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Symptomatic Adjacent Segment Degeneration Following Posterior Lumbar Arthrodesis : Retrospective Analysis of 26 Patients Experienced in 10-year of Periods

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Objective : The authors retrospectively analyzed clinical and radiographic features of patients who developed symptomatic adjacent segment degeneration (ASD) that required re-operation.
Methods : From 1995 to 2004, among 412 patients who underwent posterior lumbar fusion surgery, the authors experienced twenty-six patients who presented symptomatic ASD. Records of these patients were reviewed to collect clinical data at the first and second operations.
Results : The patients were 9 males and 17 females whose mean age was 63.5 ± 8.7 years. Among 319 one segment and 102 multi-segment fusions, 16 and 10 patients presented ASD, respectively. Seventeen ASDs were noticed at the cephalad to fusion (65%), eight at the caudad (31%), and one at the cephalad and caudad, simultaneously (4%). All patients underwent decompression surgery. Nine patients underwent additional fusion surgeries to adjacent degenerated segments. In 17 patients who underwent only decompression surgery without fusion, the success rate was 82.4%. In fusion cases, the success rate was observed as 55.5%. There were no statistically significant factors to be related to development of ASD. However, in cases of multi-level fusion surgery, there was a tendency toward increasing ASD.
Conclusion : Multi-segment fusion surgery could be associated with a development of ASD. In surgical treatment of symptomatic ASD, selective decompression without fusion may need to be considered as a primary procedure, which could reduce the potential risk of later occurrence of the other adjacent segment disease.

KEY WORDS : Degenerative lumbar disease · Lumbar fusion · Adjacent segment degeneration.

INTRODUCTION

Goal of the surgical treatment of degenerative lumbar disease is the re-stabilization of painful motion segment as well as proper neural decompression. Since Albee first described spinal fusion surgery for the treatment of Pott's disease in 1911[2], spinal solid arthrodesis has been developed as standard surgical method for degenerative lumbar diseases.

However, there have been many reports to mention the development of junctional degeneration adjacent to fused levels with zero motion because of increased biomechanical stress[1,3,4,6,7,10,12,14-16,20,23]. Adjacent segment degeneration (ASD) could be observed radiographically up to 50% in the patients who were followed more than 5 years after fusion surgery[21]. Additionally, some of them may present as the symptomatic condition requiring re-operation.

In this study, we evaluated the clinical characteristics of 26 patients who required surgical treatment due to presenting symptomatic ASD after lumbar spinal fusion surgery. The clinical factors which were expected to be related to the occurrence of symptomatic ASD were also studied.

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MATERIALS AND METHODS

Out of 412 patients who underwent posterior lumbar arthrodesis at our hospital during the period from February 1995 to January 2004, 26 patients who were diagnosed with and treated for symptomatic ASD were included for this study. Of the 412 patients, 139 were male and 282 were female, and their age ranged from 22 to 78 and 56.5 ± 11.2 on the average. One segment fusion was performed in 319 patients, and multi-segment fusion in 102. Diagnostic criteria for symptomatic ASD were : first, preoperative symptoms that are improved after operation but occurrence of new patterns of pain during the follow-up period; second, the progress of existing degenerative changes or new degenerative changes are observed in the segments adjacent to the fused level on imaging study; and third, symptoms complained by the patients are consistent with the adjacent segment degenerations. The postoperative spondylolisthesis was defined as a radiologic condition in which progress of slippage was greater than 3 mm in comparison with preoperative radiograph, flexion and extension lateral radiographs. The angle change greater than 10 to 15° in flexion and extension lateral radiographs was used to denote segmental instability.

