

Endosonography of the puborectalis muscle- interobserver comparison of the anal and vaginal ultrasonography

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Background. The aim of this study was to compare the anal ultrasonography (AUS) and transvaginal ultrasonography (TVUS) and also the interobserver variability assessment in the above comparison of visualization and dynamic activity assessment of the puborectalis muscle (PR).

Patients and methods. AUS and TVUS were performed in 25 women aged 20-72 years (median age 42). All examinations were performed by Bruel and Kjaer system, using a 7.0-MHz rotating endoprobe covered with a water-filled hard cone. All women were examined by two operators and AUS and TVUS were performed in each case.

Results. In 15 out of 25 women (60%), a better definition of the PR was achieved in TVUS than in AUS. Both observers agreed with these findings. In the assessment of the PR function a discrepancy between the two methods and the two observers was found: in 4 women by both observers (16%) and in an additional 3 women by observer 1 (28%). In all these cases, the PR function appeared to be better in TVUS than in AUS.

Conclusions. AUS and TVUS enable assessment of the morphology and dynamic activity of the PR. In the majority of cases (60%), the PR was better visualized by means of TVUS than in AUS. In the assessment of the PR function, both methods were inconsistent in 7 cases (28%) by the operator 1 and in 4 cases (16%) by the operator 2. In all these cases, TVUS showed a better PR function than AUS. In 3 cases (12%), we found the interobserver disagreement in the PR function assessment.

Key words: anal ultrasonography; vagina – ultrasonography; puborectal muscle

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Introduction

Anal ultrasound (AUS) enables accurate assessment of the anal sphincters and is a useful method in the diagnostics of patients with different pathologies of the anal canal, including fecal incontinence. In addition to the visualization of the internal anal sphincter, the anal ultrasound allows the assessment of the morphology and contraction activity of the striated muscles of the anal canal, including the puborectalis muscle (PR).^{1,2} AUS also supplements other traditional tests for the assessment of muscle contractions such as: electromyography (EMG), manometry and pudendal nerve terminal motor latency (PNTML).³⁻⁵ The visualization of the anal canal is also possible after introduction of the endoanal probe into the lumen of the vagina.⁶⁻⁸ The assessment of the deep part of the anal canal, representing the PR location, is then possible. The PR muscle loops around the posterior wall of the anal canal and, during contraction, creates a sharp angle between the rectum and the anal canal. It is this angle, together with the annulus anorectalis, that is considered to be among the most important factors responsible for gas and feces continence.⁹

The aim of this study was twofold:

1. a comparison of the transvaginal ultrasound (TVUS) and AUS with the use of the same anal endoprobe, and
2. an assessment of the interobserver variability in the above comparison of visualization and dynamic activity assessment of the puborectalis muscle.

Material and method

Ultrasonography was performed on a group of 25 women aged 20-72 years (median age 42). Eighteen women were multiparous and 7 nulliparous. Four women had Crohn's Disease (CD), 3 suffered from ulcerative colitis

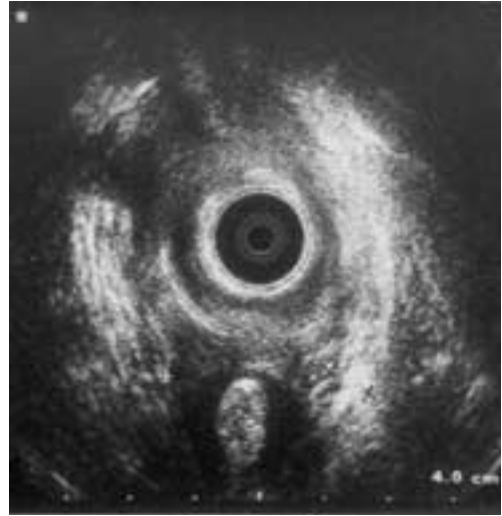


Figure 1a. Transvaginal endosonography with the use of axial endoprobe: resting image showing the loop of puborectalis (between crosses).

