# Power-Assisted Pedicle Screw Technique Protects Against Risk of Surgeon Overuse Injury

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## Introduction

Pedicle screw fixation has become the favored method of posterior spinal instrumentation when addressing spine deformity, however, pedicle preparation and screw insertion using manual technique remains labor intensive and repetitive. Surgeons' occupational demands put them at increased risk of overuse injuries; a survey of SRS members reported rates of neck pain, rotator cuff disease, lateral epicondylitis, and cervical radiculopathy at 3x, 5x, 10x and 100x greater than that of the general population.[1] Further, a survey of POSNA members reported surgeons are equally as likely to succumb to overuse injury whether in early or late stages of their careers, and the number of surgeons that required time off of work from these injuries increased with years in practice[2] (Figure 1).

The use of sophisticated power-assisted tools that maintain tactile feedback to facilitate pedicle preparation and screw insertion have shown equivalent[3-6] intra-operative efficacy compared to manual technique and may protect against risk of surgeon overuse injury. Risk of overuse injury is linked to muscle exertion, and previous studies[7-11] have correlated muscle exertion to risk of overuse injury during various tasks in painful and pain-free subjects.

**In this study, we record real-time muscle exertion of two surgeons as pedicle preparation and screw insertion are performed using both manual and power-assisted techniques in a simulated surgical environment and compare data to existing literature that links muscle exertion to risk of overuse injury.**

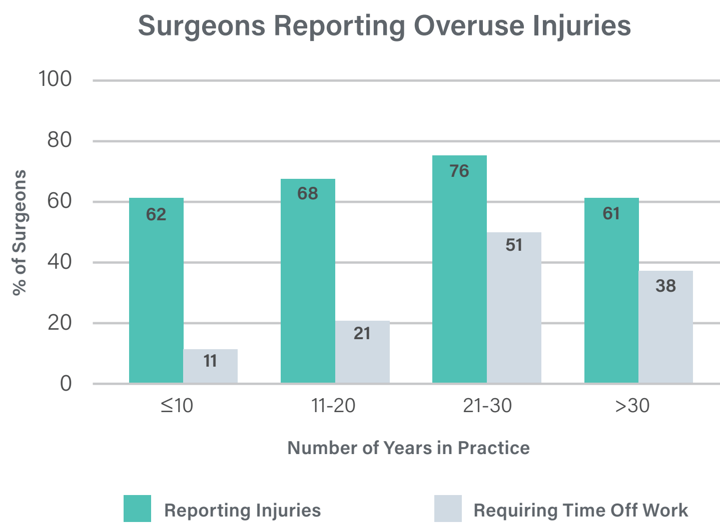


*Figure 1. The number of surgeons reporting injuries is consistent no matter the number of years in practice, but the number of surgeons requiring time off work for these injuries increases with age. Chart adapted from Alzahrani MM et al.2*

## Methods

Wireless electromyography (EMG) sensors were placed on the working arm of two board-certified spine surgeons to measure muscle activity during both manual and power-assisted pedicle preparation and screw insertion. EMG sensors recorded muscle activity from five muscle groups: flexor carpi radialis (FCR), extensor carpi radialis (ECR), biceps, triceps, and deltoid (Figure 2). Before the experiment began, the maximum voluntary exertion (MVE) of each muscle group was recorded, which allowed the experimental muscle activity data to be compared between each muscle group and each surgeon.


*Figure 2. Wireless EMG electrodes recorded muscle activity from five muscle groups on the surgeon's working arm. Flexor carpi radialis sensor not pictured.*

Pedicle preparation and screw placement was performed bilaterally from T4-L5 in four cadavers with both manual and power-assisted technique (n=56 pedicles/technique, Figure 3). Manual technique proceeded with the Vitality® Spinal Fixation System and included developing the pedicle tract with a Lenke probe, undertapping by Ø1.0 mm, and driving Ø5.5 mm Vitality polyaxial pedicle screws.* Power-assisted technique proceeded with the Vital™ Power Instrumentation Set and included the use of the flexible drill bit (Ø2.4 mm), the blunt-tip reamer probe (Ø3.2 mm), and the short threaded driver.

