

## Original Research Article

# Anorectal manometry in disorders of defecation: a retrospective study

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## ABSTRACT

**Background:** Prevalence of Chronic Constipation (CC) in India is around 12-30%. Diagnosis of Fecal Evacuation Disorder (FED) requires specialized investigations like Anorectal Manometry (ARM), Balloon Expulsion Test (BET), MR defecography. High resolution ARM is considered first line diagnostic tool for chronic constipation as it measures pressure exerted by the muscles of anus and rectum. This study aimed to evaluate the characteristics of anorectal pressure in a cohort of Indian patients with CC and fecal incontinence and types of FED in patients with CC and age distribution (in young and elderly).

**Methods:** The present retrospective study was conducted from January 2022 to May 2024 at department of gastroenterology, Yashoda hospitals, Secunderabad, India. A total of 266 patients who presented with CC or Fecal incontinence were included in the study. Sigmoidoscopy or full-length colonoscopy, BET and ARM were done in all the patients. Mean resting and squeeze pressure and other parameters were measured by ARM. Data was compiled and observations tabulated.

**Results:** Among 266 patients, 136 were young with mean age  $21.93 \pm 10.54$  years and 130 with mean age  $60.43 \pm 11.87$ . Gender distribution was 59% men and 41% women. Mean resting anal pressure was  $57.06 \pm 23.11$  mmHg, mean squeeze pressure was  $98.36 \pm 35.96$  mmHg. In present study, type I dyssynergic defecation was most common with 76 (29%) patients followed by type II 46 (17%).

**Conclusions:** The present study showed that 65% with constipation subjected for ARM had dysynergic defecation (DD) and type I DD was most common followed by type II. Similar trend was observed in both young and elderly patients.

**Keywords:** Chronic constipation, Dyssynergic defecation, High resolution anal manometry, Rome IV criteria

## INTRODUCTION

Chronic constipation (CC) is a common problem in medical practice worldwide. The estimated overall prevalence in community is around 14%, Indian studies reported 12% to 30%. Epidemiology, clinical spectrum, diagnostic assessment, treatment and expectations of patients with CC are different in India when compared to west. Ghoshal et al suggested that in India, majority are vegetarian, use high dietary fibre intake with faster gut transit (18-40 hours), have soft and more frequent stools (1-2/day), with average stool weight around 311 g/day.<sup>1</sup>

Use of Indian toilet and frequency of lactose malabsorption in community needs deliberation as well. Western definition of constipation is not applicable to India as BSFS-3 is also considered constipation along with BSFS-1&2. Prevalence rates are higher in women, elderly and low socio-economic status.<sup>1</sup>

Pathophysiologically at least three subtypes of primary constipation have been described, with substantial overlap: Normal transit, slow transit and anorectal evacuatory disorders or dyssynergic defecation (DD). Paradoxical anal contraction, impaired anal relaxation and inadequate

abdominal and rectal propulsive forces during defecation are the main mechanisms associated with DD.<sup>2</sup> A diagnosis of DD requires specialised investigations such as anorectal manometry, balloon expulsion test and/or MR defecography. High resolution anorectal manometry (HRAM) is considered a first line diagnostic tool for CC and dyssynergic defecation. This study aimed to evaluate the characteristics of anorectal pressure in a cohort of Indian patients with chronic constipation or faecal incontinence. Also, to evaluate the types of faecal evacuation disorders in patients with chronic constipation. Additionally, to evaluate types of dyssynergic defecation and correlate the prevalence in with age distribution (in young and elderly) and to evaluate response to biofeedback therapy.

## METHODS

In this retrospective study, data was collected from January 2022 to May 2024 in Department of Gastroenterology, Yashoda hospitals, Secunderabad, India. As this study was a retrospective analysis, ethical clearance was not required. Consent was obtained from all patients before the procedure.

### Inclusion criteria

All the patients who underwent anorectal manometry (January 2022 to May 2024) were included.

### Exclusion criteria

Patients with history of prior anorectal surgery, inflammatory bowel disease or anorectal malignancy were excluded from study.

### Sample size calculation

Sample size was calculated at 80% study power and  $\alpha$  error of 0.05 by using statcalc of Epi info 7 software. Final calculated sample size was 260, hence for the present study 266 patients were included.