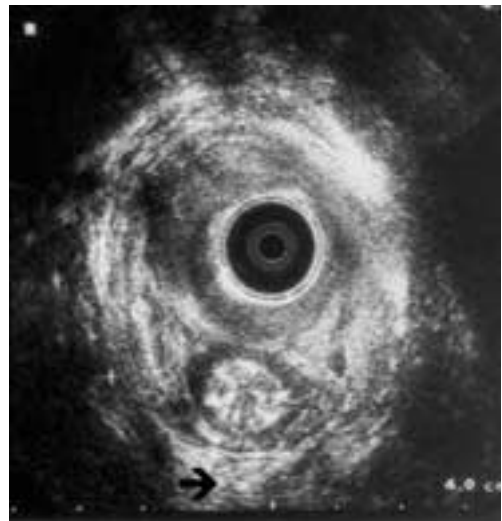


Figure 1b. Transvaginal endosonography with the use of axial endoprobe: image during contraction showing distinctly contracted puborectalis (between crosses), with well visible posterior aspect of the muscle (arrow).

(UC), 2 had ileostomies because of UC, 1 had ileostomy because of CD and fecal incontinence after the delivery complicated by a third degree tear and recto-vaginal fistula, 1

had colostomy because of rectal adenocarcinoma, 2 suffered from constipations, 1 had a third degree tear after delivering a 4000 mg baby. The 11 remaining women did not suffer from any disturbances nor had a history of obstetric trauma or any surgery.

Eight of the 25 women were incontinent: 1 nulliparous with UC for gas and 7 for gas and feces, including both women with the history of the perineal tear, 2 with UC and 3 other who were multiparous.

To analyze the interobserver variability in the assessment of the PR contraction in TVUS and AUS, a study was designed with two doctors (observers). Each patient was examined by both of them. Before the study, they agreed on the examination procedure. All examinations were performed in the left lateral position. No bowel preparation was made. A Bruel and Kjaer ultrasound scanner type 1846 (Naerum, Denmark) was used. It was equipped with the 7.0 MHz rotating endoprobe with the focal range of 2-5cm and covered with a hard sonolucent plastic cone (external diameter 1.7 cm) and filled with degassed water.

First, the probe was introduced into the lumen of the vagina. Second, AUS was performed. Each time, the PR echotexture, outlines and dynamic activity were assessed.

The defect within the PR was defined on the basis of visualization of the hypochoic area within the normal striated PR architecture and comparison with the opposite branch of this muscle. The muscle's outlines were assessed as distinct or not well visible. The dynamic activity of the muscle was assessed according to a subjective scale as lack of, poor or good (well visible) contraction. It was assessed on the basis of the comparison between the images of the PR taken at rest and during the maximal contraction.

The results of the TVUS and AUS performed by the two doctors were analyzed and compared retrospectively. The degree of agreement between the radiologists separately for

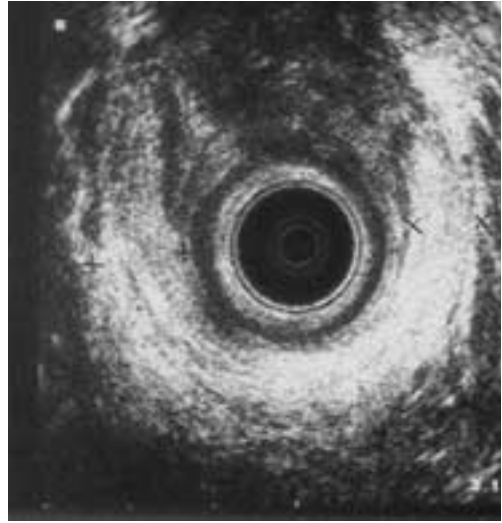


Figure 2a. Anal ultrasonography with the use of axial endoprobe: resting image showing the loop of puborectalis (between crosses).

