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THREE-DIMENSIONAL TRANSPERINEAL ULTRASONOGRAPHIC CHARACTERISTICS OF THE ANAL SPHINCTER COMPLEX IN NULLIPAROUS WOMEN

<u>Hypothesis / aims of study</u>
The introduction of three-dimensional (3D) ultrasound with its ability to determine volume sonographically, plus the fact that post-processing analysis can be carried out later, make this an attractive method of evaluating the anal sphincter. The examination does not take much time, and the results are less operator-dependent. We designed this study using 3D transperineal ultrasonography to identify the morphologic characteristics and normal biometry of the anal sphincter complex in nulliparous women.

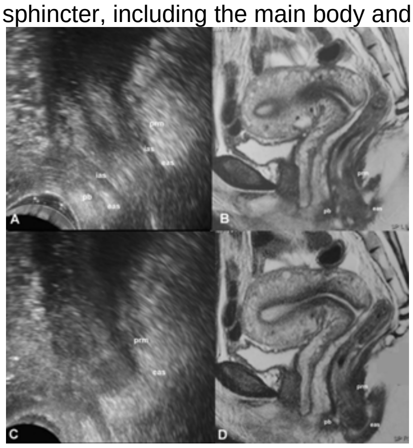
<u>Study design, materials and methods</u>
From June 2003 to December 2005, nulliparous women seen in our gynecologic or urogynecologic outpatient departments were considered for participation in a study using 3D ultrasound to evaluate the female pelvic floor and anal sphincter complex.

All subjects underwent pelvic floor assessment, which include pelvic examination, digital rectal examination, and 3D ultrasound scanning. 3D ultrasound scanning of the pelvic floor, lower urinary tract, and anal sphincter complex were assessed using a Voluson 730 scanner (GE Medical Systems, Zipf, Austria) with a 5.0- to 9.0-MHz transvaginal probe with the patient in the supine position. Sonographic volume acquisition was performed with the main transducer axis first placed at the introitus in the mid-sagittal plane and then at the perineum after turning the probe 60^{o} to 80^{o} downward. All images and sonographic data were retrieved from the scanners and stored in a desktop computer for subsequent analysis.

<u>Results</u>
The mean age, height, body weight, and body mass index for the 55 women enrolled in the study were 27.4 ± 4.8 (range, 19 to 38) years, 1.6 ± 0.1 (range, 1.5 to 1.7) m, 51.3 ± 5.5 (range, 35 to 65) kg, and 19.8 ± 2.1 (range, 15.6 to 23.6) kg/m^2, respectively. The median gravidity was zero (range, 0 to 4). Ten women had been pregnant, but none had carried a gestation beyond 10 weeks.

I. Reproducibility of ultrasonographic measurements:
Intraclass correlation coefficient values ranged from 0.43 to 0.80, with best agreement for measures of the internal anal sphincter thickness and area (0.75 to 0.80).

II. Morphologic characteristics of the anal sphincter complex:
In this study, the location, extent, and spatial relationships of the anal sphincter complex were clearly demonstrated on 3D transperineal ultrasound and were compatible with comparable measurements on magnetic resonance imaging (MRI)(Figure 1) The external anal sphincter appeared as an isoechoic structure consisting of three components: a subcutaneous part, a circular main body, and an extension portion (Figure 2). The main body, the thickest part of the three components, was most prominent as the section line moved from the mid-sagittal plane to the paramedian plane. The extension portion was constructed as a cylindrical structure and apparently displayed in the mid-sagittal view as two arms lying upward (cranially) along the anterior (superior or ventral) and posterior (inferior or dorsal) margins of anal canal. The internal anal sphincter was seen as dark echolucent strips of equal thickness regardless of location. In the mid-sagittal view, it started from the junction of subcutaneous part and main body of external anal sphincters and ended at the anorectal junction. The puborectalis muscle was a “V”-shaped echogenic structure in the axial view and banana-shaped in the sagittal view. It was located just behind the anorectal junction and extended downward along the inferior (i.e., posterior) margin of the posterior external sphincter extension. The perineal body appeared as an ovoid echolucent structure in the mid-sagittal view that covered the upper margin of the external sphincter, including the main body and anterior extension but not the subcutaneous portion.



