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Disclosures:
A. Agarwal: 1; Paradigm Spine LLC. A.K. Agarwal: 1; Joimax GmbH, Paradigm Spine LLC. 2; Pioneer Surgical. 3B; Pioneer Surgical, Invibio. 3C; Spinal Ventures. 4; Spinal Ventures LLC, Osseon, Spinal Balance, OsteoNovus. 5; Invibio, Pioneer Surgical. V.K. Goel: 1; Joimax GmbH, Paradigm Spine LLC. 4; Osseon, Spinal Balance, OsteoNovus, GAMMA Spine. 5; Invibio, Pioneer Surgical, DePuy Spine, Intrinsic.

Introduction: Dual growth rod instrumentation is used to restore growth by consecutive distraction surgeries at intervals of 6 months. However, many researcher believe that the distraction forces applied are so high that it instead is stimulating growth rather than sustaining it.[1,2] Questions arise about how much distraction force should be applied to sustain the growth equal to normal spine growth. Here we hypothesize that for every patient with dual growth rods treatment there exists a distraction force that will sustain the growth of that patient’s spine equal to normal growth; a normal growth for a 9 year old child with T1-S1 length equal to 337.7 mm is 8.6 mm. In this finite element study, our objective is to identify the effect of magnitude of distraction forces on the T1-S1 height restoration of a normal spine instrumented with dual growth rods.

Methods: A finite element (FE) model of T1-S1 juvenile ligamentous spine (9 years old and weighing 22 kg) integrated with growth modulation was used in this study. The study design consisted of two groups of FE models; intact spine model, and dual growth rods instrumented spine models. Growth rod instrumented group had 8 different models varying in magnitude of distraction force from 50 N (25N at each side: GR 25N) to 400 N (200N at each side: GR 200N) with equal intervals of 50 N. Simulation steps consisted of distraction followed by 6 months of growth.

Results: T1-S1 height increased by 4.5 mm, 5.6 mm, 6.7 mm, 7.6 mm, 8.6 mm, 9.6 mm, 10.6 mm, and 11.2 mm with 50 N (GR 25), 100 N (GR 50), 150 N (GR 75N), 200 N (GR 100N), 250 N (GR 125N), 300 N (GR 150N), 350 N (GR 175N), and 400 N (GR 200N) of distraction force after 6 months of growth (Figure 1). For intact spine (9 years old) the T1-S1 height increases by 8.6mm in 6 months as reported in the literature.[3]

Discussion: A normal juvenile spine model was chosen instead of a scoliotic spine to isolate the effect of distraction force on T1-S1 height restoration. This would thus produce results independent of the severity of deformity and curve rigidity. As shown in Figures 1. T1-S1 height gain increased with increase in distraction force. Distraction force of 250 N (GR 125N) sustained the growth i.e., it caused the growth with equal to intact baseline while distraction force above 250N stimulated the growth i.e., it resulted in higher growth than intact baseline. Therefore any force more than 250 N would results in unnecessary growth in expense of increased complications. Recent clinical literature has published reports of distraction forces stimulating the apophyseal growth of the axial skeleton with growth rods compared to normal growth rate.[1, 2] This study supports this finding along with describing the reason behind this observation.

The results satisfy the hypothesis of the study as distraction force of 250 N (GR 125N) provided height sustenance equal to normal T1-S1 growth at the end of 6 months. Any distraction force above or below this range resulted in stimulation or inhibition of growth respectively compared to normal growth. It suggests that distraction forces higher than optimal will result in unnecessary growth in expense of higher complication due to high distraction forces on the rods.

Significance: This study sheds light on the effect of magnitude of distraction forces on T1-S1 growth. As higher distraction forces leads to unnecessary growth in expense of higher complication, optimization of distraction forces relative to patient would help lower the complication rate in dual growth rod distraction surgeries.

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