

Article

In the Driving Seat with High-Resolution Ano-Rectal Manometry

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Abstract: Introduction: High-resolution ano-rectal manometry (HRAM), part of the investigative process to diagnose disorders of recto-anal co-ordination, is currently performed in the left-lateral position (LLP). This may seem unnatural for patients and recent data suggest that the seated, squatted position (SP) may improve rectal drive and recto-anal pressure gradients, raising the question as to whether defaecatory dyssnergia (DD) is over-diagnosed when the test is carried out in the LLP. Aim/method: A single centre study was carried out in patients with faecal incontinence and/or constipation to evaluate the effect of SP versus LLP on HRAM analysis and resultant manometric diagnosis of DD. Positioning was consecutive and the order was randomised for each patient. The HRAM protocol was carried out in accordance with the manufacturer's guidelines (Manoscan). Data analysis and interpretation were blinded with a consensus reached for each test position. Data (mean \pm SEM) were analysed using an unpaired *t*-test and Chi-square test. Results: In total, 40 patients completed the study, including 33 females with a median age of 56 (IQR 48–63). The mean rectal drive was significantly higher in the SP vs. LLP (82.6 \pm 5.3 mmHg vs. 44.1 \pm 3.9 mmHg, respectively, $p < 0.0001$). No difference in the anal sphincter relaxation pressure (66.7 \pm 5.7 mmHg vs. 70.9 \pm 5.5 mmHg, $p = 0.9535$) was detected. The manometric diagnoses of abnormal ano-rectal co-ordination were significantly higher in the LLP, when $p = 0.013$. Patients reported a significant preference for the seated position, when $p = 0.0001$. Conclusion: These data show that HRAM in the seated position improves rectal drive, which reduces manometric diagnoses of abnormal ano-rectal coordination. These findings may have important implications for practice and may inform future guidelines.



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1. Introduction

Dyssynergic defaecation (DD) is frequently observed in patients with chronic constipation, affecting up to 50% of this patient cohort [1]. It is characterised by uncoordinated abdominal and pelvic floor muscle activity, often with an underlying behavioural component [1]. During high-resolution ano-rectal manometry testing (HRAM), the normal recto-anal response to the bear down manoeuvre encompasses a rise in rectal pressure (>40 mmHg) and relaxation of the anal sphincter muscles, driving the evacuation of stool. In patients with DD, recto-anal co-ordination is absent.

Current guidelines for performing HRAM were recently established by the London classification [2]. This consensus document recommends performing HRAM in the left-lateral position (LLP) with flexed hips and knees. Using LLP and following current guidelines, the manometric diagnosis of defaecatory dyssnergia (DD) appears to be becoming increasingly more common in our laboratory. Moreover, lying in the LLP potentially impedes a patient's ability to increase the angle of defaecation (the angle between the rectum and the anus) because they are not able to adopt a 'squatted' position. Additional factors such as carrying out the bear down manoeuvre in the presence of physiologists may negatively impact study values due to fear of faecal or flatus excretion. This may impact



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a patient's ability to simulate defaecation, potentially leading to a false positive diagnosis of DD.

Previous studies assessing whether HRAM performed in the more physiological upright seated position (SP) provides a more valid assessment of ano-rectal function compared to the LLP have shown that, in healthy subjects, there is a significant reduction in the manometric diagnosis of dyssynergia from 36% (left-lateral position) to 20% (seated position) [3]. Osatakul et al. expanded on this by examining differences in ano-rectal manometric measurements in patients with constipation. In their cohort of 30 patients, they found the mean rectal pressure was significantly higher in the sitting position (15.3 mmHg vs. 27.6 mmHg, $p = 0.008$). There was, however, no significant difference between positions in the diagnosis of dyssynergia (lying 46.7% vs. sitting 56.7%) [4]. Several groups in recent years have investigated the impact of body position on parameters of recto-anal co-ordination. Recent studies demonstrate that the seated and squatted positions significantly improve the recto-anal pressure gradient through their impact on rectal pressure during the bear down manoeuvre in normal healthy volunteers [4,5]. Such results suggest that the SP leads to improved diagnostic accuracy when differentiating patients with the normal and prolonged balloon expulsion test and further studies have shown that DD is less prevalent in the SP in patients with chronic constipation [6–8]. Furthermore, the SP allows patients to perform valsalva manoeuvres during evacuation which has been shown to improve diagnostic accuracy of altered recto-anal coordination and dyssynergia in selected patients [9].

