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Research Article

The Defecation Index as a Predictor of Failed Rectal Balloon Expulsion Test

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Abstract

Background*: Anorectal manometry (ARM) is important to evaluate anorectal function. Dyssynergia is the inability to coordinate pelvic floor muscles during defecation. Defecation Index (DI) calculates the highest rectal pressure during bear down by its residual anal pressure. Balloon expulsion test (BET) is performed by insertion of a Foley catheter balloon into the rectum and is considered a surrogate test of pelvic floor dysfunction. Inability to expel the balloon is considered failure. The objective was to explore the value of the DI as a surrogate marker for BET.* ***Methods****: ARM studies from Johns Hopkins Hospital and Johns Hopkins Bayview Medical Center database from 2015-2016 were reviewed. Patients with complaints of constipation who underwent BET were included. DI was calculated for each patient.* ***Key Results:*** *229 patients had constipation (47.8 ± 16.7 years old, 192[84%] female); 160 (69.8%) failed BET. Abnormal DI (<1.5mmHg) was found in all patients. Patients who failed BET had a significantly lower DI when compared with patients who had a successful BET (0.44 ± 0.2mmHg vs 0.62 ± 0.2mmHg; p<0.001). A DI□ 0.1mmHg was highly specific (97.1%) for failed BET. Dyssynergia was more prevalent in BET failure versus in successful BET (74% vs 45%; p<0.001). Anal resting pressure (ARP) was higher in BET failure (71.5 ± 0.6mmHg vs 61.9 ± 24.5mmHg; p=0.001).* ***Conclusion:*** *Lower DI, dyssynergia and higher ARP were significantly associated with BET failure in constipated patients. A DI□ 0.1mmHg is predictive of BET failure and indicates that BET may not be necessary in this select group of patients.*

Key words: constipation, defecation, index, manometry, pelvic floor, pressure.

Introduction

In North America, 12-19% of the population report evacuation disorders.[1] The defecation process requires coordinated muscular contractility of the rectum and relaxation of the anus. Anorectal manometry (ARM) measures anorectal functions and reflexes, including rectal sensation and recto anal pressure changes when bearing down.[2] High-resolution manometry (HRM) provides detailed intraluminal pressure recordings and requires less time than conventional manometry.[3] Our patients all had high-resolution anorectal manometry.

During ARM, rectal and anal sphincter pressures are measured during a bear down. The defecation index (DI) is the ratio between the maximum intrarectal pressure and the anal sphincter residual pressure during attempted defecation.[2] Uncoordinated function of the anorectum is referred to as dyssynergic defecation or dyssynergia. Dyssynergia is classified into 4 types. These types are assessed during attempted defecation (also called push attempt or bear down), performed by the patient during an ARM study. In type 1, patients have an adequate push attempt followed by a paradoxical anal contraction. Type 2 is described by inadequate push attempt also with a paradoxical anal contraction. Type 3 shows increase in rectal pressure accompanied by an impaired anal relaxation. Type 4 demonstrates an inadequate increase in rectal pressure with impaired anal relaxation.[4]

The balloon expulsion test (BET) may be performed after an ARM study and it is a simple, but possibly uncomfortable, technique of assessing the patients' ability to defecate. The BET is performed by insertion of a 20 Fr Foley catheter into the rectum and inflation of the balloon with 50ml of sterile water. The patient is asked to sit on a commode and expel the balloon. The expulsion of the balloon is timed. The inability to expel the balloon within 2 minutes is highly suggestive of anorectal dyssynergia. Our aim was to determine if the DI could predict BET results in constipated patients who underwent ARM.

Materials and Methods

We reviewed 348 ARM studies from 2015 and 2016 from the Johns Hopkins Hospital and Johns Hopkins Bayview Medical Center database. Patients with constipation who underwent ARM and BET were included in this study. Patients who did not undergo BET were excluded. The results of the balloon expulsion tests were recorded for every patient.

The DI was calculated for each bear down. Standard protocol for ARM has at least 3 bear downs performed. The average defecation index (DI) value from the 3 recorded bear downs was calculated. The DI is the ratio between the maximum intrarectal pressure and its anal sphincter residual pressure during attempted defecation:

$$\text{DI} = \frac{maximum\ rectal\ pressure}{residual\ anal\ pressure}$$

Normal DI is $\geq$1.5 mmHg, according to Kim et al.[6]

All studies were performed using High Resolution Manometry, and several anorectal indices were assessed. The manometry studies were performed using ManoScan ™ AR High Resolution Manometry System [(Medtronic ©, Minneapolis, MN) Figure 1], and the readings were analyzed using ManoView™AR Analysis Software (Medtronic ©, Minneapolis, MN). The patients were studied in the left lateral decubitus position and a 3D catheter featuring a probe

with 256 points of measurement generated by 16 axial x16 circumferential sensors (Figure 2) was used for all the studies. The dyssynergia types were fully collected according to the classification of dyssynergia described by Rao et al.[5 7] and are demonstrated in Table 1.