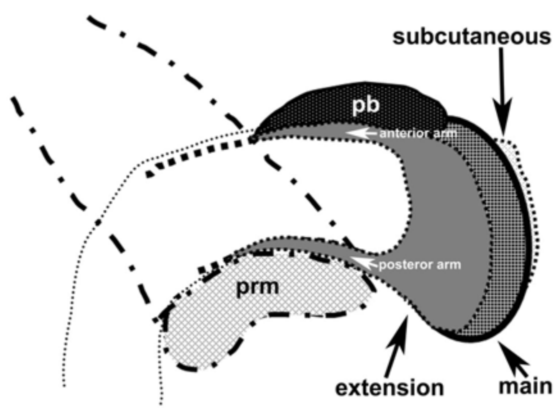


Figure 1. Mid-sagittal (A, B) and paramedian (C,D) views of the anal sphincter complex on transperineal ultrasound (A,C) and magnetic resonance imaging (B,D). (pb, perineal body; eas, external anal sphincter; ias, internal anal sphincter; a, anus; r, rectum; prm, puborectalis muscle)

Figure 2. Schematic drawing of the of anal sphincter complex. (pb, perineal body; prm, puborectalis muscle; main, the circular main body of external sphincter; subcutaneous, the subcutaneous portion of external anal sphincter; extension, the extension portion of external anal sphincter)

III. Biometry of the anal sphincter complex

The perineal thickness was strongly positively correlated with perineal body depth (r = 0.644, adjusted r^2 = 0.403, P < 0.01) (Figure 3A) and perineal body length (r = 0.606, adjusted r^2 = 0.355, P < 0.01) (Figure 3B). The perineal thickness did not, however, correlate with the external anal sphincter area or anorectal angle.

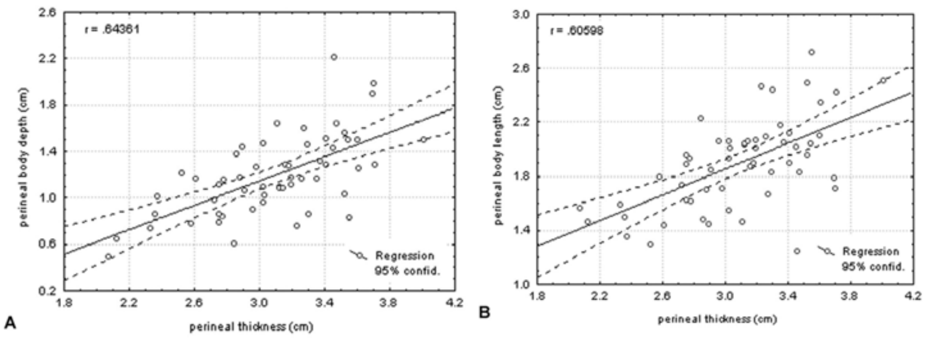


Figure 3. Scatter plots displaying the correlation between perineal thickness and perineal body depth (A) and perineal thickness and perineal body length (B).

IV. Demographic variables

Age, weight, height, body mass index, and previous early pregnancy did not correlate with the sonographic measurements of the anal sphincter complex.

Interpretation of results

The multiplanar imaging in 3D ultrasound allows simultaneous inspection of the anal sphincter complex from different angles, thus elucidating the spatial relationships of this complex structure and facilitating standardized measurements. The reproducibility of this technique in assessing the morphology of the anal sphincter complex suggests that it will be a useful tool for evaluating structural changes associated with disturbances of the fecal continence mechanism.

Concluding message

3D transperineal ultrasound clearly demonstrates the spatial relationship of each component of the anal sphincter complex. This will allow standardized measurement of the complex for investigations of its function.

References

FUNDING: **National Science Council Research Grant and Mackay Memorial Hospital Research Grant.**

HUMAN SUBJECTS: **This study was approved by the IRB committee of Mackay Memorial Hospital and followed the Declaration of Helsinki Informed consent was obtained from the patients.**