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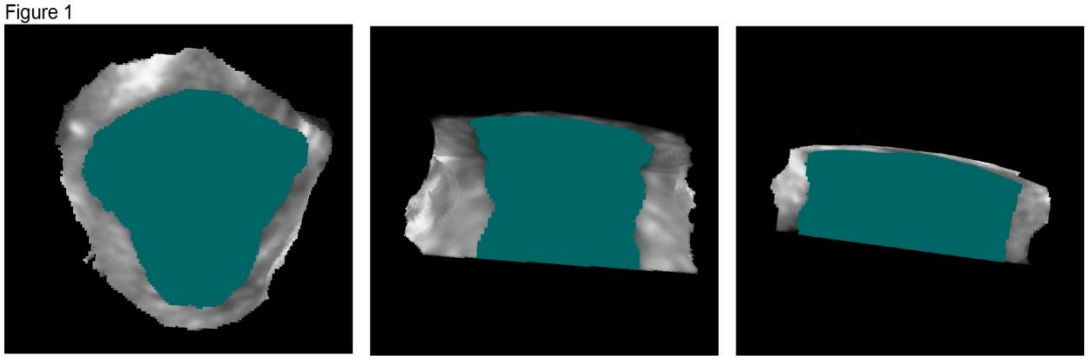
RELIABILITY OF THREE-DIMENSIONAL ULTRASOUND MEASUREMENTS OF THE LEVATOR ANI HIATUS USING VIRTUAL REALITY

Hypothesis / aims of study

The levator hiatal area as measured by three-dimensional (3D) translabial pelvic floor ultrasound examination is strongly associated with symptoms and clinical signs of prolapse (1). Although volumes of the levator hiatus can be obtained using 3D ultrasound imaging techniques, measurements still are performed in two-dimensional (2D).
As the levator is concave and convex, 2D measurements do not take this into consideration. By using the I-Space (Barco, Kuurne, Belgium) virtual reality system the concave and convex feature of the levator can be brought into consideration (figure 1), allowing information on the real measurements of the levator hiatus. This study compares 2D ultrasound measurements with the 3D measurements performed in the virtual reality system.

Figure 1



Study design, materials and methods

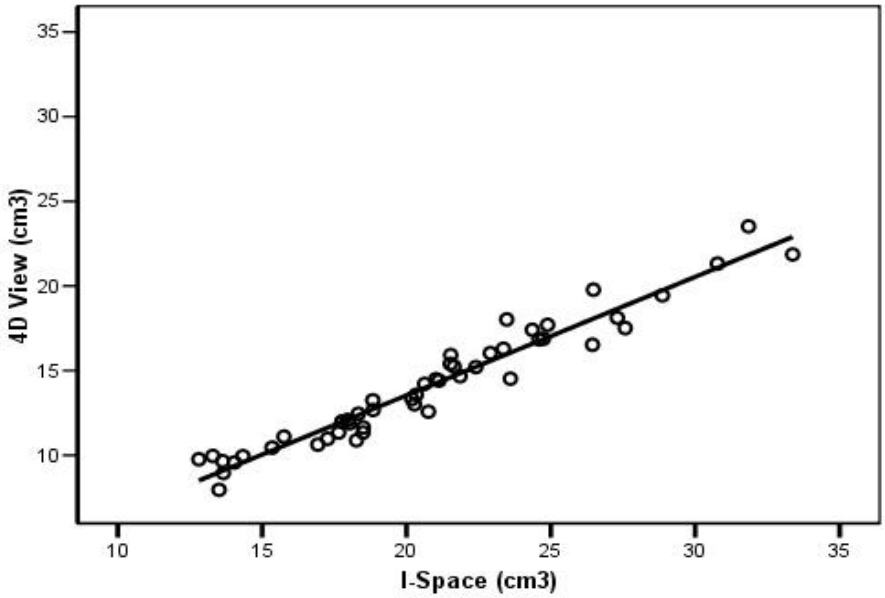
In 2008 50 symptomatic patients attending a tertiary pelvic floor clinic were analyzed as having a normal intact levator ani muscle. All had undergone a standardized interview and pelvic floor ultrasound imaging, using a Voluson 730 Expert system and a 4-8 MHz RAB probe. Offline 2D measurements were performed using specialized 3D imaging software (4D View version 9.0). With 4D View a rendered slice of 1.5 cm was obtained at the level of minimal hiatal dimension during contraction and the hiatal area was then measured manually in a 2D image (2).
The datasets were then transferred to the I-Space, a virtual reality system that allows the observer to perceive depth and interact with volume-rendered (ultrasound) data. The volumes were rendered in 3D using the V-scope application and semi-automatically measured using a virtual pointer (3). All measurements were repeated three times and their mean values were used for comparison. Differences between the measurements obtained with 4D View and with the I-Space was calculated and compared with the paired *t*-test. A *P* value < 0.05 (two sided) was considered significant. In addition, Pearson correlations coefficients and intraclass correlations coefficients (ICC) were calculated for the 2D measurements in 4D View and the 3D measurements in the I-Space.

Results

The mean age of the symptomatic patients was 54 years (range: 22 to 77 years). Their leading complaints were prolapse symptoms in 26%, urinary symptoms in 36%, and faecal incontinence in 28% of the patients.
The mean hiatal area as measured in the I-Space was 20.78 cm^3 (SD 4.97cm^3). 2D measurements obtained in 4D view showed a mean hiatal area of 14.09 cm^2 (SD 3.58 cm^2). To compare both measurements we multiplied the hiatal area (cm^2) obtained by the 2D measurements with the slab thickness of 1.5 cm to obtain a hiatal volume (cm^3) estimate. The mean difference between the measurements made with 4D view (2D) and I-Space (3D) was -0.05 (SD 1.77 cm^3) with a 95% confidence interval (CI) between -0.548 to 0.456 cm^3 (p = 0.86). The ICCs comparing 4D view with the I-Space measurements were 0.969 with a 95% CI between 0.969 to 0.982 (p < 0,001).

Figure 2: Correlation between measurements in 4D view and the I-space

Pearson correlation r = 0.941; p < 0.001



Interpretation of results

There is a very good correlation (figure 2) between measurements performed with 4D View and the I-Space with a high ICC. The measurements obtained with 2D imaging showed a slightly smaller volume in comparison with the 3D measurements. These results seems understandable as in the 2D the image of the levator hiatus will be compressed and the smallest inside measurements will then be visualized. With virtual reality we were able to obtain information about the smallest differences throughout the whole 3D volume, which resulted in a slightly higher volume. However, this investigation demonstrated that the normal 2D measurements do not differ significantly from the 3D measurements. Therefore, 3D measurements provide us with a more representative measurement of the "real" area of the levator hiatus.

Concluding message

The application of virtual reality is a novel method of visualizing 3D ultrasound data and the perception of depth in the I-Space offers possibilities for measuring non-planar structures. This study demonstrated that levator hiatal area measurements in the I-Space were comparable with measurements performed in 4D View. New areas of pelvic measurements can now be explored using this technique.

References

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Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**No**
This study did not require ethics committee approval because	**This study doesn't involve direct patientcare. Only the ultrasound images were used, without patient name or number, only characteristics. Therefor, we need no approval from the eithics committee.**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**No**