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GENERAL SESSION 1

CERVICAL SPINE TOPICS

Progressive Instability Pattern of the Cervical Spine. D.J. Lamb, MD, Jerome M. Cotler, MD, TJ. Albert, MD. Jefferson Medical College of Thomas Jefferson University, Philadelphia, PA 19107.

Characteristic injury patterns of the cervical spine have been well described with progressive ligamentous instability inferred from x-rays taken at time of patient presentation. Ultimate 3-column involvement is assumed when injury patterns progress from unilateral facet injury or dislocation to bilateral facet dislocation to flexion distraction injury with bilateral facet disruption and anterior (ALL) and posterior longitudinal ligament (PLL) rupture. The goal of this study was to quantify the degree of instability created with progressive disruption as well as section of the ALL and PLL. We hope to better assess the contributions of the facet joints and anterior and PLL in preventing displacement under distractive load in the cervical spine.

Four fresh, frozen cadavers were utilized after a 24 hr thaw and placed prone on a Stryker frame with the caudal aspect of the cadaver fixed to the frame. Gardner-Wells tongs were placed in the standard position. Four stages of instability were created as follows: Stage I control - no disruption, Stage II unilateral facet disruption, Stage III bilateral facet disruption, sectioning the ALL and PLL and disc. At each stage of disruption, 4 levels of longitudinal distraction were added. A standard lateral cervical x-ray was taken at the same tube distance from the cadaver after each addition of weight and an appropriate equilibration time. Weights used in this experiment were 0, 50, 100, and 150 pounds of longitudinal traction for each stage of disruption. Intervertebral height was measured from the x-ray for each stage of disruption and at each weight by measuring the anterior and posterior vertebral height and averaging the 2 distances. Average intervertebral distances were pooled and averaged for the 4 cadavers at each stage of disruption and for each of the 4 levels of distraction. Best fit slopes were created of distractive weight vs stage of disruption.

Tabulated results of stage of injury vs distractive load are below. The numbers represent the means of the 4 cadaveric specimens.

	Stage of Injury			
Distraction (lbs)	I	II	III	IV
0	0. mm	0.18 mm	0.25 mm	4.5 mm
50	0.06 mm	0.43 mm	0.56 mm	7.5 mm
100	0.31 mm	0.25 mm	1.13 mm	9.30 mm
150	0.06 mm	0.31 mm	1.50 mm	10.80 mm

Intervertebral distances widened with increasing stage of injury and displacement in traction was more pronounced with each addition of weight in the higher stages of injury.

This study quantifies the response of cervical vertebrae to distractive loads in various stages of distractive flexion instability. Intact cervical spines and those with unilateral or bilateral facet disruption without anterior column distractive compromise tolerate high distractive loads with minimal change in intervertebral distance. We infer from this that minimal change in the distraction of the neural elements is also seen with these degree of injury. Conversely, with 3 column disruption involving ALL, PLL, and bilateral facet joint disruption smaller loads applied to the cervical spine create significant distraction at the level of the disc space and consequently at the level of the neural elements. Three column injury of the cervical spine represents significant potential instability and warrants careful x-ray assessment when attempting closed reduction. The minimal change in disc space distraction seen with high weight distraction in our cadaveric model with stage II and III instabilities explain the necessity, efficacy, and safety of high weight reduction often utilized with unilateral facet dislocation injuries in the cervical spine.

Two Level Cervical Discectomy and Fusion with Anterior Orion and Posterior Axis Plates- A Biomechanical Study in 6 Human Spines.

J Dryer, R Nucci, A Merola, J Gorup, R Zipnick, SUNY-HSC @ Brooklyn; T Haher, E Rossario, St. Vincent's Hosp, NY

Anterior cervical discectomy and interbody fusion is a procedure commonly performed to decrease pain from bony instability and disc herniation. Although the procedure is devised to eliminate spinal motion, various techniques may be superior to others in achieving this. The goal of this study was to measure the C5/6 facet motion in 1) an intact cervical spine, 2) a C4/5, C5/6 discectomy and C5 corpectomy model and 3) a C4-6 fusion model comparing different fusion constructs. Materials & Methods: 6 fresh frozen human cadaveric C-spines, ages 32-70 years, were harvested, preserving all disc and ligamentous structures. The spines were rigidly fixed at each end using two 40cm threaded stainless steel half pins. The pins were drilled in a parallel fashion through the body of C2 and T1. C3/4, C4/5, C5/6 and C6/7 motion segments remained intact. The pins were attached to a semi-circular frames with carbon fiber rods. The rods were placed into the upper and lower hydraulic grips of an MTS 858 Bionex materials testing machine. With compression a flexion moment was created across the intact motion segments. A 632.12 MTS extensometer with a 1" gauge length was attached across the right C5/6 facet joint. The spine was flexed from neutral to 15 degrees as measured from the endplates of C3 and C6. Force was recorded from the load cell and strain measured simultaneously from the extensometer for each stage of the destabilization and plating. Spines were tested intact and after C4/5, C5/6 discectomy with C5 corpectomy. Results: The motion of the C5/6 facet joint in the intact C-spine was 1.20mm +/.14mm. A C4/5 and C5/6 discectomy with C5 corpectomy resulted in a complex motion during cervical flexion with anterior and posterior subluxations of C4 on C6. Facet motion greater than 1.70mm was produced. With anterior strut grafting alone, facet motion was.1 Omm which was a 15% decrease from the intact spine. With anterior C4-C6 Orion plating alone, facet motion averaged 0.37mm +/-0.1 5mm. This was a 74% decrease from the intact spine and a more rigid construct than bone graft alone. Anterior plating with strut graft was the most rigid construct with facet motion of 0.26mm +/-0.1 3mm, an 80% decrease from the intact spine. The Orion plate alone showed grater rigidity than the bone graft alone. This implies that most of the rigidity of the strut graft-plate construct is provided by the plate. The anterior plate and strut graft had a tension band effect on the posterior structures. C5/6 facet motion with the anterior Orion plating and strut graft plus posterior Axis plating was 0.01 mm which was a 90% decrease from the intact spine. This was the most rigid construct, although facet motion was never reduced to zero.

Conclusions: The most rigid C4-C6 anterior construct is the Orion plate with tricortical iliac crest strut graft. The least rigid construct is the anterior strut graft alone. Most of the overall rigidity of the anterior plate and bone graft construct is provided by the plate rather than by the graft. The anterior plate and bone graft construct acts as a "tension band" putting the posterior elements under tension. There is always motion within the fusion construct.