# Manometric Tests of Anorectal Function in Healthy Adult Thai Subjects

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***Background and Objectives :*** *Diseases of the distal gastrointestinal tract are becoming more common among Thai people especially in the elderly. Manometry is a new and useful technique in the diagnosis and management of anorectal disorders. This cross-sectional study aimed to measure anorectal manometric parameters in normal Thai subjects.*

***Material and Method :*** *Thirty healthy Thai subjects (17 males and 13 females) were studied. They completed a questionnaire assessing their bowel function. A water-perfused manometric system with non-pull-through technique was used to monitor pressure in the rectum and anus. All subjects were asked to squeeze the anal sphincters, bear down, then blow up a party balloon. Rectal sensation and recto-anal inhibitory reflex were also assessed by intermittent phasic balloon distention. Simulated defecation or balloon expulsion test was also performed.*

***Result :*** *The study revealed the following anorectal manometric parameters. The mean with standard deviation of the resting, squeezed, and sustained squeezed pressures were 55.4 $\pm$ 15.3, 170.3 $\pm$ 81.7 and 109.3 $\pm$ 54.4 mm Hg respectively. Men had a longer anal sphincter ($p = 0.01$) and higher squeezed, and sustained squeezed pressures ($p < 0.001$) compared to women, while their resting sphincter pressures were similar. Threshold volumes for rectal sensation and desire to defecate were not different among male and female subjects, but the threshold for urgency to defecate was higher in men. The study yielded normal anorectal manometric parameters in Thai subjects. Some parameters vary with gender. It is difficult to compare these normal ranges in Thai subjects to those in Caucasians, as the number of subjects is rather small and the details of instruments and techniques always vary from lab to lab. The manometric findings in these Thai subjects create more understanding in anorectal physiology and can be used as a guideline for the investigation of anorectal function in a symptomatic Thai population in a motility clinic.*

***Keywords :*** *Anorectal manometry, Anal sphincter, Gender*

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Anorectal function can be assessed partly by anorectal manometry which measures anal sphincter function, rectoanal reflexes, rectal sensation, rectal compliance and intraluminal pressure changes when bearing down[1,2]. In patients who have defecation problems, tests of anorectal function are known to be useful and can influence the management of defecation disorders such as fecal incontinence and constipation[3,4]. Assessing anorectal function has been useful in screening for obstructive defecation and fecal incontinence derived from motor or sensory dysfunction. There are two major techniques in manometry or intraluminal pressure measurement: water-perfusion[3] and solid-state techniques[1,5]. Many types and sizes of catheters are used. The techniques are of difference in benefits and disadvantages, however both are still applied and accepted.

The two common disorders of anorectal motility-constipation and fecal incontinence-occupy

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extremes at either end of a continuum; although uncommon, patients can present with both disorders. During anorectal manometry, one can assess anal resting pressure, anal squeeze pressure, anal canal length, degree of inhibition of the anal sphincters, rectal sensation, rectal contractility, and the defecation dynamics. These anorectal physiologic tests provide a profile, take approximately one hour to perform, and help physicians to plan effective management-either medical approach including biofeedback or surgical treatment.

At present, Thai clinicians still have no general data of manometric parameters in either normal or diseased Thai subjects. Racial difference may affect anorectal manometric parameters due to anatomical, dietary and living style variations among different ethnic groups. Therefore, the study of anorectal manometry should be carried out in normal Thai subjects to yield baseline data for Thai physicians.

**Material and Method**

This study protocol was approved by the Ethics Review Committee on research involving human subjects, Faculty of Medicine Siriraj Hospital, Mahidol University. Informed consent was obtained from all subjects.

A total of thirty healthy (anorectal asymptomatic) subjects, 17 male and 13 female, were recruited. All female subjects were nulliparous. A 13-question questionnaire was used to screen for abnormal anorectal history and bowel functions. Blood glucose measurement kit was used. No subjects had their fasting blood glucose over 105 mg/dl (5.8 mmol/l).

Manometry was performed using a Mui Pump Systems manometer calibrated by trained assistants. This system was water-perfused with the rate of 0.3-0.45 ml/min. The manometer was connected to an amplifier and recorder, which in turn was connected to a computer. An adult anorectal side-hole assembly-8 plus 1 lumen catheter with balloon (A-E1-ASH-2) Dentsleeve Pty. Ltd. (Australia) was used.