Those with the history of obvious traumas or with lesions distant from the fused segments were excluded. Patient informations were collected by retrospective review of hospital records. Radiographic investigation was performed by an independent observers (fellow spinal surgeon who was not involved in the surgery). Survey was conducted on the patients' age, sex, preoperative diagnosis, operation method, the extent of arthrodesis, the period until symptoms appear after operation, and detailed diagnosis of ASD. According to the location, the ASDs were divided into two groups; cephalad and caudad to fused level. The incidence of ASD in each group was counted. The relationship between the occurrence of ASD and the type and extent of the arthrodesis was also evaluated. The patients were divided according to the operation methods, and the result of each operation method was evaluated using MacNab criteria. The some clinical factors which were expected to be related to the occurrence of symptomatic ASD were determined by statistical analysis. The factors evaluated were age, gender, number of fusion segment, the level fused and fusion method. Statistical verification was determined using SPSS for Windows (version 11.0.1; SPSS Inc, USA). A result was considered statistically significant if the probability was less than 0.05.

Table 1. Summary of the patients who presented symptomatic adjacent segment degenerations

Case	Sex	Age	1st operation	2nd diagnosis	Time to 2nd operation (month)	2nd operation
1	F	75	PLIF L4-5	SS, SI, L3-4	12	PLIF
2	F	79	PLF L3-4	SS, L1-2-3	79	laminectomy
3	M	68	PLIF L4-5	SS, SL, L3-4	24	PLIF
4	M	64	PLIF L3-4	SS, L4-5	15	laminectomy
5	F	57	PLIF L4-5	SS, SL, L3-4	29	laminectomy
6	M	63	PLIF L3-4,	SS, HNP, L2-3	50	laminectomy & discectomy
7	M	70	PLIF L4-5	SS, FBSS, L3-4	47	laminectomy
8	F	62	PLF L3-4	SS, FBSS, L4-5	58	laminectomy
9	M	72	PLF L3-4	SS, SL, L4-5	59	PLIF
10	F	61	PLF L3-4-5	SS, SI, L2-3	48	PLF
11	F	72	PLIF L2-3-4	SS, SL, L4-5	99	PLIF
12	M	72	PLIF L4-5	SS, L3-4	28	laminectomy
13	M	69	PLF L3-4-5	SS, L2-3	32	laminectomy
14	F	57	PLIF L3-4-5	SS, SI, L2-3	48	laminectomy
15	F	58	PLIF L3-4	SS, HNP, L2-3	45	laminectomy & discectomy
16	F	60	PLIF L4-5	SS, SL, L3-4	36	PLIF
17	F	61	PLIF L3-4-5	SS, L2-3	36	laminectomy
18	F	34	PLIF L3-4	SS, L4-5	24	laminectomy
19	M	71	PLIF L4-5	SS, L3-4	44	laminectomy
20	F	68	PLIF L4-5	SS, SI, L3-4,	49	laminectomy
21	M	55	PLIF L3-4	SS, L2-3, L4-5	19	laminectomy
22	F	65	PLIF L4-5	SS, L5-S1	56	laminectomy
23	F	72	PLIF L3-4	SS, SL, L4-5	40	PLIF
24	F	68	PLIF L4-5-S1	SS, L3-4	52	PLIF
25	F	43	PLF L4-5	SS, HNP, L5-S1	40	laminectomy & discectomy
26	F	55	PLF L4-5-S1	SS, SL, L3-4	86	PLIF

SS : spinal stenosis, SI : segmental instabilty, SL : spondylolisthesis

RESULTS

Total 26 patients were 9 males and 17 females whose mean age was 63.5 ± 8.7 years (ranged from 34 to 79 years). The number of patients whose ages were 60 years and older were 20 (77%). The average period between the first operation and new symptom occurrence was 44.4 ± 25.4 months (ranged from 12 to 99 months) (Table 1).

Diagnosis for the previous fusion operation was included spinal stenosis in 14 cases, spondylolisthesis in 7, segmental instability in 3, and failed back surgery in 2 cases (Fig. 1). The level fused by the previous operation was distributed as Fig. 2. Twenty patients underwent posterior lumbar interbody fusion (77%), and 6 patients underwent posterolateral fusion (23%). Instrumentations were done in all 26 patients. Among 319 one segment and 102 multi-segment fusions, 16 (5.0%) and 10 (9.8%) patients presented symptomatic ASD, respectively. Seventeen ASDs were noticed at the cephalad to fusion (65%), eight at caudad (31%), and one at cephalad and caudad, simultaneously (4%) (Fig. 3).

