Effect of Single and Two Level Posterior Instrumented Fusion for L4-5 Degenerative Spondylolisthesis with Adjacent Spinal Stenosis

Chote Pawasuttikul, MD

Department of Orthopaedics, Sawanpracharak Hospital, Nakhon Sawan, Thailand

Backgrounds: *Pedicular screw fixation is the most popular system in instrumented arthrodesis in the lumbar spine. Long- term important complication after lumbar fusion is adjacent segment disease (ASD).The incidence of symptomatic ASD was 5.2-18.5%. Normal progression of degenerative disease and biomechanical alteration played an important role in this disease. However, the cause of ASD is not clear. It has been an attempt to find ways to prevent ASD such as arthroplasty, dynamic fixation and percutaneous fixation. However, it has not been found the effective method. Because adjacent spinal stenosis above single level fusion may increase risk of ASD, therefore we hypothesize that ASD rate will be decrease if we extend spinal fusion to adjacent level.*

Purpose: *To determine the clinical outcome, particularly in the presence ASD, which led to the second operation in patients with degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis treated with PLF and pedicular screw fixation at L4-5 compare with PLF, Pedicular screw fixation at L4-5 and prophylaxis fixation at L3-4.*

Methods: *67 patients with degenerative L4 spondylolisthesis (grade I-II) and spinal canal stenosis at L3-5. Group 1,32 patients underwent L4-5 PLF and pedicular screws fixation in 2007-2010, Group 2,35 patients underwent PLF, pedicular screws fixation at L4-5 and prophylaxis fixation at L3-4 in 2011-2013. Based on the obtained data from the patients, pre-operatively, immediately after surgery and at the time of follow-up at 3 months, 6 months, 1 years and then annually afterward including age, sex, BMI, visual analog pain scores (VAS), Oswestry Disability Index (ODI), the occurrence of ASD and the second operation. The data were analyzed by descriptive statistic, Chi-square test and student's t-test.*

Results: *Surgery patients age average of 55.76 years (range 37-69 years). The mean follow-up period was 65.64 months (range 63-72 months). The recovery rate of VAS score and ODI were not significantly different between the two groups. The lumbar lordosis after operation was decrease in both groups. There were angulation, translation, and decreased disk height at the level above the fusion in both groups but it is not significantly different. Single level fusion group found that grade of listhesis and BMI is a factor affecting ASD ($P < 0.05$). For the two level fusion groups, the four factors, age, gender, grade of listhesis and BMI did not affect ASD. The occurence of ASD in single level fusion group at L3-4 level in 4 cases (12.5%). Two level fusion group found ASD at L2-3 level in 1 cases (2.85%). The occurrence of ASD between two groups were not significantly different.*

Conclusion: *There is not significantly different in functional outcome between single level or two level fusion with pedicular screws fixation in treatment of patients with degenerative L4 spondylolisthesis and multilevel lumbar stenosis. It cannot be concluded that two level fusion with pedicular screws fixation was the effective way to prevent ASD on cranial segment.*

Keywords: *lumbar spondylolisthesis, pedicular screw fixation, adjacent segment disease*

The Thai Journal of Orthopaedic Surgery: 41 No.3-4: 9-16
Full text. e journal: *http://www.rcost.or.th, http://thailand.digitaljournals.org/index.php/JRCOST*

Introduction

The outcome of the operative treatment of degenerative lumbar spondylolisthesis associated with spinal stenosis is better than nonoperative treatment.It was found that greater pain relief and improvement in function for four years[1]. The choices of surgery include decompression alone, decompression and fusion with or without instrumentation. While decompression with fusion had superior results over decompression alone[2] Key objective of instrumentation are to increase the rate and degree of fusion, correct deformities, provide initial stability resulting in better recovery to return to activities[3,4].

Degenerative spondylolisthesis is one of the indications for instrumentation fusion and the pedicular screw fixation is the most popular system in instrumented arthrodesis in the lumbar spine[4]. There were guidelines for appropriate levels of instrumentation but there has no definite conclusion

Correspondence to: Pawasuttikul C, Department of Orthopaedics, Sawanpracharak Hospital, Nakhon Sawan, Thailand
E-mail: chote2chote@gmail.com

for degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis[5,6].