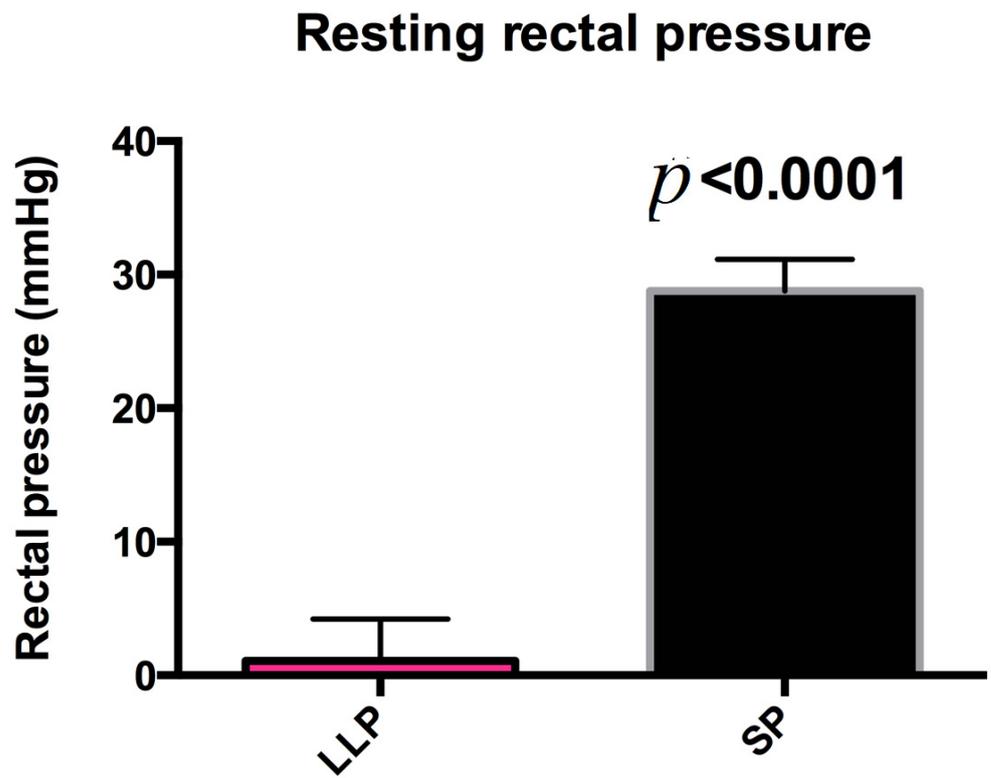
To further investigate whether positional change to the seated-squatted (SP) from left-lateral position (LLP) affects manometric measurements and clinically relevant outcomes for patients, we assessed the difference between these positions in consecutive HRAM analysis for patients with constipation and incontinence. In addition, we assessed patient's overall satisfaction with the study position.

2. Results

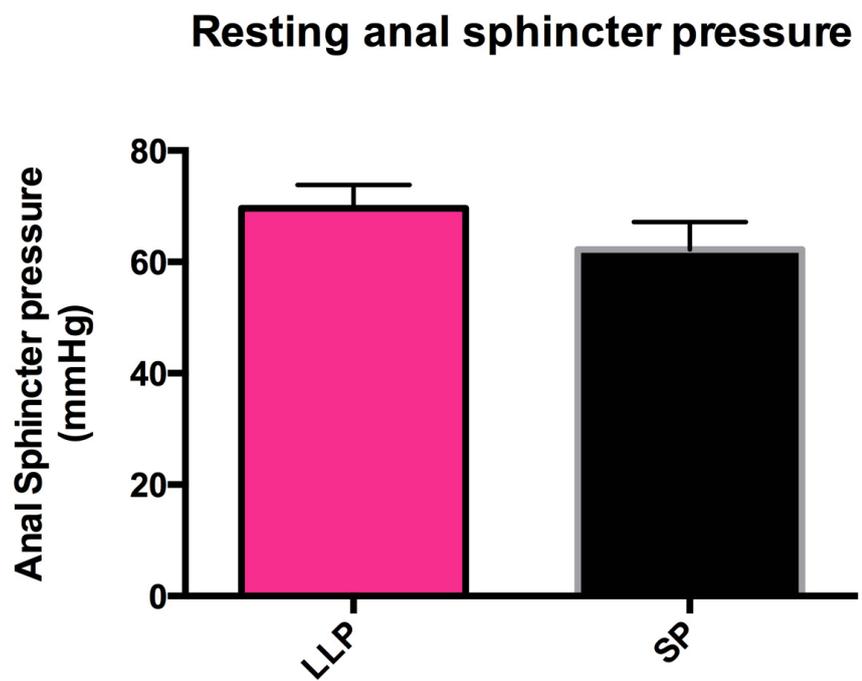
In total, 40 patients were analysed, 33 of which were female, and the median age was 56 years, with an inter-quartile range (IQR) of 48–63 years. The primary reasons for referral were faecal incontinence ($n = 26$), constipation ($n = 11$), faecal incontinence and constipation ($n = 2$), post infectious diarrhoea ($n = 1$). In addition, 76% (25/33) of female patients had an obstetric history of which 68% (17/25) reported obstetric injury. Notably, of the total 40 patients, 35 reported varying degrees of a constipation-related symptom burden according to the PAC-SYM (mild: $n = 6$, moderate: $n = 12$, severe: $n = 12$, very severe: $n = 5$).

2.1. Resting Ano-Rectal Pressures: Seated Position versus Left-Lateral Position

The mean resting rectal pressure was significantly greater in the seated position (SP) (28.8 ± 4.7 mmHg) versus the left-lateral position (LLP) (5.4 ± 1.3 mmHg) ($p < 0.0001$) (Figure 1a). The mean resting anal sphincter pressure was similar in the seated position (69.7 ± 4.1 mmHg) versus the LLP (62.2 ± 4.7 mmHg) (Figure 1b).

