study with the following aims: (i) to evaluate the frequency and spectrum of FED among the groups of patients with chronic constipation, (ii) to know the simple predictors that would suggest the diagnosis of FED among them, and (iii) to study the profile among the female and male patients with FED.

Methods

Prospectively maintained data of 249 consecutive patients referred to a GI pathophysiology and motility laboratory in a tertiary care institute in northern India for evaluation of chronic constipation from February 2004 to April 2015 were retrospectively analyzed. Relevant clinical and laboratory data were extracted from the hospital information system (case files including proforma and laboratory records). A standardized questionnaire was filled up that included information on stool frequency and consistency (Bristol stool chart) [21], incomplete evacuation, manual evacuation, straining including its duration, use of laxative and enema, mucus in stool, sensation of anorectal blockage, etc. Patients who were symptomatic for less than 3 months were excluded from the study. All patients underwent flexible sigmoidoscopy or full-length colonoscopy either in the study center or elsewhere.

Anorectal manometry

From January 2004 to October 2010, the patients ($n=135$) underwent conventional anorectal manometry using a standard technique [22]. However, after October 2010, anorectal manometry was performed using a 16-channel water-perfused high-resolution manometry system (G S Hebbard, Australia; $n=114$). An anorectal manometry catheter of 4.2 mm in diameter and 16 radial ports with a balloon at its distal tip was used for measurement of sphincter length and pressure, rectal compliance, and sensory parameters. Anorectal manometry was performed in left lateral position. The anorectal manometry catheter was inserted deep inside the rectum, and then it was pulled slowly till it was positioned in the sphincter zone such that the high-pressure zone was in the middle, low-pressure area of the rectum and exterior above and below that zone (Fig. 1[A–C]). The length of the sphincter zone and the basal pressure were estimated. After evaluating the basal or resting sphincter pressure (denotes internal anal sphincter activity), the patient was asked to squeeze the sphincter (denotes external anal sphincter activity). This was repeated twice, and an average was considered as the squeeze pressure. The patient was asked to bear down as done during defecation. The maximum intrarectal pressure and the minimum residual anal pressure were recorded. Defecation index was calculated as

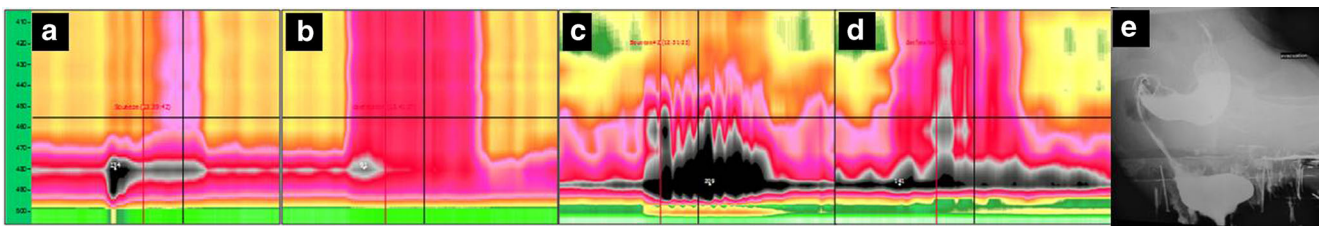

Fig. 1 High-resolution anorectal manometry and defecogram of the representative patients. *A* Normal squeeze pressure of a patient without fecal evacuation disorder. *B* Manometry during attempted defecation in the same subject showing an increase in the intrarectal pressure with a reduction in sphincter pressure. *C* High-resolution anorectal manometry in another patient with fecal evacuation disorder showing a very high squeeze pressure. *D* High-resolution anorectal manometry during attempted defecation in the same subject showing an increase in intrarectal pressure but a paradoxical increase in anal sphincter pressure. *E* Barium defecography in a patient with fecal evacuation disorder showing a large rectocele and rectal prolapse

the maximum rectal pressure divided by the minimum anal sphincter pressure [23]. Since a defecation index of at least 1.5 is needed for normal defecation, values ≤1.4 were considered abnormal [24]. The balloon was then inflated with the incremental volume of air (20, 40 and 60 mL and so on) and deflated each time after inflation. During balloon inflation, the patient was asked to report about the feel for the first time, urge (desire to defecate), and maximum tolerable limit. During balloon inflation, recto-anal inhibitory reflex was also evaluated. Manometry signals were analyzed using Trace 1.2.1 software from G S Hebbard (Australia).