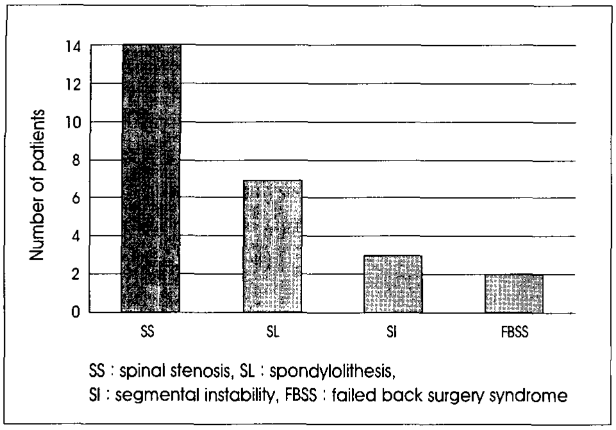

Fig. 1. Bar graphs showing the distribution of preoperative diagnoses of the first fusion operation in 26 patients who presented symptomatic adjacent segment degenerations.

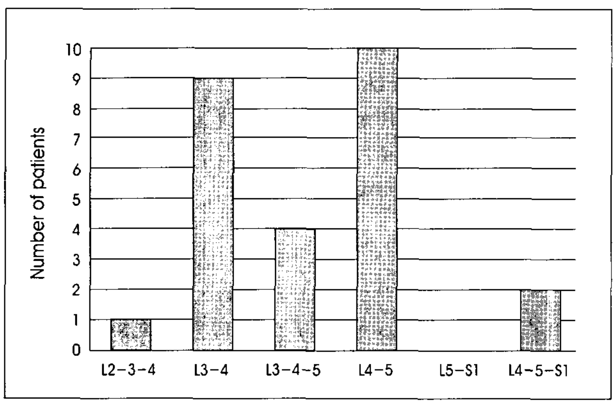

Fig. 2. Bar graphs depicting the distribution of the fused segments in 26 patients who presented symptomatic adjacent segment degenerations.

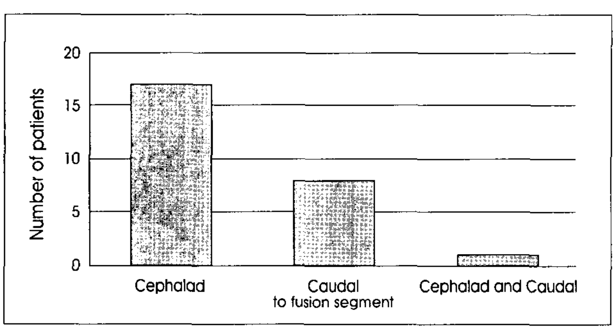

Fig. 3. Bar graphs demonstrating the location of symptomatic adjacent segment degenerations.

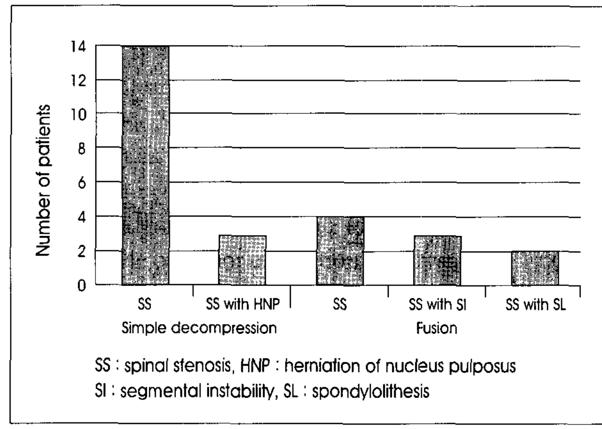

Fig. 4. Bar graphs showing the surgical methods for symptomatic adjacent segment degenerations.

