Clinical and radiological outcomes after posterior lumbar interbody fusion by the vertebral end plate degeneration

Young Min Kwon

Department of Medicine
The Graduate School, Yonsei University

Clinical and radiological outcomes after posterior lumbar interbody fusion by the vertebral end plate degeneration

Directed by Professor Dong Kyu Chin

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Young Min Kwon

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This certifies that the Master's Thesis of
Young Min Kwon is approved.

Thesis Supervisor: Dong Kyu Chin

[Thesis Committee Member #1 Ho Taek Song)

[Thesis Committee Member #2 Sung Uk Kuh)

The Graduate School
Yonsei University

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ABSTRACT

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The vertebral end plate changes (Modic changes) are suggested as a one of the source of low back pain. And posterior lumbar interbody fusion (PLIF) is effective for the treatment of low back pain due to degenerative disc disease associated with the vertebral end plate changes. This study was designed to evaluate the efficacy of PLIF with posterior pedicle screw fixation in chronic degenerative disc disease with Modic changes.

A total of 320 patients who underwent single level spinal fusion operation (PLIF with posterior pedicle screw fixation) from January 2003 and December 2007 and followed up more than 12 months were enrolled in this study. The patient's mean age was 55.6±10.7 years old and mean follow-up was 28.52±17.1 months. Patients were classified into 4 categories (Modic 0 to 3) according to Modic changes based on pre-operative lumbar magnetic resonance images. Factors such as patient's age, smoking habit, osteoporosis that may affect fusion rate were also analyzed. Clinical data were analyzed with 10-point visual analog scale (VAS) and Oswestry Disability Index (ODI).

The overall bone fusion rate was 86.6% and 88.7% in Modic type 0, 81.2% in Modic 1, 86.0% in Modic 2 and 75.0% in Modic type 3. There were no significant differences between Modic groups ($p = 0.220$). Patient's age ($p = 0.242$), smoking habit ($p = 0.095$), osteoporosis ($p = 0.270$), operated level ($p = 0.966$) and diagnosed disease ($p = 0.988$) also did not show significant differences. In all groups, significant post-operative clinical improvements ($p = 0.000$) were shown and there were significant differences between Modic types. In conclusion, PLIF with additional posterior pedicle screw fixation seems to be an effective procedure in regarding of clinical outcome and bone fusion rate.

Key words: Modic degeneration, fusion rate, posterior lumbar interbody fusion, lumbar degenerative disc disease

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I. INTRODUCTION

Chronic low back pain is the one of the most common symptoms that generating visits to primary health care institution. Up to 80% of population in a modern industrial society suffers temporary disability from low back pain and radiculopathy.[1] Various causes of low back pain have been proposed. Although the lumbar intervertebral disc disorder considered as the most common benign causes of acute and chronic low back pain, myofascial syndrome and psychosocioeconomic problems can lead to chronic low back pain.[2-4] Chronic degeneration of lumbar intervertebral disc, facet joint and ligaments are considered as a main causes of chronic low back pain. These are found as degenerative black disc, disc bulging, disc protrusion and annular tears on magnetic resonance imaging (MRI).[5-7] However, vertebral end plate degeneration, which was first described by Modic et al., are considered as a source of low back pain.[8-12]

Spinal fusion has been introduced as a treatment option for chronic low back pain more than 70 years and is the mainstay in the treatment of degenerative

disorders of the lumbar spine. Primary goal for spinal fusion is to remove pain generating tissues and establish stabilization of vertebral column. Posterior lumbar interbody fusion (PLIF) is widely used method to establish spinal stabilization. PLIF procedures have mechanical advantages over posterolateral fusion (PLF) such as wider fusion area, anterior column support, restoration of lordosis and collapsed disc height and indirect decompression of nerve root.[13-16]

There are many papers that reporting a fusion rate by various surgical approach.[17] Most of the previously reported papers compare between traditional PLF and interbody fusion techniques either anterior or posterior or using different sources of bone.[18] However, there are very few reports on fusion rate after PLIF according to pre-operative vertebral end plate changes. Previously, we reported that differences of fusion rate and clinical outcome by vertebral end plate changes after PLIF with standard cage alone.

In this study, we assess the fusion rate and clinical outcomes of patients who underwent spinal fusion surgery by PLIF using cage and pedicle screw fixation according to vertebral end plate changes in lumbar degenerative disc disease.

II. MATERIALS AND METHODS

1. Patients

Seven-hundred and twenty-one patients underwent PLIF and pedicle screw fixation in our institution from January 2003 to December 2008. Patients who received 1) single level spinal fusion, 2) performed under L3/4 lumbar level, 3) followed up more than one year post-operatively, and 3) evaluated with lumbar MRI pre-operatively were included in this study. Patients who receive spinal fusion owing to spinal trauma, tumor or inflammatory disease, followed up less than one year and post-operative complications such as infection were excluded from this study. Total of 320 patients (208 females and 112 males) were enrolled in this study and reviewed medical record and radiographic studies were reviewed retrospectively. These patients were divided into 4 groups according to vertebral end plate changes by pre-operative lumbar MRI as follows: No vertebral end plate changes or Modic type 0, Modic type 1, Modic type 2, Modic type 3. Two-hundred and twenty one patients were grouped in Modic type 0, 32 patients were with Modic type 1, 43 patients were with type 2, 24 patients were with type 24. The mean patient's age was 55.6±10.7 years old and the mean follow-up period was 28.52±17.1. Smoking habit and pre-operative osteoporosis for elderly patients were also evaluated that may influence bony fusion. Also patients were grouped into by their age, equal to over 60 and under 60, to evaluate the differences of bony fusion rate.

2. Surgical technique

The patients were placed on prone position on a spinal frame or table under general anesthesia. Laminectomy, medial facetectomy and discectomy were performed for neural decompression. Complete removal of intervertebral disc materials and cartilaginous end plate using shaver and curettes for preparing fusion bed. The local chip bones that were obtained during the posterior decompression were prepared by removal of all of the soft tissues for impaction into the radiolucent carbon fiber cages (Depuy Acromed Corp., Raynham, MA, USA). Two cages were impacted into the intervertebral disc space more than 5 millimeter from the posterior cortical margin. The(Titanium) pedicle screws and rods were used to enforce the post-operative immediate fixation(for bilateral posterior fixation).

3. Radiographic assessment

For radiographic evaluation, all patients' pre-operative lumbar simple anteroposterior and lateral X-ray and MRI were reviewed to classify into Modic types. For assessment of fusion state after operation, anteroposterior, lateral, flexion and extension views at the last follow-up were evaluated.