Balloon expulsion test

Balloon expulsion test was performed in left lateral position using an indigenously made device consisting of a 10-cm-long latex condom tied at the end of an infant feeding tube according to a method described earlier with some modifications [25]. The condom was inserted deep inside the rectum in deflated state and lubricated with Xylocaine jelly. After it was filled with 50 mL water, the patient was asked to evacuate it; if not successful in 1–2 min, an increasing weight (starting with 50 g and increasing up to 700 g) was added to a polythene bag tied at the hanging end of the infant feeding tube [25]. A normal person is supposed to be able to expel the balloon (condom) without addition or at most 200-g added weight [8].

Defecography

Defecography was performed as per the standard technique [26]; briefly, after preparation using a cleansing enema, 150 mL of barium paste was injected in the rectum. Subsequently, while the patient sat on a defecography chair, lateral films were taken in resting, squeezing, defecating, and post-evacuation phases.

Criteria

An abnormal result in any of the three tests, such as anorectal manometry (anal basal sphincter pressure >100 mmHg and/or squeeze pressure >167 mmHg, defecation index ≤1.4), defecography (lack of opening of the anorectal angle by >15° and/or perineal descend ≥4 or ≥2 cm rectocele), and BET, was noted [7]. However, FED was diagnosed according to the Rome III criteria in the presence of chronic constipation and abnormal result in at least two of the abovementioned three tests [27].

Statistical analysis

Data were checked for normal distribution using the Shapiro-Wilk test. Categorical and continuous data were presented as proportion and mean, standard deviation, median, and range depending upon their distribution. Unpaired continuous data were analyzed using the unpaired *t* test or Mann-Whitney *U* test, depending upon their distribution. Categorical variables were analyzed using a Chi- square test, with Yates' correction as applicable. For multivariate analysis, a stepwise logistic regression method was used. *P*-values <0.05 were considered significant. Data were analyzed by SPSS version 15 (SPSS, Inc., Chicago, IL, USA); R, EpiCalc, and RStudio software (R Development Core Team, Vienna, Austria), and MedCalc version 14 (Warandeberg 3, 1000 Brussels, Belgium).

Results

Demographic and clinical parameters Of 249 patients [age 43.7 ± 16.2 years, 174 (70 %) males] during an 11-year and 2-month period (February 2004 to April 2015), most suffered from constipation for a long duration (median 84 months, range 3 to 600). Of 180 patients reporting data on Bristol stool form, 63 (35.0 %), 39 (21.6 %), and 19 (10.5 %) patients passed type I, type II, and type III stools, respectively. Of the remaining 59 patients, 24 reported passing type IV, 25 type V, and 9 type VI stools and one reported passing different types of stools. The median stool frequency was 7 per week (range 0 to 49). Other symptoms included incomplete evacuation, mucus with stool, and straining. Solitary rectal ulcer was detected in 24 patients on colonoscopy/flexible sigmoidoscopy.

Result of anorectal manometry and BET Anorectal manometry diagnosed FED in 57 (22.8 %) of 249 patients (Table 1); 53 had a squeeze sphincter pressure >167 mmHg, 7 of whom also had a basal sphincter pressure >100 mmHg (Fig. 1[A, B]) and 4 others had a high basal pressure only. Of 118 patients assessed for defecation index, 64 had values ≤1.4. Recto-anal inhibitory reflex was present in 236/247 (95.5 %)

Table 1 Summary of abnormal test result for diagnosis of fecal evacuation disorder by various investigations

Investigation positive for FED	Number	Percent
Defecography	83/136	61.0
Anorectal manometry[a]	57/249	22.9
Balloon expulsion test[b]	135/242	55.8
Any abnormality of the three tests	181/249	72.6
FED (two or more abnormal tests)	86/249[c]	34

FED fecal evacuation disorder

[a] Sphincter pressure of >167 mmHg and/or resting pressure of >100 mmHg

[b] Greater than 200-g added weight is needed to expel the balloon during the balloon expulsion test

[c] Forty-four out of sixty-five patients undergoing assessment for defecation index had an abnormal result (≤1.4)

patients. One hundred and thirty-five of 242 (55.7 %) patients undergoing BET needed a >200-g weight to expel the balloon.

