*Original Article*

# Comprehensive Evaluation of Fecal Incontinence: A Preliminary Report of Anatomical Neurophysiologic Study

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***Background:*** Fecal incontinence [FI] can lead to impaired quality of life and the prevalence is under-reported. The etiology is multifactorial. Careful clinical and neurophysiologic test is used to demonstrate the underlying problem. The objectives of this study are to demonstrate the systematic assessment of the subjects with FI and to compare the investigation findings of the FI group with healthy volunteers.

***Materials and Methods:*** Forty-three subjects with FI and 46 healthy volunteers were evaluated by history taking, physical examination, anorectal manometry, endoanal ultrasound and selective use of pudendal nerve terminal motor latency test [PNTML]. The results were compared.

***Results:*** By anorectal manometry, subjects with FI had significantly shorter high-pressure zone (1.7 vs. 2.3 cm), lower resting anal sphincter pressure (35.2 vs. 64.3 mmHg), lower maximal squeeze pressure (95.7 vs. 203.5 mmHg) and sustained squeeze pressure (74.3 vs. 121.3 mmHg) ($p$<0.001). Rectal hyposensitivity and hypersensitivity were found in 61% and 23% of the subjects, respectively. Rectoanal inhibitory reflex was absent in 7% and impaired in 23% of subjects. Cough reflex was impaired in 21%. Saline continence test was abnormal in 77% of FI subjects. By endoanal ultrasound, anal sphincter defect or scar was found in 86% of the FI subjects. Anal canal length was found to be significantly shorter in subjects with FI both in the anterior (12.4 vs. 30.4 mm) and posterior (20.1 vs. 35.9 mm) position ($p$<0.001). In 10 FI subjects that PNTML was performed, 6 subjects demonstrated either unilateral (3) or bilateral (3) pudendal neuropathy. Significant correlation between FISI and posterior anal canal length was observed (r = 0.512, $p$ = 0.015).

***Conclusion:*** Various information of anorectal function and anatomy in subjects with FI can be obtained by systematic approach. This information may be useful forthe management planning and patient education.

***Keywords:*** Anorectal manometry, Endoanal ultrasound, Fecal incontinence, Neurophysiologic test, Pudendal nerve terminal motor latency test

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Fecal incontinence [FI] is defined as an uncontrolled passage of fecal material recurring for at least 3 months in the person more than 4 years old[1,2]. Severity of FI has been shown to impact on lifestyle and quality of life[3]. The estimated prevalence of FI varied from 1.4 to 19.5%[4,5]. The high prevalence of stool incontinence has been reported in 46% of postpartum women[6] and in 46% of the institution-dwelling people in whom combined FI and urinary incontinence was 44%[7].

The pathophysiology of FI is usually multifactorial results of disruption of structure and function of anorectal units[8]. The anatomical units include rectum as a reservoir of fecal material, anal sphincter muscle, puborectalis muscle and anal endovascular cushion which acts as the gate keeper of the bowel[8,9]. Neurological structure which includes central nervous system, lumbosacral spinal nerve,

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pudendal nerve and autonomic nerves also play important roles in bowel control. Defects of these structures, either congenital or acquired, may result in ineffective bowel control. Impaired colon and anorectal function are other possible factors of FI. The examples are irritable bowel syndrome, malabsorption syndrome and dyssynergic defecation.

For successful management, detailed assessment for each patient is needed to understand the contributing factors in that individual[9]. Besides careful history taking and thorough physical examination including digital rectal examination, additional tests to evaluate anal sphincter, pelvic floor and rectal anatomy and function are usually required[10]. Anorectal physiologic testing, including endoanal ultrasound, anorectal manometry and pudendal nerve terminal motor latency, is useful in management planning[11].

Endoanal ultrasound [EAUS] is a useful tool to assess anal sphincter defect[10,12] and is the study that most likely changes patient's management plan[11]. Anorectal manometry [ARM], which consists of a series of measurements assessing anal sphincter function, objectively demonstrated internal anal sphincter function, external anal sphincter function, rectal sensation, rectoanal reflexes and rectal compliance[13,14]. It is the first-line investigation for the assessment of FI[13] to define the elements of dysfunction and guide management[12]. Magnetic resonance imaging [MRI] and other imaging modalities are inferior to ultrasound imaging in term of interobserver variability[12]. The availability and the cost of the tests also limits their use.