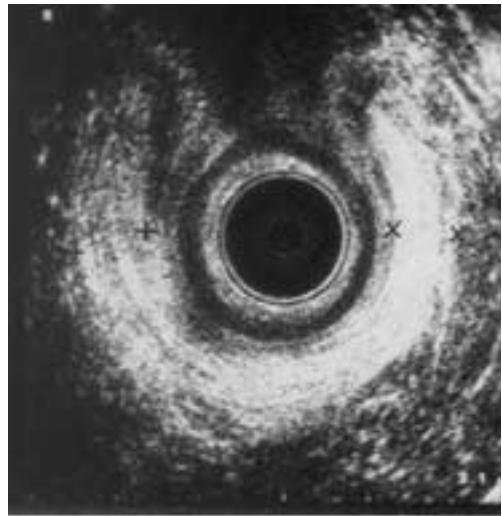


Figure 2b. Anal ultrasonography with the use of axial endoprobe: image during contraction without noticeable reaction of the muscle (the same patient).

AUS and TVUS was quantified. The percentage of the patients in the study on whose results the radiologists were in agreement were presented within the 95% confidence intervals. The results of the two examination methods by the two radiologists were also compared.

Results

In 15 out of 25 women (60%), a better definition of the PR outlines together with its posterior loop was obtained by TVUS than by AUS. Both observers agreed with this assessment.

In 2 women (8%), a hypochoic scar was visible in the right branch of PR. It was seen

Table 1. Results of the study by observer and diagnostic method

Number of patients	TVUS 1	AUS 1	TVUS 2	AUS 2
1	0	0	0	0
2	1	1	1	1
3	1	1	1	1
4	2	1	2	1
5	2	0	2	0
6	2	2	2	2
7	2	2	2	2
8	2	2	2	2
9	1	1	1	1
10	2	2	2	2
11	2	1	2	1
12	1	0	1	0
13	0	0	0	0
14	1	1	1	1
15	2	2	2	2
16	2	2	2	2
17	1	0	1	1
18	1	1	1	1
19	2	1	1	1
20	0	0	0	0
21	2	2	2	2
22	2	1	1	1
23	1	1	1	1
24	2	2	2	2
25	0	0	0	0

TVUS1 = transvaginal ultrasonography made by radiologist 1; AUS1 = anal ultrasonography made by radiologist 1; TVUS2 = transvaginal ultrasonography made by radiologist 2; AUS2 = anal ultrasonography made by radiologist 2

0 = lack of contraction of the puborectalis muscle; 1 = poor contraction; 2 = good contraction of the puborectalis muscle

in both TVUS and AUS by both observers. Both women had episiotomies.

In the PR function assessment, a discrepancy between two methods and two observers was noted (Table 1). Discrepancies between TVUS and AUS results were found by both observers in 4 women (16%) and in an additional 3 only by observer 1 (7 women, 28%). These discrepancies between the diagnoses of both radiologists in the 4 women were as follows:

PR good contraction in TVUS and poor in AUS – 2 cases;

PR poor contraction in TVUS and lack of it in AUS – 1 case;

PR good contraction in TVUS and lack of it in AUS – 1 case.

Additionally, only observer 1 found the following differences in diagnoses for 3 more women:

a) PR good contraction in TVUS and poor in AUS – 2 cases;

b) PR poor contraction in TVUS and lack of it in AUS – 1 case.

In each of these 3 cases, the observer 2 consistently diagnosed poor PR contraction using both techniques. In the remaining 18 cases (72%), the diagnoses of both observers for both methods were unanimous as follows:

a) PR good contraction – 8 cases;

b) PR poor contraction – 6 cases;

c) PR lack of contraction – 4 cases.

