

Biomechanical evaluation of proximal junctional segments following long-segment pedicle screw-only versus hybrid fixation

Vibhu Krishnan Viswanathan; Ranjit Ganguly MD; Amy Minnema; Nicole Watson; Nicole Grosland; Douglas C. Fredericks; Stephanus Viljoen MD; Francis Farhadi MD PhD

 Department of Neurological Surgery

Introduction

Proximal junctional failure (PJF) is a serious complication following spinal deformity surgery. The major predisposing biomechanical factor is thought to be the abrupt change in stress between the rigid instrumented and the adjacent mobile segments. Proximal sublaminar band (SLB) placement represents a novel technique that may widen this “transitional zone” and mitigate the risk of PJF. The current study analyzes the biomechanical properties of hybrid constructs in a human cadaveric model.

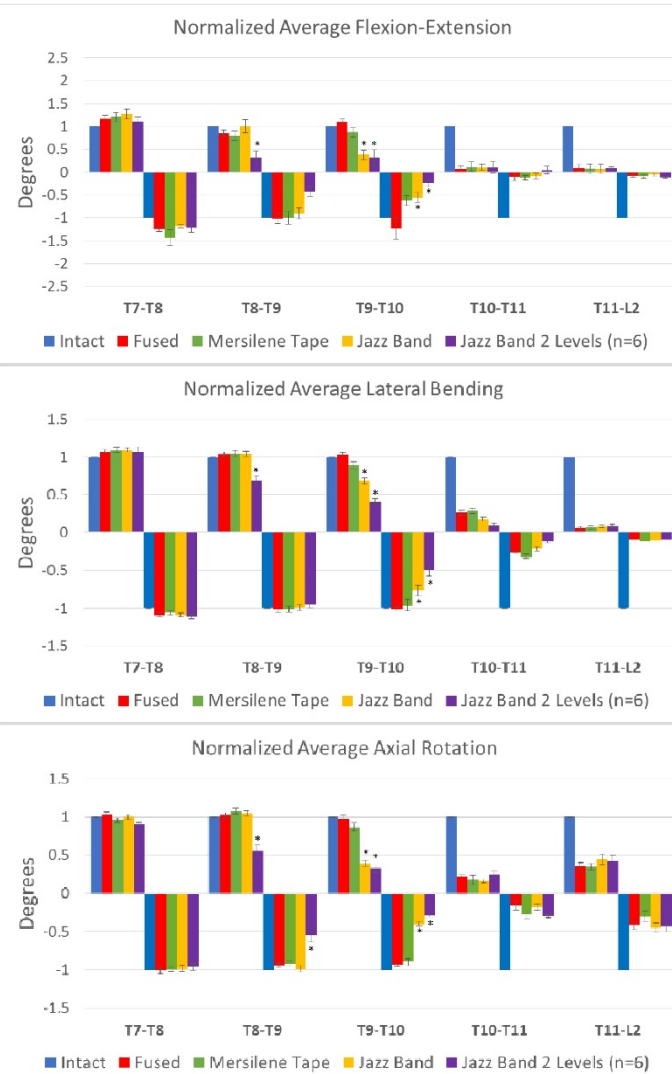
Methods

Ten fresh frozen human thoracolumbar spines (T7-L2) underwent flexibility tests (pure moments in flexion, extension, lateral bending and axial rotation) using the MTS 858 Bionix II System. Intradiscal pressure measurements were performed at the rostral adjacent motion segments. Five cycles of testing were performed: Intact (I), T10-L2 pedicle screw-rod fixation (PS), and hybrid constructs with either supplemental upper instrumented vertebra (UIV) + 1 mersilene tape, UIV + 1 sub-laminar bands (SL1) or UIV + 1/UIV + 2 sub-laminar bands (SL2).

Results

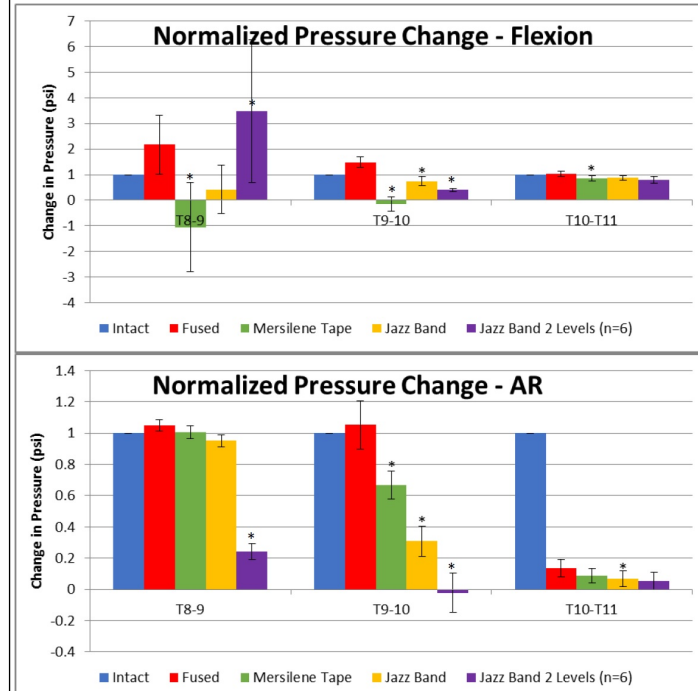
Flexibility analysis revealed that, as compared to PS, SL1 showed reduced flexibility at UIV + 1 under moments in all directions [flexion ($p=0.005$), extension ($p=0.022$), right and left lateral bending ($p=0.005$), and right ($p=0.008$)/left axial rotation ($p=0.005$)]. Similarly, as compared to PS, SL2 showed reduced flexibility at UIV + 1 [all directions ($p=0.028$)] and at UIV+2 [flexion ($p=0.046$), right lateral bending ($p=0.028$), and right/left axial rotation ($p=0.028$)]. SL1 versus PS

Figure 1: Inter-segmental motion analysis



3A. Under Flexion-Extension Moments 1B. Under Lateral Bending Moments 1C. Under Axial Rotational Moments

Figure 2: Intradiscal Pressure Analysis



2A: Normalized change in intradiscal pressure on flexion
2B: Normalized change in intradiscal pressure on axial rotation

Conclusions

SLB insertion reduced flexibility and intra-discal pressures at the UIV+1 level in our cadaveric model. This observation supports a potential role for SLB in mitigating stress at the proximal junctional levels.

Learning Objectives

1. UIV + 1 SLB insertion reduces proximal junctional flexibility
2. UIV + 1 SLB insertion reduces proximal junctional intradiscal pressures
3. SLB insertion allows for semi-rigid fixation and potential transitional zone widening at the proximal junctional levels