### Procedure

Baseline characteristics relevant clinical and laboratory data (duration of symptoms, presence of pain abdomen, feeling of incomplete evacuation, history of digital evacuation, history of enema usage, painful evacuation efforts, history of bleeding per rectum) were taken from all patients. All patients underwent flexible sigmoidoscopy or full-length colonoscopy either in the study centre or elsewhere to rule out colonic malignancy, ulcerative colitis and rectal ulcerations. Mean resting and squeeze anal pressure was measured in all the patients.

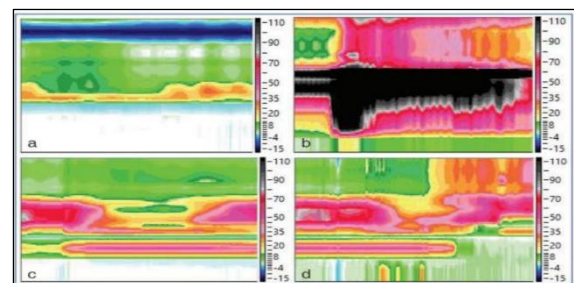
### Balloon expulsion test

Balloon expulsion test (BET) was done in all patients. For this procedure, a latex balloon applied to the tip of

manometry catheter was inserted into rectum. Balloon was filled with 50 mL water and the patient was asked to evacuate; if unable to evacuate in one-two minutes, then gradually weight was increased at another end of catheter to support evacuation (maximum weight up to 200 g). A normal person would be able to expel the balloon without addition or at most 200 g added weight. If patient was unable to evacuate despite 200 g weight, it was considered as abnormal BET.<sup>3,4</sup> During balloon inflation, balloon was inflated with 30-50 mL air and recto-anal inhibitory reflux was checked. The patient was also asked to report about feel for the first sensation, urge or desire to defecate and at the point of maximum tolerable limit.

### HRAM

Anorectal manometry was performed in all patients by using The Royal Melbourne Hospital High Resolution Manometry and 16 channel water perfusion system. Anorectal manometry catheter was 4.2 mm in diameter and had 16 radial ports. A latex balloon was applied to the tip of manometry catheter, was used for BET and rectal sensory testing. No bowel preparation was given unless the rectum was loaded and all patients were studied in left lateral position with knee and hips flexed. Resting, squeeze and bear down was explained to patient before catheter was inserted into anorectum. Manometry catheter was inserted deep inside the rectum and then it was pulled slowly till it was positioned in sphincter zone which is a high-pressure zone and placed in middle, low-pressure area of rectum and exterior were above and below that high pressure zone (Figure 1). Length of high-pressure zone (HPZ) and basal anal sphincter pressure was measured. All manoeuvres were performed in accordance to published international minimal standards using a previously published protocol.<sup>5,6</sup> After five minutes of rest to make patient comfortable, the resting or basal anal pressure (denotes internal anal sphincter activity) was measured, the patient was asked to squeeze the sphincter (denotes external anal sphincter activity) and squeeze sphincter pressure was measured. The patient was asked to bear down as done during defecation.



**Figure 1: High Resolution Manometry; a) Decreased anal or resting anal pressure (24 mmHg); b) Normal squeeze anal pressure; c) Resto-Anal Inhibitory Reflux (RAIR) present; d) Type IV dyssynergia, inadequate intra-rectal pressure and incomplete anal relaxation.**

Defecation disorder was classified according to Rao's types.<sup>6,7</sup>

Both intra-rectal and intra-anal pressure were measured by anorectal manometry during BET (Table 1).

**Table 1: Rao's classification of defecation disorders.**

Type	Description
Normal	An adequate increase in rectal pressure ( $\geq 40$ mmHg) accompanied by a simultaneous reduction in anal pressure
Type I	An increased intra-rectal pressure ( $\geq 40$ mmHg) with a paradoxical increase in the intra-anal pressure
Type II	An inadequate increase in rectal pressure of ( $\geq 40$ mmHg, poor propulsive force) and paradoxical simultaneous increase anal pressure
Type III	An increase in rectal pressure ( $\geq 40$ mmHg) and failure of reduction in anal pressure ( $\leq 20\%$ baseline pressure)
Type IV	An inadequate increase in rectal pressure of ( $\leq 40$ mmHg, poor propulsive force) and failure of reduction in anal pressure ( $\leq 20\%$ baseline pressure)

Analysis of manometry signal: ARM signal was analysed by using Trace 2.1 software from G S Hebbard (Australia). According to standard criteria, a resting anal pressure more than 68 mmHg, squeeze pressure more than 164 mmHg and length of anal high-pressure zone (denotes sphincter) more than 3.6 cm in female and more 4 cm in male were considered abnormal. Threshold volume for first sensation at  $>20$  ml in both genders, an urge to defecate at  $>80$  ml in male and  $>60$  ml in female and maximum tolerable volume of  $>126$  ml was taken as abnormal (high).

**Statistical analysis**

Continuous variables were summarised using means and standard deviations for normally distributed data. Test Performed are Independent t-test, Chi square test. The

medians and inter-quartile ranges were used to describe non nominal data. Statistical analysis was performed using SPSS version 24. Confidence interval is 95%, hence p value  $<0.05$  is considered significant.

**RESULTS**

A total 266 patients underwent anorectal manometry during the study period. Mean age was  $40.75 \pm 22.29$  years (range, 15-76) with younger ( $<40y$ ) were 136 with mean age  $21.93 \pm 10.54$  and elderly were 130 with mean age of  $60.43 \pm 11.87$  years. The cohort included 159 (59%) men and 110 (41%) women (Table 2). Among younger patients 78 (57%) were men and 58 (43%) were women; whereas 78 (60%) were men and 52 (40%) were women among elderly patients.

**Table 2: Demographic characteristics of patients.**

Para-meter	Total (n= 266)	Age (years)		P value
		$\leq 40$ (n=136)	$>40$ (n=130)	
Age	$40.75 \pm 22.29$	$21.93 \pm 10.54$	$60.43 \pm 11.87$	$<0.0001^*$
<b>Gender, N (%)</b>				
Male	156 (59)	78 (57)	78 (60)	0.7093
Female	110 (41)	58 (43)	52 (40)	

\*Statistically significant.

Indications of anorectal manometry was chronic constipation in 151 (57%), faecal incontinence in 64 (24%), perianal pain in 16 (6%), diarrhoea in 13 (5%), rectal prolapse and altered bowel habits in 11 (4%) (Table 3). Chronic constipation was the most common indication in both younger (58%) and elderly (55%) patients followed by faecal incontinence. Sigmoidoscopy was normal in 203 (76.3%) patients.

In HRAM, the mean resting anal pressure was  $57.06 \pm 23.11$  mmHg (range 14-183 mmHg). Mean squeeze pressure was  $98.36 \pm 35.96$  mmHg (range 30-290 mmHg). High Pressure Zone (HPZ) length was  $1.74 \pm 1.77$  cm. Mean volume of first sensation was  $78.87 \pm 54.69$  ml, mean

volume for urgency was  $61.21 \pm 45.33$  ml and maximum tolerable volume was  $121.4 \pm 86.36$  ml. Rectal sensory function was normal in 227 (85%), reduced in 31 (12%) and hypersensitive in 8 (3%) patients. Statistically significant difference was found in the maximum squeeze pressure between young and elderly patients. RAIR was present in 250 (94%), indeterminate in 16 (6%) patients. Weak anal sphincter was present in 46 (17%) patients (Table 4).

During an attempt at defecation, manometry was normal in 46 (17%) patients. Type I DD was the most common 76 (29%) presentation on HRAM according to Rao's classification followed by type II in 46 (17%), type III in

29 (11%) and type IV in 23 (9%) (Table 5). Among younger and elderly age groups dyssynergia type pattern was similar with type I > II > IV > III. In the younger age

group type I was most common 36 (26%) followed by type II in 31 (23%), IV in 14 (10%) and III in 11 (8%).