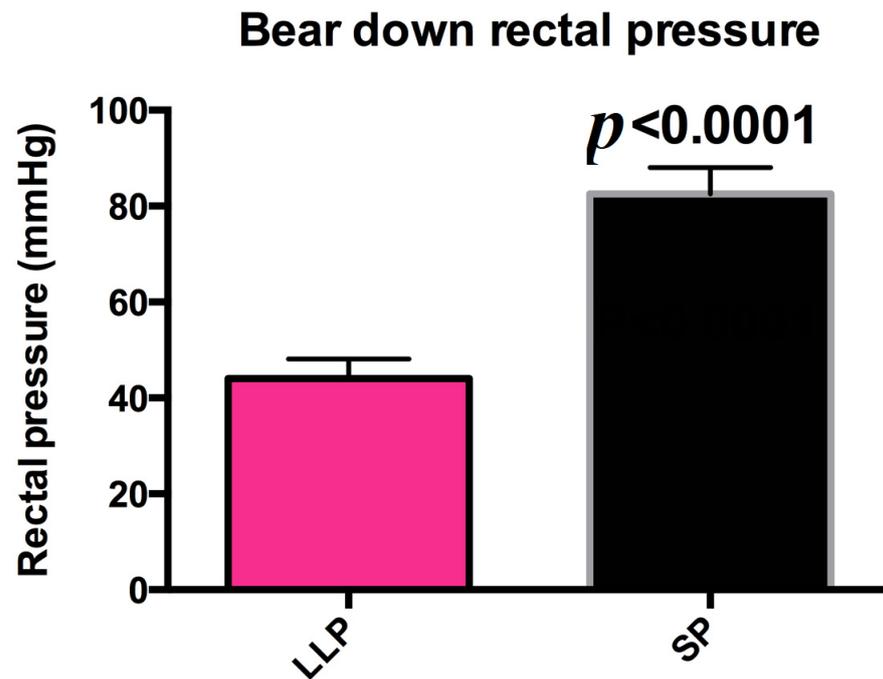


(a)

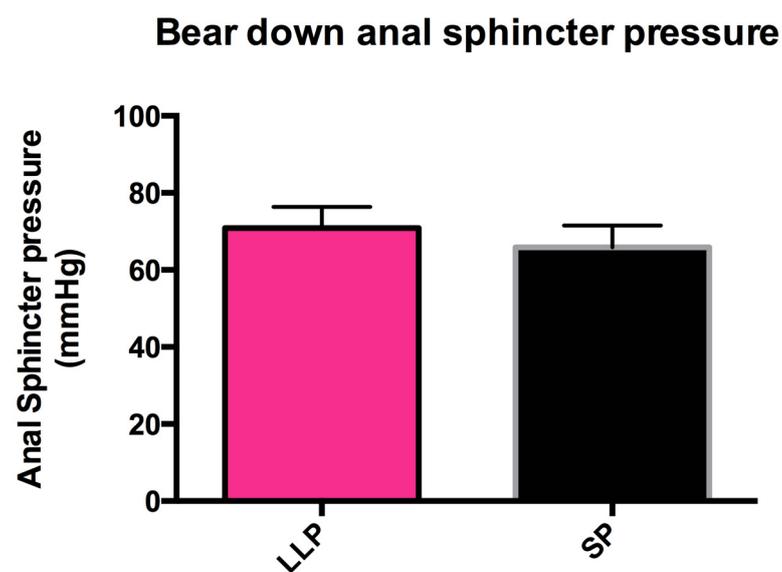


(b)

Figure 1. Cont.



(c)



(d)

Figure 1. (a) Resting rectal pressure in the left-lateral position (LLP) versus the seated position (SP). (b) Resting anal sphincter pressure in the left-lateral position (LLP) versus the seated position (SP). (c) Rectal pressure in the left-lateral position (LLP) versus seated position (SP) during the bear down manoeuvre. (d) Anal sphincter pressure in the left-lateral position (LLP) versus the seated position (SP) during the bear down manoeuvre.

2.2. Bear down Ano-Rectal Pressures: Seated Position versus Left-Lateral Position

The rectal pressure during the bear down manoeuvre was significantly higher in the SP (82.6 ± 2.3 mmHg) versus the LLP (44.1 ± 3.9 mmHg) ($p < 0.0001$) (Figure 1c). Anal sphincter pressure during the bear down manoeuvre did not differ significantly between the SP (66.7 ± 5.7 mmHg) and the LLP (70.9 ± 5.5 mmHg) (Figure 1d). Moreover, patients were able to increase rectal drive by a significantly greater order of magnitude in the SP ($5387.3 \pm 769.5\%$) versus the LLP ($2333.0 \pm 341.0\%$) ($p = 0.0047$) (Figure 2a). Furthermore,

the recto-anal pressure gradient was transformed into a positive value and significantly improved in the SP ($p < 0.0001$) (Figure 2b).