Pudendal nerve terminal motor latency [PNTML] test was considered only in some cases in whom pudendal neuropathy is suspected to identify if a weak sphincter muscle is due to muscle injury or nerve injury[15]. However, it is not a reliable predictor for the outcomes after surgical treatment[12]. The technique is operator dependent and therefore is not recommended for routine use.

While various groups in the West have established guideline for FI, there has been no study report about how the subjects with FI are assessed in Thailand. The authors would like to demonstrate the systematic approach of subjects with this condition. The objective of this study is to presence the preliminary data of anorectal physiology and anatomy of the subjects with fecal incontinence treated in the tertiary center,using basic neurophysiologic tests including EAUS, ARM and selective use of PNTML.

## Materials and Methods

Patients who visited the division of colorectal surgery with the symptoms of FI between January 2015 to December 2016 was comprehensively assessed by a thorough history taking, physical-rectal examination and neurophysiologic test including ARM, EAUS and selectively PNTML test. The anorectal physiologic results were compared with the values of healthy volunteers and is presented here.

Decision making and management plan is individually prescribed using the information from clinical and neurophysiologic tests. On-going follow-up results of the cohort will be present in the future studies.

### *Clinical assessment*

Fecal incontinence severity index score [FISI] was translated to Thai by permission of Vaizey et al[16]. Back translation was performed to check the accuracy of the information. The minimum score of 0 indicatesperfect continence and maximum score of 24 means total incontinence.

### *Anorectal manometry*

A customized, 8-sensor, water-perfused PVC probe with the side holes arranged radially at 0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.5 and 6.0 cm from the reference point (anal verge) is used together with the provided gastrointestinal motility software (Mui Scientific, Ontario, Canada; Medical Management Systems, Dover, NH). The probe has a small diameter of 3.9 mm with the non-latex balloon (maximum volume of 400 ml) situated at its tip (Figure 1).

The procedure was performed according to standards of ARM[17] with the subject lies in the left lateral decubitus position. The length of high pressure

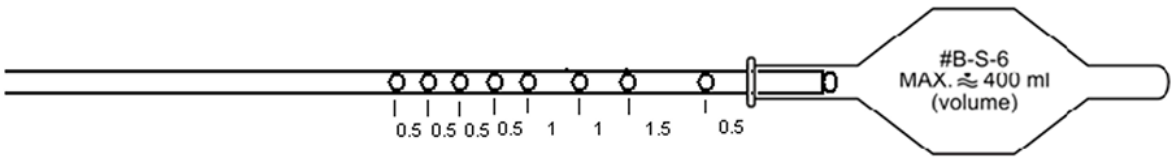


**Figure 1.** Customized water-perfused PVC anorectal manometry catheter.

zone, resting anal sphincter pressure, maximal and sustained anal squeeze pressures and defecation pattern were observed. Cough reflex and rectoanal inhibitory reflex were tested. Rectal sensation was noted for the threshold volumes required to induce 1) the first perception, 2) a desire to defecate, 3) an urgent desire to defecate, and 4) the maximal tolerable volume. If the subjects' complaint and the clinical evaluation suspected of dyssynergic defecation, balloon expulsion test wouldbe additionally performed.

Saline continence test or saline infusion test is performed by infusion of 750 ml of 0.9% of normal saline into the subjects'rectum via a 2-mm diameter feeding tube at the rate of 60 ml/min. The infused volume at when the first leakage occurred was noted and the leaked saline was collected in a graduated jar to calculated the total volume retained in the subject's rectum[17,18]. Percentage of saline retained was calculated from the formula: percent retention = volume of saline retained/volume of saline infused x100[18].

### *Endoanal ultrasound*

EAUS was performed with a rigid 360° rotational transducer (type 2050, 9 to 16 MHz, B-K Medical, Denmark)[19]. Anal sphincter defects and the length of anal canal were noted and compared with the value in healthy volunteer which had been retrieved in the previous study[20].

### *Pudendal nerve terminal motor latency*

In the subjects who were clinically suspected of the integrity of the circuit between the terminal portion of the pudendal nerve and the anal sphincter, PNTMLtest was be performed by disposable St. Mark's electrode mounted on the index finger of the examiner's[21,22].