**Table 3: Indications for anorectal manometry in study patients.**

Indication	Total (n=266), N (%)	Age (years), N (%)		P value
		≤40 (n=136)	>40 (n=130)	
Constipation	151 (57)	79 (58)	72 (55)	0.8690
Faecal incontinence	64 (24)	31 (23)	33 (25)	
Rectal prolapse	11 (4)	06 (4)	05 (4)	
Altered bowel habits	11 (4)	07 (5)	04 (3)	
Perianal pain	16 (6)	08 (6)	08 (6)	
Diarrhoea	13 (5)	05 (4)	08 (6)	

**Table 4: Characteristics of anorectal pressures and other parameters.**

Variable	Total (n=266)	Age (years)		P value
		≤40 (n=136)	>40 (n=130)	
Maximum resting pressure (mmHg)	57.06±23.11	55±22.66	59.21±23.47	0.1380
Minimum resting pressure (mmHg)	56.54±22.92	54.14±22.26	59.05±23.42	0.0805
Mean resting pressure (mmHg)	57.06±23.11	55±22.66	59.21±23.47	0.1380
Maximum squeeze pressure (mmHg)	100.5±45.07	94.33±48.02	107±40.94	0.0212*
Minimum squeeze pressure (mmHg)	86.52±40.03	82.37±42.29	90.87±37.19	0.0834
Mean squeeze pressure (mmHg)	98.36±35.96	95.96±35.65	100.9±36.25	0.2661
High pressure zone (HPZ) length (in cm)	1.74±1.77	1.79±1.67	1.68±1.87	0.6160
Mean volume of first sensation (in ml)	78.87±54.69	74.26±53.11	83.69±56.10	0.1600
Mean volume for urgency (in ml)	61.21±45.33	56.40±46.01	66.25±44.22	0.0762
Mean volume for discomfort (in ml)	121.4±86.36	118.2±89.10	124.8±83.60	0.5295
<b>Rectal sensory function, N (%)</b>				
Normal	227 (85)	117 (86)	110 (85)	0.6468
Reduced	31 (12)	14 (10)	17 (13)	
Hypersensitive	08 (3)	05 (4)	03 (2)	
<b>RAIR, N (%)</b>				
Present	250 (94)	127 (93)	123 (95)	0.9127
Absent	09 (3)	05 (4)	04 (3)	
Indeterminate	07 (3)	04 (3)	03 (2)	

\*Statistically significant.

**Table 5: Distribution of dyssynergic pattern and fecal incontinence in study population.**

Line-plot patterns	Total (n=266), N (%)	Age (years), N (%)		P value
		≤40 (n=136)	>40 (n=130)	
Type 1 DD	76 (29)	36 (26)	40 (31)	0.2995
Type 2 DD	46 (17)	31 (23)	15 (12)	
Type 3 DD	23 (9)	11 (8)	12 (9)	
Type 4 DD	29 (11)	14 (10)	15 (12)	
Weak anal sphincter	46 (17)	21 (15)	25 (19)	
Normal	46 (17)	23 (17)	23 (18)	

**DISCUSSION**

In our study, 220 (82.7%) out of 266 patients had abnormal anorectal manometry. Out of these, type I dyssynergia was most common based on Rao’s classification followed by type II, type IV and least was type III. Weak anal sphincter was present in 17% patients.

Prevalence of defecation disorder in patients with chronic constipation is 10-30% depending on patient population.<sup>8,9</sup> Prevalence of constipation is 14-29% of adults in the western countries.<sup>10,11</sup> A study by Rajput et al showed prevalence of 24.8% in constipation and was significantly more frequent in females than in males (20% vs. 13%) and in non-working population than in working population