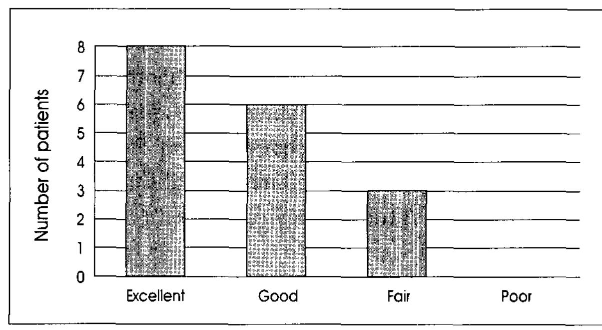

Fig. 5. Bar graphs showing the clinical result of simple decompressions (Macnab criteria).

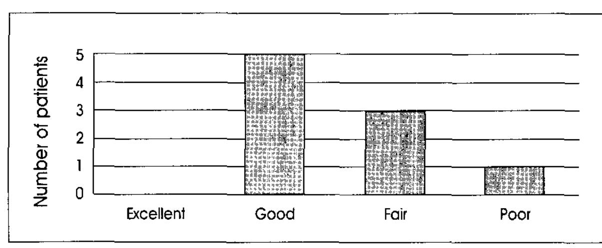

Fig. 6. Bar graphs showing the clinical result of fusion operations (Macnab criteria).

The diagnoses of ASD cases included spinal stenosis in all cases, combined with spondylolisthesis (2 patient), segmental instability (3 patients), and disc herniation (3 patients). All patients underwent decompression surgery. Among them, 3 patients presented disc herniations were performed additional discectomies and 9 patients underwent extended fusion surgeries to adjacent degenerated segments due to segmental instability or necessity of wide decompression (Fig. 4).

According to McNab's criteria, overall clinical success rate was 73.1%. In 17 patients who underwent only simple surgery without fusion, the success rate was 82.4%, among which excellent results were in 8 cases, good in 6, fair in 3, and no poor case (Fig. 5). In fusion cases, there were good in 5, fair in 3, and poor in 1 case (Fig. 6). The success rate of the fusion cases was observed as 55.5%.

Among the variables examined, there was no statistically significant factor to be related to development of ASD (Table 2). However, in cases of multi-level fusion surgery, there was a tendency toward increasing ASD (p=0.087).

DISCUSSION

Early fusion surgeries for lumbar degenerative disease had been performed without instrumentation. At that

Table 2. Statistical verification of the variables in relation to development of symptomatic adjacent segment degenerations

Variables	Statistical method	*p*-value
Age	Pearson correlation coefficient	0.117
Gender	Chi square test	0.746
Number of fusion segment	Chi square test	0.087
The level fused	Spearman correlation coefficient	0.548
Method of fusion	Chi square test	0.487

time, the finding of fusion failure or pseudoarthrodesis had been often noted, but ASD had been described as unusual complication. However, since Roy-Camille et al.[25] introduced internal fixation method using pedicle screws system in 1986, fusion rate increased dramatically[17,19,25,28], and ASD had been also reported frequently[1,3,4,9-11,14,24,26].

Alteration of biomechanical stress on adjacent segments after solid fusion could be the major cause of development of ASD. In a cadaveric spine study, Weinhoffer et al.[30] measured intradiscal pressure of the upper adjacent segment after pedicle screw-rod instrumentation in the flexion and extension. By comparing it with that in the un-instrumented state, they reported that intradiscal pressure increased significantly in the instrumented state. Nagata et al.[20] also conducted a biomechanical study on a canine cadaveric spines, and reported that lumbosacral motion and facet loading increased significantly after the immobilization of proximal segments in proportion to the number of immobilized segments. Dekutoski et al.[8], using an in vivo dog model, also demonstrated hypermobility of facets joints at the upper free segment. As well as biomechanical alterations, biochemical change was also demonstrated. Cole et al.[7] studied the neighboring disc in a canine model after segment immobilization. They found out marked changes in disc metabolism and composition, which did not appear in the control group.