Discussion

Anal ultrasound is a reliable method for the visualization of the layered structure of the anal canal and it is a useful method for the diagnostics of the anal canal diseases and consequences of injuries to the anorectal area. The visualization of the anal canal is also possible using the transvaginal approach which has several advantages.⁷ First, the anus is not disturbed, not compressed by the insertion of the probe into the lumen of the anal canal, so

the inner diameter of the IAS, its thickness and anal cushions may be measured in their true resting state.⁷ Although these characteristics are of little diagnostic value with regard to the anal incontinence, this approach may allow the assessment of the anal canal if pain or stenosis are present. In the study by Poen et al.⁸, TVUS added important information to that obtained by AUS in 25% of the patients with fecal incontinence and perianal sepsis. In spite of a limited visualization range being considered as drawback of TVUS, the same study⁸ concluded that it was not possible to image the anal sphincters in only 10% of the patients. In the remaining 90% the IAS, EAS and PR were visible and the defects such as sepsis possible to diagnose. The PR passes directly backward from the back of the pubis with its inner surface in contact with the lateral walls of the vagina or prostate and the anorectal junction.⁹ Two legs of the PR meet at the posterior of the anorectal junction to form a sling with the angle to the anorectal junction of 92° during rest and 137° during straining.⁹ The main function of the PR is to contribute to the maintenance of the anorectal angle, thereby producing a flap valve effect when the intra-abdominal pressure rises.⁹ This effect can not be visualized by defecography and only EMG is available to determine the contribution of the EAS and the PR to the continence and defecatory mechanisms.⁹ The denervation of the PR in cases of idiopathic fecal incontinence can also be demonstrated using transrectal PNTML measurements.⁹ Although the results of manometry correlate well, but not always with EMG potentials for the EAS,⁹ the assessment of only the PR is not possible with the use of manometry.

The loop of the PR is well visible in AUS and appoint the deep part of the anal canal. Transvaginal PR assessment is a useful adjunct technique to the standard anal ultrasonography. In spite of being limited to the deep canal level, TVUS, in many cases, allows a

better visualization of the PR than AUS. In our study, such a situation was observed in 15 women (60%) where both observers noted better visualization of the PR by TVUS than by AUS. We felt that an effect of perspective created by the distance between the vagina and the anal canal was the most probable reason for this finding. This perspective provided a better visualization of the whole loop of the PR and its external outlines as well as the muscle contraction. We therefore believe that the difficulties in the visualization of the posterior side of the EAS using TVUS, mentioned by Poen et al.⁸ referred to the subcutaneous and superficial parts of the anal canal not its deep part and the level of PR, which is very well visible by TVUS.⁷ Another finding of Poen et al.⁸ was a poor correlation between TVUS and AUS in diagnosing the defects of the EAS which were seen in AUS but could not be reproduced by TVUS. The authors suggested that AUS might have overestimated the EAS defects and suspected that the artifacts from the air in vagina or fibres from the deep transverse perineal muscle or stretching the anal canal by a probe might have been responsible for that result. Again, this study referred only to the EAS and not the PR and we could not find any data in the literature concerning solely the PR and diagnosing its defects. In 8% of our patients (two women), the hypoechoic defects were seen in the right branches of the PR. Both women had a history of episiotomies and both defects were seen by the two observers in TVUS and AUS. We do not have any reason to suspect any overaging of one method over another in defining the defects of the PR. Generally, because the definition of this muscle in TVUS as well as in AUS is very good and much less, if not at all, controversial to the EAS image, we believe that our diagnoses were correct.

Apart from the morphology of the anal canal muscles, endosonography enables the assessment of the contraction activity of the striated muscles of the anal canal, including

PR.¹ The imaging technique during the contraction of the anal sphincter is already known as a useful adjunct to the standard study at rest.¹ Given a better definition of the EAS, it is helpful in defining the defects in 62 % of the patients.

