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Hodges P[1], Stafford R[1], Sapsford R[1]
***1.** The University of Queensland*

VIABILITY OF A NOVEL ELECTRODE TO RECORD ACTIVITY OF THE MALE RHABDOSPHINCTER

<u>Hypothesis / aims of study</u>

Recordings of electromyographic (EMG) activity from striated muscle fibres of the external urethral sphincter (rhabdosphincter) in males are generally made using concentric needle electrodes inserted via the perineum (1). Although this technique can record discrete potentials during voluntary and reflex contractions, it is difficult to make recordings during more dynamic tasks due to needle movement and discomfort. Recent interest in the mechanical contribution of the muscles of continence to postural control and respiration has meant that alternative methods must be developed to enable recording of rhabdosphincter activity during more dynamic tasks. It is also important to be able to record activity in upright body postures. A potential alterative to traditional intramuscular recordings is transurethral surface EMG recordings. Although recordings from the internal urethral sphincter have been reported using an electrode placed adjacent to the balloon of a urinary catheter (2), no attempt has been made to record EMG from the rhabdosphincter using a transurethral approach. A major problem for this approach is to ensure the electrode maintains a constant position relative to the rhabdosphincter muscle. The main aim of this study was to design a novel electrode to enable transurethral recording of the rhabdosphincter in male subjects. The second aim was to determine the quality of the EMG recordings made from this electrode.

<u>Study design, materials and methods</u>

The requirements for the electrode were; (i) the electrode was to be inserted into the urethra and lie adjacent to the rhabdosphincter, (ii) the adjacent recording surfaces were to be placed in parallel with the striated muscle fibres, (iii) the electrode was to be stabilised internally to minimise movement relative to the urethral wall, and (iv) the electrode was to produce minimal trauma to the urethra. To satisfy these objectives a novel electrode was fabricated from a 6 Fr paediatric urinary catheter. Recording surfaces were made from 4 strands of Teflon coated stainless steel wire (75 m diameter, California Wire Company, USA). Wires were threaded through small pinholes ~15 and 25 mm from the end of the catheter (Fig. 1A). Wires were fixed distally and the proximal end was threaded down the lumen of the catheter. A small dot of glue was placed over the sites at which the wires passed though the catheter in order to fix the wire, provide a smooth surface, and ensure no air could leak (see below). The 10 mm of wire that was positioned outside the catheter was scraped with a scalpel to remove the Teflon, thus forming the recording surface. The four wires were place at equal intervals around the catheter and the two urine ports in the catheter separated pairs of recording wires. The longitudinal orientation of the recording surfaces placed each electrode at ~90 degrees to the striated muscle fibres of the muscle (3). Thus, adjacent wire pairs would run along (i.e. parallel) the expected direction of muscle fibres.

At the distal end, wires exited the catheter lumen via pinholes in the rubber connector. Suctioning the catheter to the mucosa solved the problem of maintaining the electrode in a stable position relative to the urethral wall. This was achieved by attaching a syringe fitted with an internal spring to the catheter connector (Fig. 1A). Prior to connection, the spring was compressed by pushing on the syringe plunger. After connection the plunger was released and the expansion of the spring generated a negative pressure in the catheter, thus gently suctioning the catheter onto the mucosa. Maximum stability in recordings could be achieved by differential amplification of the signal from the wires either side of the suction port. After fabrication the electrode was either gas or low temperature steam sterilised prior to use.