### *Additional tests*

Colonoscopy was performed in the subjects in whom mucosal lesion was suspected and all subjects over 50 years old. Defecography and dynamic pelvic floor MRI were selectively used when complex intraabdominal surgical management was planned. Urodynamic study was performed by urologist in the subjects with coexisting urinary symptoms.

### *Management*

After the tests, each subject was seen in the clinic to discuss their treatment options, including conservative management, medical management and surgery. All will be scheduled for follow-up to assess the treatment results.

### *Statistical analysis*

Descriptive data was presented by mean $\pm$ standard deviation [SD], median, minimum and maximum. Comparison of mean between FI group and healthy volunteer group was performed using nonparametric test and Student's t-test. Correlation coefficient between FISI and EAUS findings and ARM findings were calculated. The $p$-value <0.05 was considered significant.

## Results

### *Subjects characteristics*

During the study period, there was 43 subjects with FI (M: F = 7:36) underwent complete anorectal physiologic evaluation. Forty-six healthy volunteers (M:F = 15:31) were previously enrolled. The mean age of the FI group was 49.8$\pm$18.6 years (range 21 to 89 years) and the healthy volunteer group was 46.5$\pm$12.9 years (range 17 to 78 years). There was no significant difference between groups in term of age ($p$ = 0.33). The median onset of FI was 2 years (range 3 months to 30 years). The mean FISI was 14 (range 6 to 21). Physical examination including digital rectal examination to identify the perianal sensation, anocutaneous reflex and anal sphincter defect were performed. From clinical history and physical examination, there was 24 subjects with urge incontinence (56%), 13 with total or passive incontinence (30%), 3 with fecal seepage (7%) and 3 with overflow incontinence (7%)[21]. There were 6 subjects (14%) with co-existing urinary incontinence. The median stool frequency ranges from 1 times per week to 10 times per day. Previous abdominal operation and anorectal operation are listed in Table 1. Twenty-four females had at least 1 vaginal delivery (range 1 to 5). Three subjects had instrumentation-assisted delivery, either forceps or vacuum. None of them had delivered the baby weight >4,000 g. Two patients had pelvic irradiation due to cervical cancer and low rectal cancer.

All subjects underwent ARM and EAUS. Ten subjects had PNTML tests. Four FI subjects had defecography and 3 had MR defecography. Three subjects had urodynamic study.

### *Anorectal manometry*

Manometric high pressure zone was significantly shorter in the subjects with FI when compared to healthy volunteer (1.7$\pm$0.9 vs. 2.3$\pm$0.7 cm, $p$<0.001). Resting anal sphincter pressure, maximal

squeeze pressure and sustained squeeze pressure were significantly lower in the subjects with FI. In the FI group, resting anal sphincter pressure, maximal squeeze pressure and sustained squeeze pressurewas 35.2±21.9 mmHg, 95.7±69.4 mmHg and 74.3±59.6 mmHg, respectively. In healthy volunteer group; resting anal sphincter pressure, maximal squeeze pressure and sustained squeeze pressure was 64.3±28.7 mmHg, 203.5±79.2 mmHg and 121.3±48.5, respectively (Table 2). Rectal sensation, if separately compared for each component, has no difference between FI and healthy volunteer subjects. However, when interpreted into perception, only 4 FI subjects had normal rectal sensation (9%). Twenty-six of this group had classified as rectal hypersensitivity (61%), 10 with rectal hyposensitivity (23%) and 3 (7%) with impaired rectal sensation.

Rectoanal inhibitory reflex [RAIR] was normally present in 33 subjects. Seven subjects (16%) have impaired RAIR which is the increased balloon volume needed to elicit the response. RAIR was absent in 3 subjects (7%). Cough reflex was normal in 34

**Table 1.** Characteristic of subjects with fecal incontinence

| | Fecal incontinence (n = 43) | Healthy volunteer (n = 46) | *p*-value |
|---|---|---|---|
| Age (mean ± SD) | 49.8±18.6 | 46.5±12.9 | 0.30 |
| Gender M: F | 7:36 | 15:31 | 0.66 |
| Underlying diseases DM/previous pelvic radiation/IBS | | | |
| Breast cancer | 6/2/31 | 0/0/0/0 | |
| Surgery | | | |
| Appendectomy/LAR/LC/LVR | 4/2/2/1 | 0/0/0 | |
| TAH/CS/TL | 4/3/1 | 0/4/0 | |
| Hemorrhoidectomy/Sphincterotomy | 2/2 | 0/0 | |
| AR abscess drainage/Debridement of Fournier's gangrene with colostomy | 1/3 | | |
| RVF repair/Correction of ArM | 3/1 | | |

ArM = anorectal malformation; CS = cesarean section; DM = diabetes mellitus; IBS = irritable bowel syndrome; LAR = low anterior resection; LC = laparoscopic cholecystectomy; LVR = laparoscopic ventral rectopexy; RVF = rectovaginal fistula; TAH = total abdominal hysterectomy; TL = tubal ligation

**Table 2.** Anorectal manometric findings in subjects with fecal incontinence and healthy volunteers

| Parameters | Subjects with FI | Healthy volunteers | *p*-value |
|---|---|---|---|
| High-pressure zone (cm) | 1.7±0.9 (0 to 4) | 2.3±0.7 (1.5 to 4.5) | <0.001 |
| Resting anal sphincter pressure (mmHg) | 35.2±21.9 (0 to 120) | 64.3±28.7 (22 to 172) | <0.001 |
| Maximal squeeze pressure (mmHg) | 95.7±69.4 (18 to 330) | 203.5±79.2 (85 to 405) | <0.001 |
| Sustained squeeze pressure (mmHg) | 74.3±59.6 (18-300) | 121.3±48.5 (48 to 299) | <0.001 |
| Rectal balloon volume needed to elicit sensation | | | |
| First rectal sensation (ml) | 28.8±38.5 (10 to 180) | 15.0±9.4 (10 to 50) | <0.001 |
| Desire to defecate (ml) | 60.6±69.8 (10 to 270) | 38.8±19.4 (10 to 90) | <0.001 |
| Urgency to defecate (ml) | 77.5±77.9 (10 to 300) | 63.5±27.5 (10 to 120) | 0.335 |
| Maximal tolerable volume (ml) | 90.6±77.9 (10 to 300) | 119.1±64.1 (40 to 300) | 0.093 |
| Saline continence test | | | |
| Volume at first leak (ml) | 123.8±153.5 (5 to 700) | 283.1±150.6 (50 to 500) | <0.001 |
| Total volume retained (ml) | 228.9±190.3 (0 to 660) | 639.8±157.7 (150 to 750) | <0.001 |
| Percent volume retained (%) | 57.9±32.3 (0 to 100) | 90.1±20.1 (20 to 100) | <0.001 |

Data are expressed as mean ± SD (range)

subjects and impaired in 9 subjects (21%).

Saline continence test was abnormal in 33 subjects (77%) found to be normal in 5 subjects. SCT was unsuccessfully performed in 5 subjects due to the presence of colostomy, anal discomfort and the subjects' physical limitation.

Nine subjects with complaint of obstructed defecation underwent balloon expulsion test. The prolonged expulsion time of more than 5 minutes (300 seconds) was considered abnormal. Median balloon expulsion time was 18 seconds (range 5 to >300 seconds). Four out of nine (44%) had abnormal balloon expulsion test.

### *Endoanal ultrasound*

Anal sphincter was examined for defect or scar in 3 parts; internal anal sphincter [IAS], superficial external anal sphincter [Sp-EAS] and subcutaneous external anal sphincter [Sc-EAS]. There were 6 subjects (14%) with intact anal sphincters, i.e. 37 subjects had at least one or more defects. Twenty-five IAS defects, 25 Sp-EAS defects and 20 Sc-EAS defects were identified. Seventeen subjects had defects and/or scar in all three parts. IAS defect alone was found in 5 subjects and Sp-EAS defect alone was found in 2 subjects. However, there was no subjects with Sc-EAS defect alone.The size of sphincter defects ranged between 10 to 90 degrees (median 50 degrees).

The anal canal length was measured in the anterior and posterior position. FI subjects had significantly shorter anal canal than the healthy volunteers (Table 3). Perineal body thickness was measured in female. The mean thickness was 0.74±0.33 cm (range 0 to 1.25 cm). Moderate correlation between FISI and posterior anal canal length was seen ($r = 0.512$, $p = 0.015$).

