399:Identification of bladder wall micromotion using M-mode ultrasound in a porcine model and in humans with and without detrusor overactivity

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Figure 1: Ultrasound imaging of pig bladder. The probe is held with a clamp **(A)**. AMM cine loop showing 2D image with red and green lines indicating 1D lines tracked in time on the right half of the image **(B).**

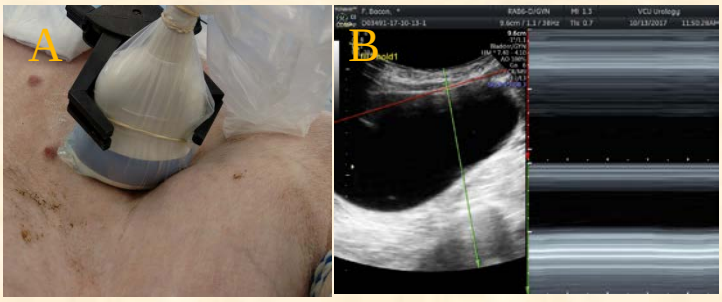


Figure 2:Ultrasound imaging of human bladder. The probe is held by a technician (A). AMM cine loop(B).

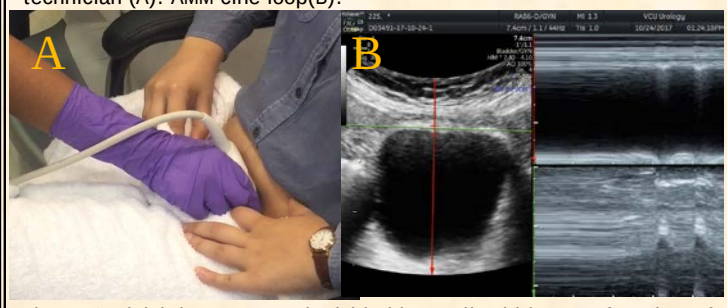


Figure 3. (Right) Image tracked bladder wall width as a function of time with intravesical pressure (Pves) overlaid. (Center) FFT of bladder wall width. The five highest peaks are designated with stars. (Left) Bladder wall width overlaid with FFT reconstruction (dark red) of the five highest peaks of the FFT.

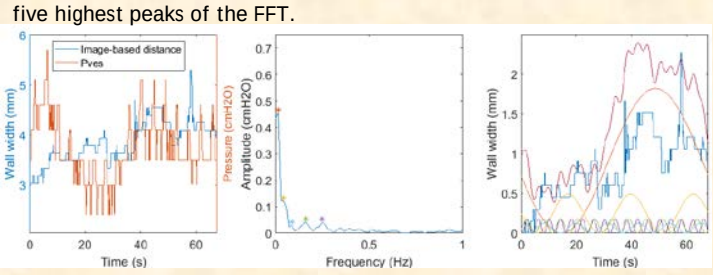


Figure 4. Changes in wall width as tracked by the algorithm from AMM cine clips overlaid with Pves obtained at the same time during maximal rhythmic contractions with (A) and without (B) respirator breathing.

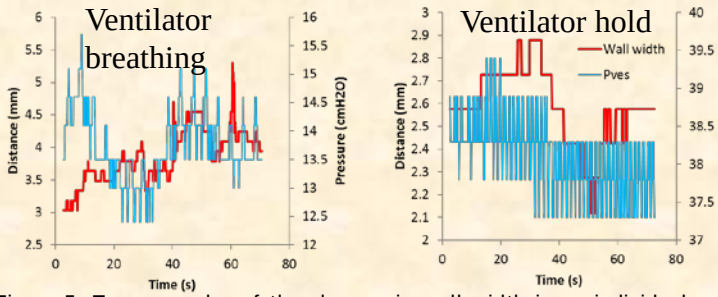


Figure 5. Two examples of the changes in wall width in an individual with OAB (A) and in one with no urgency (B).

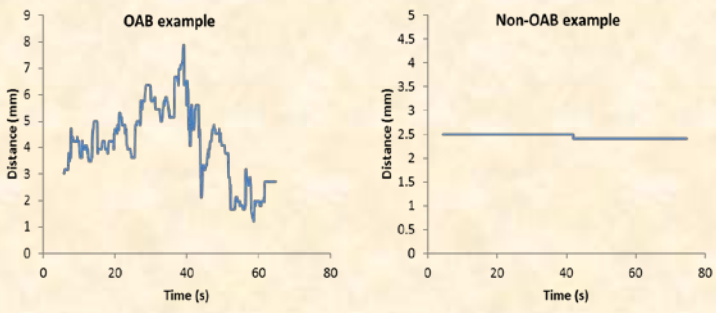
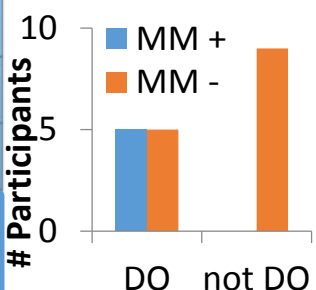


Table 1. Contingency table showing association between MM as measured by imaging and DO as diagnosed on urodynamic data.

	DO	Not DO
MM	5	0
No MM	5	9

Sensitivity = 50%
Specificity = 100%



Study Aims and Hypothesis

Low amplitude rhythmic contractions (LARC) are observed in the intravesical pressure (Pves) tracings of many patients suffering from detrusor overactivity (DO). These pressure changes are thought to be the result of synchronization of contractions that cause micromotion (MM) in different regions of the bladder wall. The goal of this study was to develop a non-invasive method to measure bladder wall micromotion *in vivo*. The first aim was to measure bladder wall MM with ultrasound and validate the method by correlating the frequency characteristics of the MM with Pves in a porcine model. The second aim was to apply the validated method in humans with and without DO to determine its effectiveness in identifying a MM mediated subtype of DO.

METHODS

For the first aim, female pigs were anesthetized with urethane and, when necessary, isoflurane and underwent an ultrasound urodynamic study (Laborie model Aquarius TT). Anatomical Motion Mode (AMM) ultrasound cine loops were obtained at pauses in filling using a GE Voluson E8 ultrasound system (fig. 1) and used to optimize a texture tracking algorithm to measure bladder wall width over time. The frequency characteristics between wall width and Pves were compared using Fast Fourier Transform analysis to validate the algorithm (fig. 3). For the second aim, 19 people were recruited including 13 individuals having urinary urgency and six with no urgency symptoms underwent an ultrasound urodynamic study (fig. 2). AMM cine loops were obtained at 40% cystometric capacity and were analysed using the texture tracking algorithm to calculate wall width as a function of time (Fig. 5). A urodynamicist blinded to the results of the MM study diagnosed DO based on UDS tracings.

RESULTS

In the pig study, FFT characteristics of wall thickness and Pves showed the same peak frequencies with proportional amplitudes showing that the texture tracking algorithm was effective (fig. 3). In the human study (fig. 4), significant MM was considered to be wall width changes with peak frequencies in the range of 1.5-7 cycles/min and amplitudes greater than 0.14 mm and was found in five of 19 individuals (26%). DO was independently diagnosed in ten of the 19 individuals (53%). A significant association was found between MM and DO ($p = 0.03$, table 1). All of those with significant MM had DO, yielding a specificity of 100%. Half of those with DO were found to have significant MM, yielding a sensitivity of 50% and implying that there may be a MM-associated subtype of DO.

CONCLUSIONS

This study demonstrates the feasibility of a non−invasive method to measure bladder wall MM using transabdominal AMM ultrasound. Identification of a MM-associated subgroup could enable better targeting of DO treatments to this group without the need for an invasive urodynamic study.