Within a vertebra, one pedicle was prepared and instrumented using manual technique and the contralateral pedicle with power-assisted technique, which yielded bone quality an internal control. Pedicle screw length was predetermined by level, therefore matched within a vertebra and between techniques as follows: T4: 30 mm, T5-T8: 35 mm, T9-T12: 40 mm, L1-L5: 45 mm. All three steps within each technique were executed before advancing to the next pedicle and order of manual versus power-assisted technique was varied to reduce bias.

Muscle activity was reported as a percent of the maximum voluntary exertion of each muscle group (%MVE, Figure 4). MVE was divided into four ranges with regards to risk of overuse injury based on published literature7-11: Low-Risk (0-20% MVE, green), Medium-Risk (20-45% MVE, yellow), High-Risk (45-70% MVE, orange), and Danger Zone (70-100% MVE, red). Each muscle exertion was analyzed with a histogram, which determined how long the muscle was active within Low-Risk and At Risk (Medium-Risk, High-Risk, Danger Zone) ranges for each step within the manual and power-assisted technique. Multiple t-tests were used to assess differences in the time spent At Risk of overuse injury between manual and power-assisted technique. Significance set to $p<0.05$.

Further, the four muscle groups most At Risk of overuse injury using manual technique were identified, subcatagorized into Medium-Risk, High-Risk, and Danger Zone, and compared to matched muscle groups using power-assisted technique.

*Pedicle screws of the Vital™ Spinal Fixation System and the Vitality® Spinal Fixation System share the same dual-lead thread form. Data on file within TPR-00663.

**Manual Technique**

**Power-Assisted Technique**

*Figure 3. Muscle activity was recorded as pedicles were prepared and screws were placed using both manual and powered techniques in a simulated surgical environment.*

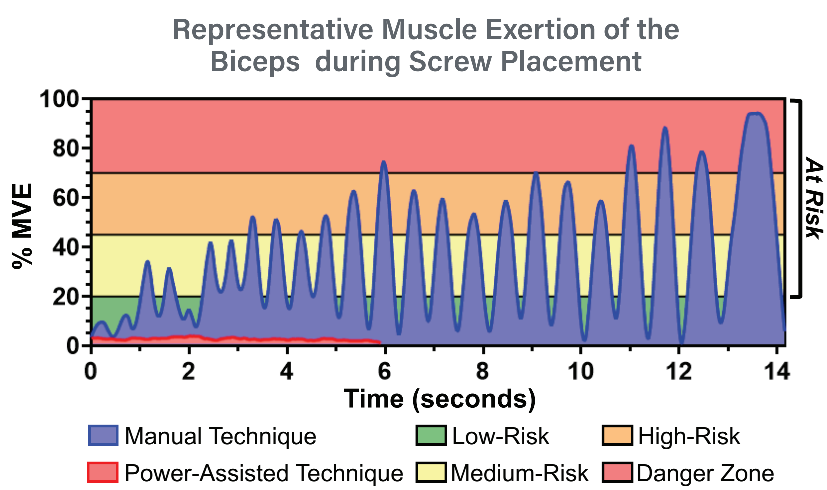


*Figure 4. Muscle activity reported as a percent of the maximum exertion of each muscle group (%MVE). Muscle exertion >20% MVE may lead to overuse injury and deemed At Risk.*

## Results

For all muscle groups recorded, manual technique requires more effort than that of the power-assisted technique as more time is spent At Risk of overuse injury >20% MVE (Figure 5). The manual technique demands the most from the ECR as it operates At Risk between 37% and almost 80% of procedure time. Even after creating and tapping the trajectory, the biceps operate At Risk for 63% of the procedure time while placing screws with manual technique.