Result of defecography Of 136 patients undergoing defecography, 83 (61 %) had abnormalities. These included rectocele in 34 (41 %, 23 of whom had anterior (Fig. 1[C]), 4 posterior, and 7 both), pelvic floor descent in 15 (11 %, 5 of whom had rectocele as well), rectal prolapse in 7 (5 %, 4 of whom had rectocele as well), puborectal dyssynergia in 12 (8.8 %), inability to defecate the contrast in 14 (10.3 %), and intrarectal intussusception in 1 (0.7 %).

Frequency and factors associated with FED Of 249 patients, 86 (34.5 %) had at least two abnormalities of the above three tests qualifying for the diagnosis of FED (Table 1). Of 65/86 patients undergoing assessment for defecation index, 44 (67.6 %) had values ≤1.4. Though age, gender, symptom duration, mucus, manual evacuation, and Bristol stool forms were comparable among the patients with and without FED, straining duration, prolonged straining [≥30 min; 21/39 (53.8 %) vs. 15/65 (23.1 %); $p = 0.002$], incomplete evacuation [75/77 (97.4 %) vs. 95/114 (83.3 %); $p = 0.004$], and >3 stools/week [60/75 (80 %) vs. 76/128 (60 %); $p = 0.004$] were commoner among the patients with FED than without on univariate analysis (Table 2). On anorectal manometry, resting sphincter pressure, squeeze sphincter pressure, and intrarectal balloon volume at which the maximum tolerable limit was reached were higher and the sphincter tended to be shorter among the patients with FED than without (Fig. 2a, b; Table 3). On multivariate analysis, prolonged straining (≥30 min), incomplete evacuation, and higher squeeze pressure were associated with FED (Table 4).

Comparison of FED in relation to gender Though female patients with FED were comparable to male patients in age, nature, and duration of symptoms, defecography and some parameters of anorectal manometry such as squeeze sphincter pressure, maximum tolerable limit of balloon inflation, and intrarectal pressure during attempted defecation were more often abnormal among the female than male patients (Table 5).

Discussion

The present study showed that (i) about a third of patients with chronic constipation referred to a tertiary referral center had FED; (ii) though prolonged straining (≥30 min), incomplete evacuation, and >3 stools/week were commoner among the patients with FED than without, other demographic and clinical parameters including fulfillment of the Rome III criteria for IBS were comparable on univariate analysis; (iii) resting and squeeze pressures and balloon volume at maximum tolerable limit were higher, and the sphincter tended to be shorter among the patients with FED than those without on anorectal manometry; (iv) prolonged straining, incomplete evacuation, and squeeze pressure were significant on multivariate analysis; and (v) female patients with FED more often had abnormal defecography and anorectal manometry findings.

Though constipation is a common condition, data on its etiology and clinical profile is scanty from India [14]. FED is a common cause of chronic constipation in tertiary care practice in the West [9, 28]. Surrenti et al. reported pelvic floor dysfunction to be the commonest cause for constipation among the 70 patients presenting to tertiary care practice [7]. Oncu et al. [29] studied 82 patients with functional constipation using colonic transit markers and balloon expulsion test and reported that 25 % of patients had FED. Similarly, Nyam et al. [30] reported pelvic floor dyssynergia in 28 % of patients, 3 % of whom had slow colonic transit as well. Studies from other Asian countries also revealed FED to be the common cause of chronic constipation. In a study from

Table 2 Demographic and symptom profile of patients with chronic constipation with or without fecal evacuation disorder

	FED ($n = 86$)	No FED ($n = 163$)	p-value[a]
Age (years)	46 (30.5–57.8)	43 (30.5–54.5)	ns
Gender (male)	62 (71.9 %)	112 (68.7 %)	ns
Duration (months)	120 (60–184)	84 (48–165)	ns
Incomplete evacuation	75/77 (97.4 %)	95/114 (83.3 %)	0.005
Manual evacuation	46/79 (58.2 %)	81/133 (60.9 %)	ns
Mucus in stool	40/71 (56.3 %)	56/98 (57.1 %)	ns
Straining	73/76 (96.0 %)	93/108 (86.1 %)	0.04
Straining ≥30 min	21/39 (53.8 %)	15/65 (23.1 %)	0.003
Stool per week	14 (7–21)	7 (2–21)	0.002

The symptom profile is shown in percentage

FED fecal evacuation disorder, *ns* no significance

[a] Continuous data are presented as median with interquartile range

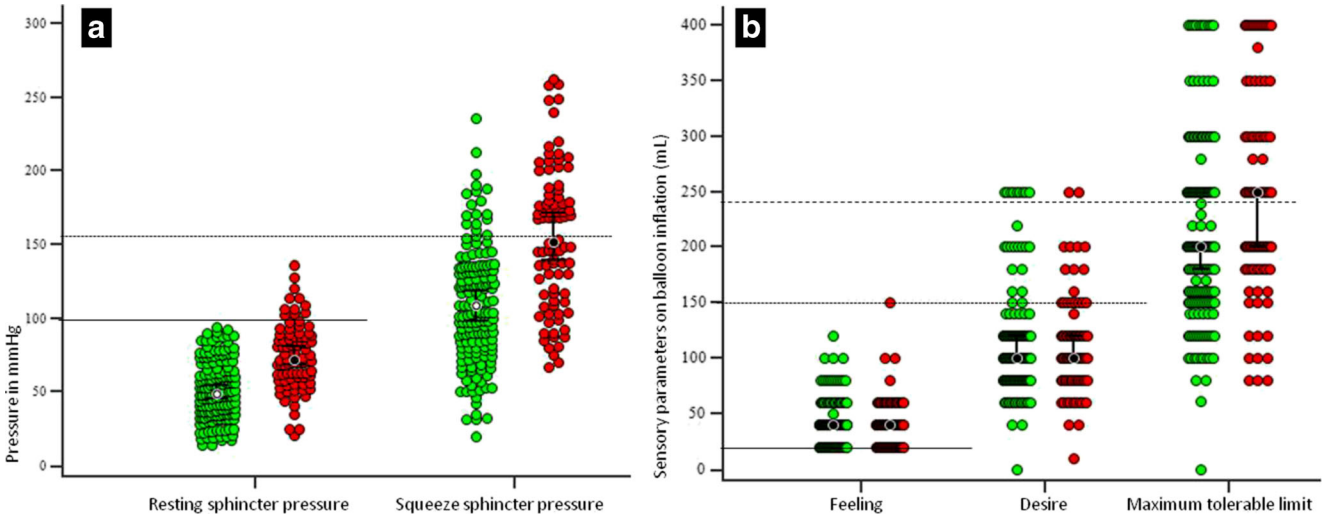

Fig. 2 Motor (**a**) and sensory (**b**) parameters on anorectal manometry in patients with constipation with (*red circles*) and without (*green circles*) fecal evacuation disorder. The *solid and dotted horizontal lines* indicate the normal cutoff values

Thailand, 40 % of 103 patients with chronic idiopathic constipation had FED, 11 % of whom also had associated slow colonic transit [31]. In the only study reported from India to date, 40/99 (40 %) patients with primary constipation had defecation disorder [14]. The results of the current study are in accordance with the earlier studies from the West and from Asia [7, 14, 15, 28, 30, 31] and suggest that FED is a common condition among the patients with chronic constipation in tertiary care setting.

Lack of awareness about FED may be one of the reasons for underreporting this entity in India. Moreover, the physiological tests needed to diagnose this condition are not widely available [18]. Hence, it is worthwhile to study simple clinical parameters, which may suggest the possibility of FED among the patients with chronic constipation. We found that prolonged straining (≥30 min), incomplete evacuation, and >3 stools per week were associated with FED on univariate analysis; on multivariate analysis, straining longer than half an hour and incomplete evacuation were associated with FED. In a previous study on 184 patients with chronic constipation, feeling of an anal blockage was the only symptom found to be associated with FED and a need of unusual postures to defecate and a feeling of incomplete evacuation were associated with slow as compared to normal transit constipation [19]. The discordance between the findings in our study and the latter might be explained by the fact that colon transit may be slowed down secondary to FED [20] as demonstrated by improvement in transit time among such patients after improvement of FED with biofeedback treatment [32]. Interestingly, the Rome III criteria for irritable bowel syndrome (IBS) were equally fulfilled among the patients with constipation with or without FED, suggesting that these symptom-based criteria alone cannot recognize FED. This supports the importance of MDCP being suggested in the

Table 3 Manometric parameters in chronic constipation with or without fecal evacuation disorder