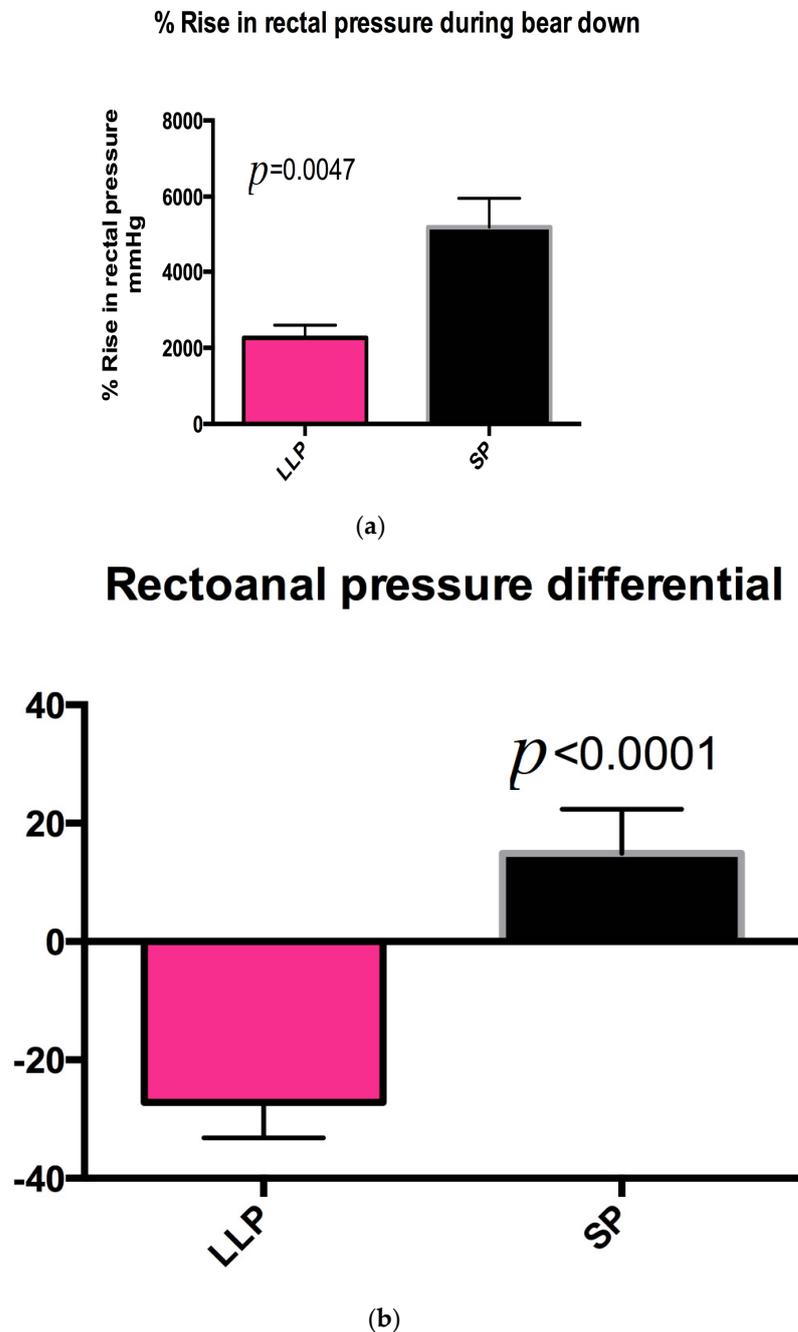
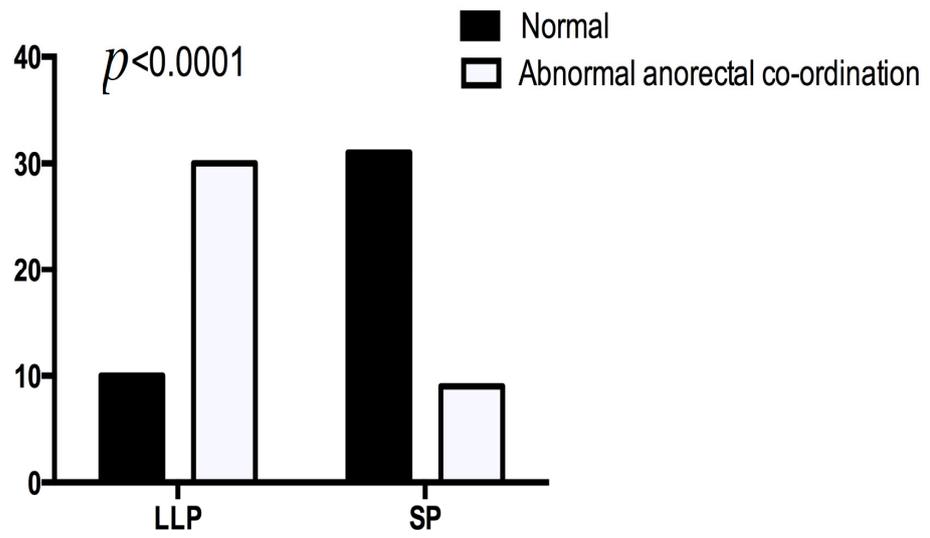