Modic types were assessed according to vertebral end-plate changes on lumbar spine MRI and divided as followed: Type 0: no vertebral end plate change. Type 1: low signal intensity on T1-weighted images and high signal intensity on T2-weighted images. Type 2 changes showed high signal intensity on

T1-weighted images and isointense or slightly hyperintense signal on T2-weighted images. Type 3 changes demonstrated low signal intensity on both T1 and T2 weighted images (figure 1).[8, 19]

Bone fusion was evaluated with plain film of lumbar spine at the last follow-up. Bone fusion criteria are defined as follow: 1) presence of a bony bridge within or posterior of cages, 2) absence of any dark halo around cages, 3) absence of motion on lateral flexion-extension dynamic view (less than 5 degree movement of lateral flexion and extension views) and 4) no traction spur formation.[20, 21] If any one of the four criteria was not satisfied, we classified the patients as being in a non-fusion state (figure 2).

4. Clinical assessment

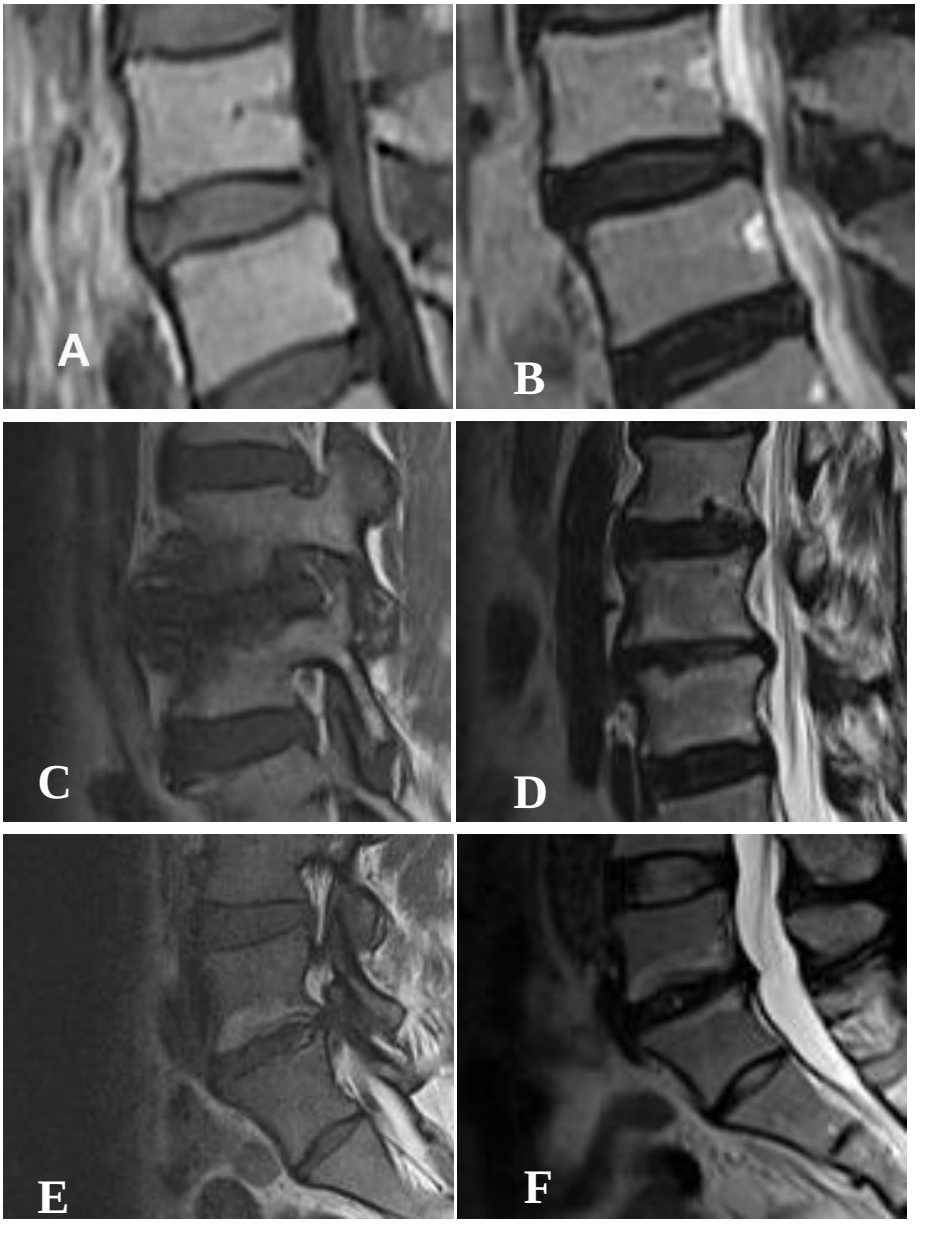
Clinical assessment was made on the improvement of back pain, leg pain and disability. Back pain and leg pain were measured with a 10-point visual analog scale (VAS) before surgery and at the last-followed up. Disability was evaluated with the Oswestry Disability Index (ODI) before surgery and at the last followed up.

5. Statistic analysis

Clinical characteristics of patients were summarized as a whole, as well as described specifically for subgroups by descriptive statistics. After descriptive analyses were performed, a Fischer's exact chi square test was used to compare

categorical variables between groups, while a one-way analysis of variance (ANOVA) was used to compare continuous variables between groups

