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14(3) 2019
Research Paper

Comparison between short segment pedicle and lateral mass screw construction strength for resisting flexion and extension motion in sub axial cervical spine

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Received: 03.12.2019
Accepted: 23.12.2019
Published: 30.12.2019

Abstract

Background: There are several kinds of posterior cervical instrumentation in vertebrae such as wiring, lateral mass, and pedicle screw. Lateral mass still becomes the main choice for instrumentation, although the pedicle screw has better pull-out strength compared to lateral mass.

Objective: The aim of this study was to compare lateral mass and pedicle screw strength in short segment construction for flexion/extension motion in the sub axial cervical spine.

Method: Six adult sub axial cervical spines were harvested from human cadavers. Each cadaver divided into Cervical 3-4 and Cervical 5-6 then 3,5 mm screw was placed with Roy-Camille technique for lateral mass and Abumi technique for pedicle. The cyclic load of flexion and extension motion was applied for each construction to evaluate the construction strength in a fatigue test. Data was collected and being tested by using a t-test.

Result: The mean cyclic load 172 cycles in lateral mas screw construction and 367 cycles in pedicle screw construction were applied until construction became failed. Pedicel screw has higher strength because pedicle structure has higher bone mineral density and longer bone-screw interface than lateral mass. Pedicle screw has longer screw than lateral mass, the mean length of screw-in pedicle was 28 mm and 14 mm for lateral mass. The longer screw used in the pedicle has the advantage for construction strength because the pedicle screw has anterior to posterior column fixation.

Conclusion: Short segment pedicle screw construction has higher fatigue strength than lateral mass screw construction in flexion/extension motion.

Keywords: cervical sub axial, lateral mass screw, pedicle screw, short segment construction

INTRODUCTION

Instability is the main cause of back pain [1]. To regain stability and to stimulate fusion, the instrumentation is needed [2]. There are several kinds of posterior cervical instrumentation in vertebrae such as wiring, lateral mass and pedicle screw [3].

Since firstly introduced in 1972 by Roy-Camille, the lateral mass becomes the main choice for cervical instrumentation, although it gives less stability in osteoporotic bone or in deformity cases. Screw loosening and pull out are often found with lateral mass [3].

In 1990, Abumi introduced a pedicle screw as an alternative to the lateral mass screw. The pedicle screw has better pull-out strength compared to lateral mass [4].

Some previous experiments show that pedicle screw has better strength in stretch test [5].

Many biomechanical experiments have been done to compare the strength of pedicle screw and lateral mass, but the experiment that measures the strength of pedicle screw and lateral mass in a fixation construction is still limited. The aim of this study was to compare lateral mass and pedicle screw strength in short segment construction for flexion/extension motion in subaxial cervical spine.

RESEARCH METHODS

This research was experimental research. The experimental research method is a research method used to find the effect of certain treatments on another in controlled conditions. This study was conducted to compare lateral mass and pedicle screw strength in short segment construction for flexion/extension motion in subaxial cervical spine. The population in this study was 6 cadavers in the Forensic Department, Saiful Anwar General Hospital Malang. Sample in this research uses total sampling and from each sub-axial cervical vertebrae divided into 2 groups, Cervical 3-4 and Cervical [5,6].

The independent variables in this study were short segment construction with lateral mass and pedicle screw. The dependent variables on this research were the strength of short segment construction. The data obtained would be tabulated with table and presented in graphical form. Statistical analysis was tested with t-test. Data were analyzed by using SPSS software version 20.00.

RESEARCH PROCEDURE

Six adult subaxial cervical spines were harvested from human cadavers. Each cadaver divided into Cervical 3-4 and Cervical 5-6 then 3,5 mm screw was placed with Roy-Camille technique for lateral mass and Abumi technique for pedicle. The cyclic load of flexion and extension motion was applied for each construction to evaluate the construction strength in a fatigue test. Data was collected and being tested by using a t-test (Fig. 1-6).

