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A MEASUREMENT MODEL FOR TROCAR INSERTION FORCE DURING TENSION-FREE VAGINAL TAPE (TVT) APPLICATION – A FEASIBILITY STUDY

Hypothesis / aims of study

Female stress urinary incontinence (SUI) is a common and distressing problem. Surgery is one form of effective treatment of SUI and tension-free vaginal tape (TVT; Gynecare, Division of Ethicon, Somerville, NJ, USA) is one of the commonest. Extensive performance of TVT has resulted in increasing awareness by the surgical community to the types and frequency of complications associated with insertion of TVT trocars, such as to the urinary bladder, blood vessels, and the bowels. With increased force of trocar entry surgeons may have less control of penetration, thus increasing the potential for serious visceral or vascular injuries. However, there is a lack of information on the measurement of TVT trocar insertion force. It is the aim of the study to establish a measurement model for the force required for trocar insertion during TVT application.

Study design, materials and methods

This was a prospective observational study designed to measure the TVT trocar insertion force. The authors' institutional ethics review board approved the study. Standardized, conventional TVT procedures were performed in this study [1], and the trocar insertion force was measured on both sides. A 3.5 x 3.5 cm pressure transducer was constructed from piezoresistive material (2 mm-thick semiconductive fabric; FSA, Vista Medical Ltd., Winnipeg, Manitoba, Canada) (Figure 1), which changed its impedance as force was exerted on its surface. The transducer was connected via an interface box to a personal computer to digitally record the pressure profile (Pressure = Force / Area, with Area assumed to be constant) continuously during trocar insertion [2]. The measured pressure profile was recorded in mmHg. The transducer and attached wires were enclosed inside a sterilized plastic cover and positioned in the center of the palm of the surgeon's dominant hand (Figure 2). The plastic cover was affixed to the surgeon's glove with adhesive tape to maintain the transducer's position. The handle of the trocar was positioned in the center of the transducer. As the trocar was inserted through the vagina the data-collection unit recorded the mechanical force exerted through the transducer by the surgeon onto the trocar. The procedure and recording were repeated on the contralateral side. Measurement data were recovered continuously from the data-collection unit and stored electronically on a laptop computer every 22 msec from the time of insertion of the trocar until the trocar exited through the abdominal incision. The profile obtained over time was examined to determine maximum contact pressure recorded for each insertion (Figure 3).

Results

Recordings were successfully obtained from the first four patients. The maximal pressure during insertion of the TVT trocar ranged from 70-90 mmHg. The pressure profiles of all four patients looked similar. Within the same patient, the profiles on both sides were similar. The pressure profile from one of the patients is shown in Figure 3.

Interpretation of results

Piezoresistive materials are semiconductors that operate on the principle that their resistance changes with application of a contact force [3]. This change in resistance results in a corresponding change in voltage measured across the material, which can be measured electronically and is directly proportional to the force applied on the sensor. It can be used to measure dynamic contact pressures at the interface between two surfaces, in this case, the surgeon's palm and the TVT trocar handle. The pressure and force are directly proportional as Pressure = Force / Area and we assume that the area is constant; therefore the force is directly proportional to the pressure recorded. From the pressure profiles it appeared they were reproducible, and the insertion force reached a maximum while the trocar was perforating the abdominal skin.

Concluding message

A model has been developed by which TVT trocar insertion force can be objectively measured. This model can be applied in the study of TVT trocar insertion and its associated complications.

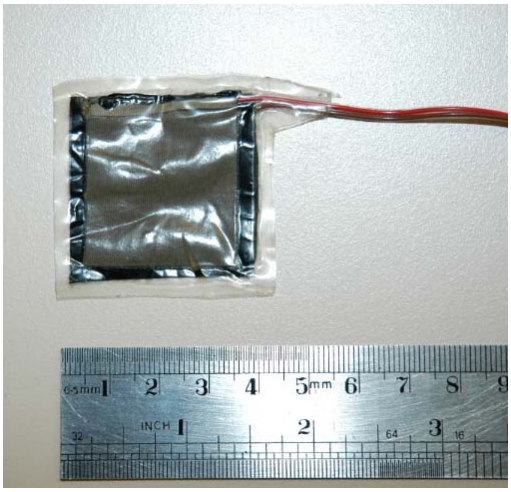

Figure 1. The pressure transducer.

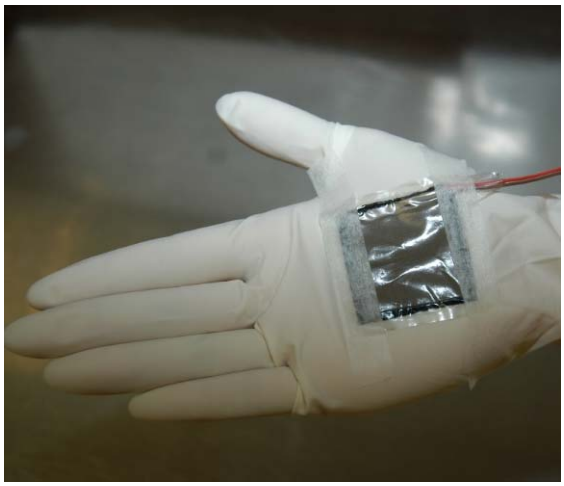

Figure 2. The transducer is affixed to the surgeon's palm.

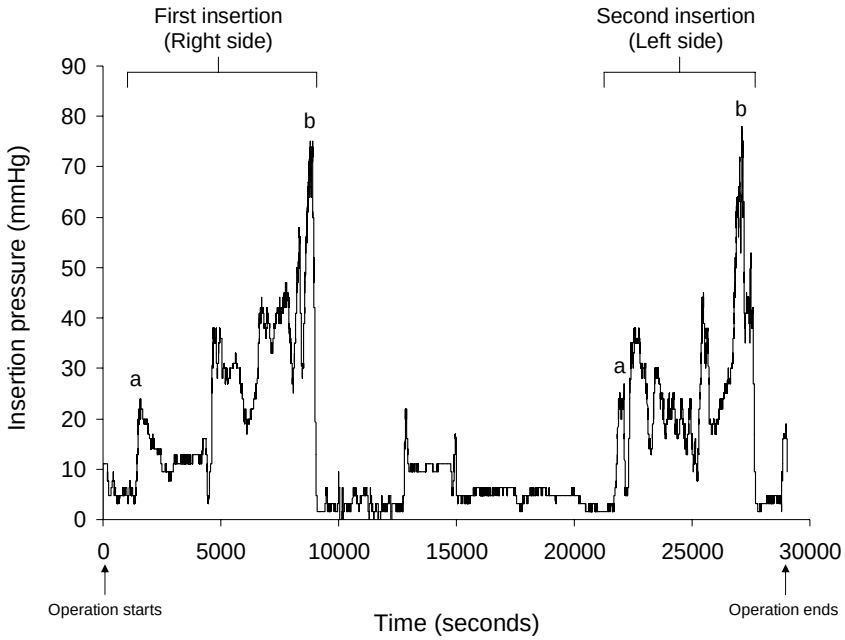

Figure 3. Typical pressure profile during TVT trocar insertion.
a = trocar perforating vagina. b = trocar perforating abdominal skin.

References

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