BIOMECHANICAL EVALUATION OF ALICI SPINAL SYSTEM

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ABSTRACT:

The three dimentional stability provided by Alıcı spinal system has been studied in an in vitro biomechanical model using fresh calf thoracolumber spine specimens. An injury was created at L1 vertebra, totally excising anterior longitidunal ligament and corpus, leaving posterior elements intact. Maximum loading has been applied to this destabilized specimen and load-deformation curves were obtained. After mounting Alıcı spinal system to this instable specimen, it was observed that stability increased more than twice.

Key Words: *Spine, biomechanical, vertebrectomy model.*

Spinal instrumentation in the past few decades has developed extensively. Recently this has occurred rapidly and has been closely related to an improved understanding of biomechanical properties (1).

Vertebral correction can be assessed by the construct's ability to resist deflection such as in the measurement of the yield strength of spinal rods and plates. The assessment of implant's ability to align vertebrae has been expressed as the power of correction (2).

The thoracolumbar region is one of the most common sites of spinal injury. Internal spinal fixation devices are often preferred for the unstable injuries. One of the important goals of a fixation device is to provide a relatively stable environment at the fracture site that will enhance healing potential and result in a bony fusion in the shortest possible time before the device fails either by an overload or by fatigue (3).

The purpose of this present study was to determine the stabilization capability of Alıcı spinal system. A burst fracture of vertebrae was simulated on fresh calf vertebrae, axial loading and amount of displacements had been recorded.

MATERIALS AND METHODS

Eight fresh calf thoracolumbar spine specimens were obtained and the surrounding soft tissues stripped off, with care being taken to preserve the bone and spinal ligaments. During the tests the vertebrae specimens were protected from drying by spraying isotonic saline solution. Each specimen was embadded in bone cement at T_{12} level superiorly and L_4 level inferiorly. The specimens were tested on Instron 1114 hydraulic material testing apparatus (Instron Corp. Canton MA) in the Mechanic Laboratory of Dokuz Eylül University Mechanical Faculty.

The entire L_1 vertebral body and anterior longitidunal ligament were removed to simulate complete disruption of the anterior and middle spinal columns encountered in a pure axial loading (burst) type of injury. This model was chosen to simulate a "worst case" scenario of spinal instability, in order to remove any load sharing by the anterior spinal column and hence apply maximal stress to posterior implant.

Axial loading was applied to the destabilized spine specimens and load-deformation curve had been obtained. Then, Alıcı Spinal System was mounted to spine specimens using transpediculer screws at T_{13} and L_2 segments, with direct visualization of the pedicle and radiographic confirmation of screw locations were obtained (Fig. 1-A, B, C). 20 centimeter long threaded rods were mounted to the transpedicular screws and transverse connectors were used to increase the stability of the system. Again axial loading was applied to this instrumented vertebrae and the same parameters from the graphical outputs were analysed. The speed of the claws of the testing machine was 5 milimeters per minute and the speed of graphical paper was 20 milimeters per minute. The averages of plastic deformations and displacement amounts were calculated from graphical outputs.

RESULTS:

The results are based on testing calf thoracolumber vertebrae specimens each destabilized by excising L_1 vertebral body.

In axial loading test of destabilized spine, plastic deformation occurred averagely at 280 daN and 28 milimeters displacement was recorded. When Alıcı Spinal System was mounted to the destabilized calf spine, plastic deformation occurred averagely at 770

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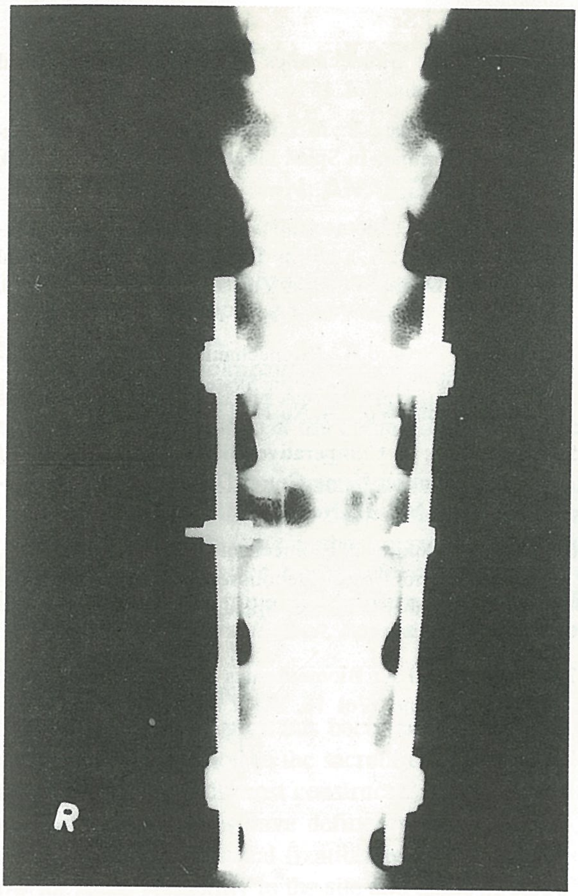