Parameter	FED ($n=86$)	No FED ($n=163$)	p-value[a]
Sphincter length (cm, median (IQR))	3 (2–3.1)	3 (2.5–3.5)	0.03
Basal pressure (mmHg, mean ± SD)	74.3 ± 22.5	51 ± 19.9	<0.001
Squeeze pressure (mmHg, mean ± SD)	154.8 ± 48.3	108.8 ± 38.7	<0.001
Sensory parameters			
First sensation (mL, median (IQR))	40 (20–60)	40 (40–40)	ns
Urge (mL, median (IQR))	100 (80–120)	100 (80–120)	ns
Maximum threshold (mL, median (IQR))	250 (180–300)	200 (150–250)	0.005
RAIR (absent)	5 (5.8 %)	6 (3.7 %)	ns

FED fecal evacuation disorder, *IQR* interquartile range, *SD* standard deviation, *RAIR* recto-anal inhibitory reflex, *ns* no significance

[a] Continuous non-parametric and parametric data were analyzed by unpaired t and Mann-Whitney U tests, respectively. A Chi-square test with Yates' correction as applicable was used for comparison of categorical data

Table 4 Results of multivariate analysis of parameters predicting a diagnosis of fecal evacuation disorder

	Crude OR (95 % CI)	Adjusted OR (95 % CI)	*p*-value (likelihood ratio test)
Straining more than 30 min vs. less than 30 min	4.53 (1.84, 11.18)	3.68 (0.98, 13.81)	0.04
Incomplete evacuation (no vs. yes)	0 (0, Inf)	0 (0, Inf)	0.02
Sphincter length	0.59 (0.33, 1.05)	0.67 (0.3, 1.49)	0.31
Resting pressure	1.06 (1.03, 1.09)	1.03 (1, 1.07)	0.06
Squeeze pressure	1.03 (1.02, 1.05)	1.02 (1, 1.04)	0.01
Balloon volume at minimum rectal sensation	1.01 (0.9837, 1.0371)	0.9959 (0.9552, 1.0383)	0.84
Balloon volume at urge	1 (0.99, 1.01)	0.99 (0.97, 1)	0.08
Balloon volume at maximum rectal sensation	1.0048 (0.9999, 1.0097)	1.0075 (0.9993, 1.0157)	0.06

OR odds ratio, *CI* confidence interval

upcoming Rome Foundation, which would require investigating for physiological factors as causes of chronic constipation before a diagnosis of IBS-C is made [11].

There are scanty data on the relationship between gender and constipation. This might be related to the fact that most patients with constipation from the West are female [4, 15, 33]. Since a large proportion of patients with functional bowel disease including chronic constipation who consulted doctors in India are male [17], we had a unique opportunity to compare the profile of male and female patients in this study. Interestingly, female patients with constipation tended to have abnormal defecography more often and abnormalities in anorectal manometry. This is quite expected as obstetric trauma is one of the major factors causing FED among the females. In a study on 54 healthy subjects

Table 5 Parameters among the male and female patients with fecal evacuation disorder

	Male ($n=62$)	Female ($n=24$)	*p*-value
Age (years, mean ± SD)	46 (16.9)	41.3 (15.7)	0.244
Duration (months, median (IQR))	120 (72, 180)	60 (27, 207)	0.18
History of straining at toilet	53/54	20/22	0.19
Duration of straining (min, median (IQR))	35 (22.5, 52.5)	35 (20, 230)	0.59
History of incomplete evacuation	52/54 (96.3 %)	23/23 (100 %)	1
Passage of mucus	29/50	11/21 (52.4 %)	0.862
History of manual evacuation	32/55	14/24	1
Stool frequency per week (median (IQR))	20 (7, 21)	7 (3, 21)	0.313
Rome III criteria for IBS fulfilled	52/59	22/24	1
Sphincter length (cm, median (IQR))	3 (2, 3.3)	2.8 (2, 3)	0.452
Basal pressure (mmHg, mean ± SD)	74.4 (22)	74 (24.1)	0.942
Squeeze pressure (mmHg, mean ± SD)	168.2 (45.4)	120.2 (37.7)	<0.001
Minimum balloon inflation volume felt (mL, median (IQR))	40 (40, 60)	40 (20, 40)	0.133
Volume at which urge felt (mL, median (IQR))	100 (80, 145)	100 (80, 120)	0.665
Maximum tolerable limit of balloon inflation (mL, median (IQR))	250 (200, 300)	190 (120, 262.5)	0.016
Anal pressure during attempted defecation (mmHg, mean ± SD)	104.4 (27.5)	84.9 (32.6)	0.015
Minimum anal pressure during attempted defecation (mmHg, mean ± SD)	50.6 (21.3)	44.2 (23.2)	0.288
Intrarectal pressure during attempted defecation (mmHg, mean ± SD)	61.6 (22)	43.4 (21.9)	0.003
Weight needed to expel the balloon (g, median (IQR))	500 (362.5, 700)	400 (300, 550)	0.093
More than 200-g weight needed to expel the balloon	56/62 (90.3 %)	21/24 (87.5 %)	0.705
Abnormal defecography[a]	36/47 (76.6 %)	21/21 (100 %)	0.03