Fig. 1. Anteroposterior view of X-ray of the left radius: osteolytic and heterogeneous lesion blowing and deforming the distal extremity of the radius

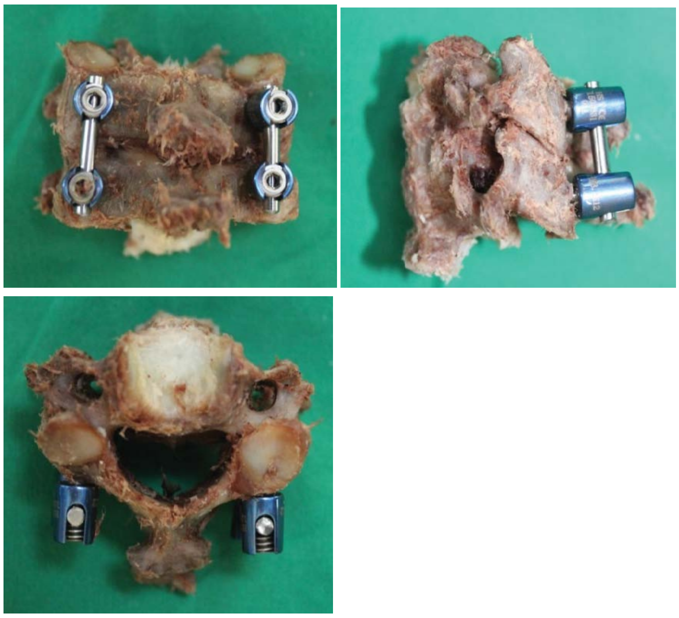

Fig. 2. Lateral mass construction

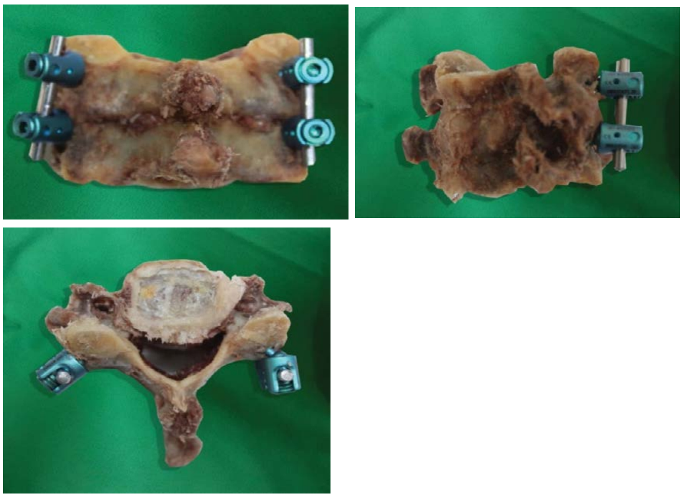

Fig. 3. Pedicle screw construction

RESULT

Data comparison between lateral mass and pedicle screw strength in short segment construction for flexion/extension motion will be analyzed by descriptive technique and inferential statistic. Descriptive analysis is intended to know the general description of the research variables. To know the description for each variable can be seen in the following Table 1.

The description above was a general description of the data obtained from the results of research and had not shown the results of research, and to determine the results of the research would be tested the hypothesis using a t-test with error rate 5% or 95% confidence level. But before using parametric statistics, previously test the requirements of data normality and homogeneity. This test was done to find out whether the data was normally distributed or not. If the test data was normally distributed, then one of the requirements to use parametric statistical analysis has been met. The test procedure was performed by the Kolmogorov-Smirnov test, with the following conditions:

Hypothesis used:

H_0: data normally distributed

H_1: data not normally distributed

If the value was sig. (p-value) >0.05 then H_0 was accepted which means normality fulfilled. The normality test results could be seen in Table 2.

The normality test in Table 2 showed the value of the Kolmogorov Smirnov test with significance value (p) for lateral mass was 0.970, and for pedicle screw was 0.952. Because value p>0.05, then H_0 is accepted and it could be concluded that the used data had a normal distribution.

Thus for knowing the difference between lateral mass and pedicle screw strength, the statistical test by using a t-test could be continued because the assumption had been fulfilled.

Hypothesis:

H_0: There is no difference between the control group and the reperfusion interval group.

H_1: There is a difference between the control group and the reperfusion interval group.

The t-test in Table 3 showed the significance value (p) was 0.000. Because value p<0.05, then Ho is rejected and it could be concluded that there was a significance difference between groups with Lateral mass has a weaker strength than pedicle screw.

