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Clinical Article

New Technical Tip for Anterior Cervical Plating : Make Hole First and Choose the Proper Plate Size Later

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Objective : It is well known that plate-to-disc distance (PDD) is closely related to adjacent-level ossification following anterior cervical plate placement. The study was undertaken to compare the outcomes of two different anterior cervical plating methods for degenerative cervical condition. Specifically, the new method involves making holes for plate screws first with an air drill and then choosing a plate size. The other method was standard, that is, decide on the plate size first, locate the plate on the anterior vertebral body, and then drilling the screw holes. Our null hypothesis was that the new technical tip may increase PDD as compared with the standard anterior cervical plating procedure.

Methods : We retrospectively reviewed 49 patients who had a solid fusion after anterior cervical arthrodesis with a plate for the treatment of cervical disc degeneration. Twenty-three patients underwent the new anterior cervical plating technique (Group A) and 26 patients underwent the standard technique (Group B). PDD and ratios between PDD to anterior body heights (ABH) were measured using postoperative lateral radiographs. In addition, operating times and clinical results were reviewed in all cases.

Results : The mean durations of follow-up were 16.42±5.99 (Group A) and 19.83±6.71 (Group B) months, range 12 to 35 months. Of these parameters mentioned above, cephalad PDD (5.43 versus 3.46 mm, p=0.005) and cephalad PDD/ABH (0.36 versus 0.23, p=0.004) were significantly greater in the Group A, whereas operation time for two segment arthrodesis (141.9 versus 170.6 minutes, p=0.047) was significantly lower in the Group A. There were no significant difference between the two groups in caudal PDD (5.92 versus 5.06 mm), caudal PDD/ABH (0.37 versus 0.32) and clinical results.

Conclusion : The new anterior cervical plating method represents an improvement over the standard method in terms of cephalad plate-to-disc distance and operating time.

Key Words : Cervical vertebrae · Diskectomy · Spinal fusion · Degeneration · Intervertebral disk.

INTRODUCTION

Anterior cervical discectomy and fusion (ACDF) is an established procedure for the treatment of patients with cervical radiculopathy and/or myelopathy secondary to degenerative disc disease. Many technological modifications and postoperative degenerative changes have been reported since the technique was originally described by Smith and Robinson[16].

Adjacent-level ossification[13] or late degenerative changes[7,12] can occur commonly after anterior cervical arthrodesis. Adjacent heterotopic ossification in which new bone formation in soft tissue does not ossify under normal conditions is important complication after ADCF[13]. In most cases, postoperative adjacent ossification changes may be unavoidable, but there is evidence that those were partially dependent on surgical technique. This is supported by some authors that have recommended the use of the shortest plate possible to avoid extending the plate into adjacent discs[2,6-7,12]. Furthermore, there is a general consensus among spine surgical specialists that for the majority of ACDF procedures, a longer plate-to-disc distance (PDD) reduces the risk of developing postoperative unavoidable degenerative changes, including adjacent level ossification.

The purpose of this study was to investigate the merits of a new technical tip for anterior cervical plating, by comparing the outcomes of two different anterior cervical plating methods for degenerative cervical disease. Specifically, new technique involves making plate screw holes first with an air drill and then choosing a plate size, whereas the other method, the standard method, involves first deciding on plate size, locating the chosen plate on the

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anterior vertebral body, and then drilling screw holes.

MATERIALS AND METHODS

We retrospectively reviewed 49 patients who had a solid fusion after anterior cervical arthrodesis with a plate for the treatment of cervical disc degeneration refractory to conservative treatment at a single institution. No patient had previously undergone cervical spine surgery prior to index arthrodesis. The patients were divided into two groups by surgical method. In Group A; making holes for plate screws first with an air drill and then choosing a plate size. In Group B; the standard method was use, namely, first decide on plate size, locate the plate on the anterior vertebral body, and then drill the screw holes. Group A contained 23 patients and Group B 26 patients. All surgical procedures were performed by two surgeons in single institution. To exclude the surgical skill bias, among 23 patients of Group A, 11 patients were operated by one surgeon and 12 were operated by the other. In addition, among 26 patients of Group B, 13 patients were operated individually.