ARM studies proceeded in the following sequence: catheter insertion, pause for accommodation, assessment of the anal resting pressure (ARP), followed by three squeezes (20 seconds each and 1 minute in between), and then three attempted defecations (same duration and interval time). Rectal sensitivity and recto-anal inhibitory reflex (RAIR) were assessed. Volume to first sensation and urge to defecate were recorded by intermittent and progressive balloon fills performed with a hand-held syringe in 10 ml increments of air, increasing to a maximum of 200 ml of air. After sensitivity testing, balloon was rapidly inflated with 60 ml of air to assess the absence or presence of RAIR.[8]

The indices reviewed were the anorectal pressure at rest, the length of the high-pressure zone (HPZ), which is automatically measured by the software[4], the average pressure of the 3 squeezes, the average DI of the 3 bear downs, and the volume and compliance at first sensation and urge to defecate. The BET results were reported, balloon expulsion within 2 minutes was termed success. Balloon expulsion beyond 2 minutes was termed failure.

Patients were divided into 2 groups, those with successful BET and those with failure of BET. The two groups were analyzed with SPSS statistical software (version 25.0; SPSS, Chicago, IL, USA), and several cutoff values of DI were determined and compared to BET results. A 2x2 conventional table was created for different values of DI (between 0.1 and 0.9 mmHg), and BET was used to define the presence or absence of defecatory dysfunction. Failure of BET was considered positive for defecation disorder, and successful BET was negative for defecatory dysfunction. The sensitivity and specificity of various DIs were calculated with the objective of finding the value with the best specificity to predict a failed BET. A ROC (receiver operating characteristic) curve was also created to demonstrate graphically the results (Figure 3). The ROC curve shows the adjustment between sensitivity and specificity, where an increase in specificity will be accompanied by a decrease in sensitivity.

	DYSSYNERGIA	**CLASSIFICATION**
	PUSH	**ANAL CONTRACTION**
TYPE 1	Adequate	Paradoxical contraction
TYPE 2	Inadequate	Paradoxical contraction
TYPE 3	Adequate	Inadequate relaxation (less 20%)
TYPE 4	Inadequate	Inadequate relaxation (less 20%) or no change

Table 1. Dyssynergia classification according to Rao et al.5

		Balloon Expulsion Test		
	(n = 229)	Success (n = 69)	Failure (n = 160)	**P value**
Age	47.8 ± 16.7	42.7 ± 16.5	50.1 ± 16.3	0.452
Male	37 (16%)	9 (13%)	28 (17%)	0.441
HPZ length (cm)	3.6 ± 0.8	3.6 ± 0.9	3.5 ± 0.8	0.917
ASP (mmHg)	158.3 ± 69.9	148.8 ± 65.6	162.4 ± 71.5	0.211
Volume at sensation (ml)	25.1 ± 22.7	26.5 ± 17.9	24.4 ± 24.5	0.109
Volume at urge (ml)	56.6 ± 36.3	56.0 ± 32.3	56.8 ± 38.0	0.528
Rectal compliance at sensation (ml/mmHg)	0.56 ± 0.53	0.63 ± 0.54	0.54 ± 0.53	0.319
Rectal compliance at urge (ml/mmHg)	1.35 ± 0.96	1.36 ± 0.88	1.34 ± 1.0	0.458
ARP (mmHg)	68.5 ± 22.3	61.9 ± 24.5	71.5 ± 20.6	<0.001
Defecation index	0.49 ± 0.25	0.62 ± 0.26	0.44 ± 0.22	<0.001
Dyssynergia	150 (65%)	31 (45%)	119 (74%)	<0.001

Table 2. All subject characteristics. HPZ: high pressure zone. ASP: average squeeze pressure. ARP: anal resting pressure.

Figure 1. ManoScan ™ AR High Resolution Manometry System [(Medtronic ©, Minneapolis, MN).

Figure 2. 3D Anorectal manometry catheter (Medtronic ©, Minneapolis, MN).