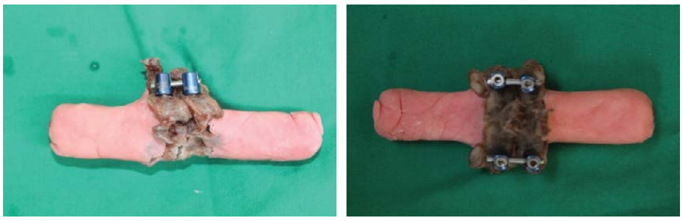

Fig. 4. Construction preparation

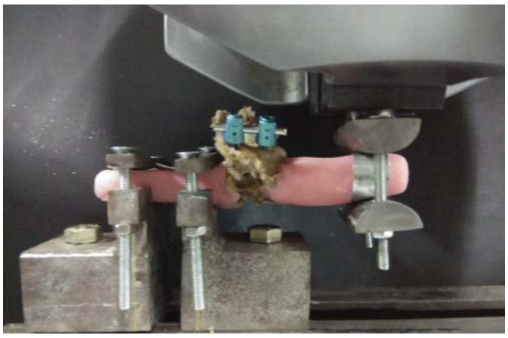

Fig. 5. Construction test

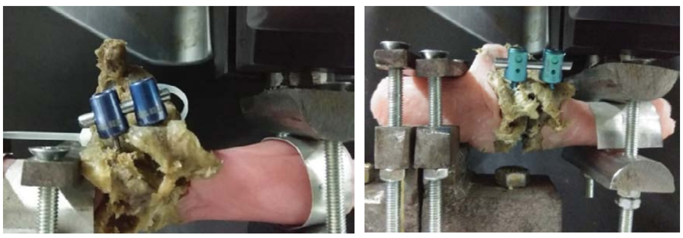

Fig. 6. Construction failed

Table 1. Descriptive analysis

Group	N	Mean	Standard deviation
Lateral mass	6	172.50	10.25
Pedicle	6	367.17	6.88

Table 2. Normality test result

	Lateral mass	Pedicle
N	6	6
Kolmogorov-Smirnov Z	0.489	0.517
P	0.970	0.952

Table 3. t-test

Group	Mean	Standard deviation	t count	p	Description
Lateral mass	172.500	10.252	-38.617	0.000	Significant
Pedicle	367.167	6.882			

DISCUSSION

The mean cyclic load 172 cycles in lateral mas screw construction and 367 cycles in pedicle screw construction was applied until construction became failed. A pedicle screw has higher strength than lateral mass. This difference can be caused by bone factor and screw factor.

Pedicle has a higher bone mineral density than lateral mass, pedicle has an average 15% higher in bone density compared to lateral mass [6]. Bone density has a great effect on the construction strength through the bone- screw interface [7]. A screw that is installed in the bone that has a good density will have good pullout strength also.

Besides bone density factor, the pedicle screw has longer screw than lateral mass, the mean length of the screw-in pedicle was 27,05-30,04 mm and 13,5-13,8 mm for lateral mass. The longer screw used in pedicle has the advantage for construction strength by increase working- a length that gives greater resistance to load to failure [8]. Pedicle screw has a higher load to failure compared to lateral mass, with average load failure 677 N for pedicle screw and 355 N for lateral mass.

Previous research showed that the pedicle screw gives more stability because the pedicle screw has anterior to posterior column fixation even though only use the posterior approach, while lateral mass only gives fixation in a posterior column only [9].

Short segment construction with a pedicle screw is stiffer compared to lateral mass. This difference is showed by the number of energy that was needed to make the same motion. In pedicle, screw construction needs 20 N, while in lateral mass construction needs only 13 N.

Even though the pedicle screw has superiority in strength, stability, and stiffness compared to lateral mass, but the insertion of the pedicle screw needs a high level of accuracy and having a higher risk of medulla spinal is and nerve root injury [10].

The limitation of this research was the small population number and sample homogeneity.

CONCLUSION

Short segment pedicle screw construction has higher fatigue strength than lateral mass screw construction in flexion/extension motion.

RECOMMENDATIONS

Some recommendations for future research are the use of a bigger population with more homogeny distribution.

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