FED fecal evacuation disorder, *IBS* irritable bowel syndrome, *IQR* interquartile range

[a] Abnormal defecography included rectocele in 9 male [anterior (5), posterior (3), and both anterior and posterior (1)] and 13 female [anterior (9) and both anterior and posterior (4)] patients, pelvic floor descent in 5 male (2 of whom had rectocele as well) and 3 female (2 of whom had rectocele as well) patients, rectal prolapse in 3 male patients (2 of whom had rectocele) and 1 female patient (who also had rectocele). Four male and none of female patients had anorectal angle defect. Other abnormalities among the male patients included inability to defecate the contrast, puborectal dyssynergia, and rectal intussusception in 9, 5, and 1, respectively; corresponding numbers in female included 2, 2, and 0, respectively

from South Korea, anal resting and squeeze pressures were lower among the female than male subjects [34]. In a population study of 4002 subjects in Turkey, 67.5 % had pelvic floor disorder including fecal and urinary incontinence, constipation, and FED [35]. Older age, higher parity, and vaginal delivery were the risk factors for pelvic floor disorder [35]. In another study from South Korea, constipated patients with a prior history of vaginal delivery more often had dyssynergic defecation (56.4 %) and abnormal BET [36]. In a study from France, abnormal defecography, particularly the presence of rectocele, was more common among the constipated female than male patients [37]. In an Indian study, stool frequency was lower among the healthy female than male populations after the age of 35 years [38]. In an earlier study from our center, among the patients with fecal incontinence, squeeze pressure was lower among the female than male patients [22]. Our data are in accordance with the other studies and suggest that female patients with constipation should be particularly investigated for FED.

The present study, though important in a clinical perspective, has a few limitations. These include retrospective design, lack of some data on clinical and laboratory parameters in a subset of patients, and lack of data on colon transit time, which may be delayed even in patients with FED secondarily [15, 39]. BET in left lateral position has been thought to be non-physiological by some schools compared to that in seated position. However, in the only study published recently comparing BET in seated and left lateral positions [40], BET in left lateral position was in agreement with that in seated position in 80 % of the subjects; in fact, in this study, defecation disorder diagnosed by other tests such as defecography was more often diagnosed by BET in left lateral position than in seated position in some patients. The device that we used for balloon expulsion test consisting of a 10-cm-long latex condom has been used earlier [41]. Another limitation of our study is the lack of data on defecation index in all the patients. High resting and squeeze sphincter pressures have been suggested earlier as diagnostic criteria for FED on anorectal manometry [7, 42]. We did not use these as the sole criterion for the diagnosis of FED, but we used other parameters including defecation index, defecography, and BET. In fact, the use of a single criterion including abnormal defecation index has been criticized as a paradoxical anal contraction was not exclusively seen in patients with difficulty in defecation and, hence, the use of multiple criteria has been suggested [43].

In conclusion, the present study shows that about a third of patients with chronic constipation referred to a tertiary referral center had FED, straining longer than 30 min predicted its occurrence, and female patients with FED more often had abnormal defecography and anorectal manometry findings. More prospective studies are needed on this issue.

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Compliance with ethical standards

Conflict of interest UCG, AB, and AM declare that they have no conflict of interest.

Ethics statement The authors declare that the study was performed in a manner to conform with the Helsinki Declaration of 1975, as revised in 2000 and 2008, concerning Human and Animal Rights, and the authors followed the policy concerning informed consent as shown on Springer.com.

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