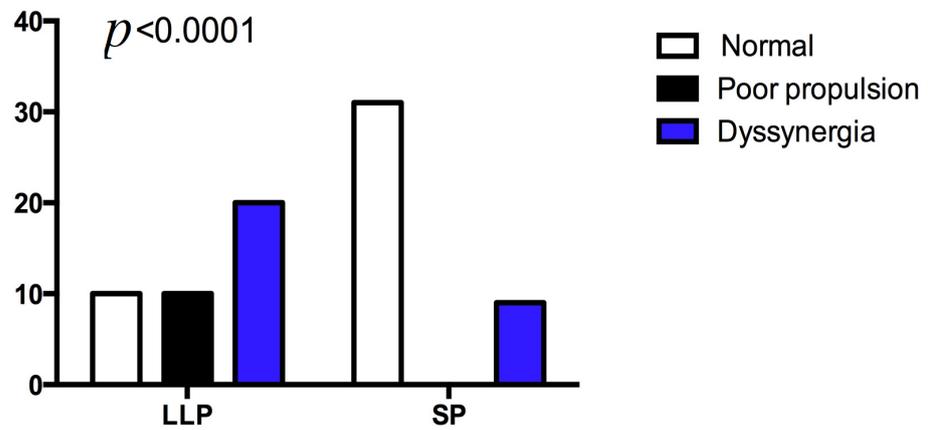
Figure 2. (a) The percentage rise in rectal pressure in the left-lateral position (LLP) versus seated position (SP) during the bear down manoeuvre. (b) Recto-anal pressure differential in the left-lateral position (LLP) versus seated position (SP) during the bear down manoeuvre.

2.3. Impact of Position on the Manometric Diagnosis of Abnormal Recto-Anal Co-Ordination

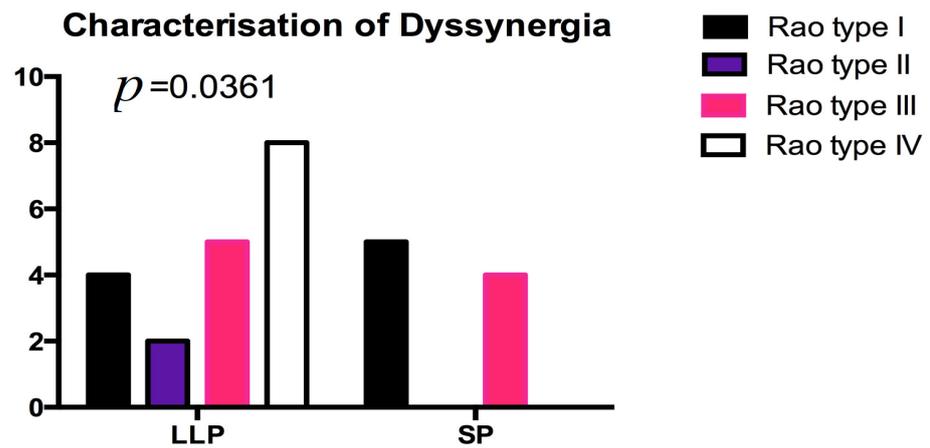
The manometric diagnosis of abnormal ano-rectal co-ordination was significantly higher in the LLP versus the SP ($p = 0.0013$) (Figure 3a). Furthermore, the manometric diagnosis of poor propulsion was completely nullified in the SP ($p < 0.0001$), demonstrating that bearing down in the SP significantly improves rectal drive (Figure 3b). Patient position also had an impact on the characterisation of dyssynergia, with Rao type II and IV dyssynergia non-existent in the SP (Figure 3c).



(a)



(b)



(c)

Figure 3. (a) The relative proportion of normal recto-anal co-ordination and abnormal recto-anal co-ordination in the left-lateral position (LLP) versus the seated position (SP). (b) The relative proportion of normal recto-anal co-ordination, poor propulsion and dyssynergia in the left-lateral position (LLP) versus the seated position (SP). (c) Characterisation of dyssynergia in the left-lateral position (LLP) versus seated position (SP).

2.4. Patient Preference for Carrying out the Bear down Manoeuvre

Patients reported a preference for the SP because they found it easier to carry out the bear down manoeuvre in that position ($p < 0.0001$) (Figure 4). The number of patients that found the SP more comfortable did not differ significantly from the number of patients that found the LLP more comfortable (Figure 4).