Long-term important complication after lumbar fusion are adjacent segment disease (ASD). ASD refers to the degeneration of adjacent segment leading to clinical symptoms that require further treatment, whereas adjacent segment degeneration is a finding of the radiographic changes of the intervertebral discs adjacent to the fusion levels and have no significant symptom[7]. The incidence of ASD according to radiographic criteria was 8-100%, while the reported symptomatic ASD was 5.2-18.5%[8] Ghiselli et al reported the incidence of ASD after the index decompression or arthrodesis was 16.5% at five years and 36.1% at ten years[9]. The cause of ASD is not clear. Based on a review of the literature by Park et al, it is concluded that normal progression of degenerative disease and biomechanical alteration played an important role in this disease[8].

Several studies of the risk factors, surgical factor include the application of instrumentation, type of instrument, length of fusion (especially three or more levels), facet joint destruction, loss of lumbar lordosis and sagittal and coronal imbalance. And patient factor include age, gender, BMI, BMD, prexisting degeneration of adjacent disks, sagittal aligment, laminar incrination, sacral incrination and facet tropism. Still can not conclude what factors affect ASD?[10-12] Hikata et al. Reported in 2014 that the sagittal angle of the facet joint was a factor that affected symtomatic ASD[13].

It has been an attempt to find ways to prevent ASD such as arthroplasty, dynamic fixation and percutaneous fixation.

However, it has not been found the method to prevent statistically significant and long-term results are also unavailable[14-16]. Because adjacent spinal stenosis above single level fusion may increase risk of ASD, therefore we hypothesize that ASD rate will be decrease if we extend spinal fusion to adjacent level[17]. The objective of this study was to determine the clinical outcome, particularly in the presence ASD, which led to the second surgery. In patients with degenerative spondylolisthesis of L4-5 and multilevel lumbar stenosis treated with PLF and pedicular screw fixation at L4-5 compare with PLF, pedicular screw fixation at L4-5 and prophylaxis fixation at L3-4.

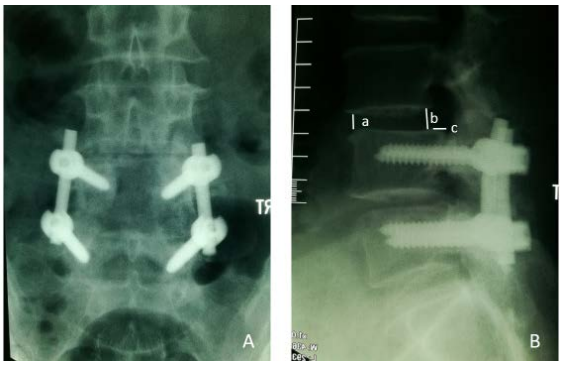
Patients and Methods

76 patients with degenerative L4 spondylolisthesis (grade I-II) has been diagnosed by computed tomography scan, myelography, CT-myelography or magnetic resonance imaging. The inclusion criteria are patients with L45 spondylolisthesis and spinal canal stenosis at L3-5. All patients were treated with PLF and pedicular screws fixation (Xia system) between 2007 and 2013. Patients who were postoperative follow-up period of less than 60 months, non-compliance, or incomplete data were excluded. The remaining 67 patients (30 male and 37 female) were included in the study. The mean age of 55.76 years at surgery (range 37-69 years). The mean follow-up period was 65.64 months (range 63-72 months).This retrospective study was approved by the Ethics Committee of Sawanpracharak Hospital.

Surgical technique

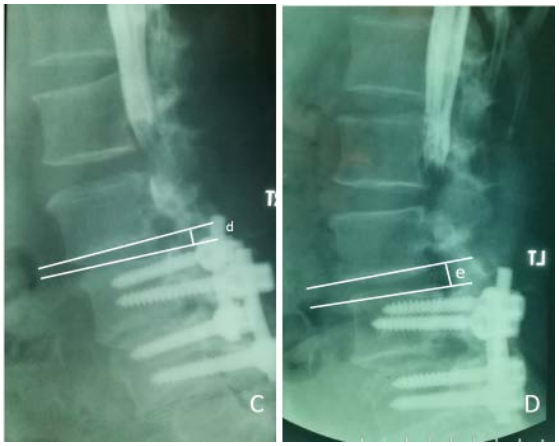
Group 1,32 patients underwent PLF and pedicular screws fixation at L4-5 in 2007-2010,Group 2,35 patients underwent PLF, pedicular screws fixation at L4-5 and prophylaxis fixation at L3-4 in 2011-2013. All surgeries were performed by a single surgeon form January 2007 to December 2013. The surgery started with routine posterior midline incision. Laminectomy was performed, decompression was done by total resection of the ligamentum flavum, lateral recess were decompressed by carefully resected medial aspect of facet joint less than 50% of total. The pedicular screws were placed to correct the sagittal and coronal alignment of the lumbar spine and reduced spondylolisthesis as much as possible. Confirmed position of pedicular screws by radiography. PLF were performed by autogenous bone grafts from the resected spineous process at each level.