Although there are some contrary reports[14,22,29], numerous clinical studies have supported the experimental results as stated above. Lee et al.[15] observed 18 patients who treated for the symptomatic ASD after lumbar fusion. They reported that the average symptom free interval was 8.5 years and the hypertrophy of posterior joints was observed in most of the patients. With regard to spinal canal stenosis of adjacent segments and changes in intervertebral discs after fusion, Lehmann et al.[16] reported that spinal canal stenosis is closely related to the instability of the spine. Schlegel et al.[26] made follow-up observation of 58 patients who had thoracic or lumbosacral fusion without instrumentation and reported an average symptom free period of 13.1 years before symptomatic presentation at adjacent segments. Guigui at al.[12] also noted that there was significant higher rate of degenerative changes at adjacent segments to fused level comparing age- and gender-matched control groups.

The incidence of radiographic ASD has been reported as 8-100% with 36-396 months follow-up periods[21]. However, reported rates of symptomatic ASD were much lower, which was 5.2-18% with 48-164 months follow-up[11,21]. Wide range of reported prevalence of ASD could be explained by variability of follow-up duration and diagnostic criteria in various studies. In our series, an incidence of symptomatic ASD was observed as 6.2% during average 44 months follow-up. Considering that the follow up period was relatively short, it could be comparable result with other reports. The interval between the previous fusion surgery and development of symptomatic ASD showed tendency toward shortening recently. The initial report mentioned that the interval for symptomatic adjacent failure required more than 10 years after fusion without instrumentation[26]. However, since rigid instrumentation using various metal systems has been adopted, an occurrence rate has been increased, as well as reducing the interval[9,10,12,19,20]. Rigid instrumentation leads to an instant increase in neighboring segment stress postoperatively. Especially, in surgery using pedicle screw system, cephalad facet joints could be injured by insertion of screw. This might enhance the hypermobility of upper adjacent segment and further increase the degeneration[18].

Although they might associate with segmental instability such as spondylolisthesis and hypermobile spine, herniation of disc, and deformity of spine[3,13,20,26], ASD usually takes the configuration of facet and ligamentous hypertrophy, and disc degeneration, which results in spinal stenosis. In our series, the patients who required re-operation, presented spinal stenosis in all cases and combined with spondylolisthesis in 1, segmental instability in 2, and disc herniation in 3 patients. Therefore, surgical intervention for symptomatic ASD is focused on the decompression of spinal canal stenosis. Whether or not performing additional fusion surgery could depend on presenting instability at adjacent segment. However, the diagnostic criteria for instability are diverse among the reports. Phillips et al.[23] proposed that subsequent extension of fusion could be required because decompression of adjacent segment was inevitably destabilizing. Whitecloud et al.[31] reported that there was higher occurrence rate of pseudoarthrodesis in uninstrumented decompressive surgery, compared with the use of supplemental instrumentation. On the contrary, some authors defined instability as the radiological findings such as, listhesis, coronal-sagittal malalignment and dynamic sagittal translation[5,26]. Considering that all previous reports were retrospective and different subpopulation patients, the necessity of additional fusion surgery is indeterminate. In our series, in simple surgery without fusion cases, the success rate was 82.4%, compared with 55.51% in additional fusion cases. In 9 cases of additional fusion surgery, there were grade 1 spondylolisthesis in 2 cases and segmental instability in 3 cases. The rest of cases were undertaken extending the fusion to prevent instability after wide decompression. And, most patients who showed favorable clinical outcome presented listhesis or instability. According to our results, spinal stenosis without definite instabiliy on juxta-fused segment could be treated with simple decompression alone. Additional fusion surgery should depend on well-defined radiological instability correlated with clinical symptoms.

In our study, occurrence rate of ASD was not significantly different between upper and lower adjacent segments, although there was a tendency of increase in the occurrence rate of ASD at the upper adjacent. The investigators have also proposed that ASD of upper segment tended to occur more frequent than that of lower segment. Aota et al.[3] that the incidence of ASD was significantly more often observed in the adjacent segments above the fusion than below the fusion, at rates of 25.5 and 2.6%, respectively. Shono et al.[27] noted that instrumented constructs produced higher segmental displacement values at the upper residual intact motion segment when compared with those of the intact spine in biomechanical study using calf lumbosacral spine. For the possible cause of this phenomenon, Etebar et al.[10] presumed that the thoracic spine acted as a lever on one end and the lumbosacral fusion segment as a lever on the other, each pulling across the remaining mobile segments as the fulcrum.

