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Evaluation of time-dependent changes in lower urinary tract function in BOO rats using noninvasive approaches

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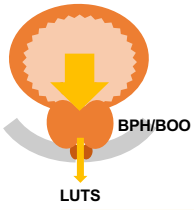
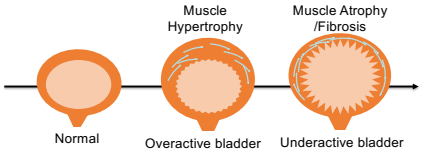
Hypothesis / aims of study



Bladder outlet obstruction (BOO) caused by benign prostatic hyperplasia (BPH) is a primary factor inducing male lower urinary tract symptoms (LUTS). It is known that chronic BOO induces time-dependent changes in the bladder structures including detrusor smooth muscles, contributing to the development of both overactive and underactive bladder conditions.

Time-dependent changes in detrusor and LUTS



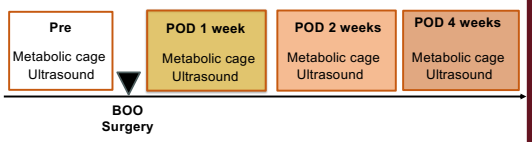
In the clinical management of patients with BPH/BOO, **UROFLOWMETRY** and **ULTRASONOGRAPHY (USG)** are commonly conducted as noninvasive methods for evaluating lower urinary tract dysfunction (LUTD). However, in the basic research using animal models of BOO, few studies have assessed BOO-related functional parameters such as voiding time, maximal flow rate, and bladder wall thickness

AIMS OF STUDY

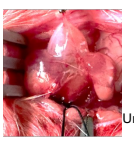
To clarify time-dependent changes in these parameters to assess LUTD in a male rat model of partial BOO using noninvasive approaches such as uroflowmetry and ultrasonography.

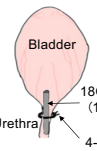
Study design, materials and methods

STUDY DESIGN



Boo Surgery (Partial Urethral Ligation)



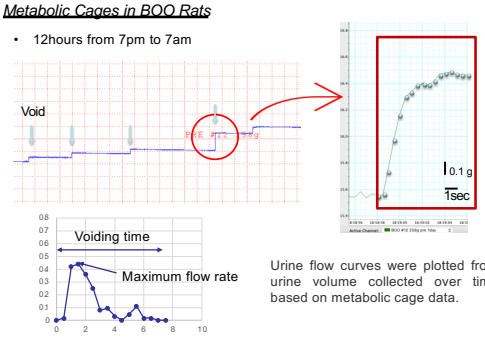


<ANIMALS>
Male Sprague-Dawley Rats

<Methods>
1. Separate the prostate lobes to expose the urethra
2. Place an 18G metal rod on the ventral side of the urethra
3. Tie the urethra and rod together using a 4-0 silk thread
4. Remove the rod

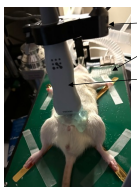
Metabolic Cages in BOO Rats

- 12hours from 7pm to 7am



Urine flow curves were plotted from urine volume collected over time based on metabolic cage data.

Ultrasonography in BOO rats (Under isoflurane anethesia)



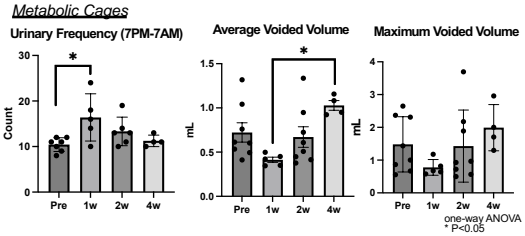
<Ultrasound>
The Vevo® MD (FUJIFILM Visual Sonics)
Probe; MX250 (Linear)

<Methods>
1. Anesthesia induced quickly after urination
2. Intramuscular injection for diuresis. Furosemide 1.0mg (+ Saline 1mL s.c.)
3. Fully filled phase ultrasound with overflow incontinence

<Assessment>
- Bladder volume
- Anterior bladder wall thickness

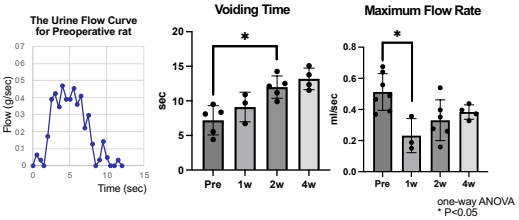
Results

Metabolic Cages



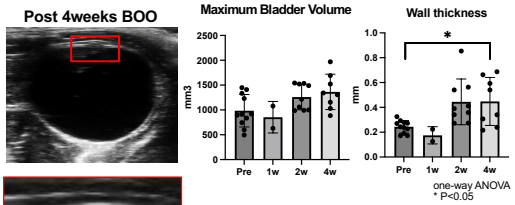
The urinary frequency was significantly increased in rats one week postoperatively compared to that measured preoperatively and gradually decreased by four weeks postoperatively.

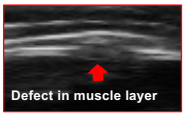
Urine Flow Measurement



- Urinary flow curves plotted from metabolic cage data showed more pronounced sawtooth-like waveforms in rats rather than typical human bell-shaped urinary flow curves.
- The voiding time was significantly increased at two weeks postoperatively vs. preoperative data.
- Max flow rate was decresaed at one week postoperatively vs. preoperative data.

Ultrasound Measurement

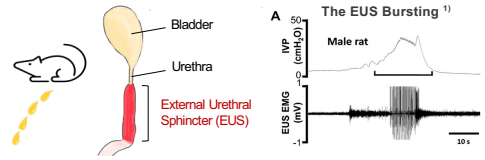




There was a significant increase in anterior bladder wall thickness both in the fully-filled and post-void phases at four weeks postoperatively compared to preoperative values of wall thickness.

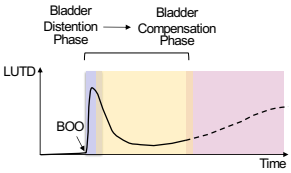
Interpretation

Characteristics of the Male Rat Urinary Flow Curve



The serrated wave pattern in urine flow curves in male rats may be attributed to the EUS bursting during voiding, which induces the pumping action of the urethra that causes intermitted urination (Ref1).

Changes in Lower Urinary Tract Function Over Time in Partial BOO rats



Metabolic cages measurements and ultrasonography detected an early bladder distention phase with frequent urination and low flow rate, followed by later bladder compensation phase with bladder wall hypertrophy, longer voiding time and increased flow rate after BOO.

Conclusions

It seems possible to track time-dependent functional and morphological changes in the same BOO rats using non-invasive approaches, which could be applied to the pathophysiological process during the bladder compensation phase in male LUTS patients with BOO/BPH.

References

1. Chen SC, Lai CH, Fan WJ, et al. Sex Differences in the External Urethral Sphincter Activity of Rats. J Exp Clin Med. 2012