Objective: Long posterior fixations have been shown to have a significant rate of screw loosening or fracture at the lumbosacral junction. Current practice in deformity surgery is to protect the S1 screw with supplemental distal (S2 or iliac screws) or anterior fixation (ALIF). These strategies are not without clinical challenges. AxiaLIF has the potential to address the shortcomings of current approaches for stabilizing long posterior fixation due AxiaLIF’s unique, presacral access. The objective of this study was to compare the effect of various surgical strategies on L5-S1 segmental range of motion (ROM) and S1 pedicle screw bending moment utilizing a finite element model.

Methods: A 3D sagittally symmetric nonlinear finite element model from L2-Sacrum was developed (Fig.1). Four constructs were considered:
1) L2-S1 posterior fixation (pedicle screws),
2) pedicle screws with distal fixation,
3) pedicle screws with ALIF and
4) pedicle screws with AxiaLIF.
Both ALIF and AxiaLIF were modeled without distraction of the L5-S1 disc. The anterior annulus of the ALIF construct was compromised to simulate implant insertion. To measure bending moments acting on the screws, strain gages were modeled as shell elements on the cranial, caudal, medial and lateral faces of the screw immediately below the screw head. The resultant screw bending moment was calculated using the Pythagorean Theorem based on the strain read-outs. All constructs were subjected to an unconstrained moment of 7.5Nm in flexion/extension, left bending and right torsion without preload. The overall and segmental ROM as well as the screw bending moment in the construct with pedicle screws alone was found to be in good correlation with in vitro data from six cadaveric lumbosacral spines.

Results: In flexion, all constructs that supplemented the posterior fixation showed a reduction in ROM relative to the pedicle screws alone by 45% with distal fixation, 79% with ALIF and 89% with AxiaLIF. Distal fixation and AxiaLIF showed the same ROM reduction in extension as in flexion and reductions of 57% and 38% respectively in torsion. Compared to the pedicle screws alone, the ALIF construct showed double ROM during extension (0.37° vs. 0.77°) and had no effect on ROM during the torsion. AxiaLIF and distal fixation constructs showed similar reductions of bending moment relative to pedicle screws alone: 87% and 86% respectively in flexion/extension; 29% and 31% respectively in torsion. Compared to pedicle screws alone, the ALIF construct reduced the bending strain by 24% in flexion, increased it by 47% in extension, and had no effect in torsion. The ROM and the S1 screw bending strain were lowest in lateral bending for all constructs and no significant differences were observed.
Conclusions: FEA results indicate that AxiaLIF may provide similar supplemental support as distal fixation to reduce S1 pedicle screw loads.