Set-Screw Break-off Study in Spinal Neurosurgery

Gautham Ramesh, Tsuchin Philip Chu, Ajay Mahajan
Department of Mechanical Engineering and Energy Processes
Southern Illinois University
Carbondale, Illinois 62901

INTRODUCTION
The objective of this study was threefold:
- Comparison of manual and powered torquing instruments based on the results of g-force measurements.
- Onset of fatigue in a surgeon based on these results.

PURPOSE
Pedicular Fixation Systems are used to correct deformity and to stabilize the spine. The purpose for choosing the pedicle as the place for screw fixation to achieve these goals arises from anatomic as well as from biomechanical factors. The pedicle is considered to be the strongest part through which the vertebra is accessible and it is large enough to fix the screws. Common implant materials used are stainless steel, commercially pure titanium and titanium-aluminium-vanadium alloys with varying compositions.

Results of Torque Test

<table>
<thead>
<tr>
<th>Method</th>
<th>G-force Value m/s² (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design break-off</td>
<td>11,000 N·m</td>
</tr>
<tr>
<td>Distortion Energy Theory</td>
<td>12.26 N·m</td>
</tr>
<tr>
<td>Fully Plastic Torque</td>
<td>12.28 N·m</td>
</tr>
<tr>
<td>Torque Wrench</td>
<td>11.30 N·m</td>
</tr>
</tbody>
</table>

Results of G-force Test

<table>
<thead>
<tr>
<th>Method</th>
<th>Manual (average)</th>
<th>Powered (average)</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max G-force</td>
<td>532.83</td>
<td>385.33</td>
<td>27.08</td>
</tr>
<tr>
<td>95% Die-Down</td>
<td>0.004513</td>
<td>0.002872</td>
<td>36.42</td>
</tr>
<tr>
<td>Work Done</td>
<td>0.0053</td>
<td>0.00463</td>
<td>12.64</td>
</tr>
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Comparative Chart for the 5 Surgeons depicting Max G-force, 95% reduction and work done

Onset of Fatigue - Probability Chart (Overall MVC % Plot)

Surface EMG during break-off event

Set-screw break-off analysis flow chart

- Set Screw Break-Off Study
- G-Force & Torque Measurement
- Torquing Instrument Comparison
- Onset of Fatigue in a Surgeon
- Multi-Level Construct
- EMG Data Analysis
- Torque Measurement
- Manual Instrument
- Powered Prototype
- Accelerometry
- Single and Multiply
- High Speed Camera Validation
- Distortion Energy Theory
- Torque Wrench
- Tangential Torque
- Fully Plastic Torque
- 95% Die-Down & Work Done

Comparison of Manual and Powered Instrument Comparison

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Percentage Reduction

- Max G-force
- 95% Die-Down
- Work Done

Surface EMG during break-off event

- EMG Test-set-up for Onset of Fatigue
- Tru-trainer and Cadaver Test-set-up
- EMG Test-set-up

Pedicular Fixation System

- Smaller Spinal Construct
- Larger Spinal Construct
- Torquing Instrument

Onset of Fatigue - Probability Chart (Overall MVC % Plot)