(20% vs. 12%).<sup>12</sup> A study by Baijal et al reported that 58% of patient who underwent ARM had pelvic floor dyssynergia.<sup>13</sup> It is important to diagnose defecatory disorder, in patients with chronic constipation because of response to anorectal biofeedback therapy. HRAM is a gold standard test to diagnose dyssynergic defecation. A study from Surrenti et al showed pelvic floor dysfunction as most common cause of severe constipation among the 70 patients presenting to tertiary referral motility clinic, followed by slow transit constipation and irritable bowel syndrome equally.<sup>14</sup> Fulfilling ROME criteria for IBS-C does not exclude the possibility of fecal evacuatory disorders or slow transit constipation. Study by Chitkara et al showed that frequency of chronic constipation increases with age. In this study, stool frequency reduced with age, particularly among females. Dyssynergic defecation is a common cause of chronic constipation in tertiary care practice in the west.<sup>15</sup> Ghoshal et al showed that 86 patients (34%) had faecal evacuation disorder.<sup>16</sup> Another study from India by Baijal et al in 178 patients presenting with anorectal disorders showed faecal incontinence in 11 (6.7%), dyssynergic defecation in 104 (58.4%), irritable bowel syndrome (IBS) type constipation in 53 (29.7%), Hirschsprung's disease 4 (2.24%) and IBS in 4 (2.24%).<sup>13</sup> In a study Gonlachanvit et al, 103 patients of chronic constipation from Thailand, 40% had faecal evacuation disorder and 11% also had associated slow transit constipation.<sup>17</sup> A study by Li et al in Asian population showed mean maximum resting and squeeze pressure of 69 and 194 mmHg, with HPZ length 3.6cm; first sensation, urge and discomfort were 44ml, 102ml and 154 ml respectively.<sup>18</sup>

In the current study, overall dyssynergic defecation was noted in 66%, of which type I was most common 76 (29%) followed by type II in 46 (17%), type IV in 29 (11%) and type III in 23 (9%) patients. These findings were supported by study published in Zhao et al, from China in 82 chronic constipation patients. In this study type I was the most common (n=24) based on Rao's classification, followed by type IV (n=13), type II (n=12) and type III (n=11).<sup>19</sup> Ghoshal et al, studied SRUS patients who more often (43%) had defecation disorder as compared to healthy subjects.<sup>16</sup> Patient with SRUS with abnormal BET had thicker internal anal sphincter.<sup>20</sup> In a population study from Turkey constituting 4002 subjects, 67.5% patients had pelvic floor disorders.<sup>21</sup> A study by Ratuapli et al comparing BET in sitting versus left lateral position showed that there was modest agreement between rectal BET in left lateral and seated positions.<sup>22</sup> The present study showed that 220 (82.7%) patients had abnormal anorectal manometry and almost 65% patients had defecatory disorders. Diagnosing the abnormal pressure patterns is of paramount importance as many studies have shown that biofeedback therapy is more effective than dietary modification, laxatives, diazepam, muscle relaxants, placebo, and sham biofeedback.<sup>23-25</sup>

This study is important in clinical perspective but has a few limitations such as retrospective design and did not include

healthy subjects for HRAM test as a control group. BET in left lateral position has been thought to be non-physiological as compared to that in seated position. Also, there could have been a referral bias of sending patients with suspected dyssynergic defecation for ARM and not others with constipation.

## CONCLUSION

The present study showed that 65% patients had defecation disorders and type I dyssynergia was most common. Frequency of various types of DD is not different in younger and elderly subjects. Rectal ulcerations were more common in patients referred for HRAM. Diagnosing the type of dyssynergia is helpful for treatment because these patients respond to biofeedback therapy along with laxatives. More prospective studies are needed on this issue.

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## REFERENCES

1. Ghoshal UC. Chronic constipation in Rome IV era: the Indian perspective. *Ind J Gastroenterol.* 2017;36(3):163-73.
2. Bharucha AE, Wald A, Enck P, Rao S. Functional anorectal disorders. *Gastroenterol.* 2006;130(5):1510-18.
3. Pezim ME, Pemberton JH, Levin KE, Litchy WJ, Phillips SF. Parameters of anorectal and colonic motility in health and in severe constipation. *Dis Colon Rectum* 1993;36(5):484-91.
4. Lee BE, Kim GH. How to perform and interpret balloon expulsion test. *J Neurogastroenterol Motil.* 2014;20(3):407-09.
5. Imran Aziz, William WE, Palsson OS, Törnblom H, Simrén M. An approach to the diagnosis and management of Rome IV functional disorders of chronic constipation. *Expert Rev Gastroenterol Hepatol.* 2020;14(1):39-46.
6. Rao SS, Mudipalli RS, Stessman M, Zimmerman B. Investigation of the utility of colorectal function tests and Rome II criteria in dyssynergic defecation (anismus). *Neurogastroenterol Motil.* 2004;16(5):589-96.
7. Rao SS, Welcher KD, Leistikow JS. Obstructive defecation: A failure of rectoanal coordination. *Am J Gastroenterol.* 1998;93(7):1042-50.
8. Pare P, Ferrazzi S, Thompson WG, Irvine EJ, Rance L. An epidemiological survey of constipation in Canada: Definitions, rates, demographics, and predictors of health care seeking. *Am J Gastroenterol.* 2001;96(11):3130-37.
9. Peppas G, Alexiou VG, Mourtzoukou E, Falagas ME. Epidemiology of constipation in Europe and Oceania: A systematic review. *BMC Gastroenterol.* 2008;8:05.