Clinical assessments were performed using the Oswestry Disability Index (ODI) and a Visual Analog Scale (VAS), before surgery and at 12 months after operation. In addition, operation times and radiologic parameters plate-to-disc distance (PDD), PDD/ABH (PDD to anterior body height) ratios were also assessed.

Radiologic Parameters

PDD (Fig. 1) and PDD/ABH were determined (both cephalad and caudal to disc spaces) (Fig. 2) in both groups on last follow-up postoperative plane radiographs. All radiographic analyses were performed independently by an independent spine surgeon and a neuroradiologist who were unaware of treatment details. Each of these independent observers determined distances twice and the averages of four measurements were used in the analysis.

Operative technique

The same cages and plates were used in all cases; Cervios cages (Synthes, Oberdorf, Germany) and Atlantis plate (Medtronic Sofamor-Danek, Memphis, TN). Furthermore, all patients were placed in a supine position and underwent general anesthesia. A Smith-Robinson anteromedial approach to the cervical spine was performed through a transverse incision. Complete intervertebral discectomy was performed and cartilaginous end plates were removed using curettage and a high-speed burr in a combination. Cage heights were selected to obtain a 2 mm disc height distraction to establish proper compressive forces on the cage-end plate interface[1]. A high-speed burr was used to remove osteophytes and to smooth the anterior surface of involved vertebrae to allow proper fixation of the plate and its insertion with the new technique (Group A) or the standard technique (Group B). Specifically, the new method involves making holes for plate screws first with an air drill and then choosing a plate size. The other method was the standard technique, that is, deciding the plate size first, then locating the plate on the anterior vertebral body, and then drilling the screw holes.

Distance from center of holes on Atlantis plate (Medtronic Sofamor-Danek, Memphis, TN, USA) is 10 mm. Holes were made which were placed as close as possible to the endplate, 5 mm far from Caspar pin (Fig. 3A). The holes were made just through the cortex and did not need to drive deeply because screw for plate is self tapping one. Subsequently, the distance between the upper and lower hole was measured with a compass and the plate size was chosen (Fig. 3B).

Statistical analysis

SPSS for Windows (Version 12.0K; SPSS, Chicago, IL, USA) was used for the analysis. Intergroup comparisons were made using the paired t-test, the Mann-Whitney test, or the Chi-Squared test. p values of <0.05 were considered statistically significant.

RESULTS

Of the 49 patients (34 men and 15 women), 23 were in Group A and 26 in Group B. Mean age at time of surgery was 52 years (range, 33 to 80 years). The mean durations of follow-up were 16.42±5.99 (Group A) and 19.83±6.71 (Group B) months, range

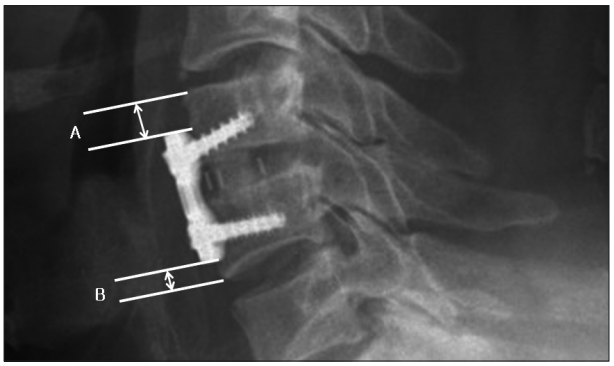

Fig. 1. Radiologic parameters on postoperative lateral plane radiographs. Cephalad plate to disc (A) and caudal plate to disc (B) distances are measured.

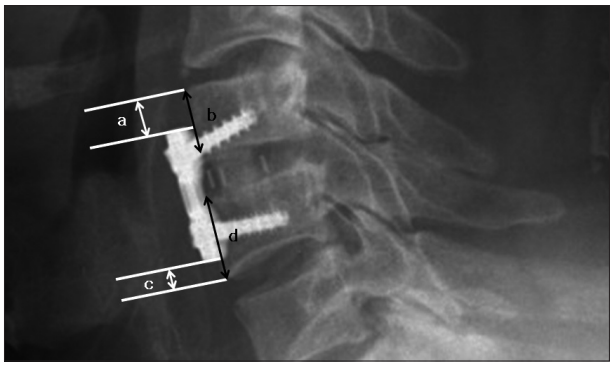

Fig. 2. Radiologic parameters on postoperative lateral plane radiographs. Cephalad plate-to-disc distance (PDD)/anterior body height (ABH) (a/b), and caudal PDD/ABH (c/d) are being measured.

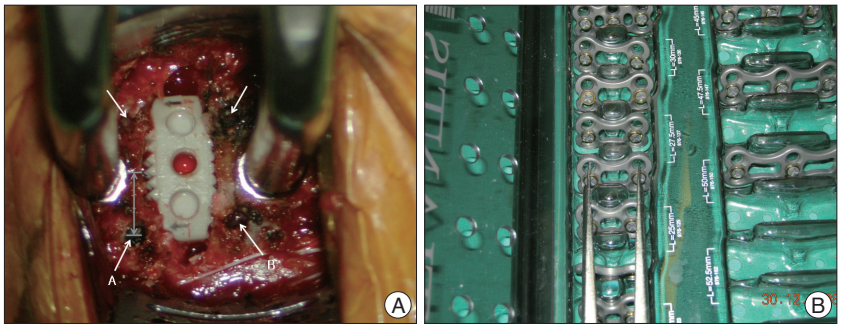

Fig. 3. New technical tip regarding anterior cervical plating. First, four holes are made (white arrows) as close as possible to the endplate for plate screws before placing the plate over the inserted cage, 5 mm far from Caspar pin (gray arrow) (A). Then, the distance between the upper and lower hole is measure (from A to B) with a compass and choose the appropriate plate size (B).

Table 1. Radiologic outcomes and operation time

All patients	Group A (n=23)	Group B (n=26)	*p*
PDD (Cephalad, mm)	5.43±2.3	3.46±2.3	0.005*
PDD (Caudal, mm)	5.92±22.9	5.06±23.6	>0.05
PDD/ABH (Cephalad)	0.36±0.1	0.23±0.1	0.004*
PDD/ABH (Caudal)	0.37±0.1	0.32±0.1	>0.05
Operation time (minutes)	120.35±32.4	138.04±43.0	>0.05
1 level ACDF	n=15	n=15	
PDD (Cephalad, mm)	4.63±2.0	3.03±2.1	0.029*
PDD (Caudal, mm)	5.59±2.0	4.75±2.3	>0.05
PDD/ABH (Cephalad)	0.32±0.1	0.21±0.1	0.049*
PDD/ABH (Caudal)	0.36±0.1	0.31±0.1	>0.05
Operation time (minutes)	108.87±24.7	114.13±29.7	>0.05
2 level ACDF	n=8	n=11	
PDD (Cephalad, mm)	6.94±22.9	4.04±2.6	0.026*
PDD (Caudal, mm)	6.52±2.8	5.47±2.5	>0.05
PDD/ABH (Cephalad)	0.42±0.1	0.26±0.1	0.017*
PDD/ABH (Caudal)	0.39±0.1	0.32±0.1	>0.05
Operation time (minutes)	141.88±35.6	170.64±36.7	0.047*

PDD : plate-to-disc distance (Fig. 2). PDD/ABH : The ratio for the PDD/ anterior body height (Fig. 3). *Significance was assessed using the Mann-Whitney U test

12 to 35 months. Diagnoses were cervical myelopathy, radiculopathy, or myeloradiculopathy secondary to a herniated cervical disc or spondylosis. Thirty one-level and 19 two-level ACDF procedures were performed C4/5 in 4, C5/6 in 18, C6/7 in 8, C4/5/6 in 5, and C5/6/7 in 14. C5/6 was the most common level treated by one-level ACDF, and C5/6/7 the most common level for two-level ACDF. In Group A, 15 patients underwent 1-level ACDF and 8 underwent 2-level ACDF, and in Group B, 15 underwent 1-level ACDF and 11 underwent 2-level ACDF. No significant intergroup differences were found in terms of ages, follow-up period, or gender. A summary of radiologic outcomes and operation times is presented in Table 1. In terms of radiologic outcomes, cephalad PDD (5.43 versus 3.46 mm, p=0.005) and cephalad PDD/ABH (0.36 versus 0.24, p=0.004) were significantly greater in Group A (Table 1).

Caudal PDD and caudal PDD/ABH showed no significant statistic difference between groups. We subdivided the parameters mentioned above to 1-level and 2-level ACDF. In cases of 1-level ACDF (Group A; 15, Group B; 15), cephalad PDD (4.63 versus 3.03 mm, p=0.029) and cephalad PDD/ABH (0.32 versus 0.21, p=0.049) were also significantly greater in Group A (Table 1). In cases of 2-level ACDF (Group A; 8, Group B; 11), cephalad PDD (6.94 versus 4.04, p=0.026) and cephalad PDD/ABH (0.42 versus 0.26, p=0.017) were also significantly greater in Group A (Table 1). Mean operation time was also significantly shorter in Group A (141.88 versus 170.64 minutes, p=0.047). To exclude the surgical skill bias, among 23 patients of Group A, 11 patients were operated by one surgeon and 12 were operated by the other. In addition, among 26 patients of Group B, 13 patients were operated individually.

With regards to the clinical outcomes, no significant intergroup difference was found. In Group A mean VAS score (from 0 to 100) was improved from a preoperative 80.4 to a postoperative 23.0, and Group B also improved from 83.4 to 25.8, respectively, at 12 months. Mean ODI scores were significantly improved in both groups (Group A : from 32.20 to 16.24, Group B : from 31.56 to 15.52) at 12 months.

DISCUSSION

Anterior cervical discectomy and fusion is currently the most commonly selected surgical approach for the treatment of cervical disc herniation or degeneration because it is effective at achieving immediate stability, restoring the normal lordotic curve, and increasing fusion rates[4,11,15,19]. Although there are some debates regarding the efficacy of rigid plate fixation in one-level ACDF, the application of an anterior cervical plate has gained widespread acceptance in terms of promoting successful fusion, restoring segmental lordosis, and reducing the period of immobilization[13,19,21].

However, adjacent level ossification seems to occur with increased frequency after plate fixation if the plate is 5 mm of less away from an adjacent disc space[13], and this is a major recent concern of spine surgeons after anterior cervical plating[13,19,21]. Furthermore, a number of reports have concluded that cervical arthrodesis is associated with adjacent level degenerative changes, such as, osteophyte development, disc degeneration, facet hypertrophy, spinal canal stenosis, and segmental instability[2,5,7-9,17].

The mechanism of adjacent-level ossification in anterior cervical arthrodesis has achieved a level of consensus[3,20]. Irritation of the anterior aspect of the adjacent disc space, stripping of anterior longitudinal ligament, Caspar pins, or anterior fibers of the annulus fibrosus by a cervical plate are accepted causative factors, and there is evidence that some of these postoperative radiographic changes are technique-dependent[14,20]. Mähring[12] described two types of anterior spondylophyte formation, 'noses and bridges', at segments adjacent to fused segments and stressed that a careful operative technique can reduce postoperative spondylophyte formation at adjacent segments, and Yang et al.[20] concluded that adjacent level ossification is infrequent when certain techniques, such as, minimal stripping of the anterior longitudinal ligament and the avoidance of Caspar pins and anterior plates, are adhered to. However, in most cases adjacent segment degeneration or ossification may be unavoidable.

Several authors have recommended the use of the shortest possible plate to avoid undesirable changes caused by excessive extension of the plate into adjacent healthy discs[7,12]. Furthermore, the findings of biomechanical studies and anecdotal evidence suggest that ideally anterior cervical spine plates should have longer plate-to-disc distances to adjacent disc levels to reduce the likelihood of adjacent-level ossification. Goffin et al.[7] found late degenerative changes at disc levels adjacent to fused regions in 15 of 25 patients with fractures and/or dislocations of the cervical spine, and recommended the use of the shortest plate possible to avoid extending the plate into adjacent discs. Tye et al.[18] suggested that the risk of developing adjacent level ossification is increased in the setting of plate placement within 5 mm of an adjacent unfused disc space and another study also reported that a PDD of at least 5 mm from adjacent disc spaces reduces the likelihood of moderate-to-severe adjacent-level ossification, and that the risk of adjacent-level ossification is higher at cephalad adjacent levels than caudal adjacent levels[13]. As mentioned above, there is a general consensus that use of the shortest plate and the longest PDD possibly reduces the likelihood of developing postoperative degenerative changes, including adjacent level ossification, after ACDF. However, no previous study has examined the effects of technical modifications to the anterior cervical plating procedure versus the standard anterior cervical plating method in terms of PDD, PDD/ABH, and operation time.