Odd ratio (OR) for comparison of two groups was summarized with its 95% confidence interval and p-value using logistic regression. P-values lower than 0.05 were considered as a statistically significant.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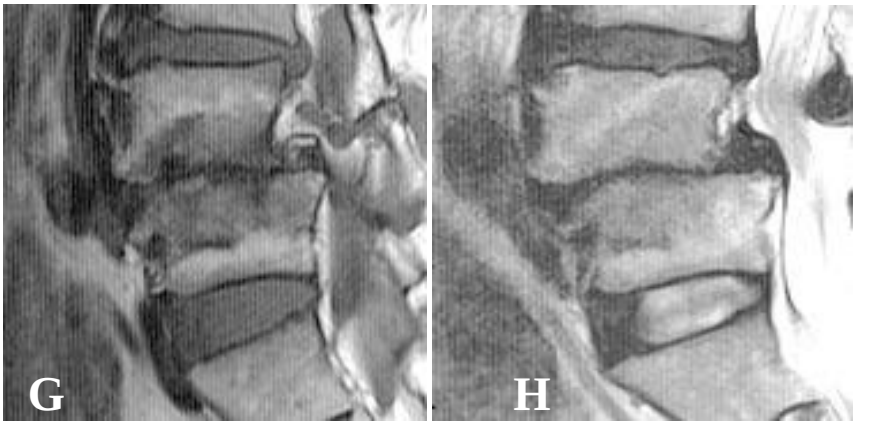
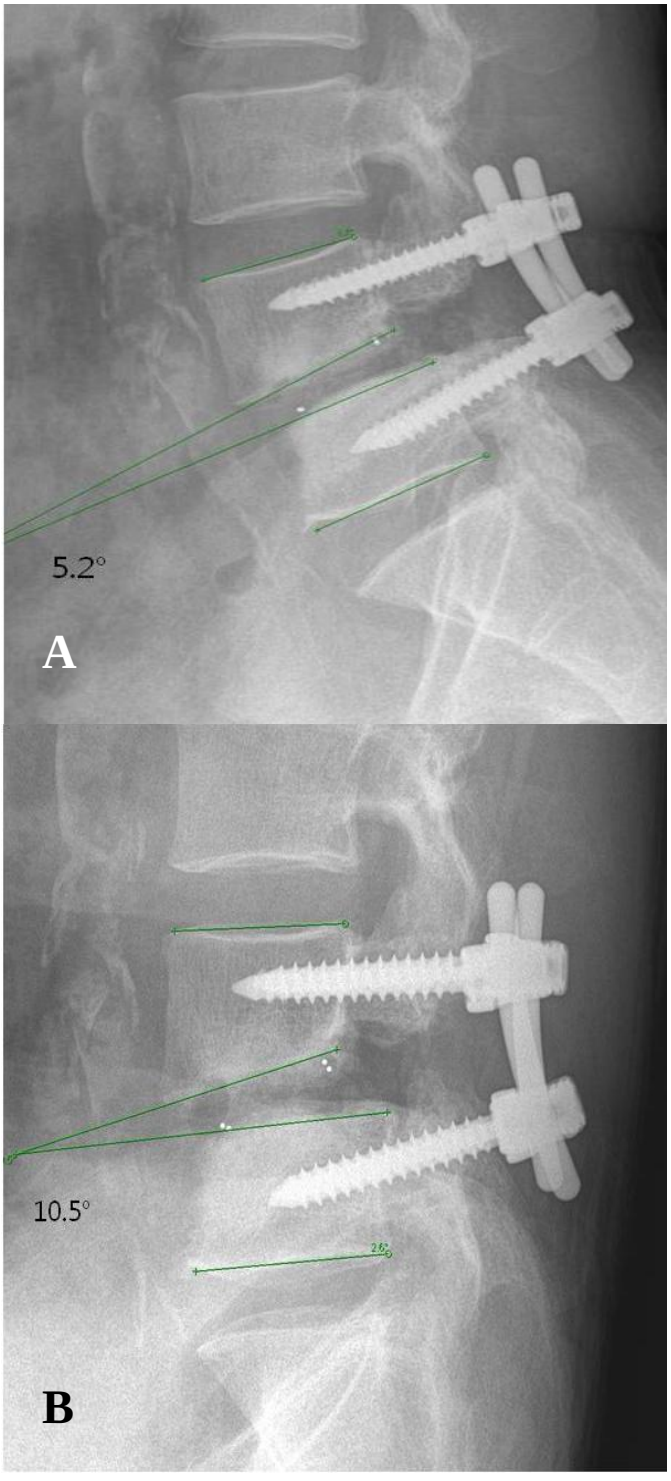


Figure 1. Classification of Modic changes. Moidc type 0 or no vertebral end plate degeneration shows no vertebral end plate abnormality in T1 and T2 – weighted lumbar MRI images (A, B). Modic type 1 changes shows low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (C, D). Modic type 2 changes shows high signal intensity on T1-weighted images and isointense or slightly hyperintense signal on T2-weighted images (E, F). Modic type 3 changes demonstrated low signal intensity on both T1 and T2 weighted MRI images (G, H).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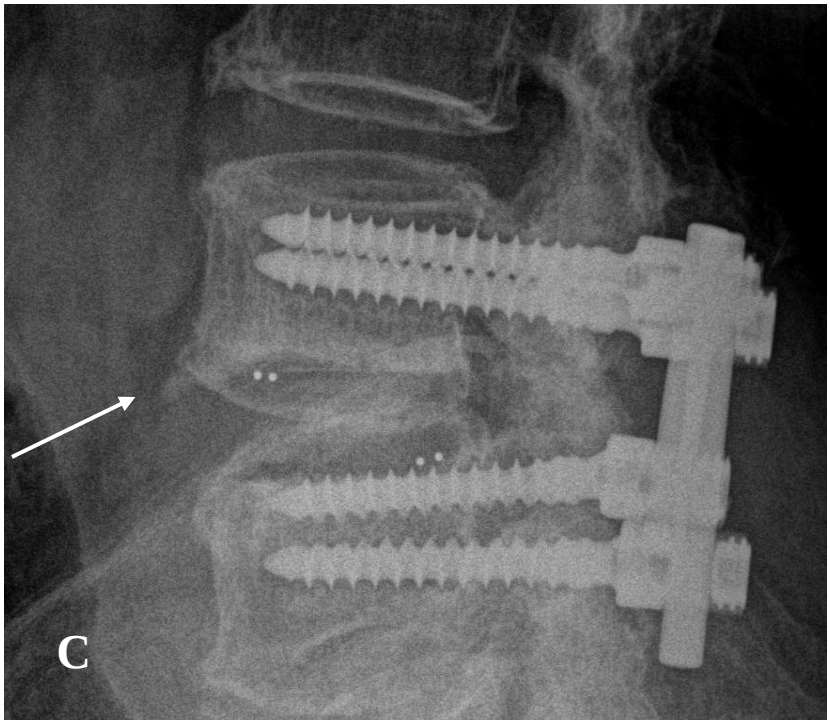
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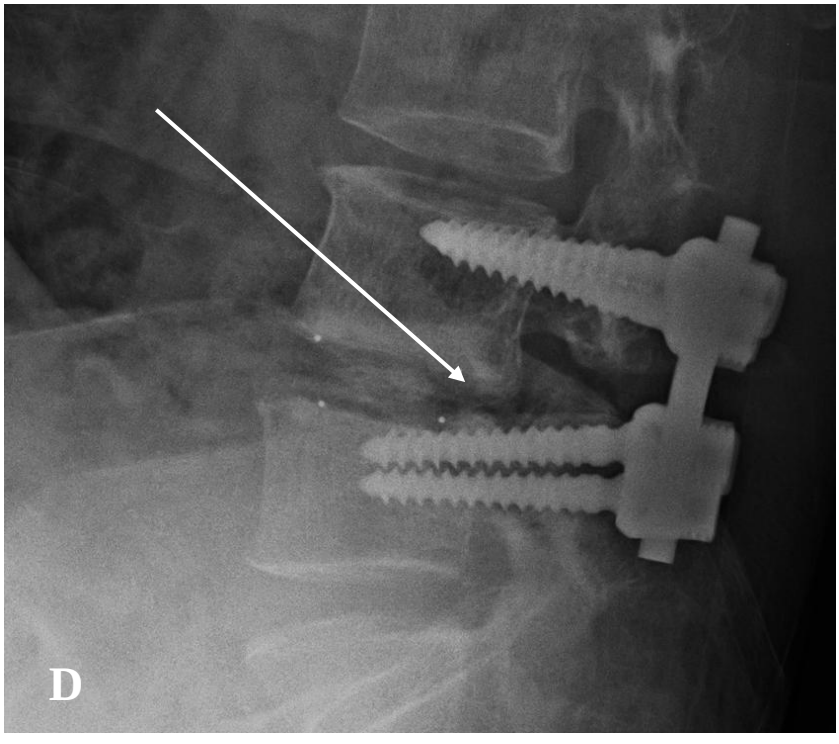
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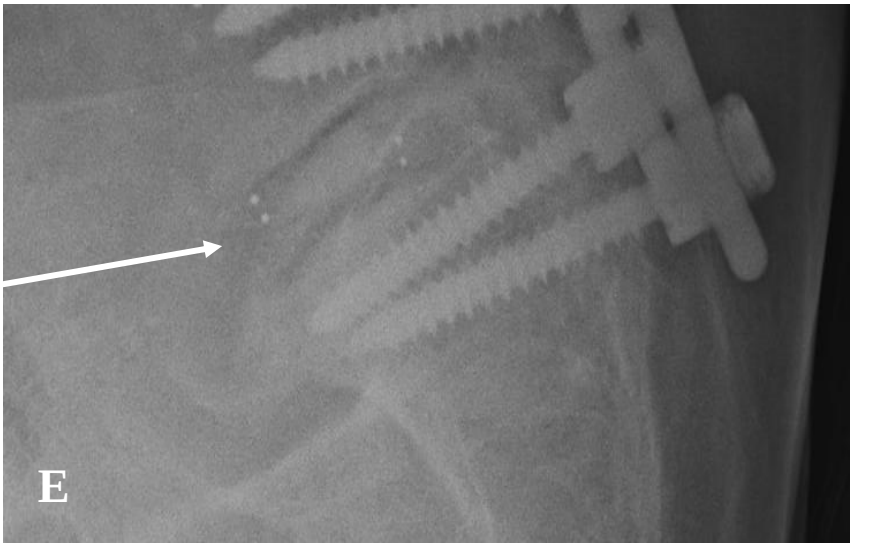
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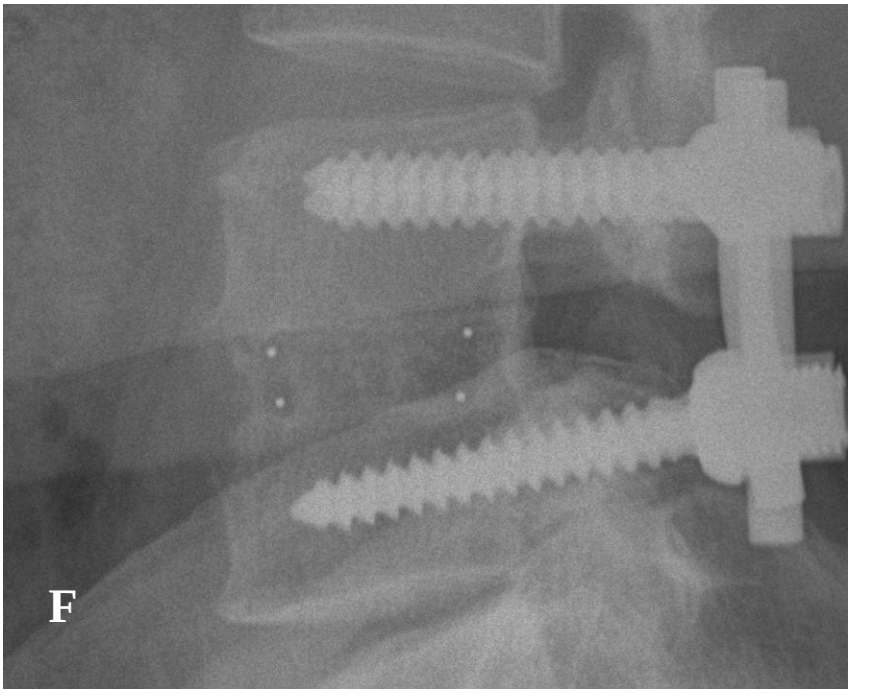
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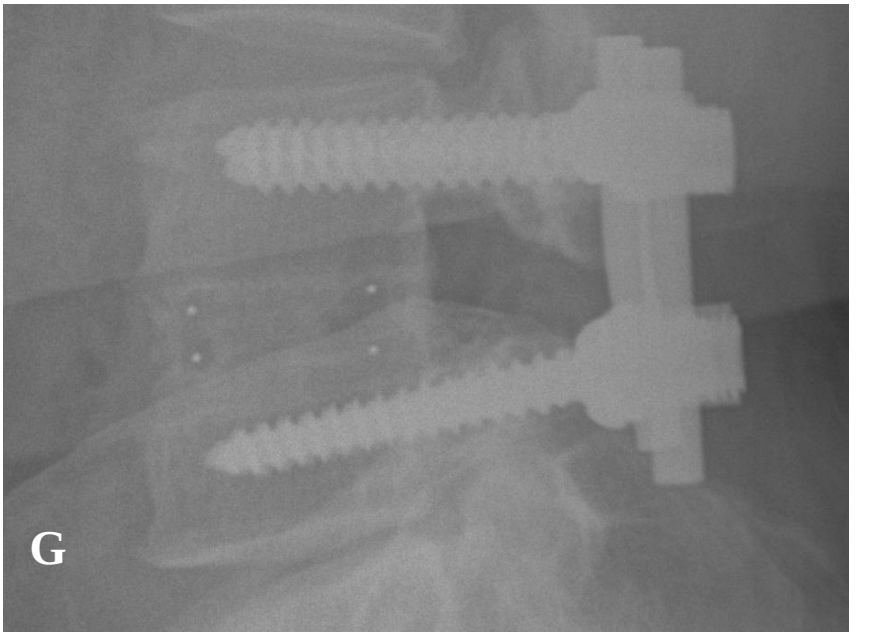
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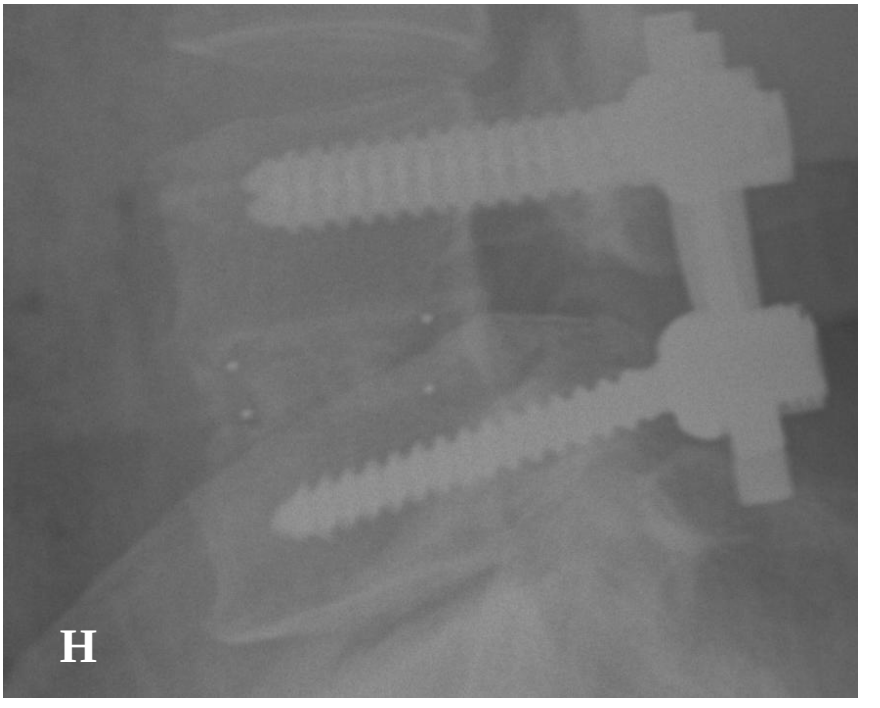
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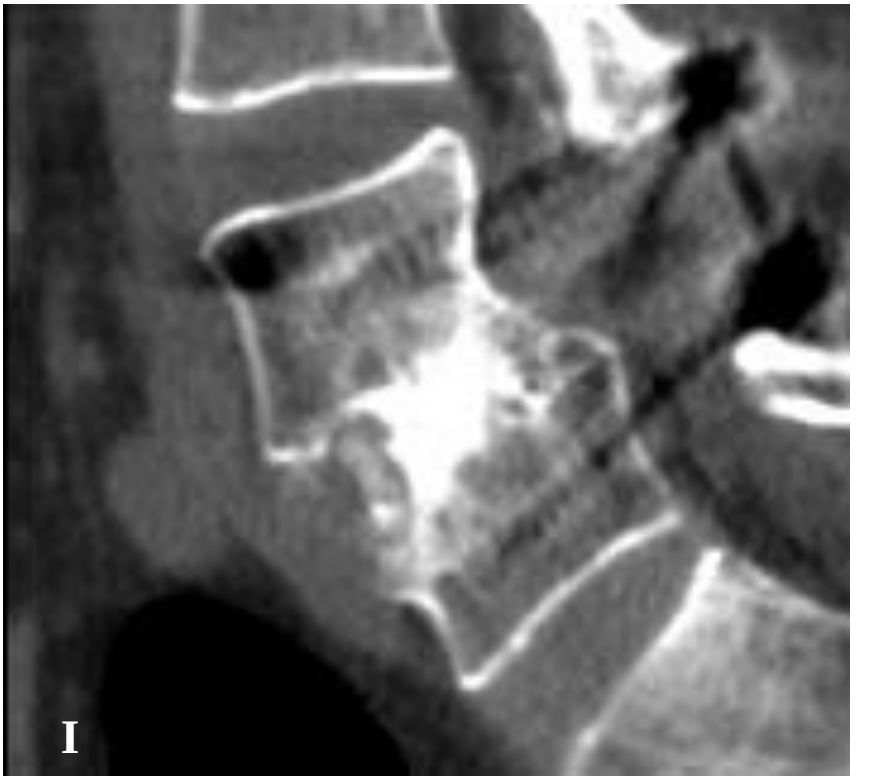