The data for the patients were obtained, pre-operatively, immediately after surgery and at the time of follow-up at 3 months, 6 months, 1 years and then annually afterward. Including age, sex, BMI, visual analog pain scores (VAS), Oswestry Disability Index (ODI), the occurrence of ASD and the second operation.



A B

Fig.1 Imaging measurement A. AP static view
B. Lateral static view
1) Disc height has been measured as (a+b) / 2
2) Translation has been measured as the distance of c (The distance on superior end plate of the lower vertebral body between the posterior margin of vertebral column) in flexion-extension view.



C D

Fig.2 Imaging measurement angulation by angle between two adjacent end-plates (d and e) in flexion-extension view (C and D)

Radiologic assessment was performed, AP and lateral static plain radiography and flexion-extension radiography to detect the instability, on the basis of comparison with pre-operative and post-operative lateral radiographs including lumbar lordosis, transitional motion > 4 mm in flexion/extension and angular motion > 10 mm.[3,4] and disc height at the level above the fusion. Criteria for diagnostic ASD were disc degeneration (loss of disc height, disc space narrowing), listhesis (anterolisthesis, retrolisthesis), instability, herniated nucleus pulposus, stenosis, hypertrophic facet arthritis, osteophyte formation scoliosis, and vertebral compression fracture[8]. (figure 1 and 2)

The primary outcome were ODI and VAS. By using The Oswestry Low Back Pain Disability questionnaire (Version1.0) Thai Version[18]. Reduction of ODI at least 15% indicates a successful clinical outcome by the criteria of the US FDA[19].

The data were analyzed by descriptive statistic. Compared the base line characteristics and the results of treatment between group by Chi-square test for discrete data and student's t-test for continuous data. Analysis was performed with STATA 10, statistic significant at $P < 0.05$.

Result

There were no significantly different in demographic data, sex, age, grade of listhesis, BMI and the average follow-up period between two groups. Data are shown in table1. No serious neurological complication or deep surgical site infection. Dura tear occurred intra- operatively in 5 patients. All were repaired and no further complications have been found. Two patients in group one had re-operative from misplaced screws. There were no pseudarthosis or implants remove at the last follow-up examination. The lumbar lordosis after operation was decrease in both groups. There were angulation, translation, and decreased disk height at the level above the fusion in both groups but no significantly different. Data are shown in table 2. Clinical outcome form ODI and VAS score were not significantly different between the two groups. Single level fusion group found that grade of listhesis and BMI is a factor affecting ASD ($P < 0.05$). For the two level fusion groups, the four factors, age, gender, grade of listhesis and BMI did not affect ASD. Data are shown in table 3 and 4.

ASD was found in single level fusion group at L3-4 level 4 cases. All were loss of disc height. Anterior listhesis in 3 cases and retholisthesis in 1 case. Two level fusion group was found ASD at L2-3 level in 1 cases which have severe angulation and loss of disc height. Second operation was performed in 5 cases. The mean period between the first surgery and the second surgery was 21 months (range from13-27 months) in single level fusion group and 58 months in two level fusion group. (figure 3 and 4)

Table 1 Demographic Data

	Single level fusion	**Two level fusion**	***P*-value**
Number	32	35	
Sex			
Male	16 (50.00)	14 (40.00)	0.411
Female	16 (50.00)	21 (60.00)	
Age	54.31 (7.54)	57.22 (7.05)	0.107
Grade of listhesis			
Gr I	18 (56.25)	31 (88.5)	0.493
Gr II	14 (43.75)	4 (11.5)	
BMI	23.09 (2.46)	22.68 (2.51)	0.505
Average follow-up	65.84 (2.98)	65.45 (2.45)	0.563

