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### **Semi-rigid Lumbar Spinal Stabilization Lowers Screw-bone Interface Force and Cancellous Bone Strain when Compared with PEEK and Titanium Rod Systems in a Healthy and Osteoporotic Spine**

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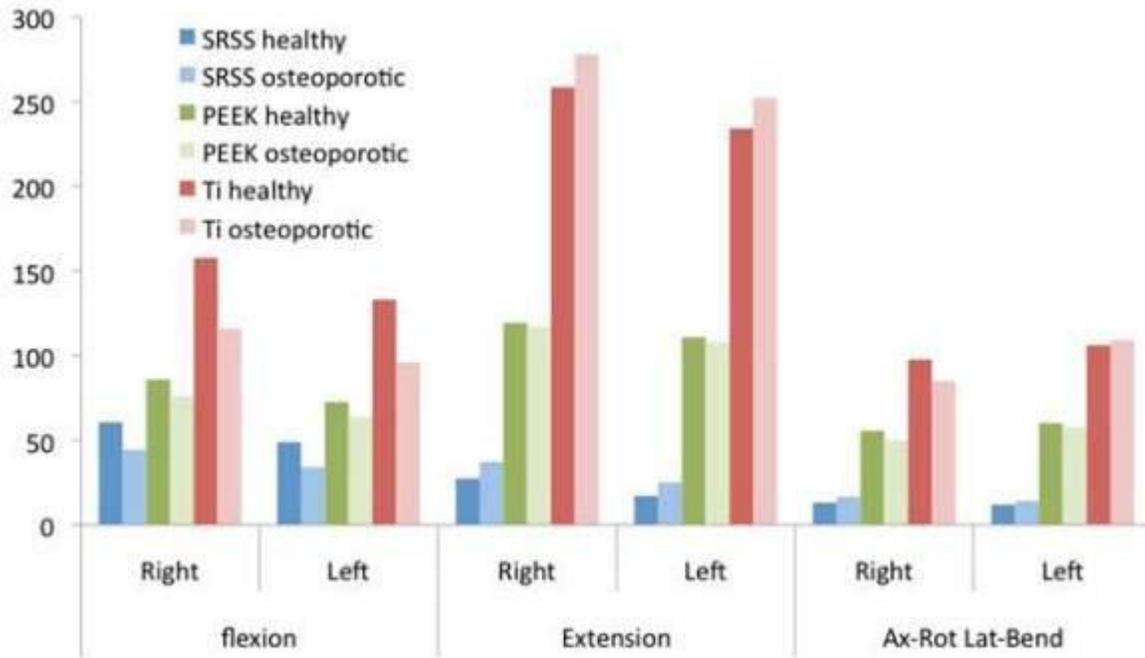
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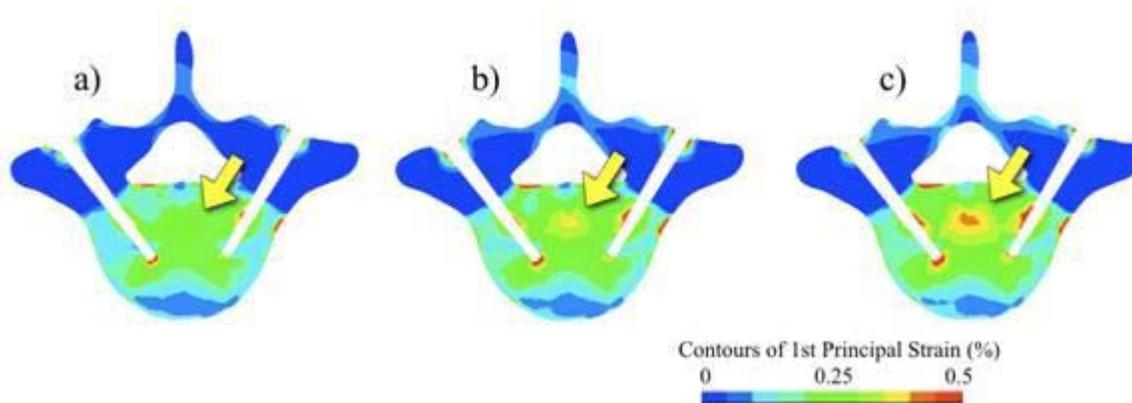
**Intro:** While posterior spinal fusion (PSF) in the treatment of lumbar degenerative spinal conditions remains the gold standard treatment, the adjacent levels to a fusion may experience increased stresses and motion, potentially contributing to accelerated degeneration. With the introduction of motion-preserving strategies, including dynamic stabilization, it is possible to stabilize an unstable motion segment, while still retaining motion at the index level, thereby reducing stresses at the adjacent level. Additionally, rigid pedicle screw instrumentation are prone to failure at the screw-bone interface in a compromised host bone environment, i.e., osteoporosis. The objective of the current study was to evaluate pedicle screw pull-out propensity between a variety of posterior stabilization devices including a semi-rigid stabilization system (SRSS), Titanium rods, and PEEK rod systems. Finite element models (FEM) of both a healthy and osteoporotic lumbar spine were utilized. It was hypothesized that a SRSS would minimize screw-bone interface force and cancellous bone strain maxima when compared with PEEK and Ti rods in both a healthy and osteoporotic spine.

**Methods:** A validated FEM of the L3-S1 was utilized. Virtual implantation was performed with three pedicle screw-based posterior stabilization systems; PEEK rods, Titanium rods, or SRSS. Osteoporosis was simulated by reducing the moduli of cancellous bone by 66%, and cortical shell, bony endplates, and posterior elements by 33%. Flexion, extension, and combined lateral bending/axial rotation were simulated. Strain in the bone around the pedicle screws, initial remodeling stimulus, and interface shear forces at screw-bone interface were evaluated.

**Results:** Total force at the bone-screw interface was greatest for the titanium models, reduced for the PEEK rods, and minimized for the SRSS(Fig1). Generally, a similar trend was observed for bone strain maxima. Areas of bone strain maxima around the bone-screw interface were minimized for the SRSS(Fig2). Remodeling stimulus generally indicated formation around the bone-screw interface for all three systems. The PEEK and Ti rods resulted in bone resorption signal near the anterior vertebral body during extension for both the healthy and osteoporotic models.



[Fig1. Bar graph of screw-bone interface forces]



[Fig2. Cancellous bone 1st princ strain contours]

**Discussion:** The results demonstrate that a pedicle screw-based SRSS mitigates strain maxima near the screws when compared with PEEK or Titanium rods, while also reducing the presence of bone resorption signal(stress shielding) in the anterior vertebral body. We conclude that compared with PEEK and Ti rod systems, SRSS may provide a “soft landing” in osteoporotic spines, thereby reducing the likelihood of screw pullout and fracture in this patient cohort, while at the same time minimizing stresses transferred to the adjacent levels by facilitating motion at the operative level.