TITLE: Management of Severe Pediatric Spinal Deformity: A safe and effective approach.

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ABSTRACT:
Introduction
Conditions associated with higher complication rates while treating pediatric spinal deformity include poor bone quality, larger deformities (especially hyperkyphosis), neuromuscular and congenital scoliosis. Progressive spinal deformity in childhood leads to abnormal lung development with compromised pulmonary function and reduced life expectancy. Current methods of treatment include dual growing rods (GR), magnetically controlled GR (MCGR). In this study, we describe the basic science and clinical rationale for the usage of the 4-rib upper thoracic fixation rib construct (RC) for medically fragile children with severe deformity.

Methods
An RC was developed by necessity in 2 cases of early onset scoliosis (EOS) with severe kyphosis and osteoporosis. We had a total of 21 medically-fragile patients with adequate follow-up, 6 died of unrelated causes, and the other 15 had >5 year follow-up (average of 86 months). Biomechanical testing of a porcine model was performed with applied kyphotic loads to compare traditional pedicle screw fixation to the RC. We then performed successful thoracic kyphosis creation on a porcine model via an anterior transthoracic approach. This was followed by posterior corrective instrumentation using the RC. Post-operative x-rays were obtained at 2 week intervals until necropsy was performed at 6 weeks. CT and histologic imaging were performed at necropsy.

Results
With biomechanical testing, 6 pedicle screw constructs all failed at a remarkably constant deflection angle. There were no failures with the 6 rib constructs. Corrective instrumentation applied to a 25-kg pig with a fixed thoracic kyphotic deformity resulted in remodeling of the instrumented spine adjacent to the deformity. Histology was compatible with the effect of the Huetter-Volkmann law. We evaluated 21 patients with complex EOS treated with the RC and had 86-month average follow-up period. We present results for blood loss, operative time, post-operative complications, and degrees of correction for the subtypes of EOS. No complications had permanent effect on final result and none of the subjects had proximal junctional kyphosis (PJK) as a complication.

Conclusions
The rib construct is a safe and effective method for management of severe deformity in medically fragile pediatric patients. Complications related to failure of fixation are common but treatable. There were no permanent complications and no proximal junctional kyphosis (PJK). This method can also be used to improve chin brow angle in patients with pre-existing PJK.