Figure 2. Criteria for bone fusion. Patients who showed more than 5 degree angulations on flexion – extension dynamic view defined as instability and non-fusion state (A, B). Traction spur (C), incomplete posterior bony bridge (D) and dark halo around the cages (E) were also defined as a non-fusion state. Patients who showed complete bony bridge without instability, traction spur and dark halo around the cages were defined as a fusion state (F, G and H). Some patients who underwent lumbar CT showed complete bone fusion state on sagittal reconstruction images (I).

II. RESULTS

1. Patients

Patients' clinical characteristics obtained according to sex, age, post-operative followed up period, operation level, smoking habit, and osteoporosis showed no significant statistical differences between 4 groups. However, pre-operative diagnostic disease showed significant differences between 4 groups ($p = 0.000$). The diagnoses were lumbar disc herniation in 88 cases (including 12 recurrent cases); degenerative spondylolisthesis in 101 cases; spondylolytic spondylolisthesis in 54 cases; and lumbar spinal canal stenosis with or without segmental instability in 54 cases. For all the patients, PLIF and pedicle screw fixation was performed only at a single level, which was L3/L4 for 24 cases (7.5%), L4/L5 for 248 cases (77.5%), and L5/S1 for 48 cases (15.0%). Number of patients with smoking habit were 33 (14.9%) in Modic type 0, 4 (12.5%) in Modic type 1, 3 (7%) in Modic type 2, and 5 (20.8%) in Modic type 3. Number of patients with osteoporosis were 65 (29.4%) in Modic type 0, 8 (25%) in Modic type 1, 11 (25.6%) in Modic type 2, and 5 (20.8%) in Modic type 3 (Table 1).

