INTRODUCTION:
Spinal growth modulation is an attractive alternative to arthrodesis for spinal deformity correction. Because these treatments in theory effect guided growth without the use of permanent rigid constructs, they have the potential to correct deformities without causing irreversible motion restriction. Although several mechanisms for spinal growth modulation have been proposed, including anterolateral tethering, only anterolateral stapling is currently in clinical use. Because a primary goal of these treatments is to preserve normal motion, it is imperative that they not adversely affect disc health. However, current literature is inconsistent as to the effects of such constructs on intervening discs. This information is crucial to predicting long-term outcomes of spinal growth modulation procedures.

In this study, the effect of anterolateral tethering on disc morphology was examined in a bovine model. Because no scoliotic animal model exists, tethering was used to induce scoliosis rather than correct it (inverse approach). Disc shape was evaluated using three-dimensional (3D) micro-computed tomography (μCT) reconstructions of spinal motion segments. Disc heights on the instrumented (right) side vs. non-instrumented (left) side and between tethered animals and surgical sham controls were compared.

METHODS:
Twelve five-week-old calves were included in the study. Six received an anterolateral spinal tether (four vertebrae had anterolateral vertebral body screws connected with a flexible tether, Tether Group), and six received a sham surgical procedure (anterolateral screw placement only, Sham Group). Instrumented levels were harvested after a six-month growth period. This produced three intervening discs in each surgical spine to be compared: a proximal disc (P), an apical disc (M) and a distal disc (D). The motion segments (distal half of a vertebral body, proximal half of the adjacent vertebral body and intervening disc) were preserved embedded in methylmethacrylate for previous undecalcified histological analysis. Three of the six spines in each group produced an apical motion segment and the remaining three produced a proximal and distal segment, resulting in a total of 9 motion segments in the Tether Group and 9 in the Sham Group (Figure 1). Although it is not ideal to combine different vertebral levels into a single group, both groups had identical compositions.

These samples were assessed by microtomograph (Skyscan 1076 μCT scanner, Belgium), using 35μm resolution scans, 0.4 degree rotation step, 100mA, 100KV, and a 1.0mm Aluminum filter. Vertebral surface reconstructions were created from μCT scans using MMICS (Materialise, Leuven, Belgium), and vertebral body epiphyses were identified. Using a custom MATLAB (Mathworks, Natick, Massachusetts) script, inter-epiphyseal distances were calculated and used to generate disc-space height maps (Figure 2). Average height values were calculated for the right (instrumented) and left (non-instrumented) sides of each map. Normalized left-right height differences were reported for each sample.

Two-tailed unpaired student-t tests were used to evaluate significance of left-right disc height differences and to compare tethered with sham results. Significance was set at p<0.05.

Figure 1: Schematic representation of six spines in each Surgical Group (Tether Group and Sham Group, n=6 each). Shaded sections indicate levels that had μCT analyses.

Figure 2: Motion segment with epiphyseal surfaces marked in blue and red (left). Epiphysis with superimposed disc-height map (right). An example from the control group.

DISCUSSION:
As expected, the tether created a greater coronal deformity when compared to the Sham group. The significant wedging away from the instrumentation seen in the Sham group discs suggests that even without tension, anterior vertebral body instrumentation can affect intervening discs. All samples had been previously processed for histology, therefore some coronal slices were missing from each motion segment. However, previous 2D analyses of these discs indicated that the disc thickness of the Tether group decreased on the left by 27% and on the right by 28% compared to the Sham group1. Those results correlate to the results of this analysis with 24% and 34% decrease of disc height on the left and right side, resp.

SIGNIFICANCE:
The data obtained from this study have the potential to directly impact patient care and promote or refute the use of growth modulation surgical techniques in the treatment of children with idiopathic scoliosis. The anterior tether may play a valuable role in the treatment of children who have many years of remaining growth with a high risk for curve progression.

REFERENCE: