

DIFFERENCE IN BIOMECHANICAL PROPERTIES BETWEEN A CERVICAL PEDICLE SCREW CONSTRUCT AND LATERAL MASS CERVICAL FIXATION

Hyung Soon Park^{1,2}, Brad Dunlap², Eldin E. Karaikovic², and Li-Qun Zhang^{1,2}

¹ Rehabilitation Institute of Chicago, Chicago, IL, USA

² Northwestern University, Chicago, IL, USA

E-mail: l-zhang@northwestern.edu

INTRODUCTION

Posterior cervical spine fixation with lateral mass screws has traditionally been used (An, 1991). There are concerns of inadequate fixation in cases with poor bone quality or large defects in the posterior elements due to fracture or post laminectomy. In patients with poor bone quality who require multi-segmental fixations, the current dorsal stabilization procedures in the sub-axial cervical spine using lateral mass screws are often insufficient.

Cervical pedicle screw fixation has been suggested as an alternative procedure (Abumi, 1994), but there are still limited data available on the biomechanical differences between pedicle screw and lateral mass fixation. Prior work has indicated that cervical pedicle screws had higher screw pullout strength (Jones, 1997; Johnston, 2006), and increased stability (Kothe, 2004).

The purpose of our study was to measure the residual load in the adjacent discal surfaces and facet joints for two different posterior fixation constructs (lateral mass screw and pedicle screw), and to investigate whether there was any difference in biomechanical properties between the two constructs.

METHODS

Two different posterior cervical fixation systems (pedicle screw-rod vs. lateral mass screw-rod constructs) were used in order to determine if there was any biomechanical advantage of one over the other.

Two motion segments (C4-5 and C6-7, each instrumented with one type of instrumentation) from five cervical cadaver spines (for a total of ten motion segments) were used for testing. Bone mineral density was determined using DEXA scan. Radiographs and CT scans were used to exclude the presence of fractures or other pathologic conditions. Lateral mass screws and pedicle screws were then installed at one and the other segment of a specimen. The instrumentation method for a segment was chosen randomly so that each spine would contribute one motion segment to each group, and it would serve as its own internal control.

A pressure sensor (Tekscan Inc.) was placed through a slit in the annulus at the junction of the inferior end plate/superior surface of an intervertebral disc. The pressure sensor measured pressure values and distribution during axial loading.

The motion segments were securely clamped and mounted into a jig and tested with a non-destructive physiologic load (Fig. 1). Uniplanar axial load was applied with a maximum load of 90 Newtons for 200 cycles as previously described (Johnston, 2006). The jig was designed so as to align the vertical axis of loading with the center of flexion axis (Fig. 1). By using a force sensor (Transducer Techniques Inc), a high precision linear motor (8.5 μm resolution by Physik Instruments) was controlled so that the constant loading/unloading rate (22.5 N/sec) was maintained during the cyclic loading between 0 to 90 Newtons.

Once the type of screw is chosen randomly, a specimen was preloaded by 40 cycles of loading between 0 to 40 Newtons. Then the specimen was loaded at two conditions; without instrumentation and with the screws fixed to the rods.

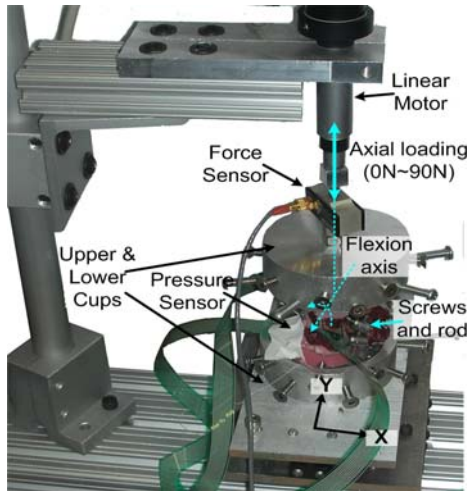


Figure 1. Experimental setup. The specimen was clamped into a jig which was designed so as to align the vertical axis of loading with the center of flexion axis.

RESULTS

For data analysis, average pressure, peak pressure, and contact area under 90 Newton load were measured at the sensor area (about 200mm²). The pressure reduction at disc area before and after the instrumentation was then compared between the two types of instrumentation methods: lateral mass screw-rod and pedicle screw-rod.

The pedicle screw instrumentation reduced significantly larger amount of average pressure, peak pressure, and force (P-value < 0.05) at the disk area than did the lateral mass screw (Fig. 2).

DISCUSSION

In addition to the significantly higher pullout strength (Johnston, 2006) and higher stability to lateral bending (Kothe, 2004), the results from this study showed that the pedicle screw reduced larger amount of

pressure at the disc area and took more load than did the lateral mass screw.

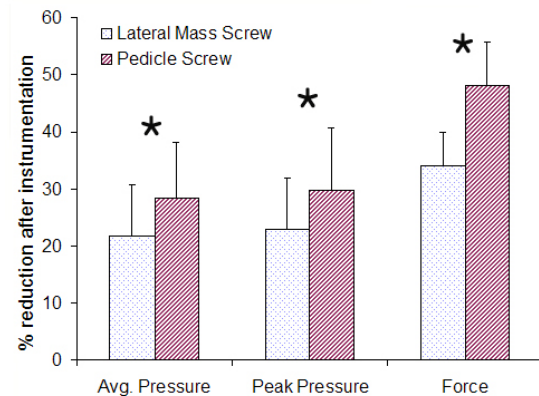


Figure 2. The difference between the two constructs. Average and peak pressures, and force at the disc area were measured under 90N loading over 200 cycles for without and with the instrumentation. The % reduction in those parameters after instrumentation were then calculated and compared. Pedicle screw showed significantly higher reduction ratio for the three parameters. * P<0.02

Due to proximity of neurovascular structures and small pedicle size, some authors have expressed concerns of potential iatrogenic injury with cervical pedicle screws (Kowalski, 2000). However, our results showed that pedicle screws provided more rigid constructs which are needed in cases of comminuted vertebral body fractures or destructive flexion-extension cervical spine injuries.

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