Table 1. Demographics of patient

	Modic type				
	0	**1**	**2**	**3**	**p-value**
No. of patients	221	32	43	24	
Sex (%)					
male	82(37.1)	8(25.0)	12(27.9)	10(41.7)	0.354
female	139(62.9)	24(75)	31(72.1)	14(58.3)	
Age (years)	56.1±11.1	52.5±10.1	54.47±9.6	56.3±9.3	0.296
Follow up period (months)	27.74±16.2	29.47±18.4	28.09±18.4	35.17±20.0	0.240
Operation Level(%)					0.248
L3/4	16(7.2)	2(6.2)	2(4.7)	4(16.7)	
L4/5	180(81.4)	24(75.0)	26(60.5)	18(75.0)	
L5/S1	25(11.3)	6(18.8)	15(34.9)	2(8.3)	
Disease (%)					0.000
Disc herniation	56(25.3)	7(21.9)	17(39.5)	8(33.3)	
Spondylotic stenosis	44(19.9)	3(9.4)	6(14.0)	1(4.2)	
Degenerative spondylolistheis	83(37.6)	7(21.9)	5(11.6)	6(25.0)	
Spondylolytic spondylolisthesis	38(17.2)	15(46.9)	15(34.9)	9(37.5)	
No. of smoker (%)	33(14.9)	4(12.5)	3(7.0)	5(20.8)	0.380
No. of patients with osteoporosis(%)	65(29.4)	8(25.0)	11(25.6)	5(20.8)	0.411

2. Bone fusion

For assessment of bone fusion, the overall fusion rate at 1 year or later following PLIF with posterior fixation was 86.6%, based on the bone fusion criteria. When the fusion rate was analyzed according to preoperative vertebral end plate degeneration, it was 88.7% for Modic type 0, 81.2% for patients with Modic type 1, 86.0% with Modic type 2, and 75.0% with Modic type 3. Although Modic type 3 showed lowest bone fusion rate compare to other types, there were no statistical significant differences between groups ($p = 0.220$) (Table 2). By analyzing of bone fusion rate by comparing of each Modic type to type, it showed no significant differences (Table 3). Other clinical characteristics such as patient's age, smoking habit, operation level, diagnostic disease and osteoporosis demonstrated no significant differences on bone fusion rate (Table 2 and 3). Forty-three out of 320 patients (13.4%) were classified as non-fusion at the last follow-up. Eighteen patients did not satisfied more than one fusion criteria. Most common reason for classified as a non-fusion is presence of instability (83.7%) and presence of dark halo around the cage (30.2%), incomplete bony bridge (18.6%) and presence of traction spur are followed (Table 4).

Table 2. Fusion rates after posterior lumbar interbody fusion with posterior fixation according to various parameters

	Fusion	Non-fusion	Total	p-value
No. of patient (%)	277(86.6)	43(13.4)	320	
Modic change (%)				0.220
0	196(88.7)	25(11.3)	221	
1	26(81.2)	6(18.8)	32	
2	37(86.0)	6(14.0)	43	
3	18(75.0)	6(25.0)	24	
Age (%)				0.242
over 60	107(83.6)	21(16.4)	128	
under 60	170(88.5)	22(11.5)	192	
Smoking				0.095
Yes	35(77.8)	10(22.2)	45	
No	242(88.0)	33(12.0)	275	
Osteoporosis				0.270
Yes	75(84.3)	14(15.7)	89	
No	91(88.3)	12(11.7)	103	
Level				0.966
L3/4	21(87.5)	3(12.5)	24	
L4/5	214(86.3)	34(13.7)	248	
L5/S1	42(87.5)	6(12.5)	48	
Disease				0.988
Disc herniation	76(86.4)	12(13.6)	88	
Spondylotic stenosis	46(85.2)	8(14.8)	54	
Degenerative spondylolisthesis	88(87.1)	13(12.9)	101	
Spondylolytic spondylolisthesis	67(87.0)	10(13.0)	77	

Table 3. Univariate analyses of fusion rate according to various parameters

	OR	95% CI	p-value
Age (<=60 vs. >60)	1.517	(0.796, 2.891)	0.206
Modic changes			
type 0 vs. 1	1.809	(0.679, 4.823)	0.236
type 0 vs. 2	1.128	(0.698, 1.820)	0.623
type 0 vs. 3	1.377	(0.983, 1.931)	0.063
type 1 vs. 2	0.703	(0.204, 2.423)	0.576
type 1 vs. 3	1.202	(0.633, 2.281)	0.574
type 2 vs. 3	2.056	(0.581, 7.276)	0.264
Cigarette (nonsmoking vs. smoking)	2.095	(0.216, 1.053)	0.067
BDM (no osteoporosis vs.osteoporosis)	1.416	(0.618, 3.244)	0.412

Table 4. Reasons for bony non-fusion

Fusion Criteria	
Instability	36/43(83.7%)
Halo	13/43(30.2%)
Incomplete body bridge	8/43(18.6%)
Traction spur	4/43(9.3%)

3. Clinical results

All patients in Modic type's subgroups improved significantly in all clinical assessment parameters. Mean preoperative both back and leg VAS and ODI score were 6.8, 8.2 and 45.37 and improved to last follow-up score of 2.4, 2.8 and 19.07 in Modic type 0 ($p = 0.000$). In Modic type 1, back and leg VAS and ODI score were improved from 6.5, 7.9 and 43.94 to 2.7, 2.8 and 20.19 ($p = 0.000$). In Modic type 2, back and leg VAS and ODI score were improved from 7.1, 7.5 and 4.82 to 3.2, 2.8 and 21.83 ($p = 0.05$). In Modic type 3, back and leg VAS and ODI score were improved from 6.7, 8.5 and 45.94 to 2.9, 3.0 and 20.94 ($p = 0.000$) (Fig 3 and 4). Also there were no significant differences between groups in all clinical assessment parameters.

Figure 3. Clinical outcome by Oswestry disability index (ODI). ODI were checked pre-operatively and at the time of last follow-up. All patient's ODI were improved significantly in all subgroup ($p = 0.000$) while there were no differences between Modic type's subgroup ($p = 0.899$).

