The effects of pedicle screw trajectory and presence of a crosslink during bilateral pullout

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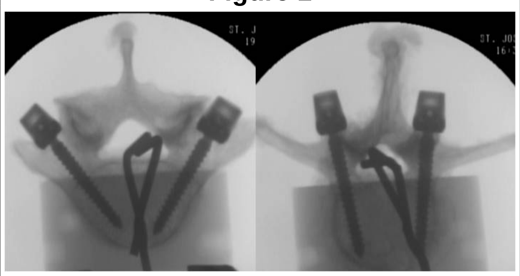
Introduction There are two common methods for inserting pedicle screws, having different entry points: a straight forward approach using Roy Camille's (Magerl, 1985) entry point and a trajectory involving a lateral entry point (Figure 1). With both techniques, the screws are ideally confined completely within bone inside the pedicle. The objective of this study was to analyze the biomechanical differences between the two trajectories using bilateral pullout testing and human cadaveric vertebrae, with and without an interconnecting crosslink.

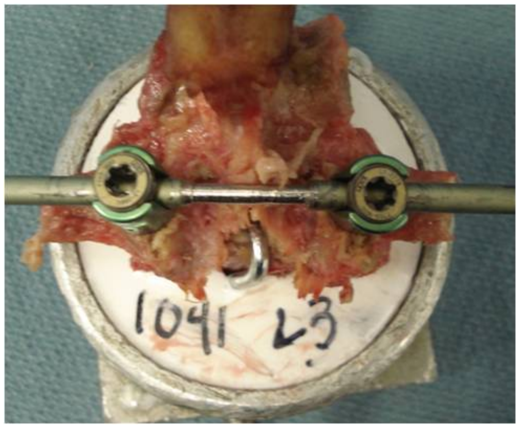
Figure 1



Axial view x-rays showing lateral (L-left image) vs. straight (S-right image) screw entry points.

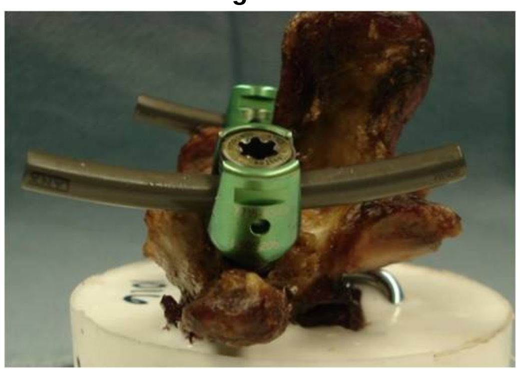
Methods 62 individual lumbar vertebrae were dissected, disarticulated, potted and instrumented using appropriately sized pedicle screws. The specimens were divided into two groups according to the trajectory used (S-straight and L-lateral) with further subdivision into groups receiving a crosslink (CL, Figure 2) or not (no CL, Figure 3). Screws were pulled out bilaterally, in a dorsal direction, while recording load vs. displacement.

Figure 2



Photograph showing rod configuration used to study screw pullout with a crosslink (CL - rod with reduced diameter).

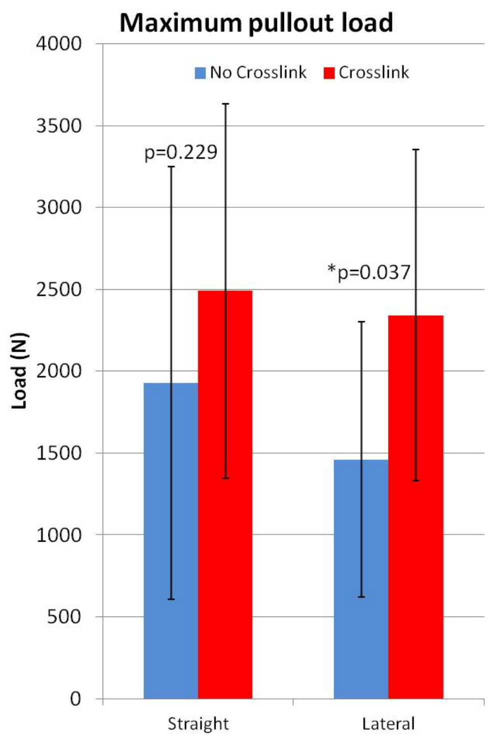
Figure 3



Photograph showing rod configuration used to study screw pullout without a cross link (no CL).

Results
The mean (±one stdev) maximum pullout loads are shown in Fig. 4. The differences in pullout between S and L, with or without a crosslink were not significant ($p>0.4$). The mean pullout load was greater with a crosslink vs. no crosslink for both S ($p=0.23$) and L ($p=0.04$). There were more unilateral failures in cases without a crosslink (S and L), and the mean pullout load with unilateral failures (S and L) was greater with a crosslink than without ($p<0.001$). Multiple regression analysis did not show significant relationships between pullout, BMD, %Fill-Pedicle or %Fill-Length, for individual sub-groups of screw trajectory and presence of crosslink. However, disregarding S, L and CL, pullout load could be predicted by age, BMD and %Fill of the screw ($p<0.001$).

Figure 4



Mean maximum pullout load for S- and L-groups, with and without a cross link. Error bars show one standard deviation.

Conclusions

Based on dorsally directed pullout tests, there were no differences between straight (S) and lateral (L) trajectory screws, with or without a crosslink. However, the addition of a crosslink increased the resistance to pullout by 60% (L, $p=0.04$) and 30% (S, $p=0.23$).

References

Magerl, F.: External spinal skeletal fixation. In The External Fixator, Edited by Weber, B.G., and Magerl, F. Springer-Verlag, New York, 1985.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) have increased knowledge about the most used pedicle screw trajectories, 2) understand the biomechanical advantages and disadvantages of different screw trajectories, 3) understand the importance of using a crosslink in short constructs.