

Transpedicular screw의 고정강도에 관한 생체역학 연구

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A Biomechanical Study on the Fixational Strength of the Transpedicular Screws

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Introduction

The fixational strength of transpedicular screw in the vertebra relied on bone density and anatomical characteristics of vertebral pedicle, design of screw and types of connection(rod or plate) with screw. But the results of studies were controversial. The purpose of this study is to verify the biomechanical nature of the transpedicular fixation in spine under various conditions with porcine vertebrae.

Material & Method

Fresh porcine vertebra and the custom-made screw were used in this experiment. To reduce the errors caused by vertebra bodies of different size and density, vertebral bodies of which pedicular width ranged from 10.0 to 11.5 mm in diameter and bone density ranged from 1.0 to 1.25 gm/cm² were measured by dual photon absorptiometry. The pedicle screw was inserted in the same procedure and axial pull out test was performed with using the Material Testing System(Instron 8501; bi-axial cyclic testing machine, U.S.A). Maximal holding strength was measured in each experiment. The experiment was performed in two sessions. Experiment I was to assess the difference of strength of pedicle screw according to the operative techniques and divided into four tests.

Test A was performed to evaluate the effect of insertion of depth on the same vertebra(15mm vs. 30mm). Test B was to verify the effect of drill bit size(drill bit/diameter of screw). Test C

was to verify the holding strength for the different ratio of surface size of the screw to pedicle(cross section ratio). Test D was to evaluate the effect of cortex of entrance point. Test E was to evaluate the effect of bone cement augmentation in loosened hole. Experiment II was to assess the difference of strength according to designs of the screw and also divided into four tests by using five types of screws. The five types of screws were designed according to diameter, pitch, shape, and profile of screw. The effect of screw designs was evaluated in the condition which fixed all factors except only one factor. Test A was to verify the effect of outer diameter(5mm vs. 7mm). Test B was to verify the effect of pitch(2mm vs. 3mm). Test C was to verify the effect of screw shape(cylindrical vs. conical). Test D was to verify the effect of thread profile(Butress vs. V-shape).

Results

The results of Experiment I and II were summarized as follows : Test I-A showed that the strength of fixation increased in accordance with the depth of insertion but there was no proportional increase after passing through the pedicle. Test I-B showed that the size of drill bit used to get maximal holding power was 60-70% of inner diameter of the screw. Test I-C showed the holding strength was greater when cross section ratio was ranged from 60 to 80%. Test I-D showed that cortical bone played the most important role in screw fixation. The holding strength of screw inserted into the

cortical bone of the pedicle was superior to that of cancellous bone of the vertebral body. Test I-E showed that the holding strength was restored to the level of normal bone after reinforcing cement. Test II-A showed that the screw of larger outer diameter had greater holding strength. Test II-B showed that there is no statistical significance between different modes of pitch. Test II-C showed that the holding strength of cylindrical shaped screw is superior to that of conical shaped screw. Test-D showed that the holding strength of V-shaped of thread profile is superior to that of butress shape.

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