Standardization of Vaginal Distention Injury in a Rat Model of Birth Trauma And Resultant Stress Urinary Incontinence: A Randomized Controlled Trial

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Introduction

• ~1/3 women experience stress urinary incontinence (SUI) following vaginal delivery
• The rat vaginal distention (VD) translational model mimics fetal passage through the birth canal and the resultant injury causing lowered leak point pressure (LPP)
• Injury is caused by intravaginal inflation of a modified foley balloon to 3 mL
• Altered LPP is a surrogate marker for SUI
• Prior investigators have shown that a greater distention volume leads to greater injury
• Animal size discrepancy with diabetes, obesity, and age represent potential confounders (increased ratio of animal size to fixed VD volume) (Figure 1)

Specific Aims

① Determine balloon pressure variability exerted intrinsically by catheter ex-vivo
② Determine pressure mechanics of catheter in-vivo under standard isovolumetric (IV) conditions
③ Use mean in-vivo pressure at 3 mL balloon inflation to determine target pressure (TP)
④ Demonstrate feasibility of performing VD under isobaric (IB) conditions based on TP
⑤ Compare LPP of IB versus IV versus sham and vs. weight
⑥ Compare intra-group variability of LPP (IB vs. IV groups)

Methods

• Ex-Vivo: 10 Fr modified Foley catheters were inflated to 3.0 mL and connected to pressure transducer. Overall pattern and uniform intrinsic pressure responses to volume were described
• In-Vivo: Ex-vivo method of pressure recording was repeated with catheters inside 5 rats. Mean in-vivo result generated TP
• LPP: 30 rats (Figure 2) were divided into 3 groups and LPP was measured following VD or sham
• Statistics: Students T-test was used to compare groups’ LPP

Table 1: LPP as a function of weight

<table>
<thead>
<tr>
<th>Group</th>
<th># Rats</th>
<th>Slope Estimate</th>
<th>SE</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isobaric</td>
<td>6</td>
<td>0.40</td>
<td>0.86</td>
<td>0.932</td>
</tr>
<tr>
<td>Isovolumetric</td>
<td>7</td>
<td>-0.10</td>
<td>0.95</td>
<td>0.662</td>
</tr>
<tr>
<td>Sham</td>
<td>6</td>
<td>0.32</td>
<td>0.77</td>
<td>&lt;ref&gt;</td>
</tr>
</tbody>
</table>

Insufficient evidence to conclude that rat size (weight) effects LPP of IV or IB groups different than slope of Sham.

Fig. 3: Ex-vivo catheter pressure curve with increasing balloon volumes followed by 4-hr duration at 3-mL volume.

Fig. 4: In-vivo pressure curve with increasing balloon volumes followed by 4-hr duration at 3-mL volume.

Fig. 1: Diabetic and Obese Animal Models.

Fig. 2: Experimental design for LPP

Fig. 5: LPP and variance of IB, IV, and Sham groups (dark line and box represent mean value and SDev)

Conclusions & Future Directions

• In-vivo mechanics of VD are uniform and predictable and different than ex-vivo (catheter only) pressure patterns
• TP for use as standard for VD injury production is feasible
• TP-generated injury pattern is equivalent to IV standard and more severe than sham
• Variability may not be better with IB vs. IV VD injury
• In-vivo pressures supersede those sufficient to cause ischemic injuries in humans
• Rat VD model remains a well-validated translational model for studies of SUI following simulated birth trauma injury
• IB performed at TP should be the new standard for VD investigations of age, obesity, and diabetes

Acknowledgments

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