A hand-held elastometer for measuring pelvic floor muscle stiffness

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Background

Female pelvic floor (PF) muscles support pelvic organs, help ensure continence and facilitate childbirth. 20% of women will develop some form of pelvic floor disorder (PFD) during their lifetime (1).

There are strong correlations between muscle damage and PFD (2), but a lack of data describing the mechanical properties of the pelvic muscles in health and disease.

We have developed a novel hand held elastometer to assess the stiffness of the pelvic floor muscle with high repeatability and reliability (3). We are using this tool to to measure stiffness of the PF muscle during pregnancy, post delivery and among different ethnic groups.

Design

The elastometer consists of a hand-piece, real time controller and laptop computer.

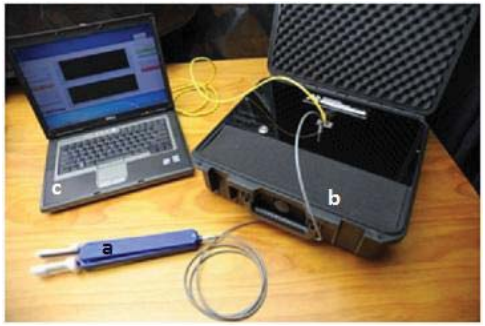

Figure 1: Components of the elastometer system. a) handpiece b) Real-time controller c) laptop with user interface

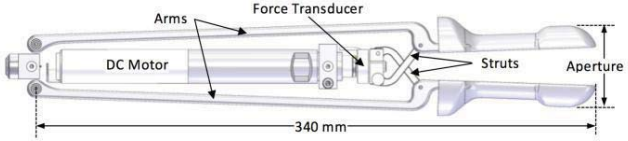

Figure 2: Internal components of the elastometer hand piece.

Performance

- Performance was tested against spring load measurements from an Instron and the elastometer with excellent correlation (Figure 3).
- Force-displacement data are displayed using a LabVIEW application on a laptop computer.
- Experimental measurement protocols can be varied as required. Data are filtered and acquired at 100Hz, presented as a force displacement plot (Figure 3).

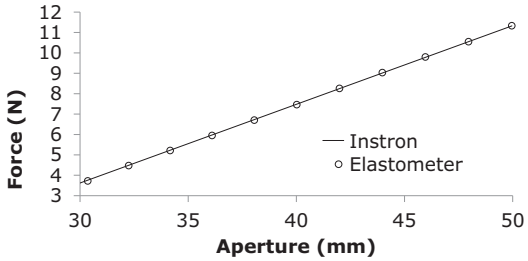

Figure 3: A test measurement against a spring load, comparing Elastometer measurements to an Instron device

Pelvic-floor stiffness measurements

- Three cycles are conducted per patient, using a prescribed protocol; first cycle is treated as tissue pre-conditioning.
- Linear trend line fitted to the most linear portion of the curve to calculate stiffness (Figure 4) .

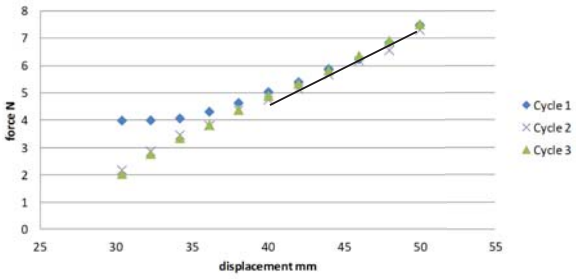

Figure 4: Representative plot showing force-displacement measures. Linear trend lines are fitted to measurements spanning apertures from 40 mm - 50mm

Current clinical study

- 107 first time pregnant women have enrolled for the study (65 European; 42 Maori/Pacific Islander).
- 71 have ante and postnatal elastometry data.
- Overall there is a significant difference ($p < 0.01$) between ante and postnatal elastometry data (Figure 5).
- There is also a significant difference ($p=0.03$) in elastometry data between the ethnic groups, with Maori/Pacific Island women measuring.

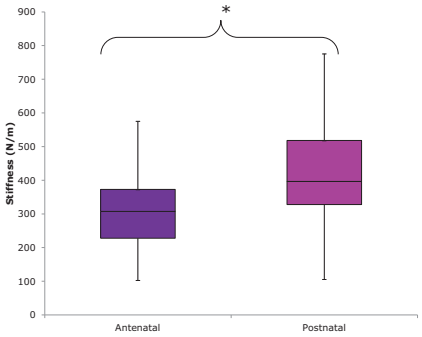

Figure 5: Differences in elastometry measurements between ante and postnatal women (n=71)

- Prevalence of PF muscle damage to date is 17%.
- Therefore the predictability of elastometry for muscle damage is not yet known due to small numbers.

Conclusion

- The elastometer is able to discriminate differences in stiffness measures both pre and post delivery and between ethnic groups.
- The study is ongoing.

References

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[3] JA Kruger, PM Nielsen, SC Budgett, AJ Taberner. *An automated hand-held elastometer for quantifying the passive stiffness of the levator ani muscle in women. Neurourol Urodyn 2013.*