Biomechanical Study: Characterization of Spinous Process Plate Versus Pedicle Screw Fixation in Pure Bending

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Learning Objectives

Biomechanical evaluation of two lumbar spine fusion constructs: bilateral pedicle screws and rods versus spinous process fixation with plating.

Introduction

Pedicle screw and rod insertion (PS) is a common construct fusion spine surgery. A recently developed alternative is the spinous process plate (SPP). Advantages of SPP over PS include significantly less lateral muscle dissection and the elimination of the risk of nerve root injury. One criticism of SPP is possible inferior rigidity compared to PS, which could potentially lead to decreased fusion rates. The purpose of this study is to biomechanically compare posterior lumbar interbody fusion (PLIF) supplemented with SPP versus PS.

Methods

Thirteen human cadaveric specimens from seven donor spines were implanted with either SPP or PS. Functional spinal unit (FSU) test specimens consisted of two vertebrae, the intervertebral disc and associated ligaments. The specimens were tested in four states: (1) intact, (2) after removal of ligaments and disruption of facet joints (destabilized), (3) after placement of interbody grafts (PLIF), and (4) after fixation with either SPP or PS. A pure bending moment was applied to each FSU using a load frame to assess: (1) flexion, (2) extension, and (3) lateral bending. Deformation of the FSU was measured utilizing photogrammetry.

Results

The stiffness of the implanted FSU (SPP or PS) was found to be greater than the intact, destabilized or PLIF states. SPP and PS behaved similarly in flexion and extension, with PS having a slightly higher but statistically nonsignificant average modulus than SPP. SPP was statistically not as stiff as PS in lateral bending, but it was still as stiff as the intact FSU. (Table 1).

	PS (N/radian ± SD)	SPP (N/radian ± SD)	*p-value*
Flexion			
Intact	371 ± 261	321 ± 116	0.54523
Destabilized	105 ± 43	138 ± 34	0.03552
PLIF	458 ± 320	223 ± 168	0.04321
Hardware	1473 ± 956	849 ± 330	0.05009
Extension			
Intact	583 ± 316	706 ± 276	0.30521
Destabilized	381 ± 348	369 ± 231	0.83682
PLIF	946 ± 663	439 ± 259	0.03306
Hardware	1553 ± 558	1221 ± 560	0.14413
Lateral Bending			
Right			
Intact	294 ± 171	449 ± 272	0.09172
Destabilized	242 ± 176	331 ± 313	0.37192
PLIF	623 ± 535	621 ± 359	0.99190
Hardware	1667 ± 176	604 ± 313	0.00137
Left			
Intact	365± 164	393 ± 227	0.71498
Destabilized	234 ± 161	274 ± 76	0.44220
PLIF	761 ± 478	509 ± 168	0.10619
Hardware	1619 ± 536	577 ± 240	0.00002

Table 1.

Conclusions

SPP performed comparably to PS in flexion and extension but was inferior in lateral bending stiffness. SPP might be a reasonable and safer alternative to PS in lumbar fusion, and further investigation of its overall performance is warranted.

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