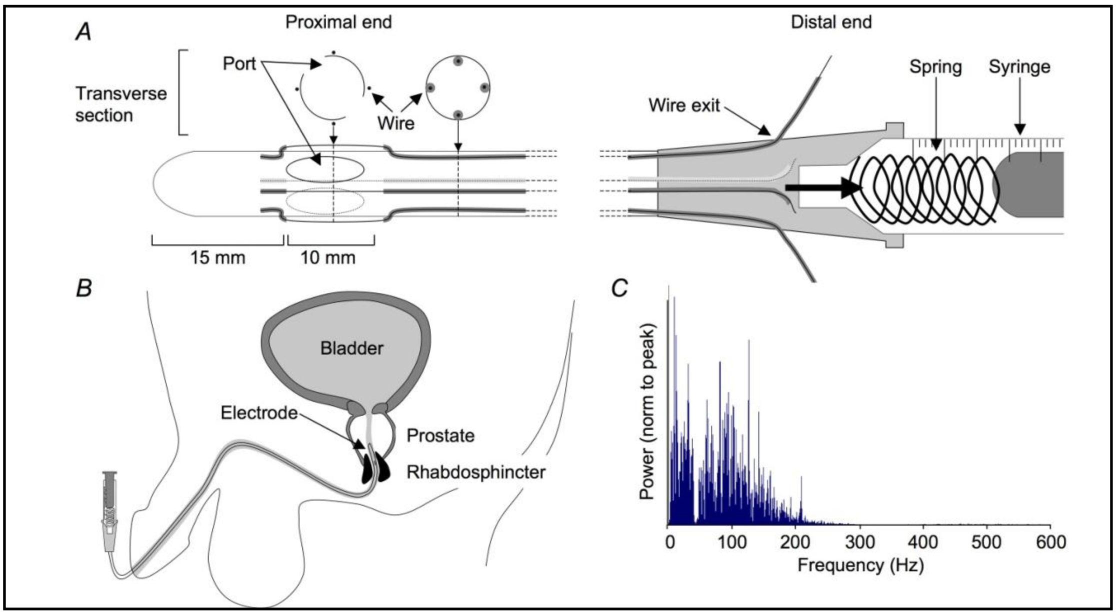

Figure 1. A *Electrode design. The left panel shows the distal end of the electrode. Four wires were threaded through pinholes in the catheter so that a 10 mm section of wire was positioned longitudinally outside the catheter. Wires lay adjacent to the urine port. The insets show the catheter in transverse section. The right panel shows the distal end of the catheter. Wires exited via pinholes and a syringe fitted with a spring was inserted into the distal connector. The extraction of the syringe plunger by the spring created a gentle vacuum to suction the catheter to the urethral wall.* ***B*** *Electrode in situ. The electrode was positioned adjacent to the rhabdosphincter at a level where EMG activity could be detected during voluntary efforts. In the ideal position the suction was applied via the spring-loaded syringe.* ***C*** *Power spectrum of rhabdosphincter EMG during a moderate voluntary effort. The reduction in power at 50 Hz is due to the notch filter used to remove electrical interference.*

The electrode can be inserted by the subject using a conventional aseptic technique for self-catheterisation. After emptying the bladder and cleaning the meatus with normal saline, 20 ml of 2% lidocaine jelly (Xylocaine, Astra) was inserted into the urethra via a syringe in two doses of 10 ml with 5 min between each administration. The electrode was introduced into the urethra (Figure 1B) until urine was released from the catheter. At this point the catheter was withdrawn ~10 mm to stop the flow of urine and the recording electrodes were connected to EMG amplifier. While EMG was recorded, subjects performed gentle voluntary contractions or coughs of moderate effort as the catheter was gently withdrawn. When clear EMG potentials were observed the location of the electrode was maintained by application of suction using the technique described above. At the completion of recording the syringe was disconnected and the catheter was easily and painlessly withdrawn.

Results
Using the novel technique described here we have made recordings from 5 healthy male subjects (25-38 years). Recordings have been tolerated well with minimal evidence of urethral trauma and only mild discomfort on urination for <24 hr. Stable EMG recordings have been made during voluntary efforts, coughing, and trunk/limb movements in standing and sitting. Good signal to noise ratio has been achieved and only small amplitude movement artefact is observed, even during very dynamic tasks. As can be seen in Fig. 1C the quality of EMG can be confirmed by the power spectral density of the EMG signal. Most of the energy in the signal falls in the range from 20-200 Hz, which is consistent with surface EMG recordings with some filtering by tissue interposed between the electrode and striated muscle fibres.

Interpretation of results
High quality recordings of EMG activity of the striated muscle fibres of the male rhabdosphincter can be made with a urethral electrode. The stabilisation of the electrode placement by suction to urethral mucosa enables recordings during dynamic tasks.

Concluding message
This novel EMG recording technique provides a unique method to record from the male rhabdosphincter during static and dynamic tasks and may be more acceptable to subjects when compared to needle electrode techniques.

References
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Is this a clinical trial?	**No**
What were the subjects in the study?	**HUMAN**
Was this study approved by an ethics committee?	**Yes**
Specify Name of Ethics Committee	**The University of Queensland**
Was the Declaration of Helsinki followed?	**Yes**
Was informed consent obtained from the patients?	**Yes**