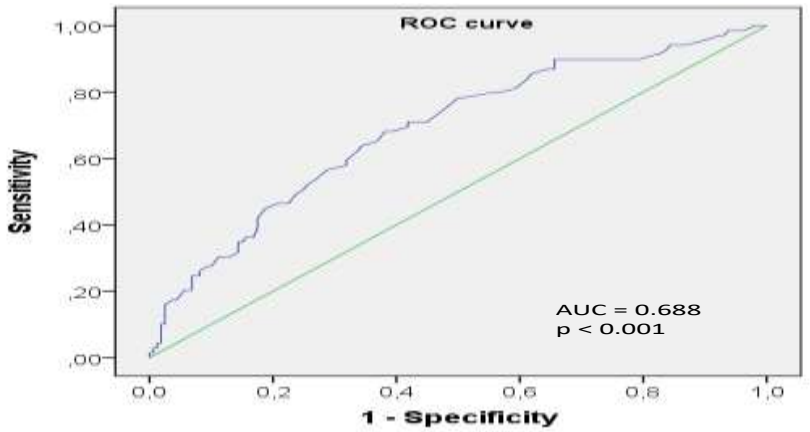


Figure 3. Defecation index ROC curve.

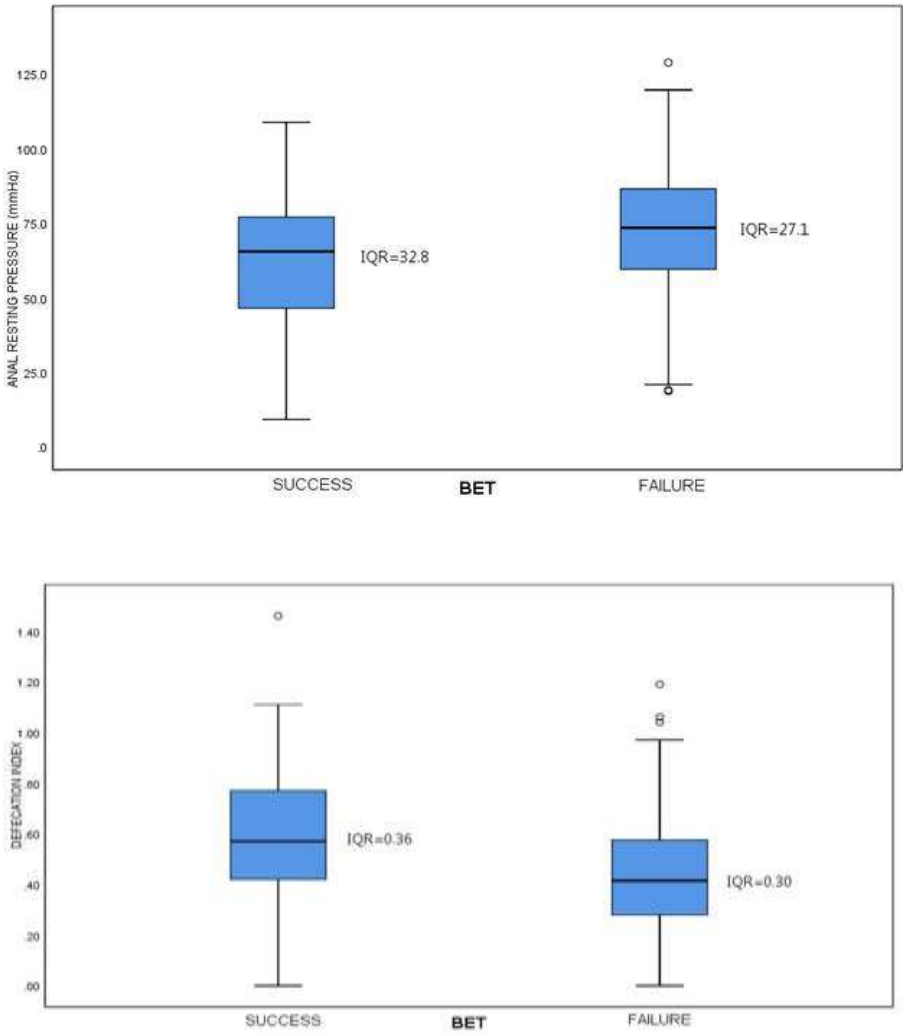
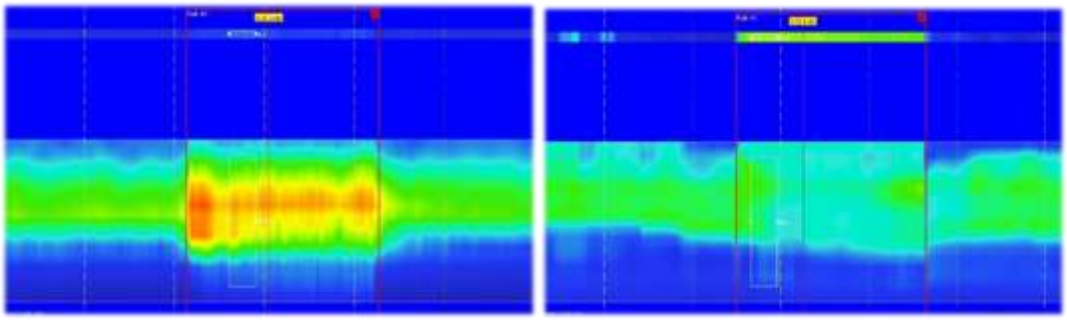


