Quasistatic Stress Comparison between Spring Distraction System and Traditional Growing Rods for Early Onset Scoliosis

Justin VC Lemans MD*, Manoj K Kodigudla MS**, Amey Kelkar MS**, Moyo C Kruyt MD PhD*, Vijay K Goel PhD**, Aakash Agarwal PhD**
*University Medical Center Utrecht, Department of Orthopedics, Utrecht, The Netherlands
**University of Toledo, Engineering Center for Orthopedic Research Excellence (E-CORE), Department of Bioengineering and Orthopaedic Surgery, Toledo, Ohio, USA
Presenter: Daksh Jayaswal**

INTRODUCTION:

- Traditional growing rod (TGR) and magnetically controlled growing rod (MCGR) need to be periodically lengthened.
- Spring Distraction (growing rod) System (SDS), in which rods freely slide along each other through a "polyaxial parallel connector" whilst continuous distraction is achieved through two parallel 75N titanium springs (Figure 1).
- The springs guide growth, while also able to act as a shock absorber, in contrast to traditional distraction-based devices, in which all forces are transmitted to the rods and screws.
- SDS has currently been implanted in over 30 patients as part of a clinical study in the University Medical Center Utrecht.
- In the current finite element study, we compared von Mises stresses in the rods between SDS to TGR in an instrumented scoliotic spine model.

METHODS:

- A representative, ligamentous, scoliotic, finite element model was created (Figure 2).
- Two versions of the same model were created and compared: An SDS model with a 75N spring (analytical spring element) on each side, and a TGR model without springs.
- Surgical correction of the curve with instrumentation was modeled by applying 20 mm distraction. After that, follower load accounting for gravity and muscle forces was simulated. Then, pure 1 Nm flexion-, extension-, lateral bending- and axial rotation moments were introduced to T2 (upper instrumented level) and maximum von Mises stresses on the rods were measured.

RESULTS:

- The maximum von Mises stresses in all four rods were slightly lower for SDS compared to TGR. The stress reduction ranged from 10-28MPa (4-11%)
- This reduction was combined with a small increase in spring compression, in which the SDS spring converted gravity and muscle stabilization force to spring energy.

DISCUSSION:

- SDS provides slightly lower von Mises stresses compared to TGR. Research is currently pursued to investigate the spatial distribution of stresses, spinal range of motion due to unique design features in SDS and spring-force optimization for optimal growth potential while minimizing rod fractures, as compared to TGR.
- Future studies should also investigate different spring configurations and aim to validate this data biomechanically.

SIGNIFICANCE/CLINICAL RELEVANCE:

- Rod fractures are a frequent complication in growing rod surgery and require additional surgery.
- The addition of SDS to standard instrumentation may reduce von Mises stresses on the rods and thus reduce the incidence of rod fractures.
- Since SDS lengthens automatically, it also removes the need for frequent forceful rod lengthening.