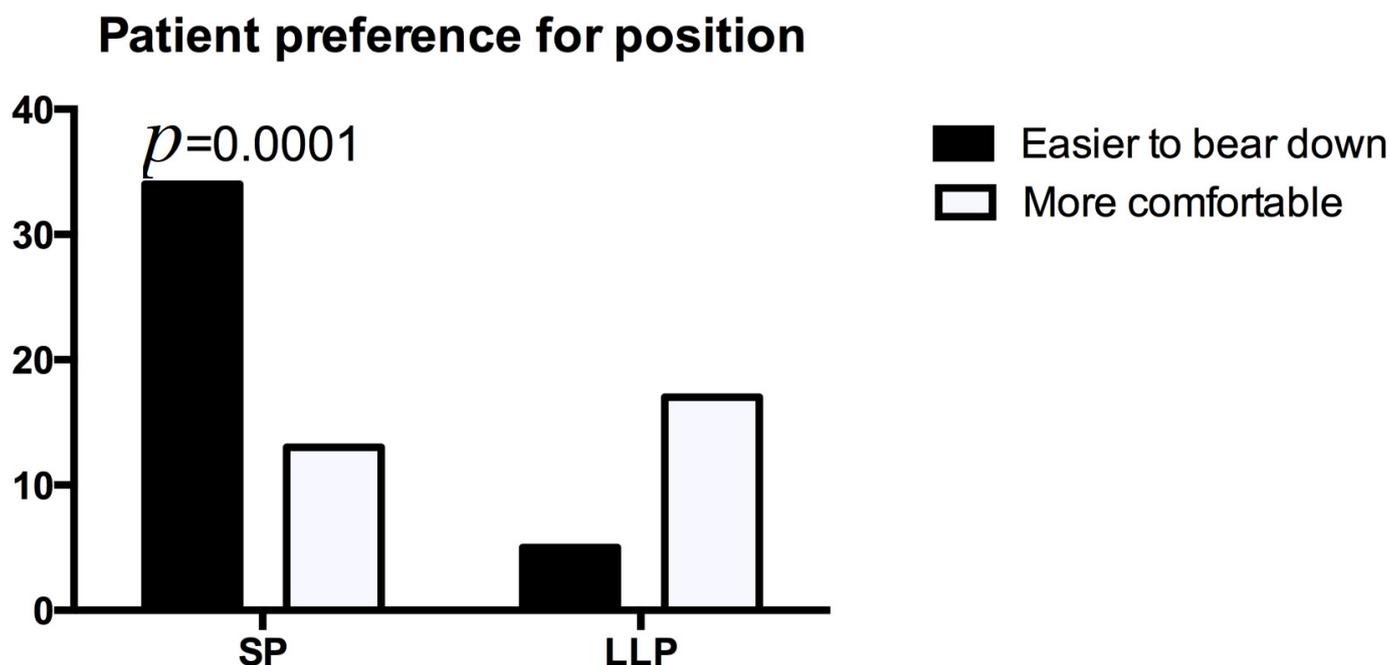


Figure 4. Patient preference for position during the bear down manoeuvre in the left-lateral position (LLP) versus the seated position (SP).

3. Methods

Individuals referred to our GI function unit to investigate anorectal muscle function for varying severity of constipation and faecal incontinence were invited and consecutively recruited to participate in the study. All participants provided written informed consent and the study was approved by the University affiliated Clinical Research Ethical Committee of the Cork teaching hospitals. Studies were performed at the gastrointestinal (GI) function lab in the Gastroenterology Department of the Mercy University Hospital, Cork, from October 2020 to October 2021. HRAM was performed using the standardised London protocol to measure ano-rectal resting pressures, ano-rectal squeeze pressures and ano-rectal pressures during simulated defaecation. These manoeuvres were consecutively performed in both the left-lateral and seated-squatted positions.

The squatted position was achieved by patients sitting on a commode with their knees positioned so that they are above hip level. A circumferential opening was made at the bottom of the commode to allow the insertion of the HRAM probe. Additionally, self-reported constipation status was assessed using a 'Patient Assessment of Constipation Symptoms Questionnaire' (PAC-SYM) [10]. The PAC-SYM questionnaire assesses the relative severity of patient-reported symptoms. It is a 12-item questionnaire and is segregated into three different symptom subscales (abdominal, rectal and stool) [11]. The results in the range of 0–4 are equal to the total score/no of items completed. Likert scales, with scores ranging from 0 to 4 (0 = symptom absent, 1 = mild, 2 = moderate, 3 = severe, 4 = very severe), are then used to score each question.

3.1. Procedure

HARAM catheters (Manoscan TM; 4.2 mm diameter) were used throughout the study. These catheters were calibrated in accordance with manufacturer's guidelines prior to use. The tip of the HARAM catheter was coated in lubricant gel prior to insertion. Patients were asked to lie in the left-lateral position (LLP) with knees bent toward their chest. The probe was inserted gently through the anal canal and into the rectum. Once the probe was placed, a stabilisation period of three minutes was allowed to facilitate acclimatisation of the muscles of the anal sphincter canal. Ano-rectal pressures were recorded for 20 s at rest and for 20 s during the voluntary contraction of the anal sphincter muscles (squeeze manoeuvre). The squeeze manoeuvre was performed three times with a 30 s recovery period between each attempt. Ano-rectal pressures were subsequently measured for a period of 20 s during the bear down manoeuvre, where patients were asked to simulate stool evacuation, with a 30 s recovery period between each attempt. Finally, rectal sensation was assessed by establishing thresholds for first sensation, urge and discomfort.