Figure 4. High resolution ARM parameters and BET results. Patients who failed BET had higher ARP values when compared to those who succeeded. A lower DI was also associated with BET failure. IQR= interquartile range.



DI=0.08 DI=1.38

Figure 5. ARM examples of bear downs with low and high DI values. DI=0.08, patient had BET failure. DI=1.38, patient had successful BET.

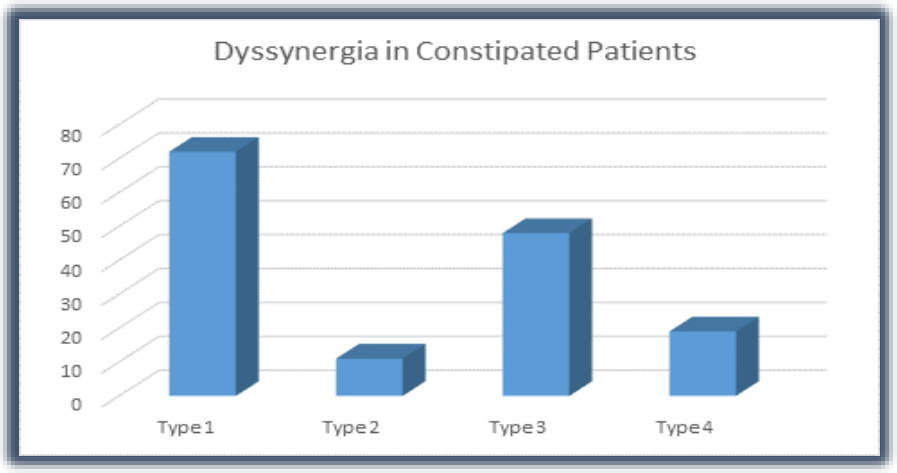


Figure 6. Dyssynergia types in constipated patients.

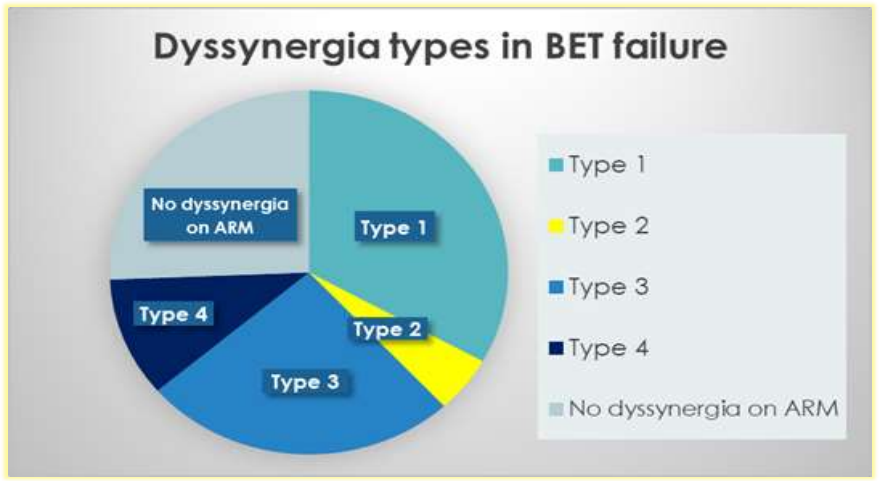


Figure 7. Dyssynergia types in patients with BET failure.

Results

We reviewed 348 patients. After excluding patients without constipation, 229 patients were evaluated. The mean age was 47.8 ± 16.7 years old, and the majority were female patients (192 - 84%). The mean anal squeeze pressure (ASP) was 148.8 ± 65.6 mmHg in the successful BET group and 162.4 ± 71.5 mmHg in the BET failure group and was not statistically different (p= 0.2111). Over half of patients failed the BET (160 - 69.8%). There were no patients with normal DI (≥ 1.5 mmHg [6]). DI values ranged between 0 and 1.46 (mean 0.48 ± 0.25 mmHg).