In the present study, cephalad PDD and cephalad PDD/ABH were significantly greater for the devised method. However, caudal PDD and caudal PDD/ABH were not significantly different, which we attribute to different vertebral body end plate and disc directions. During operation, the disc/endplate directed usually superiorly (Fig. 4). Therefore, surgeons usually tend to use long plate not to penetrate the inferior endplate. However, if you use new technique, it is possible to choose precise and smaller plate than classical method. In the caudal screw, if a surgeon inserts the screw vertically at operation field, it is usually inserted closely to the endplate (Fig. 4). From caudal vertebral characteristics, we can explain the result of caudal PDD and caudal PDD/ABH that showed no significant statistic difference between groups. In addition to these radiologic findings, many authors have described a clinical correlation between these late degenerative changes and recurrent pain, radiculopathy, and myelopathy. However, this topic has some controversies[7,8]. Ipsen et al.[10] reported a correlation between clinical outcome and PDD, but in this previous study, average distance from the plate to the cephalad disc space was only 3.3 mm and no adverse effects were observed because of short term follow up.

From this study, we failed to find any postoperative clinical difference between the two groups, but mean operation time for 2-level ACDF was significantly shorter when the suggested technique was used. We used transverse incision for 2-level ACDF, because sometimes surgeon faces trouble to check entire plate from end to end and all screw holes at a time on operation field and surgeon tends to worry about the location of plate and screw holes. To confirm the plate and hole locations precisely, more time would be necessary. However, if new technique is used, we do not need to check entire cervical plate and screw holes. Measurement of the distance between the upper and lower hole with a compass (Fig. 3B) is only step to choose the plate. Screw for plate is self tapping screw, so if the screw is located closely on already made hole, screw usually can be inserted easily. However, to show efficiency of time, time span for only plating should be checked. It is difficult to classify only time for plating. During the plating, sometimes we spend time because of other procedures such as bleeding in the cage, or bony spur removal. Surgical time is also dependent on surgical skill and level of surgeon's skill. To figure out the exact efficiency of time, we need more study.

Some limitations of this study deserve mention. We emphasize that the results and conclusions of this study are based on a relatively short-term clinical follow-up, and that the long-term clinical and radiological outcomes of the devised anterior cervi-

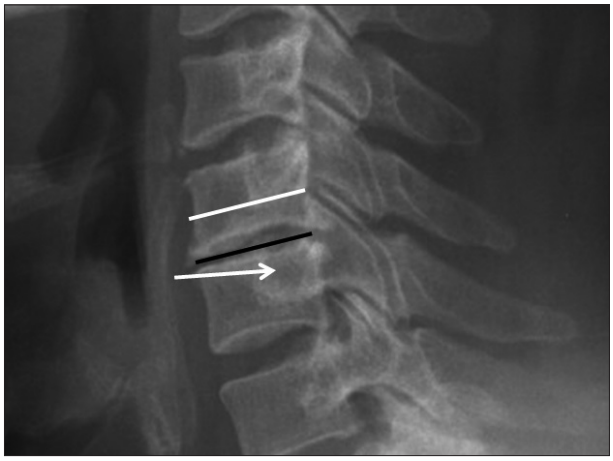

Fig. 4. Lateral plane radiographs of herniated cervical disc C5/6. During operation, disc (black line) and endplate (white line) directed superiorly. In the caudal screw, if the screw is inserted vertically on operation field, it usually is inserted close to the endplate (white arrow).

cal plate procedure are needed to be verified. In addition, this short-term clinical follow-up precludes our commenting on adjacent-level ossification. Nevertheless, we now routinely try to use the described modification during anterior cervical plating, and the shortest plate possible.

CONCLUSION

In the present study, cephalad PDD and cephalad PDD/ABH were significantly greater in the new cervical plating method group. However, caudal PDD and caudal PDD/ABH were not significantly different. In addition, there was no clinical difference between the new method group and standard methods group, with the exception of mean operation time for 2-level ACDF. Mean operation time for 2-level ACDF was significantly shorter when the suggested technique was used.