10. Talley NJ, O'Keefe EA, Zinsmeister AR, Melton LJ 3rd. Prevalence of gastrointestinal symptoms in the elderly: A population-based study. *Gastroenterology.* 1992;102(3):895-01.
11. Sonnenberg A, Koch TR. Epidemiology of constipation in the United States. *Dis Colon Rectum.* 1989; 32(1):01-08.
12. Rajput M, Saini SK. Prevalence of constipation among the general population: A community-based survey from India. *Gastroenterol Nurs.* 2014;37(6):425-29.
13. Baijal R, Jain M. Analysis of indications and results of anorectal manometry in two tertiary hospitals in India. *Arch Clin Gastroenterol.* 2017; 3(1):09-10.
14. Surrenti E, Rath DM, Pemberton JH, Camilleri M. Audit of constipation in a tertiary referral gastroenterology practice. *Am Gastroenterol.* 1995;90(9):1471-75.
15. Chitkara DK, Bredenoord AJ, Cremonini F, Delgado-Aros S, Smoot RL, El-Youssef M, et al. The role of pelvic floor dysfunction and slow colonic transit in adolescents with refractory constipation. *Am J Gastroenterol.* 2004;99(8):1579-84.
16. Ghoshal UC, Verma A, Mishra A. Frequency, spectrum, and factors associated with faecal evacuation disorders among patients with chronic constipation referred to a tertiary care centre in northern India. *Indian J Gastroenterol.* 2016;35(2):83-90.
17. Gonlachanvit S, Patcharatrakul T. Causes of idiopathic constipation in Thai patients: Associations between the causes and constipation symptoms as defined in the Rome II criteria. *J Med Assoc Thai.* 2004;87(Suppl 2):S22-28.
18. Li Y, Yang X, Xu C, Zhang Y, Zhang X. Normal values and pressure morphology for three-dimensional high-resolution anorectal manometry of asymptomatic adults: a study in 110 subjects. *International journal of colorectal disease.* 2013;28:1161-8.
19. Zhao Y, Ren X, Qiao W, Dong L, He S, Yin Y. High-resolution anorectal manometry in the diagnosis of functional defecation disorder in patients with functional constipation: A retrospective cohort study. *J Neurogastroenterol Motil.* 2019;25(2):250-57.
20. Sharma A, Misra A, Ghoshal UC. Fecal evacuation disorder among patients with solitary rectal ulcer syndrome: A case-control study. *Neurogastroenterol Motil.* 2014;20(4):531-38.
21. Kepenekci I, Keskinilic B, Akinsu F. Prevalence of pelvic floor disorders in the female population and the impact of age, mode of delivery, and parity. *Dis Colon Rectum.* 2011;54(1):85-94.
22. Ratuapli S, Bharucha AE, Harvey D, Zinsmeister AR. Comparison of rectal balloon expulsion test in seated and left lateral positions. *Neurogastroenterol Motil.* 2013;25:e813-20.
23. Rao SS, Patel RS. How useful are manometric tests of anorectal function in the management of defecation disorders. *Am J Gastroenterol.* 1997;92(3):469-75.
24. Szojda MM, Tanis E, Mulder CJ, Felt-Bersma RJ. Referral for anorectal function evaluation is indicated in 65% and beneficial in 92% of patients. *World J Gastroenterol.* 2008;14(2):272-77.
25. Schmulson MJ, Drossman DA. What is new in Rome IV. *J Neurogastroenterol Motil.* 2017;23(2):151-63.

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