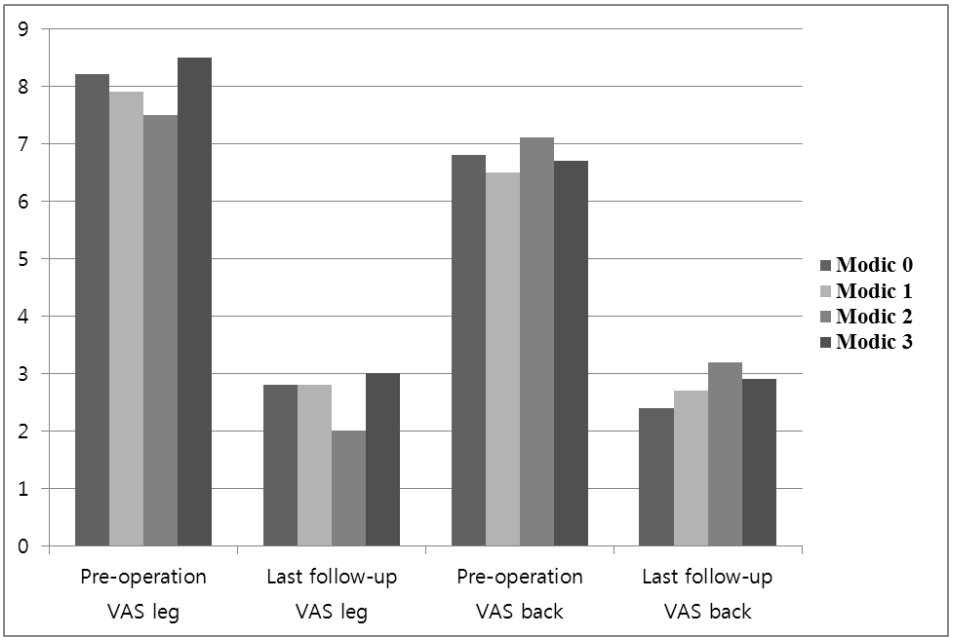

Figure 4. Visual analog scale (VAS) for both leg and back pain. It shows significant improvement in all Modic types and there were no significant differences between Modic type's subgroup pre-operatively and at the last follow-up ($p = 0.000$)

IV. DISCUSSION

The vertebral end plate changes that occur with disc degeneration have been described by Modic et al..[8] Modic type 1 is characterized by decreased signal in T1-weighted image and bright signal in T2-weighted images on lumbar spine MRI. Histopathology findings of Modic type 1 are disruption and fissuring of the endplate and vascularized fibrous tissues within the adjacent marrow. In Modic type 2, changes of fatty degeneration in the bones adjacent to the end plates are reflected by bright signal in T1-weighted and intermediate signal in T2-weighted images. Finally, Modic type 3 corresponding with advanced degeneration changes in which extensive bony sclerosis formation is made and characterized by decreased signal intensity in both T1-weighted and T2-weigthed images.[19] Modic type 3 shows sclerosis on vertebral end plate in plain film while Modic type 1 and 2 do not show sclerosis changes.

However, clinical importance of vertebral end plate changes is not extensively known. Crock et al.[22] proposed the concept of "internal disc disruption", suggesting that repeated trauma to the intervertebral disc could result in the production of chemical substances by the damaged disc tissues. Diffusion of toxic chemicals through the vertebral end plate could then result in hypersensitivity in intradiscal nerve fibers causing back pain. And also these toxic chemical substances may leak into the general circulation through the vertebral end plate vessels, producing local changes around nerve roots, causing leg pain. Later, Burke et al.[23] examined disc specimens biochemically that were

harvested during operation and detected high levels of interleukin-6 and interleukin-8. The authors hypothesized that the high level of proinflammatory mediators may indicate that a specific inflammatory form of disc degeneration exists.

Modic type 1 degenerative lesions correspond to edema of vertebral endplates and subchondral bone that could correspond to microfractures of the cancellous bone and endplate cracks accompanied by increased vascular density along with an increase in the number of nerve endings and levels of proinflammatory chemical mediators.[24, 25] These vascular and inflammatory phenomena follow the initial mechanical phenomena. There is a possibility that Modic type 1 lesions are replaced by Modic type 2 lesions, which correspond to a globally less disabling state in terms of low back pain. Intermediate stages sometimes can be seen between Modic type 1 and 2 lesions, tending to confirm the hypothesized natural history for such lesions. Modic type 3 or sclerotic stage, which is much rarer than Modic types 1 or 2, probably corresponds to a state close to natural fusion.

Toyone et al.[11] studied the patients with end plate and vertebral bone marrow changes associated with degenerative lumbar disc disease. They classified the vertebra end plate changes into Type A (low signal intensity on T1-weighted images) and Type B (high signal intensity on T1-weighted images). They found that Type A changes correlated with a greater degree of back pain and segmental hypermobility, while Type B changes were more common in patients with stable

degenerative disc disease. These are supported by Lang et al.[26] who evaluated functional fusion stability in patients who underwent arthrodesis. They noted that more patients with solid fusion showed Modic 2 changes, whereas more non-union was shown in Modic type 1 changes. They suggested that Modic type1 in patients with unstable fusions might be related to reparative granulation tissue, inflammation, edema, and hyperemic changes while Modic type 2 in solid lumbar fusions might be related to marrow composition changes resulting from decreased biomechanical stress.

Collins et al.[27] correlated Modic changes with symptomatic discs at discography, and found that low number of patients (6 of 13) showed positive discogram. However, Braithwaite et al.[9] suggested that vertebral end plate has been identified as a possible source of discogenic low back pain after provocation of pain with discogarphy on the disc associated with adjacent Modic changes. They found that Modic changes appear to be a relatively specific but insensitive sign of a painful lumbar disc in patients with discogenic low back pain. This is supported by Weishaupt et al.[10] who concluded that moderate and severe end plate abnormalities appear be useful in the prediction of painful disc degeneration in patients with symptomatic low back pain.

Buttermann et al.[28] have reported that patients with vertebral end plate degeneration on pre-operative MRI had a continuous low back pain after posterolateral fusion (PLF). They proposed that vertebral end plate degenerations are the source of low back pain and direct treatment of end plate

with anterior fusion. And also Chataigner et al.[29] suggested that anterior fusion is effective for the treatment of low back pain due to degenerative disc disease, when associated with vertebral end plate changes. Lumbar fusion in patients with severe chronic low back pain can diminish pain and decrease disability more efficiently than commonly used nonsurgical treatment through a prospective multicenter randomized controlled trial from the Swedish Lumbar Spine Study Group.[30]

Thus the establishment of solid bone fusion is the most important goal after spinal PLIF procedure. If fusion was not achieved after PLIF procedures, biomechanical stability would not maintained, and restoration of the height of the disc space cannot be achieved, causing continuous pain in patients. Numerous numbers of studies have been reported about fusion rate after spinal fusion operation. However, these studies were focused on fusion rate by different surgical approach, techniques, instruments or deformity diseases.[17, 18, 31-33] Earlier we reported on fusion rate after PLIF with standard cage alone according to Modic types.[34] It shows significantly low bone fusion rate and poor clinical outcome in Modic type compare to other types. So we suggested PLIF combined with pedicle screw fixation for better result in Modic type 3. In the current study shows overall fusion rate was 88.7%. Although Modic type 3 showed lowest fusion rate (75.0%) compare to other types (88.7% for Modic type 0, 81.2% for Modic type 1, 86.0% for Modic type2), it did not show statistical significant differences. Posterior pedicle screw fixation may imply

that increase fusion rate in Modic type 3. Since the pedicle screw fixation supply more rigid fixation and anterior compression force on anterior column and cages, the fusion may increase in Modic type 3. However, direct comparison with previous study is difficult since previous study was done much earlier period (1993 to 2000 vs. 2003 to 2008), different type of cages used (threaded fusion cage vs. carbon cage), slight different study design (single and multiple segments vs. single segment under L3/4) and shorter follow-up period (three years vs. one year). In the patient's demographic, all parameters showed no significant differences between Modic types except pre-operative diagnostic disease. But, we don't think uneven distribution of spinal diseases among the group did not affect the final fusion rate since the fusion rate analyses by the spinal disease category shows no significant differences.