Because continence depends on the function of these muscles, their accurate diagnosis requires, first of all, an assessment of the neuromuscular axis of the anorectum. The evaluation usually begins with the palpation followed by manometric measurement of pressures within the anal canal at rest and during squeezing or by means of EMG. PNTML is also assessed.⁶ Although manometry is the most widely used examination of the anal sphincter function, the assessment of the PR only cannot be achieved by this method. Additionally, in the patients with a deep defect of the EAS, the manometry does not always correlate with AUS findings and usually shows a normal function of the EAS. The reason can be a pull-through technique of manometry which may show a short anal canal or suggest a proximal defect, whereas a sleeve technique will not give this information.¹⁰ Similarly, EMG, although correlating highly with AUS in mapping of the EAS defects, is suitable only for the assessment of a superficial and subcutaneous parts of the EAS.¹¹ The deep parts of the EAS and PR are beyond the reach of the standard 3 cm concentric needles.^{10,11} In short, it is difficult to assess the function of the PR. First, apart from the limitations of the most common methods presented above, the majority of these methods cannot differentiate between the striated muscles, the EAS and PR. Second, interpretation of the findings of these tests frequently differs from one radiologist to another. Finally, they do not provide the surgeon with the anatomic information needed to plan an anatomic repair.^{2,6} AUS enables a clear imaging of the IAS, the EAS and the PR. The accuracy of clinical examination in diagnosing these muscles' defects is 50 %, whereas that of EMG

and of anal manometry is 75 % each.² AUS is more accurate than clinical and conventional physiological methods.² We did not find any data in the literature referring to the possibilities of endosonography in the assessment of the function of either the PR or EAS. This is not surprising since this examination is focused on the imaging of the morphology rather than physiology of the anal muscles. In this study, we found such a possibility for both AUS and TVUS which, especially in the light of the above difficulties in assessing the function of the PR, could have a considerable diagnostic value.

In the majority of women (18 women; 72 %), the assessment of the PR contraction (i.e. lack/poor/good) was identical in TVUS and AUS. The 95 % confidence interval for the overall percentage of identical diagnoses using TVUS and AUS was then 50.4 % and 87.1 %, respectively. We also analyzed the percentage of identical diagnoses for each radiologist. The 95 % confidence intervals for these individual percentages were 50.4 % and 87.1 % for radiologist 1 and 63.1 %, 94.7 % for radiologist. In order to find out whether the two diagnostic methods yielded significantly different results, we needed to decide on a threshold percentage of identical diagnoses. The threshold would be used as an evaluation tool. If the confidence interval for the percentage of identical diagnoses reaches the threshold, we may infer that the two diagnostic methods do not differ significantly. We decided to use a subjective, yet reasonable threshold of 85 %. Since all above confidence intervals reach the threshold of 85 %, we may conclude that with reference to 95 % confidence level the two diagnostic methods do not differ significantly. The details about the differences in diagnoses using TVUS and AUS are presented below.

Discrepancies were noted in 7 women by operator 1 and, in 4 of them, also by operator 2. In all these cases, the result of TVUS was better than that of AUS, i.e. the lack of or po-

or PR contraction in AUS appeared poor or good in TVUS. In one case, confirmed by the two operators, the discrepancy was most pronounced. A good contraction of the PR, detected by TVUS could not be confirmed by AUS, which showed a lack of contraction. None of these seven women with inconsistent diagnoses of the PR function suffered from fecal incontinence. All women with the symptoms of fecal incontinence were in the group of 18 women for whom both operators on the basis of two approaches consistently diagnosed the lack of contraction of the PR (4 women) and poor contraction (3 women). The eighth woman incontinent only for gas had good contraction of the PR. It is known that the damage to the PR may be inflicted during parturition.¹⁰ All (10) women with impaired (poor or lack of) PR contraction diagnosed by both radiologists by TVUS and AUS were multiparous. Two of them had additional history of the third degree perineal tear and two suffered from UC. Two women suffering from constipations had normal function of the PR seen by the two operators by both methods, TVUS and AUS. It is known that, in idiopathic anorectal incontinence and rectal prolapse, with or without incontinence, often associated with a long history of excessive straining during defecation in the constipated patients, the PR is not at all or only slightly damaged.^{10,12} The innervation of the PR is most probably responsible for its preserved function in constipated patients. Likewise the anterior part of the EAS, the PR and levator ani muscle receive innervation from the perineal nerve.¹³ The main nerve supply to PR arises from the direct branches of S3 and S4 reaching the muscle from above the pelvic floor.¹⁰

