Pedicle Screw Hubbing in the Adult and Immature Thoracic Spine: A Biomechanical and Micro-Computed Tomography Evaluation

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Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the proposed advantages of the hubbing technique, 2) Discuss the biomechanical consequences of the hubbing technique on pedicle screw fixation strength.

Introduction

Pedicle screw hubbing involves seating the screw head into the dorsal lamina. This technique is postulated to provide 1)a load-sharing effect thereby improving pullout resistance, and 2)a reduction in the moment arm thereby decreasing cephalo-caudad toggling and implant loosening. The purpose of our study was to evaluate pull-out strength(POS) of fixed-head pedicle screws after hubbing versus standard insertion in the adult and immature thoracic spine.

Methods

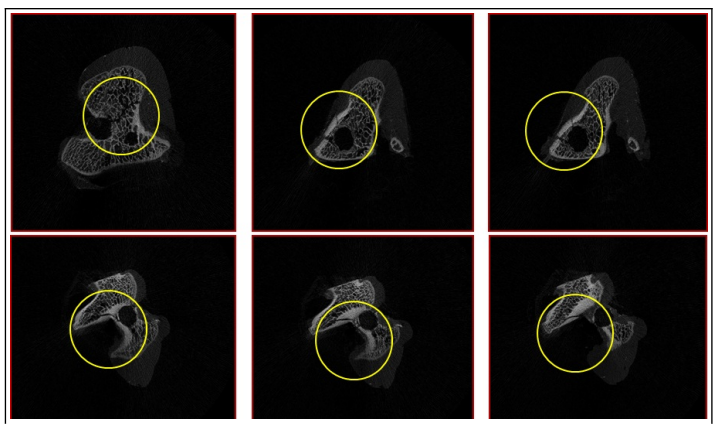
26 fresh-frozen human cadaveric and 22 fresh-frozen immature calf thoracic vertebrae were prepared. Osteoporotic BMD(n=16), normal BMD(n=6), and immature(n=12) specimens were instrumented with pedicle screws in Group I(non-hubbed, control) and Group II(hubbed) in the opposite pedicle. Cyclic, fatigue loading in a cephalocaudad direction was applied for 2000 cycles at a rate of 1 Hertz(Hz). Pull-out testing was performed in-line with the midline of the vertebra at 0.25mm/sec and peak POS measured in Newtons(N). Micro-computed tomography(uCT) was used to evaluate trabecular architecture and incidence of iatrogenic microfractures in both adult(n=4) and immature(n=10) specimens.

Results

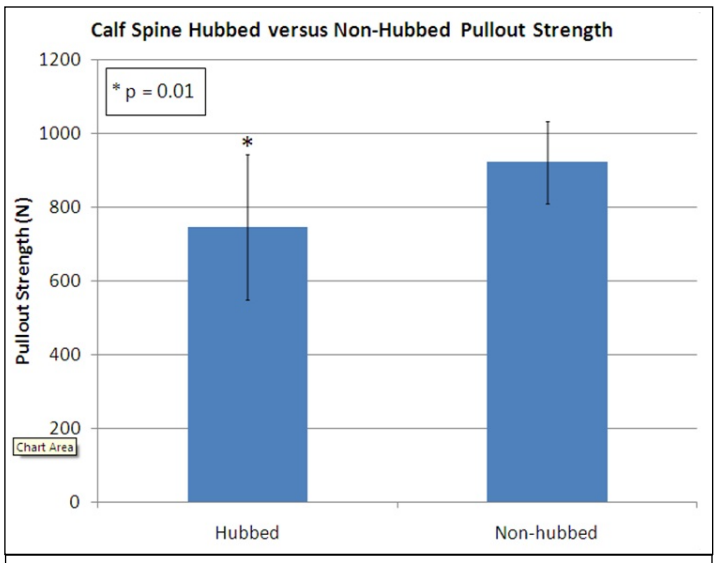
Hubbed screws resulted in significantly lower POS($p<0.05$) in all specimens(452±274N versus 656±285N), adult specimens(291±142N versus 512±243N), and immature specimens(747±197N versus 922±112N). With the hubbing technique, 50% of all adult specimens, and 83% of non-osteoporotic adult specimens had visible fractures of the dorsal cortex. For immature specimens, the dorsal cortex demonstrated plastic deformation and conformed to the screw head in 88% of cases. No visible fractures occurred in the control group. uCT demonstrated microfractures of the dorsal cortex in 4/4 adult and 10/10 immature hubbed specimens, and no fractures in 0/4 adult and 0/10 immature control specimens.

Conclusions

Hubbed pedicle screws have significantly lower POS in adult and immature thoracic vertebrae, and frequently cause iatrogenic fractures of the dorsal cortex (micro or visible). This study provides the surgeon with vital information to avoid this common misconception with screw insertion.



Micro-CT of Calf Spine with Fractures of SAF and Pedicle



Adult Spine Hubbed versus Non-Hubbed Pullout Strength