It has been known that older and postmenopausal women had high risk in the development of ASD. Osteoporotic bone leads to early metal failure. It also could make to be difficult to correct sagittal and coronal imbalance at first fusion surgery. Schlegel et al.[26] suggested that such imbalance could cause development ASD in their series. Etebar et al.[10] reported that 15 of 18 adjacent-segment failures occurred in postmenopausal women, and nearly half developed symptomatic ASD, and the average patient age in their series was 67 years. In our series, however, gender did not relate with development of symptomatic ASD. In age factor, older patients had a trend of more frequent occurrence of symptomatic ASD.

The relationship between the occurrence of ASD and the number of fusion segments has been considered. Ghiselli et al.[11] noted that single level fusion had a three times higher risk for the development of ASD than multi-level fusion, as results of Cox regression analysis. They explained this finding by the fact that a patient who has a one-level fusion has more levels at risk for ASD than a patient who has a long segments fusion. However, many authors reported that ASD was observed more frequently after fusion procedure that encompasses multi-segments[5,6,10,24,32]. Long lever arm produced with multi-segments fusion could cause more stress at the remaining free segments. In our study, although there was no statistical significance, we observed a tendency toward increasing ASD with multi-segment fusion.

This study has some limitations. We performed a retrospective study and did not compare with control group. Also, the occurrence pattern of radiological ASD was not included. In future, well designed controlled prospective study will be required.

In consideration that symptomatic ASD might be a side effect of fusion surgery and good surgical outcome was observed in most of our patients, strict criteria for the extension of fusion procedures in surgical treatments of adjacent segment syndrome is necessary.

CONCLUSION

Although this study is a retrospective analysis with lack of control group without statistically significance, there was a tendency of development of ASD associated with multi-segment fusion surgery. Age, gender, location of fused level, and fusion method were not related to occurrence of symtomatic ASD.

In surgical treatment of symptomatic ASD, selective decompression without fusion may need to be considered as a primary procedure, which may cut off the vicious cycle to reduce the potential risk of later occurrence of adjacent segment disease.

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References

1. Akamaru T, Kawahara N, Tim Yoon S, Minamide A, Su Kim K, Tomita K, et al : Adjacent segment motion after a simulated lumbar fusion in different sagittal alignments : a biomechanical analysis. **Spine 28** : 1560-1566, 2003
2. Albee F : The classic. *Transplantation of a portion of the tibia into the* spine for Pott's disease. A preliminary report. Jama, 57 : 885, 1911. **Clin Orthop Relat Res 87** : 5-8, 1972
3. Aota Y, Kumano K, Hirabayashi S : Postfusion instability at the adjacent segments after rigid pedicle screw fixation for degenerative lumbar spinal disorders. **J Spinal Disord 8** : 464-473, 1995
4. Axelsson P, Johnsson R, Stromqvist B : The spondylolytic vertebra and its adjacent segment. Mobility measured before and after posterolateral fusion. **Spine 22** : 414-417, 1997
5. Chen WJ, Lai PL, Niu CC, Chen LH, Fu TS, Wong CB : Surgical treatment of adjacent instability after lumbar spine fusion. **Spine 26** : E519-524, 2001
6. Chou WY, Hsu CJ, Chang WN, Wong CY : Adjacent segment degeneration after lumbar spinal posterolateral fusion with instrumentation in elderly patients. **Arch Orthop Trauma Surg 122** : 39-43, 2002

