Verification of Force Sensor Apparatus Data using Expert Grading of a Radical Prostatectomy Nerve Sparing Simulation

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OBJECTIVE:
• A necessary aspect of robotic assisted radical prostatectomy nerve sparing (NS-RARP) includes minimal traction to the neurovascular bundle (NVB) during dissection to limit postoperative neuropraxia.
• We recently demonstrated a force sensor imbedded in the NVB of a hydrogel model with the ability to differentiate performance.
• Our objective was to verify the accuracy of these sensors in detecting NVB injuries during simulation by comparing its results to those determined by an expert surgeon.

METHODS: Model and Sensor Development
• Hydrogel models were constructed from a patient’s MRI using 3D-printed injection molds.
• A force sensor apparatus (FSA) was incorporated into the NVB of the model during construction.
• FSA outputs the various forces applied to the NVB.
• An algorithm was developed that detects excessive forces that would translate into major insults.
• Excessive forces were characterized by minimum peak prominence over 0.1x standard deviation of the overall force.

METHODS: Study Design
• Five experts (>250 caseload) completed the simulation (baseline).
• Force sensor apparatus (FSA) data and videos were collected from nerve sparing (NS).
• NS videos were graded by an expert for clinically relevant insults.
• Expert identified insults were overlaid with the FSA identified insults (Figure 1).
• The FSA identified insults and the expert grading was compared using an error matrix to determine the sensitivity, precision, and F1 score.

RESULTS:

<table>
<thead>
<tr>
<th>Actual (Expert) Insult</th>
<th>Predicted (Algorithm) Insult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error Matrix</td>
<td>Positive</td>
</tr>
<tr>
<td>Positive</td>
<td>239 (TP)</td>
</tr>
<tr>
<td>Negative</td>
<td>101 (FP)</td>
</tr>
</tbody>
</table>

Statistical Analysis:
• Sensitivity = 67.73%
• Precision = 70.29%
• F1 score = 0.7071

CONCLUSIONS:
• Addition of the FSA to the hydrogel NS-RARP simulation provides an accurate, time effective, reproducible and standardized metric to measure insults during NS.
• Removes the need for expert video review.
• Further bolsters the educational potential for procedural simulation.
• Further steps (larger participant and reviewer cohorts and detection of minor insults) are required to truly utilize it as feedback training and assessment tool in simulation.

Source of funding
• None