References

1. An HS, Evanich CJ, Nowicki BH, Haughton VM : Ideal thickness of Smith-Robinson graft for anterior cervical fusion. A cadaveric study with computed tomographic correlation. **Spine 18** : 2043-2047, 1993
2. Baba H, Furusawa N, Imura S, Kawahara N, Tsuchiya H, Tomita K : Late radiographic findings after anterior cervical fusion for spondylotic myeloradiculopathy. **Spine 18** : 2167-2173, 1993
3. Bartolomei JC, Theodore N, Sonntag VK : Adjacent level degeneration after anterior cervical fusion : a clinical review. **Neurosurg Clin N Am 16** : 575-587, v, 2005
4. Bose B : Anterior cervical instrumentation enhances fusion rates in multilevel reconstruction in smokers. **J Spinal Disord 14** : 3-9, 2001
5. Döhler JR, Kahn MR, Hughes SP : Instability of the cervical spine after anterior interbody fusion. A study on its incidence and clinical significance in 21 patients. **Arch Orthop Trauma Surg 104** : 247-250, 1985
6. Garland DE : A clinical perspective on common forms of acquired heterotopic ossification. **Clin Orthop Relat Res** : 13-29, 1991
7. Goffin J, van Loon J, Van Calenbergh F, Plets C : Long-term results after anterior cervical fusion and osteosynthetic stabilization for fractures and/or dislocations of the cervical spine. **J Spinal Disord 8** : 500-508; discussion 499, 1995
8. Gore DR, Gardner GM, Sepic SB, Murray MP : Roentgenographic findings following anterior cervical fusion. **Skeletal Radiol 15** : 556-559, 1986
9. Hunter LY, Braunstein EM, Bailey RW : Radiographic changes following anterior cervical fusion. **Spine 5** : 399-401, 1980
10. Ipsen BJ, Kim DH, Jenis LG, Tromanhauser SG, Banco RJ : Effect of plate position on clinical outcome after anterior cervical spine surgery. **Spine J 7** : 637-642, 2007
11. Kaiser MG, Haid RW Jr, Subach BR, Barnes B, Rodts GE Jr : Anterior cervical plating enhances arthrodesis after discectomy and fusion with cortical allograft. **Neurosurgery 50** : 229-236; discussion 236-238, 2002
12. Mähring M : [Segment changes in the cervical spine following cervical spondylodeses of unstable injuries.] **Unfallchirurgie 14** : 247-258, 1988
13. Park JB, Cho YS, Riew KD : Development of adjacent-level ossification in patients with an anterior cervical plate. **J Bone Joint Surg Am 87** : 558-563, 2005
14. Park Y, Maeda T, Cho W, Riew KD : Comparison of anterior cervical fusion after two-level discectomy or single-level corpectomy : sagittal alignment, cervical lordosis, graft collapse, and adjacent-level ossification. **Spine J 10** : 193-199, 2010
15. Schneeberger AG, Boos N, Schwarzenbach O, Aebi M : Anterior cervical interbody fusion with plate fixation for chronic spondylotic radiculopathy : a 2- to 8-year follow-up. **J Spinal Disord 12** : 215-220; discussion 221, 1999
16. Smith GW, Robinson RA : The treatment of certain cervical-spine disorders by anterior removal of the intervertebral disc and interbody fusion. **J Bone Joint Surg Am 40-A** : 607-624, 1958
17. Teramoto T, Ohmori K, Takatsu T, Inoue H, Ishida Y, Suzuki K : Long-term results of the anterior cervical spondylodesis. **Neurosurgery 35** : 64-68, 1994
18. Tye GW, Graham RS, Broaddus WC, Young HF : Graft subsidence after instrument-assisted anterior cervical fusion. **J Neurosurg 97** : 186-192, 2002
19. Wang JC, McDonough PW, Kanim LE, Endow KK, Delamarter RB : Increased fusion rates with cervical plating for three-level anterior cervical discectomy and fusion. **Spine 26** : 643-646; discussion 646-647, 2001
20. Yang JY, Song HS, Lee M, Bohlman HH, Riew KD : Adjacent level ossification development after anterior cervical fusion without plate fixation. **Spine 34** : 30-33, 2009
21. Zaveri GR, Ford M : Cervical spondylosis : the role of anterior instrumentation after decompression and fusion. **J Spinal Disord 14** : 10-16, 2001