7. Cole TC, Burkhardt D, Ghosh P, Ryan M, Taylor T : Effects of spinal fusion on the proteoglycans of the canine intervertebral disc. **J Orthop Res 3** : 277-291, 1985
8. Dekutoski MB, Schendel MJ, Ogilvie JW, Olsewski JM, Wallace LJ, Lewis JL : Comparison of in vivo and in vitro adjacent segment motion after lumbar fusion. **Spine 19** : 1745-1751, 1994
9. Eck JC, Humphreys SC, Hodges SD : Adjacent-segment degeneration after lumbar fusion : a review of clinical, biomechanical, and radiologic studies. **Am J Orthop 28** : 336-340, 1999
10. Etebar S, Cahill DW : Risk factors for adjacent-segment failure following lumbar fixation with rigid instrumentation for degenerative instability. **J Neurosurg 90** : 163-169, 1999
11. Ghiselli G, Wang JC, Bhatia NN, Hsu WK, Dawson EG : Adjacent segment degeneration in the lumbar spine. **J Bone Joint Surg Am 86A** : 1497-1503, 2004
12. Guigui P, Wodecki P, Bizot P, Lambert P, Chaumeil G, Deburge A : Long-term influence of associated arthrodesis on adjacent segments in the treatment of lumbar stenosis : a series of 127 cases with 9-year follow-up. **Rev Chir Orthop Reparatrice Appar Mot 86** : 546-557, 2000
13. Ha KY, Schendel MJ, Lewis JL, Ogilvie JW : Effect of immobilization and configuration on lumbar adjacent-segment biomechanics. **J Spinal Disord 6** : 99-105, 1993
14. Hambly MF, Wiltse LL, Raghavan N, Schneiderman G, Koenig C : The transition zone above a lumbosacral fusion. **Spine 23** : 1785-1792, 1998
15. Lee CK : Accelerated degeneration of the segment adjacent to a lumbar fusion. **Spine 13** : 375-377, 1988
16. Lehmann TR, Spratt KF, Tozzi JE, Weinstein JN, Reinarz SJ, el-Khoury GY, et al : Long-term follow-up of lower lumbar fusion patients. **Spine 12** : 97-104, 1987
17. Louis R : Fusion of the lumbar and sacral spine by internal fixation with screw plates. **Clin Orthop Relat Res** : 18-33, 1986
18. Luk KD, Lee FB, Leong JC, Hsu LC : The effect on the lumbosacral spine of long spinal fusion for idiopathic scoliosis. A minimum 10-year follow-up. **Spine 12** : 996-1000, 1987
19. Maciejczak A, Radek A : Internal fixation of thoracolumbar, lumbar and lumbosacral spine with internal fixators. **Neurol Neurochir Pol 28** : 243-250, 1994
20. Nagata H, Schendel MJ, Transfeldt EE, Lewis JL : The effects of immobilization of long segments of the spine on the adjacent and distal facet force and lumbosacral motion. **Spine 18** : 2471-2479, 1993
21. Park P, Garton HJ, Gala VC, Hoff JT, McGillicuddy JE : Adjacent segment disease after lumbar or lumbosacral fusion : review of the literature. **Spine 29** : 1938-1944, 2004
22. Pellise F, Hernandez A, Vidal X, Minguell J, Martinez C, Villanueva C : Radiologic assessment of all unfused lumbar segments 7.5 years after instrumented posterior spinal fusion. **Spine 32** : 574-579, 2007
23. Phillips FM, Carlson GD, Bohlman HH, Hughes SS : Results of surgery for spinal stenosis adjacent to previous lumbar fusion. **J Spinal Disord 13** : 432-437, 2000
24. Rahm MD, Hall BB : Adjacent-segment degeneration after lumbar fusion with instrumentation : a retrospective study. **J Spinal Disord 9** : 392-400, 1996
25. Roy-Camille R, Saillant G, Mazel C : Internal fixation of the lumbar spine with pedicle screw plating. **Clin Orthop Relat Res** : 7-17, 1986
26. Schlegel JD, Smith JA, Schleusener RL : Lumbar motion segment pathology adjacent to thoracolumbar, lumbar, and lumbosacral fusions. **Spine 21** : 970-981, 1996
27. Shono Y, Kaneda K, Abumi K, McAfee PC, Cunningham BW : Stability of posterior spinal instrumentation and its effects on adjacent motion segments in the lumbosacral spine. **Spine 23** : 1550-1558, 1998
28. Vaccaro AR, Garfin SR : Internal fixation (pedicle screw fixation) for fusions of the lumbar spine. **Spine 20** : 157S-165S, 1995
29. Van Horn JR, Bohnen LM : The development of discopathy in lumbar discs adjacent to a lumbar anterior interbody spondylodesis. A retrospective matched-pair study with a postoperative follow-up of 16 years. **Acta Orthop Belg 58** : 280-286, 1992
30. Weinhoffer SL, Guyer RD, Herbert M, Griffith SL : Intradiscal pressure measurements above an instrumented fusion. A cadaveric study. **Spine 20** : 526-531, 1995
31. Whitecloud TS 3rd, Davis JM, Olive PM : Operative treatment of the degenerated segment adjacent to a lumbar fusion. **Spine 19** : 531-536, 1994
32. Wimmer C, Gluch H, Krismer M, Ogon M, Jesenko R : AP-translation in the proximal disc adjacent to lumbar spine fusion. A retrospective comparison of mono- and polysegmental fusion in 120 patients. **Acta Orthop Scand 68** : 269-272, 1997