On the day of measurement, the subjects came to the lab. Rectal (Unison ) enema was given for anorectal evacuation two hours before the tests. Blood pressure, pulse rate and capillary blood sugar were obtained before the tests. Each subject lay in the left lateral position with knees flexed. A lubricated probe was introduced into the rectum about 15 cm using non-pull-through technique. After a 10-minute run-in period, resting anal pressure was recorded. Subjects were asked to perform three separate maneuvers. Each maneuver was performed three times with at least 1-min rest between maneuvers. They were first instructed to squeeze the anus as tight and as long as possible, at least 15 seconds. Then a small party balloon was given to each subject to inflate by blowing air into it as hard and as long as possible. Then subjects were asked to bear down as if to defecate, on three separate occasions.

The rectal sensation and recto-anal inhibitory reflex (RAIR) were evaluated simultaneously by sequentially inflating the intrarectal balloon. The balloon was inflated with 10 ml of air initially and then at increments of 10, 20, 30 and 50 ml (to 10, 20, 40, 60, 100, 150 and 200 ml) to elicit subjective sensory responses. During this test, subjects were provided with a 10-score chart and asked to grade their sensation as followes: a transient or first sensation (sensory threshold), a constant sensation of fullness or bloating, a desire to defecate, urge to defecate (discomfort threshold) and maximum tolerable distension. The threshold volumes required to induce these sensations and the maximum tolerable volume were recorded. Then the balloon was deflated. Finally, it was inflated with 60 ml of air to evoke a desire to defecate[6]. Subjects were then asked to bear down once more. After this test, the manometry probe was removed.

***Statistical analysis***

All data were calculated by computer, using a SPSS program. All basic parameters such as resting anal sphincter pressure, anal squeeze pressure, and anal canal length were presented as mean plus and minus one standard deviation. Kolmogorov-Smirnov test was used to test the data distribution. Statistical comparisons for the gender and age differences of any two groups were run by Student's unpaired t-test for the data with normal distribution, and Mann-Whitney U test for those with non-normal distribution. Statistical comparisons for the gender and age differences of more than two groups were run by analysis of variance for the data with normal distribution, and Kruskal-Wallis H test for those with non-normal distribution. Statistical significance was assigned for P-value $< 0.05$.

**Results**

The mean age of the subjects is presented in Table 1 together with their weight and height. The

male and female groups were of the same mean age. The mean stool frequency was 6.6 per week (range 4-14) in both gender groups.

Maximum resting anal pressure, maximum squeeze pressure, and sustained squeeze pressure were calculated using the mean of the two highest pressures at any site in the anal canal (Table 2 and Fig. 1A). The anal sphincter zone was longer in males with a higher maximal squeeze pressure and sustained squeeze pressure compared to those of the female group.

The correlation test between the anal sphincter length and body height was done. It showed a slightly significant correlation (Pearson correlation coefficient, r = 0.401, p = 0.014).

All subjects showed an increase in intrarectal and sphincteric pressures in response to the increase in intra-abdominal pressure while they inflated a party balloon (Fig. 1B).

Threshold volumes for sensory perception of all subjects are presented in Table 3. Though the thresholds among men and women were not different for the first sensation and desire to defecate, the threshold volume for urgency to defecate was significantly higher in men.

The anal sphincter responses when bearing down as if to defecate are presented in Table 4. The normal relaxation response was seen in about half (53.3%) of the subjects. In about one third of the subjects (36.7%), an obstructive pattern of defecation was seen while one tenth (10%) showed no response at all.

In the simulated defecation test, all subjects were able to expel a 60-ml air-filled balloon without any difficulty. The balloon expulsion time was the same

**Table 1.** Age, weight and height of all subjects

| | All (n=30) | Male (n=17) | Female (n=13) |
|---|---|---|---|
| Age (year) | 32.0 10.7 | 32.9 13.2 | 31.2 6.6 |
| Weight (kg) | 59.4 13.8 | 65.8 14.5 | 51.2 7.0* |
| Height (cm) | 161.2 8.4 | 166.8 6.5 | 153.9 3.1* |

(mean SD, * = $p < 0.05$ comparing male to female)

**Table 2.** Manometric changes of anorectal parameters at rest and during squeeze

| | All (n=30) | Male (n=17) | Female (n=13) |
|---|---|---|---|
| Length of anal sphincter (cm) | 2.8 0.7 | 3.2 0.7 | 2.5 0.7* |
| Max anal rest pressure (mm Hg) | 55.4 15.3 | 57.4 16.7 | 52.8 13.4 |
| Max squeeze pressure (mm Hg) | 170.3 81.7 | 216.1 75.3 | 110.5 41.3* |
| Sustained squeeze pressure (mm Hg) | 109.3 54.4 | 141.5 48.9 | 67.2 24.1* |

(mean + SD, * = $p < 0.05$ comparing male to female)

**Table 3.** Threshold volume for sensory perception

| | All (n=30) | Male (n=17) | Female (n=13) |
|---|---|---|---|
| First sensation (ml) | 14.0 5.0 | 14.7 5.1 | 13.1 4.8 |
| Desire to defecate (ml) | 32.0 12.4 | 31.8 12.4 | 32.3 13.0 |
| Urgency to defecate (ml) | 140.0 51.7 | 164.1 44.2 | 108.5 44.1* |

(mean SD, * = $p < 0.05$ comparing male to female)

(A) Squeeze

(B) Party balloon inflation

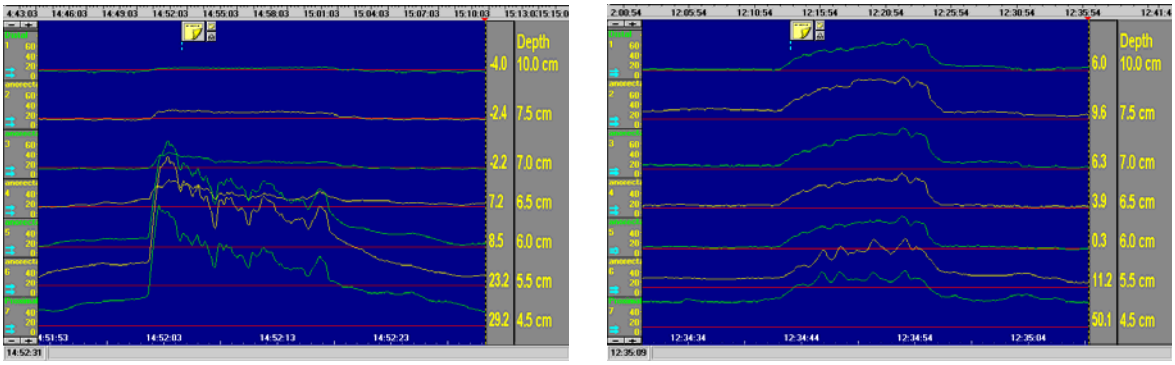


**Fig. 1** Manometric tracing showing a normal response during squeeze (A) and during party balloon inflation to increase the intra-abdominal pressure (B)

in both gender groups (men 16.2 ± 7.7 vs women 16.2 ± 5.8 sec, p = 0.993).

The manometric parameter comparisons between the age groups of 18-30 years and the 31-50 years are presented in Table 5. The anorectal function parameters were not different among the age groups of 18-30 and 31-50 years of either gender.

## Discussion

This study presents the most comprehensive investigation of anorectal function in 30 healthy Thai volunteers, using water perfusion technology and non-pull-through technique. Also, by using a catheter with multiple, closely spaced pressure transducers that span the known length of the anal sphincter, it is possible to estimate the length of the anal high-pressure zone without a pull-through.

The mean stool frequency was 6.6 per week or nearly once a day, a normal bowel habit no diarrhea no constipation[7]. The manometric finding showed that men had a significantly longer anal sphincter zone with higher maximal squeeze pressure and sustained squeeze pressure. So men seem to have a stronger mechanism of fecal continence compared to women. Rao SC et al in 1999[3] also indicated that the anal sphincter length in males was 4.0 cm (range 3.8-4.2 cm), slightly longer than the 3.6 cm length (range 3.4-3.8 cm) in females.

It has been suggested that, in females, sphincter defects could occur after vaginal delivery[8]. In this present study all female subjects were nulliparous. However, fecal incontinence does not depend totally upon the anal sphincter muscle strength. Although the true incidence of fecal incontinence is unknown, one study estimated the prevalence to be 4.2/1000[9]. Analysis of data from the Wisconsin Family Healthy Survey of 1993 revealed an incontinence rate of 2.2%[10]. The population groups at particular risk seem to be the elderly and institutionalized persons. Diabetes mellitus can cause diabetic neuropathy and autonomic disturbances which also affect the lower GI function. In the present study, all subjects were nondiabetic[11] at the time of the study proven by their postprandial plasma glucose.