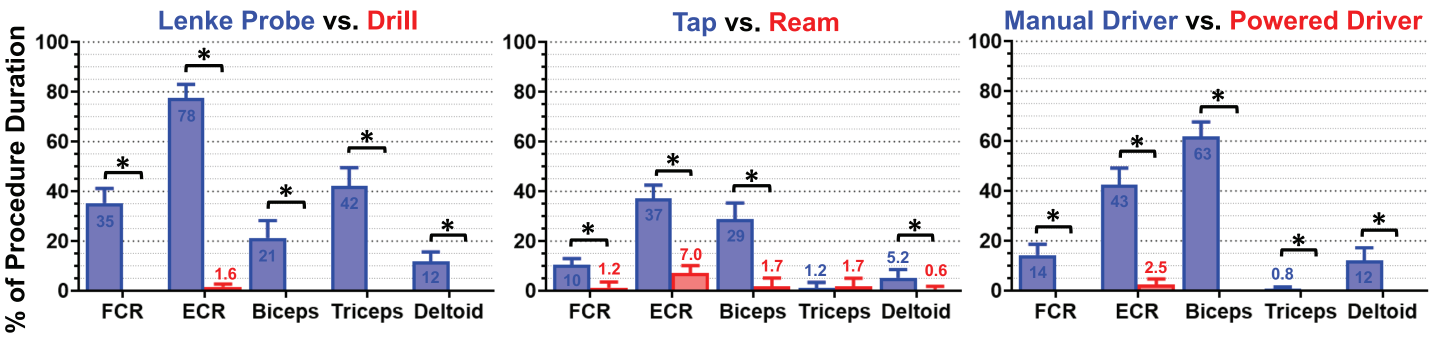


*Figure 5.* *Power-assisted technique significantly reduces the amount of time muscle exertion risks overuse injury (>20% MVE). Significant comparisons at p<0.05 denoted by *, error bars denote 95% confidence intervals.*

In contrast, use of the power-assisted technique significantly reduces time At Risk of overuse injury. At most, 7% of procedure time is spent At Risk using power-assisted technique, as compared to up to 78% using manual technique, a 91% decrease. The majority of muscle exertion remains Low-Risk while using power-assisted technique.

The muscle groups most At Risk during manual technique are the ECR, biceps and triceps. While creating the trajectory with the Lenke probe (manual technique), the ECR spends about as much procedure time at High-Risk (19.4%) as Low-Risk (22.2%). While using power assisted technique, all muscle exertion outside Low-Risk is Medium-Risk, whereas muscle exertion is within the Danger Zone in each of the top At Risk muscle groups using manual technique.

### TOP AT RISK MUSCLE GROUPS
### Difference in Procedure Time Spent at Ranges of Muscle Exertion

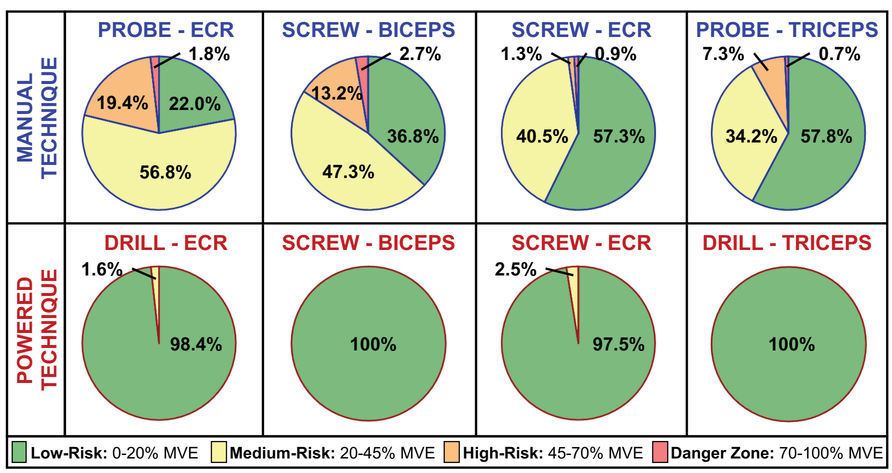


*Figure 6.* *Power-assisted technique facilitates Low-Risk of overuse injury for 98-100% of procedure time compared to the matched muscle groups most At Risk with manual technique.*

## CONCLUSION

Power-assisted technique protects against risk of overuse injury as use of power-assisted tools allows a surgeon to stay at Low-Risk muscle exertions between 93% and 100% the time for each of the three procedural steps in the technique. Manual technique does not protect against overuse injury as the technique demands surgeons to operate in unsafe ranges up to 78% of the time. Muscle exertions within the Danger Zone only appear while using manual technique, and though only for a short time, short exposures such as these are associated with sudden onset injury.12 As power-assisted technique protects against risk of overuse injury, adoption of the technique may extend a surgeon's practice and advance the quality of care he/she provides to his/her patients.

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