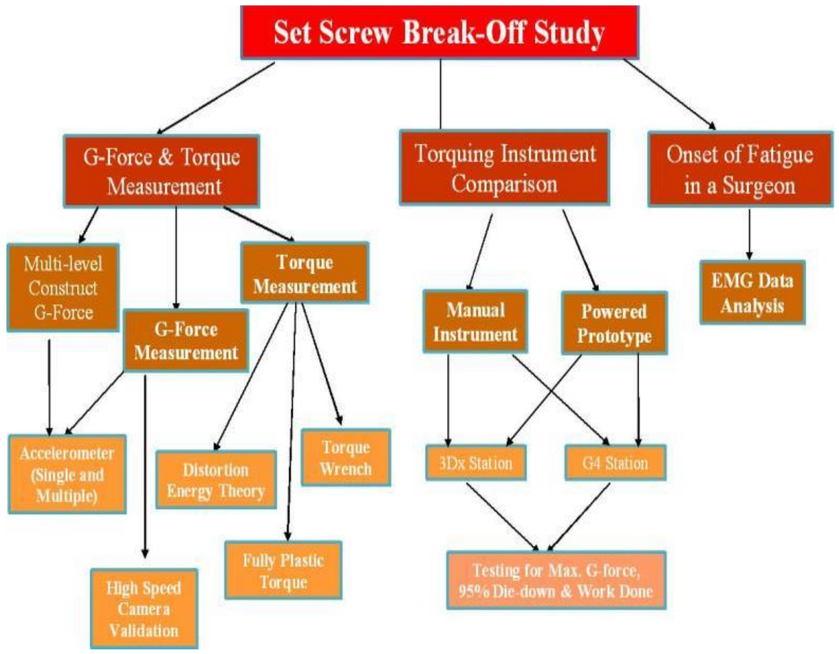
Set-Screw Break-off Study in Spinal Neurosurgery

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

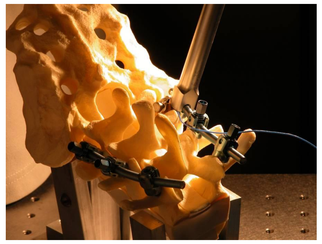
INTRODUCTION

The objective of this study was threefold:

- **Determine G-forces and Torque using modern instrumentation on a multi-level construct during set-screw break-off and validating using materials engineering and machine design theories.**
- **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.**



Set-screw break-off analysis flow chart

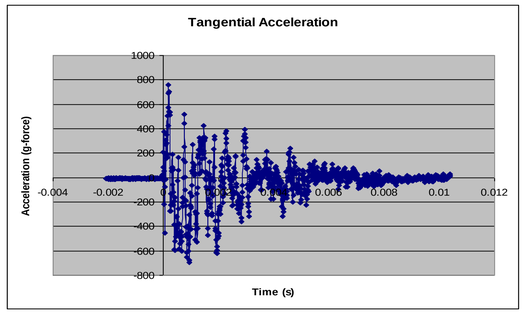


Pedicular Fixation System

High Speed Camera test Set-up

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



Accelerometer test showing 800 g's

Design break-off torque	11.000 N-m
Distortion Energy Theory	12.26 N-m
Fully Plastic Torque	12.28 N-m
Torque Wrench	11.30 N-m

Results of Torque Test

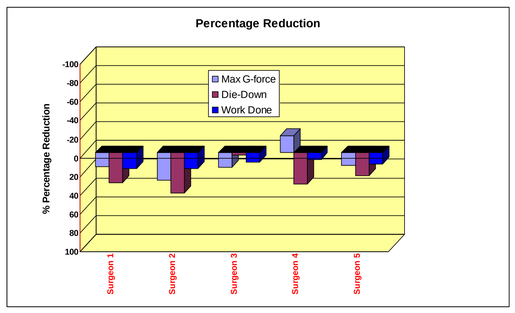
Method	G-force Value m/s² (g)
Accelerometer Test	7848 (800g)
High Speed Camera Test	8160 m/s² (832g)

Results of G-force Test

Tru-trainer and Cadaver Test Set-up

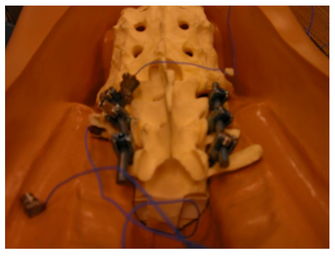
	Manual (average)	Powered (average)	% Reduction
Max G-force	532.83	385.33	**27.68**
95% Die-Down	0.004513	0.002872	**36.42**
Work Done	0.0053	0.00463	**12.64**

Results of Manual and Powered Instrument Comparison

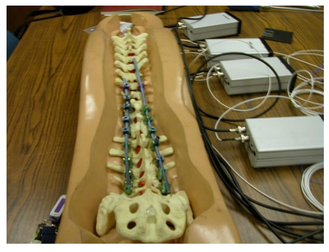


Comparative Chart for the 5 Surgeons depicting Max G-force, 95% reduction and work done

Spinal Constructs and Torquing Instrument

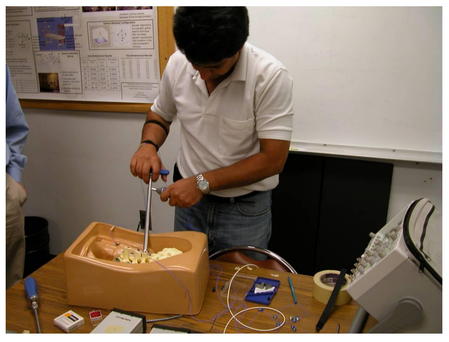


Smaller Spinal Construct

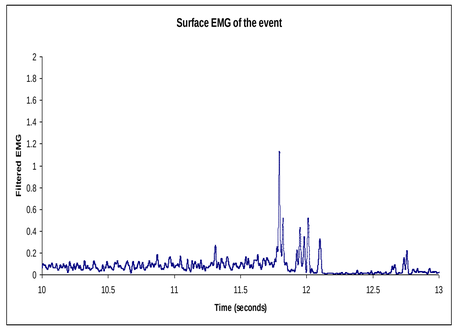


Larger Spinal Construct

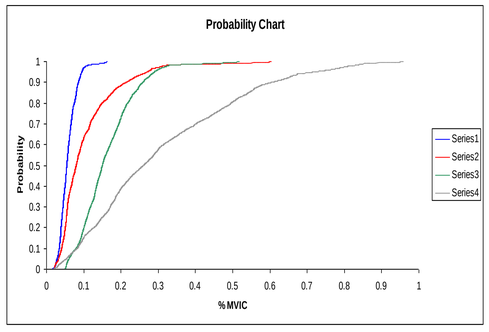
Torquing Instrument



EMG Test Set-up for Onset of Fatigue



Surface EMG during break-off event



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

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