There are some limitations that affect the interpretation of current study. First, all PLIF and posterior fixation procedure that are assessed in this study were performed by several physicians rather than a single physician. Even all procedure were performed using the same surgical technique, there may be differences in lumbar stability due to different skills of the surgeons or the degrees of laminectomy and facetectomy. Second, radiographic assessment was done on plain radiograph and flexion – extension dynamic view. Ideally, computerized tomography (CT) with sagittal reconstruction would provide better information about bone fusion state. However, it is difficult to exam the CT scan on real clinical experience due to increase of medical expenses. So we

had to use the proposed fusion criteria by simple radiographic studies that were reported on previous studies. In the PLIF with cages, Brantigan et al.[33] reported that comparisons of radiographic diagnosis and fusion success at exploration indicated a sensitivity of 97.1%, a positive predictive value of fusion of 94.4%, and an overall accuracy of 93%. These results indicate that the radiologic fusion interpretation as defined in this study is sufficiently accurate to be used for the assessment of fusion status. Third, only limited numbers of patient were evaluated bone densitometry (BDM) to assess pre-operative osteoporosis. Because of policy of National Health Insurance Corporation, only elderly patients over 60 years can evaluate BDM pre-operatively. Chin et al.[35] reported the prevalence of osteoporosis in patients requiring spine surgery. The author reported that one fourth to one fifth of female patients, who is under 50 years, show osteoporosis while more than half of patients showed osteoporosis in 60 years or older. In male patients also show higher incidences of osteoporosis in 60 years or older age groups. So we had to assume that patients younger than 60 years have low incidence of osteoporosis in this study. And also, in this current study imply that osteoporosis has no effect on fusion rate compare to who do not have osteoporosis. Lastly, current study is not a prospective randomized control bias but retrospective comparative study. In order to have a proper comparison and result, a prospective study and evaluation bone fusion with a CT scan are required.

V. CONCLUSION

Since vertebral end plate changes on lumbar MRI can be source of back pain and leg pain, spinal fusion of affected lumbar segment is sometime necessary. In current study was aim to analysis the fusion rate and clinical outcome according different types of Modic changes after spinal fusion procedure.

Vertebral end plate changes were shown in 91 out of 320 patients (31%). Among them, Modic type 2 degeneration was common (13.4%) and Modic type 1 and 3 were followed.

Overall fusion after PLIF with posterior pedicle screw fixation was 86.6%. Highest fusion rate was shown in Modic type 0 (88.7%) and Modic type 3 showed lowest fusion rate (75.0%). However, there were no significant differences among the Modic types. Other clinical factors such as smoking habit, patient's age and osteoporosis that may effect on bone fusion did not show significant differences in fusion rate. All groups showed significant improvement of clinical parameters after spinal fusion procedure. PLIF with cage and additional posterior pedicle screw fixation seems to improve the fusion rate in Modic type 3 compare to the prior study.

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ABSTRACT(IN KOREAN)

요추 후방 융합술 후 종판 변성에 유형에 따른 임상적 및 방사선학적 결과

<지도교수 진동규>

연세대학교 대학원 의학과

권영민

척추체 종판 변성이 만성 요통의 원인 중 하나로 제시 되어 오고 있다. 또한 케이지를 이용한 요추 후방 융합술이 퇴행성 요추 추간판 질환의 치료에 좋은 효과를 보이고 있다. 이 전 보고된 여러 논문에서는 본 논문에서는 여러 수술 방법에 따른 요추체 융합률이 보고 되어 왔으나 척추체 종판 변성 분류에 따른 융합률 보고는 아주 적은 편이다. 본 연구에서는 퇴행성 요추질환으로 요추 후방 융합술 및 후방 척추경 나사못 고정술을 시행 받은 환자를 대상으로 요추 종판 변성 유형에 따른 임상적 및 방사선학적인 결과를 비교 분석하며 임상적 결과에 미치는 영향을 분석하였다.

2003년 1월부터 2008년 12월까지 한 분절 요추 융합술을 시행 받고 12개월 이상 추적 관찰이 가능했던 환자를 대상으로 시행하였으며 총 320명의 환자가 포함되었다. 이들을 수술 전 요추 자기공명영상에서 척추체 종판 변성에 따라 4개의 군으로 분류하였다 (Modic 변성 0 - 3 군). 환자의 평균 나이는 55.6±10.7 세였으며 평균 추적 기간은

28.52±17.1 개월이었다. 환자의 나이, 흡연력, 골다공증과 같이 골 유합률에 영향을 줄 수 있는 요인도 같이 분석하였다. 임상적 결과는 10점 통증 측정 척도와 요통 기능 장애 척도를 이용하여 분석하였다.

결과적으로 전체 환자 군 골 융합률은 86.6% 이였으며 Modic 변성 0 군은 81.2%, Modic 변성 1군은 86.0%, Modic 변성 2군은 86.0% 및 Modic 변성 3군은 75.0% 융합률을 보였다. Modic 변성 3군에서 가장 낮은 융합률을 보였지만 Modic 변성 군간 골 융합률은 통계학적 유의한 차이를 보이지 않았다 ($p = 0.220$). 환자의 다른 요소들도 역시 통계학적 유의한 차이를 보이지 않았다: 나이 ($p = 0.242$), 흡연력 ($p = 0.095$), 골다공증 ($p = 0.270$), 융합 분절 ($p = 0.966$) 및 수술 전 진단명 ($p = 0.988$). 또한 모든 Modic 변성 군에서 수술 전, 후 의미 있는 임상적 호전을 보였으며 각 군간에 의미있는 차이는 없었다.

결론적으로, 후방 척추경 나사못 고정술을 병합 한 요추 후방 융합술이 각 Modic 변성 군 간의 골 융합률로 본 방사선학적인 결과과 임상적 결과에 좋은 효과를 보였다.

핵심되는 말 : 척추체 종판 변성, 퇴행성 요추 추간판 질환, 요추 후방 융합술, 골 융합률