Table 2 Outcome of treatment

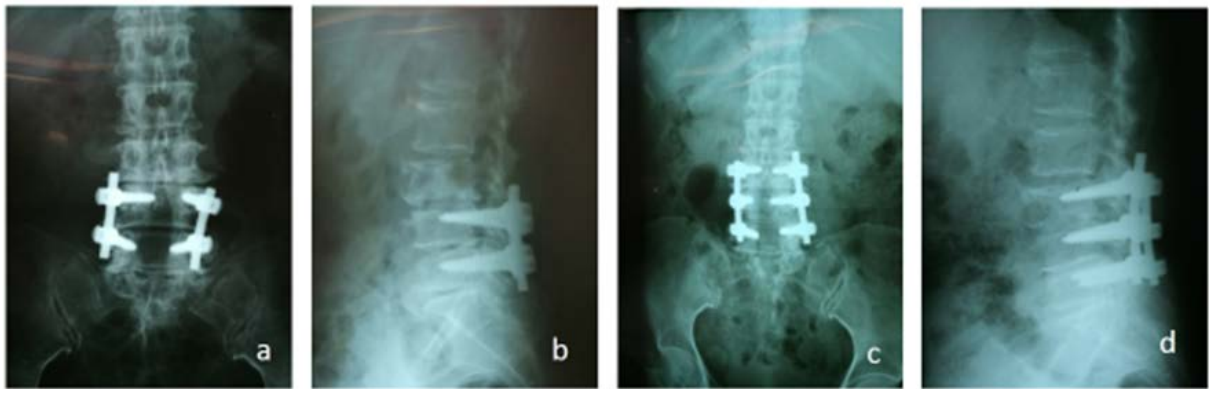
	Single level fusion	**Two level fusion**	***P*-value**
Number	32	35	
Lordosis			
Pre-op	52.78 (8.69)	50.37 (7.46)	0.761
Post-op	48.34 (8.51)	47.94 (8.35)	0.766
VAS			
Pre-op	8.96 (0.60)	8.72 (0.51)	0.076
3 months	5.45 (0.56)	4.97 (0.77)	0.001
6 months	4.74 (0.68)	4.38 (0.64)	0.033
1 year	3.35 (0.55)	3.13 (0.35)	0.056
5 years	1.83 (0.58)	1.63 (0.59)	0.170
ODI			
Pre-op	40.09 (2.66)	39.94 (2.94)	0.826
3 months	31.45 (3.02)	31.47 (2.64)	0.976
6 months	26.54 (2.97)	26.55 (1.94)	0.990
1 year	22.32 (1.79)	21.83 (1.85)	0.279
5 years	21.83 (2.49)	19.61 (1.62)	0.170
Angulation			
Pre-op	0	0	
F-U	2.75 (3.75)	2.08 (5.15)	0.551
Translation			
Pre-op	0	0	
F-U	0.68 (1.20)	0.48 (1.09)	0.474
Disk height			
Pre-op	10.03 (1.65)	9.08 (1.17)	0.05
F-U	7.96 (2.23)	7.14 (1.88)	0.73
Second operation form Symptomatic ASD			
Yes	4 (12.5%)	1 (2.85%)	0.13
No	28 (87.5%)	34 (97.15%)	

Table 3 Factors affecting ASD in Single level fusion

Factors	**No ASD (N=28)**		**ASD (N=4)**		***P*-value**
	Number	**Percent**	**Number**	**Percent**	
Sex					0.788
Male	12	42.86	2	50.00	
Female	16	57.14	2	50.00	
Age (year)					0.662
< 40	1	3.57	0	0.00	
41-50	7	25.00	2	50.00	
51-60	15	53.57	1	25.00	
61-70	5	17.86	1	25.00	
Grade oflisthesis					0.054
Gr I	14	50.00	4	100	
Gr II	14	50.00	0	0.00	
BMI					0.013
< 18.5	0	0.00	1	25.00	
18.5-24.9	20	71.43	1	25.00	
25.0-29.9	8	28.57	2	50.00	

Table 4 Factors affecting ASD in two level fusion

Factor	No ASD (N=34)		ASD (N=1)		*P*-value
	Number	Percent	Number	Percent	
Sex					0.407
Male	14	41.18	0	0.00	
Female	20	58.82	1	100	
Age (year)					0.808
< 40	4	11.76	0	0.00	
41-50	17	50.00	1	100	
51-60	10	29.41	0	0.00	
61-70	3	8.82	0	0.00	
Grade of listhesis					0.764
Gr I	30	88.50	1	100	
Gr II	4	11.50	0	0.00	
BMI					0.612
< 18.5	0	0.00	0	0.00	
18.5-24.9	27	79.41	1	100	
25.0-29.9	7	20.59	0	0.00	



a b c d

Fig.3 Imaging studies of ASD in single level fusion. Preoperative (a,b) and postoperative (c,d)

a b c d

Fig.4 Imaging studies of ASD in two level fusion. Preoperative (a,b) and postoperative (c,d)

