A novel device for assessing pelvic floor muscle function in women

Stéphanie Madill
Background

- **Urinary Incontinence**
  - Young women: <5 to 30%
  - Highly active young women: ≤35%
  - Middle-age women: 30-40%
  - Post-menopausal women: 30-50%

- **Prolapse**
  - ≈50% of women over age 50
  - 11-19% of women will require surgery
  - 1/3 will have at least one re-operation

- PFM exercise: First line treatment
† Estimated as difference in mean Health Utilities Index (HUI3) score between those with and without condition, adjusted for age and all other conditions (p ≤ 0.05). 
‡ Respondents aged 12 to 19 with "not applicable" code were assigned to "no" group.
Research Problem

- Urinary incontinence is a motor control problem
- Limitations of current devices
Purpose

- To test the feasibility and reliability of a novel device for recording PFM EMG and vaginal pressures simultaneously.
Methods - Design

- Self retaining & comfortable
- 3 pairs of EMG electrodes
  - Centred at 3, 12 & 9 o’clock
  - Coupled with Delsys miniTrigno™ electrodes
- 2 pressure sensors
  - Proximal & distal at 6 o’clock
  - Freescale Semiconductor MPX2300DT pressure transducers
  - Interfaced with Trigno™ load cell adaptors.
Methods – Reliability Testing

- **Subjects:** Female pelvic floor physiotherapists
- **Test-Retest design**
  - 2 one-hour testing sessions, 1 week apart
- **Tasks:** PFM MVC & Coughing
  - Supine & Standing, 3 trials each
Methods – Data Processing & Analyses

- Pressure and EMG recorded simultaneously at 2000 Hz
- EMG: RMS 200ms sliding window, 199 ms overlap
- Peak values extracted

- Channel independence
  - Pressure: cross-correlation
  - ANOVA, nMAD
- Between trial reliability
  - ANOVA, coefficients of variation
- Between day reliability
  - ANOVA, Spearman’s rho, nMAD
Results: Participants

- 8 women
- Mean age 42
- 4 nulliparous
- 4 parous
  - median 3 (2-5) births
- 4 urinary incontinence
  - 3 stress predominant
- Device was comfortable and stayed in place
Results: Data Quality
Results: Channel Independence

- **Pressure:**
  - PFM MVC PFM > IAP,
  - Standing cough IAP > PFP
  - No time lag IAP vs. PFP

- **EMG:**
  - R > L
  - nMAD

  - Supine MVC: 28.67%
  - Standing MVC: 41.31%
  - Supine Cough: 40.75%
  - Standing Cough: 48.50%
Results: Between Trial

- No between trial differences in either EMG or pressure for either task or position

<table>
<thead>
<tr>
<th>Task</th>
<th>MVC</th>
<th>Cough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Supine</td>
<td>Standing</td>
</tr>
<tr>
<td>Channel</td>
<td>IAP day 1</td>
<td>31.16%</td>
</tr>
<tr>
<td></td>
<td>IAP day 2</td>
<td>27.83%</td>
</tr>
<tr>
<td></td>
<td>PFP day 1</td>
<td>56.34%</td>
</tr>
<tr>
<td></td>
<td>PFP day 2</td>
<td>69.03%</td>
</tr>
<tr>
<td></td>
<td>PFM_R</td>
<td>37.5%</td>
</tr>
<tr>
<td></td>
<td>PFM_L</td>
<td>72.0%</td>
</tr>
</tbody>
</table>
Results: Between Day

- EMG – no between day differences
- Pressure
  - PFP day 1 < day 2
  - IAP – Supine only, MVC day 1 < day 2, Cough day 1 > day 2

<table>
<thead>
<tr>
<th>Task</th>
<th>MVC</th>
<th>Cough</th>
<th>MVC</th>
<th>Cough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position</td>
<td>Supine</td>
<td>Standing</td>
<td>Supine</td>
<td>Standing</td>
</tr>
<tr>
<td>Channel</td>
<td>Spearman’s Rho</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IAP</td>
<td>0.43</td>
<td>0.79</td>
<td>0.89</td>
<td>0.82</td>
</tr>
<tr>
<td>PFP</td>
<td>0.82</td>
<td>0.86</td>
<td>0.82</td>
<td>0.71</td>
</tr>
<tr>
<td>PFM_R</td>
<td>1.00</td>
<td>0.97</td>
<td>0.50</td>
<td>0.53</td>
</tr>
<tr>
<td>PFM_L</td>
<td>0.72</td>
<td>0.83</td>
<td>0.61</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Conclusions

- Pressure sensors and EMG channels clearly independent
- Between trial repeatability is acceptable
- Between day repeatability is acceptable
  - No difference in PFM EMG amplitudes
  - Pressure differences suggest learning or functional adaptation
- Standing seems to be more reliable than supine
Where next?

- Lifting
- Jumping
- Running
THANK YOU

Angelica Lang, School of Rehabilitation Science, College of Medicine; Gordon Sarty, Biomedical Engineering, College of Arts and Science; Bob Wilson, College of Engineering, Mechanical Engineering Shops