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THE GEOMETRY OF A BLADDER CONTRACTION: TECHNIQUES FOR BLADDER SHAPE MEASUREMENT USING ULTRASOUND URODYNAMICS (BLAST)

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Background

Bladder shape test (BlaST) is a conceptual urodynamic modality designed to measure the shape of the bladder during filling. Techniques for quantifying change in bladder shape are essential for the utility of this novel test. The aim was to evaluate techniques developed to measure bladder shape changes during ultrasound urodynamics.

Methods

Multiple ultrasound images of the bladder in transverse plane were captured from 72 women who underwent BlaST during initial feasibility studies. Methods developed to assess bladder shape were compared with intra and inter-observer reliability, correlation co-efficient and inter-metric variability tests.

Results

Three techniques used measurements following manual tracing of the bladder outline. The 'AB' method utilised division of height (a) by width (b) to derive a ratio. Inner and outer 'circles of best-fit' and subsequently 'ellipses of best-fit', whereby the area of the inner circle or ellipse was divided by the area of the outer circle or ellipse, produced a ratio termed 'sphericty quotient' (SQ). Of these the ellipses of best fit method had the best inter-rater and intra-rater reliability and was adopted.

Automated SQ has now been developed, utilising angular analysis to automatically plot bladder outline, reducing time and error in calculation. Computed SQ strongly correlates with manual SQ measurement (r=0.997). Angular analysis was also used to evaluate curvature, measuring the gradient of each section of the bladder and change in gradient between adjacent sections, enabling the derivation of 'curvature quotient' (CQ) and 'gradient quotient' (GQ). These correlated strongly with computed SQ (r=0.87). A further method under evaluation is Fourier analysis which breaks down complex shapes into constituent simple shapes, aiding measurement.

Conclusion

Whilst further work and evaluation is required, SQ appears to offer a reliable and reproducible technique for bladder shape analysis. Developing machine learning for these techniques may be aided significantly by integrating Fourier analysis.

References

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