Discussion

Degenerative spondylolisthesis usually has multi-level disc or facet degeneration which cause ASD in the future. Based on Choon Sung Lee et al report, there is a correlation between preexisting disc and facet degeneration and ASD[10]. Beside, Hikata et al reported that sagittal orientation of the facet joint at L3/4 is the risk factor for the development of symptomatic ASD (P<0.024)[13]. Yet, some patients in this study did not have CT myelogram therefore there is a lack in information about facet sagittalization.

Altered biomechanical that cause ASD is described in two theories, adjacent intradiscal pressure increase 45% in instrumented posterior fusion and loss of ROM of the fused segments cause torque in adjacent level. However, there still cannot demonstrate the relationship between increase ROM and intra discal pressure among fusion and control group[8,20]. Prophylaxis pedicular screw fixation at L3-4 in this study found ASD 2.85% compared to single level fusion found ASD 12.5% but no significant difference was found. There should be prospective RCT studies in sufficient number of patients to provide more accurate results. The most common finding of adjacent segment disease was disc degeneration. The other were listhesis, instability, hypertrophic facet joint arthritis, and stenosis[8,13]. Referring to 5 patients in the study, they all have disc space narrowing and instability. 4 patients have anterior listhesis and one has retrolisthesis. The average interval between the index and second surgery was 52.3 months (range from 9 -1 2 5 months)[9]. However, the incidence is expected to increase with longer follow-up. In this study, the average interval between the index and second operation in two level fusion (58 months) was longer than single level (21 months).

On the clinical outcome, VAS score was significantly improved at 3-12 months in both groups. Then, in 1 to 5 years, the level of pain was relatively constant. For ODI, it has been found to improve over 15% in both groups since the third month and there is no significantly difference between the two groups. This study is similar to that of Yossi Smorgicket al.[6] which study comparison between single level fusion and multilevel fusion.

This study found that factor affecting ASD ($P < 0.05$) was grade of listhesis and BMI, which was found only in single-level fusion group.

All ASD was found in listhesis grade I. This is different from the reported by Choon Sung Lee et al.[10] that grades of listhesis did not affect ASD. To prove that listhesis grade I is a risk factor for single level fusion for treatment of degenerative L4 spondylolisthesis and multilevel lumbar stenosis need futher study and sufficient sample size. For BMI, increased BMI contributed to ASD, especially BMI ≥ 25 kg/m, which was compatible with reported by Choon Sung Lee et al.[10] Moreover, Hypolordotic alignment of L4-L5 resulted in the greatest amount of flexion-extension motion at L3-L4 whereas hyperlordotic alignment of L4-L5 resulted in the greatest amount of flexion-extension motion at L5-S1[20]. This study found that lordosis angle after fusion are hypolordotic alignment and found cranial ASD in all 5 patients.

Limitations of this study including data regarding preexisting degeneratiion of adjacent disk, facet sagittalisation and facet tropism, especially for above fusion level which may be affected ASD, small case series, a short-term follow up for discovery ASD and the surgeon experience of the number of surgeries.

Conclusion

There is not significantly different in functional outcome between single levelor two level fusion with pedicular screws fixation in treatment of patients with degenerative L4 spondylolisthesis and multilevel lumbar stenosis. It cannot be concluded that two level fusion with pedicular screws fixation was effective for prevention ASD on cranial segment.

Acknowledgments

The authors wish to thank Torphong Bunmaprasert, who was my research consultant, and Pornjan Suwonmontri for statistical data analysis.

Potential conflicts

None.

References

1. Weinstein JN, Lurie JD, Tosteson TD, Zhao W, Blood EA, Tosteson AN, et al. Surgical compared with nonoperative treatment for lumbar degenerative spondylolisthesis. four-year results in the Spine Patient Outcomes Research Trial (SPORT) randomized and observational cohorts. J Bone Joint Surg Am 2009; 91: 1295-304.
2. Herkowitz HN, Kurz LT. Degenerative lumbar spondylolisthesis with spinal stenosis. A prospective study comparing decompression with decompression and intertransverse process arthrodesis. J Bone Joint Surg Am 1991; 73: 802-8.
3. Truumees E, Herkowitz HN. Lumbar spinal stenosis: treatment options. Instr Course Lect 2001; 50: 153-61.
4. Glaser JA, Bernhardt M, Found EM, McDowell GS, Wetzel FT. Lumbar arthrodesis for degenerative conditions. Instr Course Lect 2004; 53: 325-40.