The mean resting anal pressure in these thirty Thai subjects is 55 mm Hg (range 17-87 mm Hg). The pressure is lower than that reported by Timmoke AE[5] in American subjects in 1995, which showed a mean value of 88 mm Hg (range 43-164 mm Hg, n = 35), and Rao SC[3] in 1999, of 68 mm Hg (range 62-74 mm Hg, n = 45). The difference in pressure recorded might be

**Table 4.** Anal sphincteric response when bearing down as if to defecate

| | All | | Male | | Female | |
|---|---|---|---|---|---|---|
| | Frequency | % | Frequency | % | Frequency | % |
| Relaxed sphincter | 16 | 53.3 | 7 | 41.2 | 9 | 69.2 |
| Contracted sphincter | 11 | 36.7 | 8 | 47.0 | 3 | 23.1 |
| No response | 3 | 10.0 | 2 | 11.8 | 1 | 7.7 |
| Total subjects | 30 | 100 | 17 | 100 | 13 | 100 |

**Table 5.** Anorectal function of different gender and age groups

| | Male | | Female | |
|---|---|---|---|---|
| | 18-30 yr (n=10) | 31-50 yr (n=7) | 18-30 yr (n=7) | 31-50 yr (n=6) |
| Max anal rest pressure (mm Hg) | 58.7 19.2 | 57.2 13.5 | 54.1 14.2 | 51.3 13.6 |
| Max squeeze pressure (mm Hg) | 205.7 49.8 | 250.0 122.2 | 106.2 24.7 | 115.4 57.5 |
| Sustained squeeze pressure (mm Hg) | 133.9 29.4 | 163.9 80.9 | 62.0 16.9 | 73.2 31.0 |
| First sensation (ml) | 17.0 4.8 | 10.0 0* | 12.9 4.9 | 13.3 5.2 |
| Urge to defecate (ml) | 164.0 50.2 | 170.0 44.7 | 100.0 41.2 | 118.3 49.2 |
| Balloon expulsion time (s) | 16.7 7.8 | 13.4 6.2 | 15.7 7.6 | 16.7 3.2 |

(mean SD, * = p < 0.05 comparing 18-30 yr to 31-50 yr of the same gender)

due to many factors such as measurement technique and equipment, anatomical details, and psychosocial factors affecting subjects' embarrassment and co-operation.

The anal sphincter length measured in the present study correlated well with the body height. Jules in 1956[12] reported the intestinal length measured in living subjects swallowing a radio-opaque line and suggested that the length of the intestine correlated well with the individual's height.

This study found that the sensory thresholds for first rectal fullness sensation and desire to defecate were not affected by gender, but in females the volume that induced an urgency to defecate was significantly less than in males. This might suggest that females defecate at a smaller fecal volume due to a shorter bowel. Another possible explanation was that females were more conscious and embarrassed during the manometry procedure that they felt the urge at a lower volume.

With the party balloon inflation test, all subjects showed an increase in anal sphincteric pressure which is a generally normal response. During coughing, sneezing or blowing the nose, there is an increase in intra-abdominal pressure which activates a reflex increase in anal sphincter pressure[7].

When a subject is told to bear down (Valsalva maneuver) as if to defecate, the anal sphincter relaxation is expected. In the present study only half of all the subjects showed sphincter relaxation, one third of them came up with contracted sphincter (which may represent an obstructive pattern of defecation) while a few showed no change in sphincter pressure. This data indicates that this test is not a good test for sphincter function. Only in a private and suitable place that one should relax the anal sphincter as if to defecate. Due to embarrassment and anxiety, many people will try to keep their anal sphincter closed when they are told to bear down. Rao SC et al carried out a test of this same maneuver[3]. They found that, during bearing down in the lying down position, 22% of their healthy subjects exhibited an obstructive pattern of defecation. But when sitting on a commode, most subjects (95%) showed a normal pattern (sphincter relaxation). Hence, it is suggested that if a subject exhibits an obstructive pattern of defecation in the lying down position, it is important to repeat the maneuver in a sitting position.

Anismus is defined as failure of the striated pelvic muscles to relax upon straining[13]. The etiology is unknown but psychological factors may play a role[14]. Difficulties with childhood toilet training or traumatic events including sexual abuse in the past may contribute to these factors. On physical examination, an unyielding posterior bar of puborectalis muscle which does not relax on straining may be indicative of anismus. Defecography demonstrates a non-relaxing puborectalis muscle with incomplete rectal evacuation, an anorectal angle which remains acute and immobile pelvic floor which fails to descend with straining. In some patients, electromyographic (EMG) studies of the puborectalis muscle show paradoxically increased electrical activity; however, this is a finding in some healthy subjects without constipation[15]. In these patients a colonic transit study is indicated to exclude slow transit constipation.