We assume that two reasons could be responsible for the discrepancies in the diagnosis of the PR contraction by TVUS and AUS (7 cases by operator 1 and 4 cases by operator 2). First, similar to a better visualization of the PR in TVUS, a better assessment of its activity by TVUS could be due to a different pers-

pective that we achieved from the lumen of the vagina. Second, the discrepancies could be due to a kind of mental sensation in some patients who were unable to contract PR naturally having the probe introduced into the anal canal. Thus, the PR function visualized by TVUS was better. In our study, we did not observe any reverse reaction, namely worse (i.e. lack or poor) PR contraction by TVUS and better (i.e. good or poor) by AUS. This finding is in accordance with the second suggestion above. Moreover, it was supported by clinical data. Except multiple deliveries in 6 out of 7 women with worse diagnosis of the PR contraction by AUS than by TVUS, all had a history of peritoneal tear or constipation, therefore, we did not have any reasons to suspect that TVUS was incorrect.

In the assessment of the PR morphology in all 25 examined cases, the diagnoses of the two observers agreed. Knowing the endosonographic appearance of the PR, it is not difficult to recognize its defects. Such finding seems to be objective. The interpretation of the dynamic activity of the PR varied between the two operators and caused some diagnostic differences in our study. In 3 cases (12%), we found the interobserver variability in the estimation of the PR contraction. This variability could have been due to a subjective scale we have used to assess the PR function. An objective scale, like the flow measurements, B-mode and Doppler ultrasound measurements, does not eliminate all the interobserver variability.¹⁴ In an ideal situation, the data variance due to observers should be non-significant and the effect of the operator can be eliminated entirely by cooperative training and surely by using the same operator in both examinations.¹⁴

In this study, we chose 85% as a threshold of agreement between the radiologists as adequate to define insignificant interobserver variability at a 95% confidence level.

We quantified the degree of agreement between the radiologists separately for TVUS

and AUS. For TVUS, a 95% confidence interval for the percentage of agreement was 72.5% and 98.6%, respectively. For AUS, the corresponding confidence interval was 77.7% and 99.8%, respectively. The overall percentage of agreement between the two radiologists and for both methods was 72% (18 patients out of 25) with a 95% confidence interval (50.4%, 87.1%). Since our threshold of 85% was attained by all confidence intervals, we may conclude that the interobserver variability, although present, was not significant.

Conclusions

AUS is currently a method of choice for obtaining detailed images of the IAS, EAS and PR. It is unable to detect denervation of the EAS and PR, although the identification of the sphincters with no scars, a thickened IAS and a decreased anal sonography index (which means thin EAS and thick IAS) seem to be the indicators of a denervation pathogenesis.¹⁵ Because it is painless, available, inexpensive and rapid, AUS is recommended as the examination suitable for screening.^{3,4} Our study showed that AUS and TVUS of the anal canal can be useful adjuncts to physiologic studies of anorectal function. Of course, as imaging techniques they are not the methods of choice for the assessment of the anorectal functions. For this purpose, anal manometry, EMG and PNTML are suggested because they offer full and objective estimation of the functional disorders of the anal sphincters. The anal ultrasound supported by transvaginal ultrasonography seem to be valuable methods in assessing the PR morphology. They are also very promising in initial diagnosis of the PR function indicating an eventual necessity to perform more precise, more objective but less available method as e.g. manometry or EMG.

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