### *Pudendal nerve terminal motor latency test*

PNTML was performed in 10 subjects. Prolonged latency time of more than 2.2 milliseconds was considered abnormal[17,23]. Bilateral neuropathy was found in 3, unilateral left pudendal neuropathy in 3 and no neuropathy detected in 4 subjects. The mean conduction time was 2.04 and 2.46 milliseconds on the right and left side respectively. This ranged from 1.5 milliseconds to absent of evoked potential.

### *Additional tests*

There was no malignant disease or mechanical cause of FI detected by colonoscopy. Three subjects were planned for MR defecography and 4 were planned for defecography regarding to surgeons' request. Three subjects underwent urodynamic study. Results of the tests are beyond the scope of this study.

## Discussion

FI is a disturbing condition which leads to impaired quality of life[2,24,25]. The true prevalence trends to be under reported due to its awkward nature. In Thai population, the prevalence reported in the stroke rehabilitation registry was 7.6% for isolated FI and 33% for double fecal and urinary incontinence[26]. The duration of FI varied from 3 months to 30 years in our study. This may reflect that the etiology of FI is multifactorial[8,9] and the compensatory mechanism may be able to minimize the symptoms to a level that does not disturb their daily living for periods of time before they need medical attention[25]. The authors have used the Thai version of the developed incontinence score by Vaizey et al (St. Mark's score) which had been shown to correlate well with a detailed clinical assessment[16,27]. Quality of life assessment which is a complex measurement process is beyond the scope of the current study.

Comprehensive and systematic assessment including detailed history, severity score grading and neurophysiologic evaluation are needed to demonstrate the pathophysiology of the symptoms in each individual patient[12,28]. History taking can classify the type of FI according to the leakage pattern into (1) urge incontinence (leakage despite active attempts to retain content) (2) passive incontinence (involuntary leakage without any awareness) (3) fecal see page (leakage of stool with grossly normal continence and

**Table 3.** Endoanal ultrasound findings in subjects with fecal incontinence and healthy volunteers (mean ± SD, (range))

| Parameters | Subjects with FI | Healthy volunteers | *p*-value |
|---|---|---|---|
| Anterior anal canal length (mm) | 12.4±4.1 (6.5 to 22.5) | 30.4±7.5 (17.7 to 54.8) | <0.001 |
| Posterior anal canal length (mm) | 20.1±7.7 (8.3 to 39.5) | 35.9±5.7 (25.8 to 54.7) | <0.001 |

Data are expressed as mean ± SD (range)

evacuation[9,29] and overflow incontinence (leakage of liquid stool in the presence of impacted liquid stool. The possible etiology including previous pelvic and anorectal surgery, previous spinal cord injury, underlying diabetes and obstetric history in female were reviewed[12,29]. There may be more than one contributing factors. A detailed physical examination, including inspection, digital examination and anoscopy, is an important part of the evaluation[12,21]. Perianal complication from fecal irritation, scar from previous vaginal delivery, anorectal surgery or trauma can be detected. Digital palpation can assess the resting anal sphincter tone, length of the anal canal, integrity of the puborectalis sling, anal squeeze tone and stool consistency. Also, the defecation mechanism can be assessed to identify the subjects with dyssnergic defecation[30].

Anorectal physiology testing (manometry, rectal sensory testing and volume tolerance) can help define the elements of the dysfunction and guide management[12,28]. Currently, the probe we used is the PVC, water-perfused probe which cost less and easy for maintenance. The pressure values obtained by the 3D-high-resolution manometry correlated well with this conventional manometry[31]. In the future, this machine may be replaced by high-resolution manometry[9]. The area of high-pressure zone is related to the length of the functioning anal sphincter at rest. We found a significantly shorter length of high-pressure zone in FI group than healthy volunteer group. Resting anal sphincter pressure and anal squeeze pressure were also decreased in the subjects with FI compared to healthy volunteer. The manometric findings do not correlate with the severity of FI or prediction of outcomes but they may influence the management strategies in the individual[12]. For example, the subjects with dyssynergic defecation and overflow incontinence may be benefit from biofeedback training[12,28]. Subjects may also benefit from muscle strengthening and rectal sensory training in the presence of abnormal rectal sensation[32]. Rectal sensory testing in the current study revealed only 4 subjects with normal rectal sensation. Ten subjects with rectal hyposensitivity and 3 subjects with impaired rectal sensation. Rectal hyposensitivity is defined as elevation of sensory thresholds beyond normal range in at least one of the sensory thresholds[33]. Abnormal rectal sensation is present in 10% of subjects with FI and 27% of subjects with FI associated with constipation[33]. For rectal hypersensitivity which could be found in the patients with urge incontinence[34]. However, it is possible that the hypersensation of the rectum in the subjects with FI may occur as the protective mechanism of accidental fecal leakage and the rectal hypersensitivity itself was found to be the independent risk factor for FI[35].

RAIR is the initial part of the sampling reflex which is important to the discrimination of the nature of rectal contents. It involves enteric nervous system, internal anal sphincter and sacral spinal neural arc. The absent of reflex can be seen in the presence of autonomic neuropathy, the loss of myenteric plexus ganglion cell and atrophy of internal anal sphincter[36]. The impaired anal sensation can also lead to defective sampling mechanism, which is probably contribute to the pathogenesis of FI[13]. In this study, 16% of the subjects has impaired RAIR and 7% has absent RAIR. Cough reflex also involves neuromuscular connection circuit to prevent the fecal leakage during increased intraabdominal pressure. In our study, impaired cough reflex was present in 21% of subjects with FI.

Saline continence test [SCT] is used for overall assessment of rectal accommodation and ability to maintain continence with liquid stool[21]. In the current study, the subjects with FI significantly failed to retain liquid in their rectum when compare to healthy volunteers. The benefit of SCT is that it can be repeat at the other time, such as after a period of treatment. Thus, objective improvement can be assessed.

EAUS is a useful and sensitive tool in detection of anal sphincter defects[12,28]. Other imaging modalities such as MRI and dynamic MRI have some limitation in the accuracy of interpretation and cost but may provide additional information where EAUS is unavailable[12] or in the study of functional outcome after surgery[28]. Defecography has been proven for accuracy and specificity in diagnosis of FI. However, limitation occur in severe FI where the ability to retain contrast is poor.In this study, only 6 subjects (14%) had intact anal sphincters while others have at least one location of internal or external anal sphincter defect or scar. We also demonstrated the significantly shorter anal canal length in the FI group when compare to healthy volunteer both anteriorly and posteriorly. For a patient with anterior anal sphincter defect from obstetric injury or a large external anal sphincter defect from previous surgery or trauma, sphincteroplasty may be appropriate.

PNTML measured the conduction time between the terminal portion of the pudendal nerve to the anal sphincter. The normal latency time indirectly infer to the integrity of the circuit. Pudendal neuropathy is reported in up to 70% of patients with FI[28]. In this

study where we selectively use PNTML in the subjects highly suspected for neuropathy, bilateral and unilateral pudendal neuropathy was found in 7 subjects (16%). The routine use of PNTML has been argued because it does not directly show the neurological damage as the needle EMG. It may underestimate the nerve damage since the latency time reflects the function of the most rapidly conducting nerve fiber and the results did not correctly predict the treatment outcomes[23,28]. More novel nerve conduction test using translumbar and transsacral magnetic stimulation to induce motor evoked potential had been reported to be safe and well tolerated and may be used in the future[37].

The authors have demonstrated the use and the results of the tests i.e. ARM, EAUS and the selectively used PNTML test in the assessment of subjects with FI by comparing the group with the healthy volunteers. With combination of simple and available neurophysiologic test including these 3 tests, physicians would be able to define the defective mechanisms that may contribute to FI in each subject. The integration of the information is valuable for treatment planning which may involve multi-disciplinary team. Also, it is important to inform the patient about his or her continence mechanism and how the treatment will work for them.

The limitation of our study is that it is only a preliminary report of the test results and have not correlated the findings with the treatment decision making or the treatment outcomes. The authors believe that the integrated information is useful for management decision making[38]. To answer these questions accurately, we need to follow the cohort for periodand perform further analysis.

## Conclusion

Systematic assessment of fecal incontinence includes detailed history taking, careful physical and rectal examination and appropriate neurophysiologic test mainly ARM, EAUS and selective use of PNTML test. This study demonstrated various pathology detected in the subjects with fecal incontinence when compare to healthy volunteers.

## What is already known on this topic?

Anatomical and neurophysiologic test is necessary for assessment of subjects with fecal incontinence.

## What this study adds?

This study has demonstrated a systematic assessment of subjects with fecal incontinence, presents preliminary data of these subjects in Thailand and the comparative results with healthy volunteers.


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## Potential conflicts of interest

None.

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