5. Knaub MA, Won DS, McGuire R, Herkowitz HN. Lumbar spinal stenosis: indications for arthrodesis and spinal instrumentation. Instr Course Lect 2005; 54: 313-9.
6. Smorgick Y, Park DK, Baker KC, Lurie JD, Tosteson TD, Zhao W, et al. Single- versus multilevel fusion for single-level degenerative spondylolisthesis and multilevel lumbar stenosis: four-year results of the spine patient outcomes research trial. Spine (Phila Pa 1976) 2013; 38:797-805.
7. Helgeson MD, Bevevino AJ, Hilibrand AS. Update on the evidence for adjacent segment degeneration and disease. Spine J 2013; 13: 342-51.
8. Park P, Garton HJ, Gala VC, Hoff JT, McGillicuddy JE. Adjacent segment disease after lumbar or lumbosacral fusion: review of the literature. Spine (Phila Pa 1976) 2004; 29: 1938-44.
9. Ghiselli G, Wang JC, Bhatia NN, Hsu WK, Dawson EG. Adjacent segment degeneration in the lumbar spine. J Bone Joint Surg Am 2004; 86-A(7): 1497-503.
10. Lee CS, Hwang CJ, Lee SW, Ahn YJ, Kim YT, Lee DH, et al . Risk factors for adjacent segment disease after lumbar fusion. Eur Spine J 2009; 18: 1637-43.
11. Epstein NE. Adjacent level disease following lumbar spine surgery: A review. Surg NeurolInt 2015; 6(Suppl 24): S591-S599.
12. Chen BL, Wei FX, Ueyama K, Xie DH, Sannohe A, Liu SY. Adjacent segment degeneration after single-segment PLIF: the risk factor for degeneration and its impact on clinical outcomes. Eur Spine J 2011; 20: 1946-50.
13. Hikata T, Kamata M, Furukawa M. Risk factors for adjacent segment disease after posterior lumbar interbody fusion and efficacy of simultaneous decompression surgery for symptomatic adjacent segment disease. J Spinal Disord Tech 2014; 27: 70-5.
14. Guyer RD, McAfee PC, Banco RJ, Bitan FD, Cappuccino A, Geisler FH, et al. Prospective, randomized, multicenter Food and Drug Administration investigational device exemption study of lumbar total disc replacement with the CHARITE artificial disc versus lumbar fusion: five-year follow-up. Spine J 2009; 9: 374-86.
15. Morishita Y, Ohta H, Naito M, Matsumoto Y, Huang G, Tatsumi M, et al. Kinematic evaluation of the adjacent segments after lumbar instrumented surgery: a comparison between rigid fusion and dynamic non-fusion stabilization. Eur Spine J 2011; 20: 1480-5.
16. Lee DY, Lee SH, Maeng DH. Two-level anterior lumbar interbody fusion with percutaneous pedicle screw fixation: a minimum 3-year follow-up study. Neurol Med Chir (Tokyo) 2010; 50: 645-50.
17. Cook DJ, Yeager MS, Cheng BC. Range of motion of the intact lumbar segment: a multivariate study of 42 lumbar spines. Int J Spine Surg 2015; 9: 5.
18. Sanjaroensuttikul N. The Oswestry low back pain disability questionnaire (version 1.0) Thai version. J Med Assoc Thai 2007; 90: 1417-22.
19. Fairbank JC, Pynsent PB. The oswestry disability index. Spine (Phila Pa 1976) 2000; 25:2940-52.
20. Cunningham BW, Kotani Y, McNulty PS, Cappuccino A, McAfee PC. The effect of spinal destabilization and instrumentation on lumbar intradiscal pressure: an in vitro biomechanical analysis. Spine (Phila Pa 1976) 1997; 22: 2655-63.
21. Kumar MN, Baklanov A, Chopin D. Correlation between sagittal plane changes and adjacent segment degeneration following lumbar spine fusion. Eur Spine J 2001; 10: 314-9.

