

EFFECTS OF ANTERIOR ROD NUMBER AND THE REMOVAL OF MID-COLUMN ON ANTERIOR AND POSTERIOR INSTRUMENTATION IN THORACOLUMBAR BURST FRACTURE

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INTRODUCTION

In the surgical treatments of thoracolumbar burst fractures, surgeons have the option of either an anterior or a posterior approach. However, to date, there have been lack of information about the increase of anterior rod number and the effect of the removal of mid-column. In this study, we investigated the biomechanical effect of the increase of anterior rod and the removal of mid-column in anterior fixation, posterior fixation, and combined anterior-posterior fixation in thoracolumbar fractures using finite element analysis.

MATERIALS AND METHODS

A 3-D finite element model of two spinal motion segments, from T12 to L2, in intact thoracolumbar junction was reconstructed from CT slices of 1mm thickness. The data of material properties presented in previous researches were used for this study. The developed intact model was validated by comparing with the previous experimental results.

Ten spinal fusion models were developed using the finite element model of intact spine according to the change of anterolateral rod number from 0 to 2, with or without, posterior fixation in the removal of mid-column case and no-removal case (Fig. 1). 1R, 2R, or 0R indicates the number of rod used in anterolateral fixation, NM indicates the removal of mid-column, and P indicates whether posterior fixation was additionally performed. The bottom of L2 vertebra was fixed and 5Nm of pure moment was applied on the top of T12 vertebra for flexion, extension, lateral bending and torsion using rigid bar. The spinal stiffness of each model was obtained by finite element analysis.

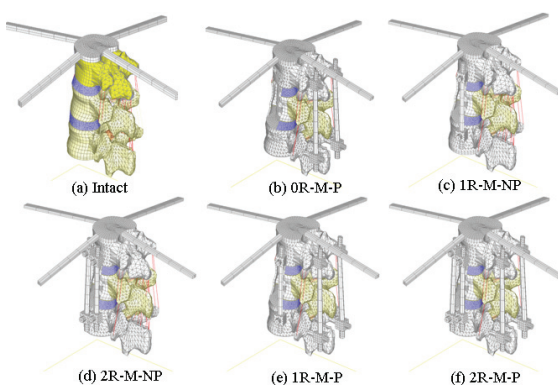


Fig.1 Finite element models of an intact model(a) and five fusion models (b- f). R indicates the number of anterior rod, M indicates no-removal of mid-column, and P indicates additional posterior fixation. NP indicates no posterior fixation.

RESULTS

In flexion, the stiffness of intact model was 1.86Nm/° which was a little higher than the results of experimental data, which are from 1.61 - to 0.81 Nm/°. The stiffness of intact model in extension, lateral bending, and torsion were 1.6 Nm/°, 1.09 Nm/°, and 3.89 Nm, and those values are all matched with experimental results.

The effect of the increase of rod number used in anterolateral fixation on spinal stiffness decreased when additional posterior fixation was performed. In anterolateral fixation without posterior fixation, however, the two anterior rod fixation case, 2R-M-NP, showed 161, 354, 67, 37% higher stiffness values than those in one rod fixation, 1R-M-NP, in flexion, extension, right lateral bending, and right torsion, respectively. When adding a posterior fixation, the two anterior rod fixation, 2R-M-P, showed little higher stiffness values than those in one rod fixation, 1R-M-P.

Stiffness values of no posterior fixation cases, 1R-M-NP and 2R-M-NP, were greatly increased up to 820% and 360% by adding posterior fixation. The removal of mid-column decreased the segmental stiffness from 12 to 23% in flexion and from 14 to 17 % in lateral bending (Fig. 2). However the removal of mid-column did not change the stiffness in extension and torsion. One anterior rod cases have greater influence of the effect of mid-column removal than two anterior rod cases.

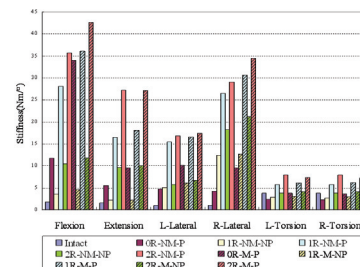


Fig. 2 Stiffness of intact and ten different fusion models

DISCUSSION

The results of this study showed that the effect of anterior rod number highly depends on the selection of additional posterior fixation. The effect of the removal of mid-column showed the meaningful change of the stiffness, but this effect is not affected by the change of the anterior rod number. The present study showed that careful consideration of choosing the anterior rod number and the removal of mid-column would be necessary in the surgical treatment of thoracolumbar burst fractures.

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