We examined sensation and urge as possible predictors of BET failure. The average values for first sensation when performing intermittent balloon filling were normal (26.5 ± 17.9 ml in succeeded BET and 24.4 ± 24.5 ml in failed BET) and were not statistically correlated with BET performance (p=0.109). For urge to defecate, the mean volumes were 56.0 ± 32.3 ml for the successful BET group and 56.8 ± 38.0 ml for BET failure group, which was not statistically correlated with BET performance (p=0.528). Therefore, neither sensation nor urge predicted BET performance.

The ARP was significantly higher in patients with BET failure (71.5 ± 20.6 mmHg) versus successful BET (61.9 ± 24.5 mmHg), p= 0.001. Meanwhile, the DI was significantly lower in patients with BET failure (0.44 ± 0.2 mmHg) versus successful BET (0.62 ± 0.2 mmHg), p<0.001. The ARP/BET and the DI/BET

comparison graphs are shown in Figure 4, and the ARM baseline parameters among the study cohort are listed in Table 2.

Specificity and sensitivity were calculated for several cutoff values of DI from 0.1 to 0.9 mmHg. The cut point with the greatest balance between sensitivity and specificity was < 0.47 mmHg, showing a specificity of 68.12% and a sensitivity of 61.88%, which was still not enough to highly predict BET failure.

Lower values of DI were more specific in predicting a BET failure. A DI ≤ 0.1 mmHg had a 97.1% specificity for BET failure and 99% when using a cut-off of ≤ 0.09 mmHg. The sensitivity in both these values of DI were below expected at 6.2% and 6% respectively. DI of 0.9 mmHg demonstrated higher sensitivity (82%), but with a specificity of only 18% for BET failure, it becomes less useful. DI=1.0 mmHg showed only 9% specificity. Some examples of studies with low and high DI are shown in Figure 5.

Dyssynergia types were also recorded, and Type 1 was the most prevalent diagnosis among constipated patients (72 – 31.4%). Eleven patients (4.8%) presented with dyssynergia type 2, 48 (20.9%) were classified as type 3, and only 19 (8.2%) had type 4 (Figure 6). Dyssynergia was more prevalent among those who failed BET versus those who had successful BET (74% vs 45%; p<0.001), and type 1 was also the most common dyssynergic pattern found in the group of BET failure (53 patients – 33.2%). However, a notable portion of patients who failed BET had no demonstrable dyssynergia on ARM (41 – 25.6%). In Figure 7, we display the range of types of dyssynergia found in patients with failed BET.

Discussion

ARM has been the most extensively used technique to evaluate pelvic floor dysfunction. ARM is recommended in the assessment of patients with constipation or fecal incontinence.[9]

The DI as described by Kang et al.[3] is a recto anal pressure gradient and is defined by the pressure difference between rectal and anal pressures taken over 2 seconds at the highest recto anal pressure gradient during pushing period. A study by Rao et al.[2] evaluated a group of 45 healthy adults undergoing ARM with a 4-cm-long latex balloon made from a latex condom (Trojan-enz, nonlubricated, Carter Wallace, New York, NY) tied to a 6-mm diameter probe. They concluded that the mean DI was higher than 2.0 in all 45 patients. They also observed a normal response to the BET in 35 (78%) individuals, showing us that healthy patients are more likely to have successful BET and higher DI. Although DI is

frequently measured, no study has yet demonstrated its clinical utility. Our study is the first to evaluate its clinical application and assess its role as a possible surrogate marker for BET.

Our retrospective study examined patients with complaints of constipation who underwent both ARM and BET. All patients had an abnormal DI below 1.5 mmHg. One patient had a DI between 1.4 and 1.5 mmHg (DI= 1.46 mmHg), and this patient had successful BET.

This study suggests that DI is a useful tool in predicting BET failure and the presence of dyssynergic defecation in patients with chronic constipation.

This study demonstrates that patients with a DI $\leq$ 0.1 mmHg have a high chance of BET failure (specificity 97.1%). Lower DI, dyssynergia and higher resting baseline pressures were associated with unsuccessful BET in patients with symptomatic constipation. A DI $\leq$ 0.1 mmHg can be highly predictive of a failed BET and suggests that BET may not be mandatory in this select group of patients.

Disclosures:

There are no disclosures for the present article.

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