The balloon expulsion test evaluates overall function of the pelvic floor. Healthy subjects voluntarily expelled a balloon filled with 50 ml of water within 1 minutes[3,13]. If a patient is unable to expel the device within 3 minutes, the clinician should suspect dyssynergic defecation[16]. In contrast, patients with anismus were unable to pass the balloon[17]. Some investigators found that intensive biofeedback training could induce normal defecation in these patients[18].

As gender influences anorectal function[19], the effect of age should also be examined. When the subjects were grouped by their age, no differences in major anorectal functions were found, except for the threshold volume of first sensation in males. However, a volume difference of 17-10 = 7 ml should bear no clinical significance. So it is likely that the anorectal motor activity and sensation remain the same in individuals in their third decade to their fourth and fifth decades of life. Since the number of subjects in each group was so small, no conclusion should be drawn. A larger number of subjects in different age groups should be studied to yield more physiologic data in Thai populations.

**Conclusion**

In the present study, anorectal manometry was performed in thirty healthy Thai volunteers without any adverse events and manometric data was successfully recorded. Some parameters showed a significant difference when comparing between male and female data. The information derived should be very useful for interpretation of manometric tests in a Thai gastrointestinal motility clinic. However, the number of subjects in this pilot study was rather small.

Further study with a larger number of subjects of different age groups or symptoms should be carried out in order to obtain more understanding in anorectal function or physiology in health and diseases.

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## *การตรวจการทำงานของไส้ตรงและทวารหนักโดยการวัดความดันภายใน ในคนไทยปกติ*

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***ความเป็นมา*** *: อาการท้องผูกหรือกลั้นอุจจาระไม่อยู่เป็นปัญหาที่พบมากขึ้นโดยเฉพาะในผู้สูงอายุ ทั้งยังตรวจหากลไกและรักษาให้หายขาดได้ยาก การวัดความดันภายในทวารหนักและไส้ตรง เป็นวิธีหนึ่งในการประเมินการทำงานของทางเดินอาหารส่วนปลาย และยังไม่เคยมีรายงานถึงการศึกษาเช่นนี้ในคนไทย*

***วิธีการ*** *: ตรวจการทำงานของไส้ตรงและทวารหนัก โดยการวัดความดันภายใน ในคนไทยที่ไม่มีอาการผิดปกติในระบบขับถ่าย 30 คนเป็นชาย 17 คนหญิง 13 คน ใช้เครื่องมือตรวจวัดความดันระบบท่อมีน้ำผ่าน (water perfused manometry) ในขณะนอนพัก ขณะขมิบก้น และขณะเบ่งเหมือนถ่ายอุจจาระ และประเมินความไวในการรับรู้ความรู้สึกในทวารหนัก เปรียบเทียบกันระหว่างชายหญิง*

***ผลการศึกษา*** *: ได้ค่าต่าง ๆ จากการวัดความดันภายในส่วนปลายของทางเดินอาหาร เป็นค่าเฉลี่ยพร้อมค่าเบี่ยงเบนมาตราฐาน ดังนี้ ความดันขณะพัก ขณะขมิบ และขมิบค้าง 15 วินาที ในอาสาสมัครทั้ง 30 คนเท่ากับ 55.4 $\pm$ 15.3, 170.3 $\pm$ 81.7 และ 109.3 $\pm$ 54.4 มม.ปรอทตามลำดับ พบว่า กล้ามเนื้อหูรูดทวารหนักในเพศชายมีความยาวมากกว่าเพศหญิง อย่างมีนัยสำคัญ และความดันบริเวณหูรูดขณะขมิบ และเมื่อขมิบค้างไว้นาน 15 วินาที ก็สูงกว่าในเพศหญิง โดยความดันในขณะพักใกล้เคียงกัน ความไวในการรับรู้ความรู้สึกในทวารหนักไม่แตกต่างกันระหว่างชายหญิง แต่ปริมาตรในไส้ตรงที่ทำให้รู้สึกปวดถ่ายเต็มที่ ในเพศชายมีปริมาตรมากกว่าเพศหญิง*

***สรุป*** *: การศึกษานี้ได้ค่าต่าง ๆ ของการวัดความดันภายในไส้ตรงและทวารหนักในคนไทยปกติ ซึ่งบ่งบอกถึงการทำงานของทางเดินอาหารส่วนปลาย ค่าบางค่าแตกต่างกันระหว่างเพศหญิงและเพศชาย ข้อมูลนี้อาจใช้เป็นแนวทางในการประเมิน วินิจฉัย และรักษาผู้ป่วยระบบทางเดินอาหารโดยเฉพาะโรคท้องผูก ในประเทศไทยต่อไป*