The balloon at the end of the anorectal manometry probe was used to perform the rectal sensory test. The balloon was inflated in increments of 10 mls up to a volume of 60 mls. If urge was not reported at 60 mls, a volume of 100 mls was applied. The London classification protocol was used as a guide for the rate of inflation.

The protocol as described above was contemporaneously performed in the squatted-seated position (SP) on a commode, which was specially modified to accommodate the probe lead and to allow the physiologist to hold the probe in place during the test. The patients were instructed to adopt a 'squatted' position, facilitated by patients placing their feet on an elevated extension of the commode which their knees above hip level. The sequence of SP and the LLP studies was randomised, and alternated, for each case.

A graphical example illustrating both positions can be seen in Figure 5.

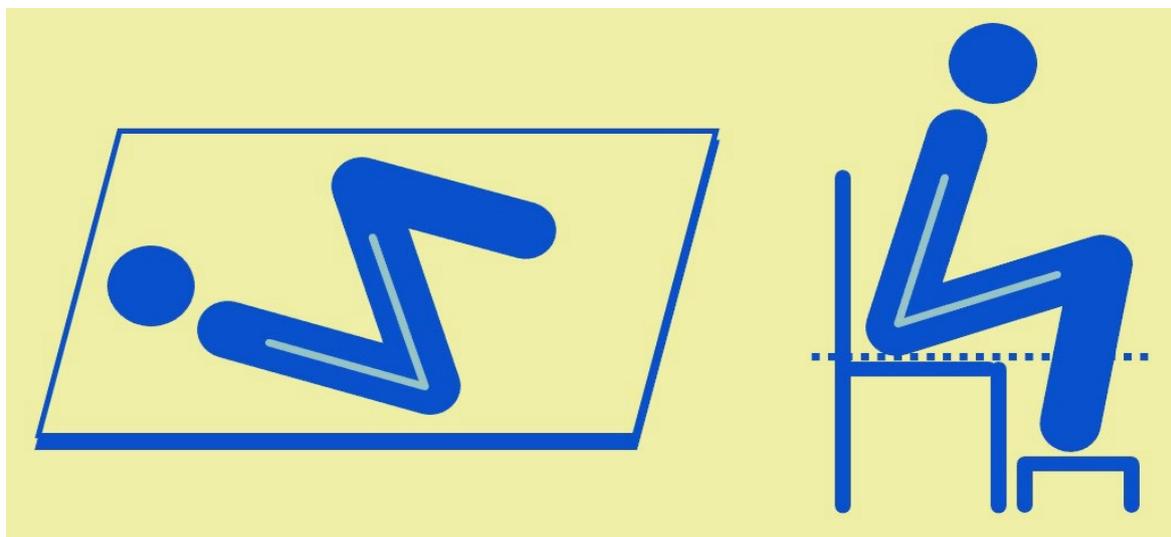


Figure 5. Left-lateral and seated position.

The procedures carried out during this study were analysed using Manoview AR v3.0, Medtronic Inc. Importantly, analysts were blinded to the patient's position during data analysis and interpretation. The London classification was adapted to classify abnormal ano-rectal co-ordination into poor propulsion, poor propulsion with dyssynergia and dyssynergia. The data were interpreted by independent reviewers with a consensus reached for each test result. Both the London and Rao classifications were used for the interpretation of recto-anal co-ordination in this study; see Tables 1 and 2 for definitions.

Table 1. Definitions of recto-anal parameters used in this study.

Parameter	Analysis
Resting anal sphincter pressure	Mean maximum anal pressure (sleeve 20 s).
Resting rectal pressure	Anal sphincter pressure, "Absolute reference"; anal sphincter pressure, "Rectal reference".
Bear down anal sphincter pressure	Average of the maximum anal pressure during the three second epoch when rectal pressure is at its highest. This value was then adjusted to mitigate the effect of resting rectal pressure in both positions.
Bear down intra-rectal pressure	Average of the maximum anal pressure during the three second epoch when rectal pressure is at its highest.
Recto-anal pressure gradient during bear down	Rectal pressure-anal pressure during bear down.
% Change in rectal pressure during bear down	$\frac{(\text{Bear down rectal pressure} - \text{resting rectal pressure}) \times 100\%}{(\text{Resting rectal pressure})}$
% Change in anal sphincter pressure during bear down	$\frac{(\text{Resting anal sphincter pressure} - \text{bear down anal sphincter pressure}) \times 100\%}{(\text{Resting anal pressure})}$

Table 2. The characterisation of recto-anal co-ordination used in this study.

Normal	No disorder of recto anal co-ordination
Poor propulsion	Rectal drive < 40 mmHg with sufficient anal sphincter relaxation
Dyssynergia	-Paradoxical anal sphincter contraction + normal propulsion (Rao type I) -Paradoxical anal sphincter contraction + poor propulsion (Rao type II) -Lack of anal sphincter relaxation + normal propulsion (Rao type III) -Lack of anal sphincter relaxation + poor propulsion (Rao type IV)

3.2. Statistical Analysis

Column statistics, with a Shapiro–Wilk test of normality, were initially obtained. A two tailed unpaired *t*-test was performed on data that were normally distributed and a two tailed Mann–Whitney U test was performed on data with a non-normal distribution. Data are reported as mean \pm SEM or as median and IQR, depending on the distribution. Chi-square statistics were used with qualitative data to determine patient preference for the LLP versus SP and to determine whether the position impacted the manometric diagnosis of abnormal recto-anal co-ordination.

4. Discussion

The main finding of this study was that the number of patients with a manometric diagnosis of abnormal recto-anal co-ordination was significantly reduced in the SP (Figure 3a). Interestingly, there was no evidence of impaired bear down rectal drive (<40 mmHg) in the SP. This has been shown previously among healthy volunteers [5]. As a direct consequence, the manometric diagnoses of poor propulsion and Rao type II and IV dyssynergia were completely eliminated in our study. Indeed, it was previously demonstrated, by Rao et al. in 2006, that performing a bear down manoeuvre in the SP with a distended rectum reduced the manometric diagnosis of dyssynergia [3,5]. Our data suggest that generation of appropriate rectal pressure to drive defecation is dependent on patient position. In addition, our data show that most patients found it easier to bear down in the SP, perhaps due to it being a more traditional position. Patients did not, however, find the SP more comfortable due to the quality of the available equipment and due to the presence of the physiologists who were required to hold the probe in place during the test.

Overall, our data suggest that a manometric diagnosis of poor ano-rectal coordination and propulsion may be over-diagnosed by carrying out the test in the left-lateral position. Our findings are supported by similar previous studies; however, further randomised controlled studies may be needed with a larger sample size to evaluate if the SP is the most appropriate testing posture when performing manometric analysis [4,5,12]. A concern

during the analysis was that rectal pressure radiating into the anal canal during the bear down manoeuvre may obscure anal sphincter relaxation in the SP. To control for this, resting rectal pressure was subtracted from anal sphincter pressure during the bear down manoeuvre. Though this method did not result in anal sphincter pressure being significantly lower in the SP compared with LLP, it did create a positive recto-anal pressure gradient (RAPG). The validity of RAPG as a metric of recto-anal co-ordination has been previously questioned as a negative value may undermine the diagnosis of disorders of recto-anal co-ordination [13]. Thus, in our study, we controlled for this by removing the impact of rectal pressures on anal canal pressure during the bear down manoeuvre.

A limitation of our study is that the balloon expulsion test (BET) was unavailable at the time; therefore, the London classification could not be fully applied, and our findings are limited to manometry and satisfaction analysis. Prolonged BET is increasingly being recognised as an independent variable for diagnosing defecatory dyssynergia in constipated patients [14].

The small sample size of ($n = 40$) that may have introduced a degree of selection bias is another limitation of this study.

A further potential limitation was that testing in both positions was carried out contemporaneously, potentially leading to patient fatigue. To mitigate this, the order of testing was randomised to ensure variability in sequence. Finally, all patients recruited to this study had symptoms of faecal incontinence, constipation, or both. Thus, this study does not include data from healthy controls.

The recent London classification has allowed standardised approaches to characterising disorders of ano-rectal co-ordination using HRAM [2,6]. There remains, however, uncertainty whether ano-rectal manometry in the LLP or SP improves accuracy in characterising disorders of recto-anal co-ordination, with some favouring the more physiological SP [3,5,6,8]. The scope of the present study was to determine whether the seated-squatted position had an impact upon the metrics of anorectal muscle function and co-ordination. Our data suggest that the upright SP may reduce the manometric diagnosis of abnormal recto-anal co-ordination, which may impact future diagnostic algorithms and patient management. Future studies may help establish normative data for rectoanal pressures in the more physiological seated-squatted position among healthy controls, which, in turn, may allow for more robust definitions of seated-position ano-rectal outflow disorders for clinical application.

5. Conclusions

The data from our study demonstrate that the more physiological seated position reduces the manometric diagnosis of abnormal ano-rectal co-ordination. This is notable as each participant acted as their own control, as the sequence of testing alternated for each subject to reduce patient fatigue bias. Our findings are predominantly influenced by improved rectal drive in the seated versus the left-lateral position. Notably, anal sphincter pressures and relaxation did not differ significantly between LLP and SP despite correcting for rectal pressure encroachment on the anal canal during the bear down manoeuvre. However, this correction significantly improved the RAPG in the SP, making the RAPG positive and thereby more in keeping with accurate rectal drive. Importantly, these data may help future guidelines in improving the accuracy of manometric diagnoses for patients with ano-rectal disorders. Performing ano-rectal manometry in the SP may be required as a standard of care for HRAM to allow further clinical application of the results.

Author Contributions: M.N., J.O. (Julie O'Neill), L.Q., L.N., J.O. (John O'Grady) and M.B. were involved in the study design, data collection and interpretation as well as drafting of the manuscript. J.O. (Julie O'Neill) carried out the majority of data interpretation. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the University affiliated Clinical Research Ethical Committee of the Cork teaching hospitals (Ethical Approval Number: 'ECM 4 (aa) 14/01/2020 & ECM 3 (ff) 11/02/2020').'' for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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