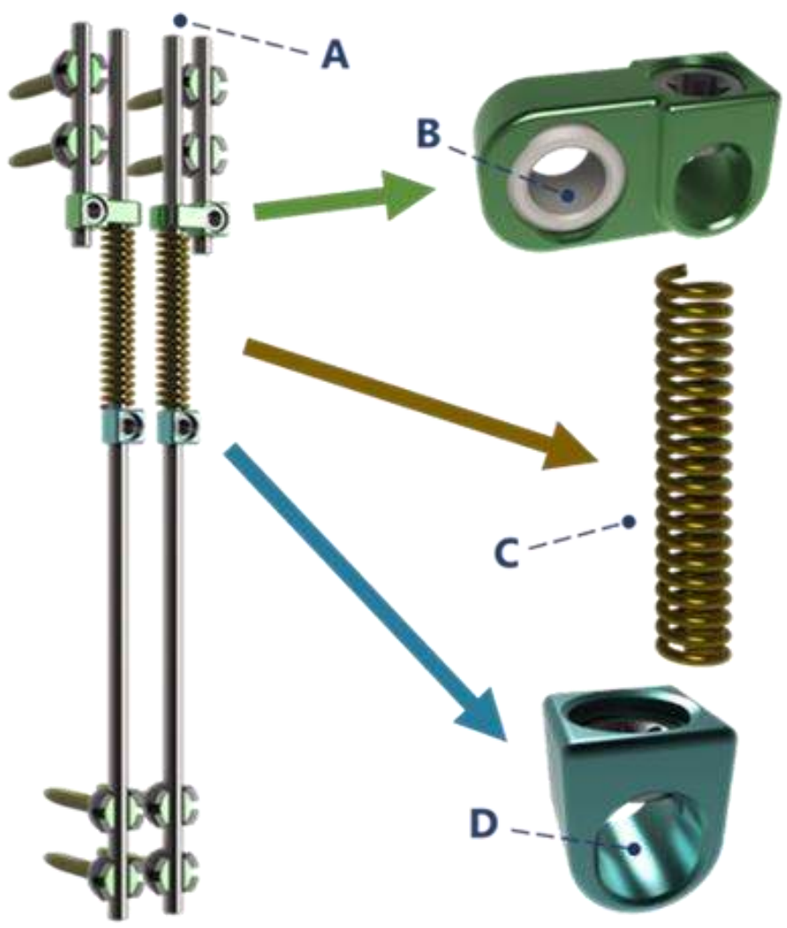

Figure 1: Spring Distraction System concept
A. Polyaxial bearing slides over free part of long rod as the spine grows **B.** PEEK polyaxial bearing allows rotation as well as sliding over the long rod. **C.** Titanium spring (75N) continuously distracts the spine. **D.** Buttress is fixed to the rod that houses the spring.

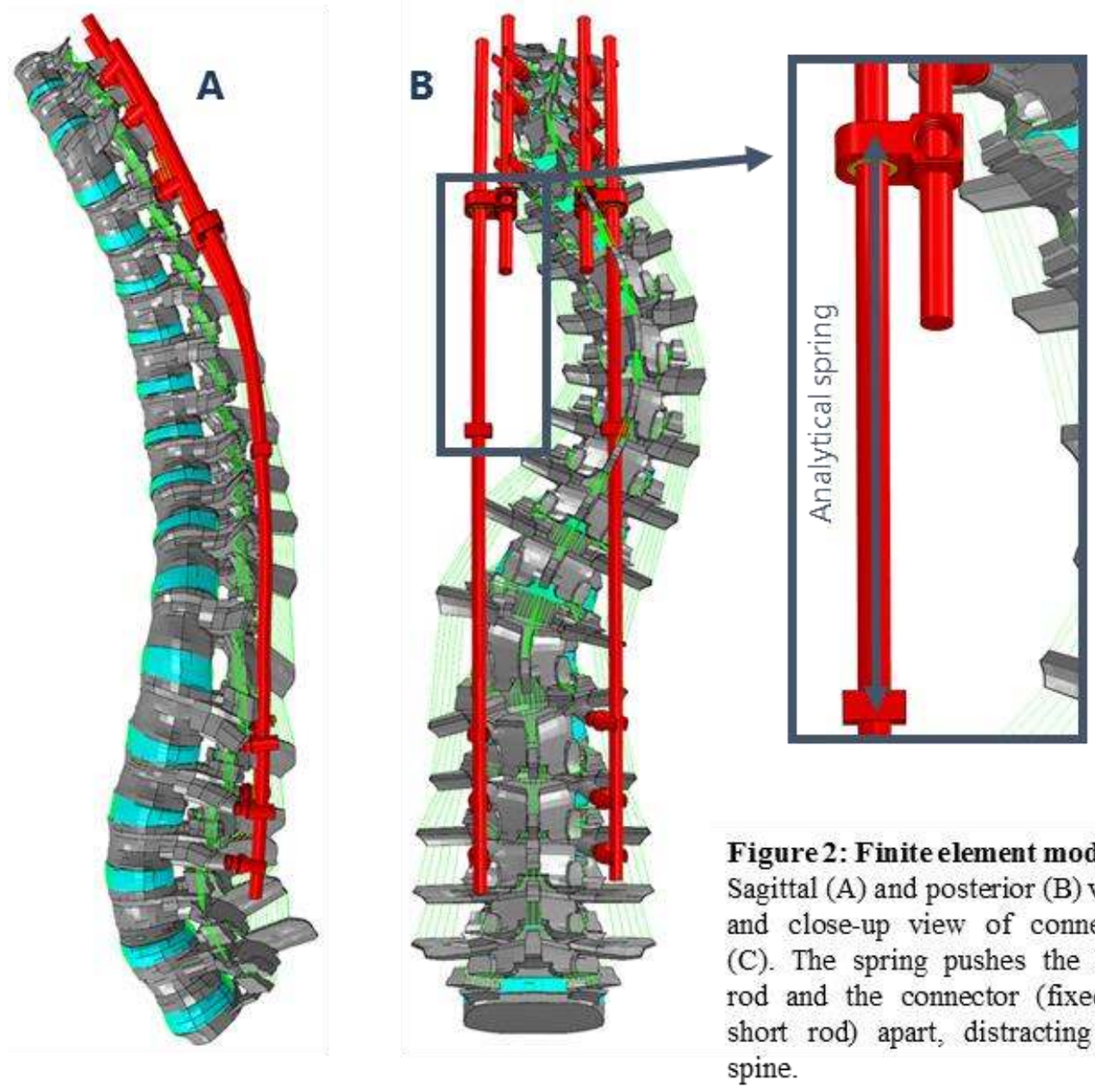

Figure 2: Finite element model
Sagittal (A) and posterior (B) view and close-up view of connector (C). The spring pushes the long rod and the connector (fixed to short rod) apart, distracting the spine.