Fig 1-A

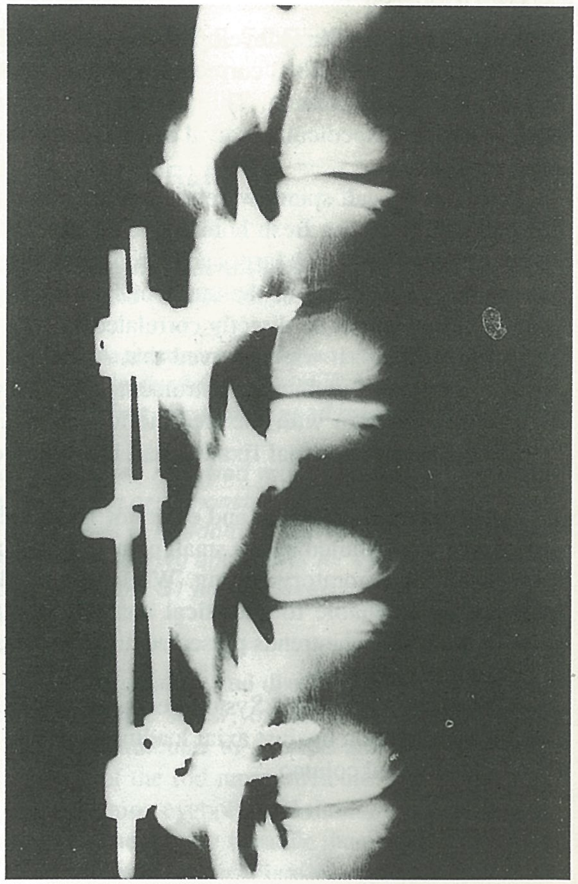

Fig 1-B

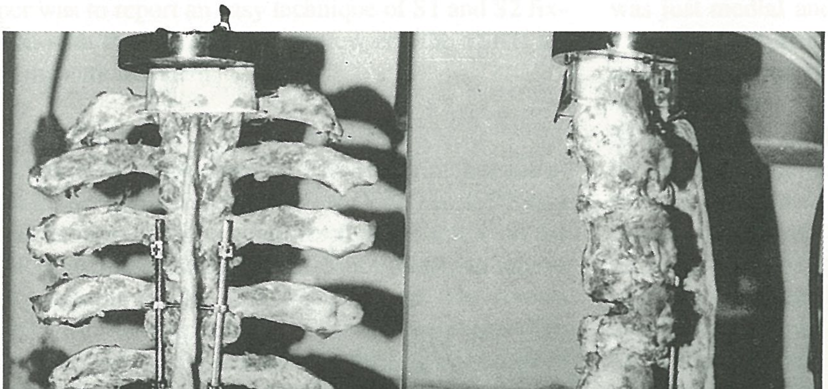

Fig 1-C

daN and 32 milimeters of displacement was recorded.

The average load-displacement curves for destabilized specimen and Alıcı Spinal System mounted-destabilized specimen are shown in Figure 2. The load is plotted on the vertical axis and amounth of displacement is plotted on the horizontal axis.

Alıcı Spinal System increased the stability significantly. At maximum loading, failure occurred at junction of instrumented segments with free motion segments.

DISCUSSION

Alıcı Spinal System, developed in recent years, provides three dimentional correction and stability to the applied spinal column. This system consists of rods, hooks, transpedicular, sacral screws and transverse connectors.

In this study, calf spines were used instead, for the difficulty of obtaining fresh human spines. Since the bovine spines were much larger and stronger than human spines, assessment of the mode of failure of instrumentation cannot be directly correlated to human spine. Neverthless, it was observed that Alıcı Spinal System did not fail within the instrumented levels but rather at its junction with the free motion segments therefore adequate internal fixation had been provided.

Furthermore, the number and extent of invitro test procedures were limited by the small number of specimens used for laboratory testing. While our results may not be amenable to statistical analysis due to small sample size, the trends presented are considered to be clinically relevant.

As a result, Alıcı Spinal System seems to provide a reliable stabilization against axial loading forces on a destabilized spinal column.

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