COMMENTARY

Fusion has become the standard of care for numerous pathologic conditions of the spine over the past 50 years. Decompression and fusion of the lumbar spine have been shown to be the superior form of the surgical management of the degenerative spondylolisthesis in prospective randomized studies. Given the high clinical success recognized in using fusion for deformity and stenosis of the lumbar spine, long-term sequele of these procedures has been considered of secondary importance. However, as spinal fusion is being performed on younger patients and as the rates of lumbar spine surgery have increased over the past two decades, concerning regarding the effect on adjacent motion segments has been increasing. Furthermore, as indications for fusion have expanded to include mechanical back and neck pain with more variable success rates, concern for ASD has been amplified[2].

The authors retrospectively analyzed clinical and radiographic features of patients who developed symptomatic adjacent segment degeneration (ASD) that required re-operation. Authors analyzed the age, gender, ASD at the cephalad or caudal area from previous fusion area, and one level vs. multi-level.

The incidence of radiographic ASD following fusion has been reported to be as high as 70% in the lumbar spine at ten years. However the incidence of clinically relevant symptomatic ASD is quiet lower, estimated at 36% in the lumbar spine at 10 years[2]. Authors' incidence of ASD is similar to the other publication comparing the follow-up period 10 years vs. 44-months.

Recent publications are focusing on the sagittal alignment, not on the levels of fusion. Sagittal malalignment appears to have a strong influence on the development of ASD[2,3]. A study about the correlation between ASD and pelvic parameters in the patients with spondylolytic spondylolisthesis concluded that the development of ASD is closely related to postoperative pelvic incidence angle (PIA) and pelvic tilt angle (PTA), not preoperative PIA and PTA. The measurement of postoperative PIA can be used as a new indirect method to predict the ASD[3]. Sagittal balance is the most important risk and prognostic factor in the development of ASD[2].

In patients with symptomatic ASD, fusion in addition to decompression of the ASD is often warranted. To overcome the ASD, spine surgeons are watching carefully the possibility of the dynamic posterior stabilization systems. In combination with PLIF at the main lesion, the posterior dynamic stabilization system may provide posterior dynamic stabilization to the transitional upper or lower segments, may enhance the fusion rate, may reduce the adjacent segment degeneration, and may provide dynamic stabilization of the spine[1]. More long-term data is needed to determine the influence of motion sparing alternatives on the development of ASD.

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References

1. Kim YS, Zhang HY, Moon BJ, Park KW, Ji KY, Lee WC, et al : Nitinol spring rod dynamic stabilization system and nitinol memory loops in surgical treatment for lumbar disc disorders : short-term follow up. **Neurosurg Focus 15;22** : E10, 2007
2. Levin DA, Hale JJ, Bendo JA : Adjacent segment degeneration following spinal fusion for degenerative disc disease. **Bull NYU Hosp Jt Dis 65** : 29-36, 2007
3. Park JY, Cho YE, Kuh SU, Cho JH, Chin DK, Jin BH, et al : New prognostic factors for adjacent-segment degeneration after one-stage 360 degrees fixation for spondylolytic spondylolisthesis : special reference to the usefulness of pelvic incidence angle. **J Neurosurg Spine 7** : 139-144, 2007