ผลการผ่าตัดเชื่อมกระดูกสันหลังในโรคกระดูกสันหลังเคลื่อนระดับ L4: เปรียบเทียบการเชื่อมข้อกระดูก 1 ระดับ กับ 2 ระดับ

โชติ ภาวศุทธิกุล, พบ

วัตถุประสงค์: *เพื่อศึกษาผลการรักษาผู้ป่วยโรคกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) และมีช่องกระดูกสันหลังระดับเอวตีบ ตั้งแต่ระดับ L3-L5 ด้านการกลับไปใช้ชีวิต (functional outcome) และการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป ด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมกระดูกสันหลังโดยใช้โลหะดาม เปรียบเทียบผลการผ่าตัดและการเชื่อมข้อกระดูก ระหว่าง 1 ระดับ กับ 2 ระดับ*

วัสดุและวิธีการ: *ศึกษาข้อมูลผู้ป่วยกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) และมีช่องกระดูกสันหลังระดับเอวตีบ ตั้งแต่ระดับ L3-L5 ที่ได้รับการรักษาด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมข้อกระดูกสันหลังโดยใช้โลหะดาม 1 ระดับ (L4-L5) จำนวน 32 ราย ระหว่างปี พ.ศ.2550-2553 และด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมข้อกระดูกสันหลังโดยใช้โลหะดาม 2 ระดับ (L3-L4 และ L4-L5) จำนวน 35 ราย ในช่วงปี พ.ศ.2554-2556 โดยผู้ป่วยได้รับการติดตามการรักษาอย่างน้อย 5 ปี ประเมินผลการรักษาใช้แบบสอบถาม Oswestry Disability Index (ODI), คะแนนความเจ็บปวด visual analog pain scores (VAS) การเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป (adjacent segment disease - ASD) และการผ่าตัดเพื่อแก้ไขการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไป*

ผลการศึกษา: *ผู้ป่วยทั้งหมด 67 ราย อายุเฉลี่ย 55.76 ปี ได้รับการติดตามการรักษาเฉลี่ย 65.64 เดือน ค่าเฉลี่ยของคะแนน VAS และ ODI ดีขึ้นทั้งสองกลุ่มและไม่แตกต่างกันอย่างมีนัยสำคัญ แนวโค้งของกระดูกสันหลังส่วนเอว (lordosis of lumbar) หลังการผ่าตัดลดลงทั้งสองกลุ่ม และพบว่ามีการเปลี่ยนแปลงของมุม(angulation) การเคลื่อนของกระดูกสันหลัง (translation) และการลดลงของความสูงของหมอนรองกระดูก ในระดับสูงขึ้นไปทั้งสองกลุ่ม แต่ไม่มีความแตกต่างกันอย่างมีนัยสำคัญกลุ่มที่เชื่อมข้อกระดูก 1 ระดับ พบปัจจัยที่มีผลต่อการเกิด ASD ได้แก่ การเคลื่อนของกระดูกสันหลังก่อนผ่าตัดระดับที่ 1 และค่าดัชนีมวลกาย (BMI)กลุ่มที่เชื่อมข้อกระดูก2 ระดับ ไม่พบปัจจัยที่มีผลต่อการเกิด ASD สำหรับการเกิด ASD กลุ่มที่เชื่อมข้อกระดูก 1 ระดับ พบ ที่ระดับ L3-4 จำนวน 4 ราย (12.5%) กลุ่มที่เชื่อมข้อกระดูก 2 ระดับ พบ ASD ที่ระดับ L2-31 ราย (2.85%) การเกิด ASD ระหว่างสองกลุ่มไม่แตกต่างกันอย่างมีนัยสำคัญวิเคราะห์ข้อมูลด้วยสถิติเชิงพรรณนา โดยใช้ Chi-square test และ student's t-test*

สรุป: *ผลการรักษาผู้ป่วยกระดูกสันหลังระดับเอวเคลื่อน (ระดับ L4) ด้วยวิธีผ่าตัดขยายช่องไขสันหลังและเชื่อมกระดูกสันหลังโดยใช้โลหะดามระหว่าง 1 ระดับ กับ 2 ระดับ ไม่มีความแตกต่างกัน และไม่สามารถสรุปได้ว่าการเชื่อมข้อกระดูกสันหลังระดับเอว 2 ระดับ สามารถป้องกันการเสื่อมของข้อกระดูกสันหลังระดับถัดขึ้นไปได้*