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Clinical Results of Posterior Lumbar Interbody Fusion Using Titanium Intervertebral Spacers in Elderly Patients over 70 Years

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Study Design: Retrospective study. **Objective**: To report the clinical and radiological results of posterior lumbar interbody fusion (PLIF) using titanium intervertebral spacers in elderly patients over 70 years. **Summary of Background Data**: PLIF with intervertebral spacers has been introduced to treat degenerative lumbar disorders. However, in the elderly patients, it is concerned that there are several possible complications that can be associated with the use of interbody support in anterior column reconstruction under weak bone quality. There were few reports about the results of PLIF using titanium intervertebral spacers in elderly patients. **Methods**: Twenty-six patients with mean age of 73 years (range, 70-78) underwent one or two-level PLIF using titanium intervertebral blocks combined with posterior instrumentation, with minimum 2-year follow-up (average 49 months; range, 25-88). Radiographic and clinical outcomes analysis was performed. **Results**: The sagittal alignment (regional lordosis) of the operative segments averaged 7.4° before surgery, 12.7° at discharge, 11.1° post-op 1-year, and 11.8° at the final follow-up. The percentage of posterior disc height was 14.1% before surgery, and was significantly improved after the surgery to 26.9% at discharge and 21.8% at the final follow-up. In 18 patients with spondylolisthesis, the percentage of slip averaged 18.9% before surgery, and was significantly improved after the surgery to 6.8% at discharge and maintained until the final follow-up. All patients had radiographic fusion at the follow-up. The average JOA score was 12.6 points before surgery, and increased significantly to 23.1 points at the final follow-up. **Conclusion**: Posterior lumbar interbody fusion using titanium spacers is valuable even in the elderly patients. The preservation of bony endplate of vertebral body, and the insertion of spacers as antero-lateraly as possible in the intervertebral space, are important for successful fusion. (Kitakanto Med J 2009；59： 1～7)

Key Words： posterior lumbar interbody fusion, elderly patient, intervertebral spacer

Introduction

Posterior lumbar interbody fusion (PLIF), popularized by Cloward,[1,2] has the potential mechanical advantage of allowing restoration of disc space height, sagittal alignment, and weight bearing through the anterior column. Recently, good results have been reported with the interbody fusion using various interbody cages or spacers combined with posterior instrumentation.[3−5] Even in elderly patients, PLIF is popular for the treatment of lumbar degenerative disorders with segmental instability.

However, along with the intrinsic benefits associated with the use of interbody support, there are several possible complications that can be associated with the use of interbody support in anterior column reconstruction under weak bone quality. One of the most common complications is subsidence of the inter-

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body support into the bony anatomy of the vertebral body, which can lead to segmental kyphosis, loss of anterior column support, pseudarthrosis, progressive deformity, and failure of posterior instrumentation. There are few reports of PLIF with interbody spacers in elderly patients.

We have used titanium spacers, PROSPACE PLIF System (Aesculap, Tuttlingen, Germany), since 2000 in elderly patients. The purpose of this sturdy was to report the clinical and radiological results of PLIF using PROSPACE PLIF System in elderly patients over 70 years.

Materials & methods

Demographics

Twenty-six elderly patients over 70 years underwent one or two-level PLIF using titanium/Plasmapore intervertebral blocks (PROSPACE) from December 2000 to March 2006 in our center, with minimum 2-year follow-up. Eleven male and 15 female patients were included, ranging in age at surgery from 70 to 78 years (mean 73±2.7). All patients had low back pain and/or leg pain with neurologic deficits. Mean postoperative follow-up was 49±15 months (range 25 to 88 months).

The spinal pathologies were degenerative spondylolisthesis in 18 patients, degenerative lumbar scoliosis (DLS) in 5, and lumbar spinal canal stenosis (LSS) with instability in 3 patients. Single-level was fixed in 23 patients and 2 levels were fixed in 3 patients. The involved level was L3-4 in 8 patients, and L4-5 in 21. In 3 cases, a posterolateral fusion (PLF) was performed adjacent to the PLIF level. The local ethics committee approved the study (Harunaso, 5989 Nakamuroda, , Takasaki, Gunma, Japan), and each individual participating in the study gave informed consent.

Surgical Method for PLIF

Laminotomy and medial or total facetectomy were performed providing wide exposure and clear visualization of the disc, nerve root, and dural sac. The entire nucleus must be removed along with the cartilage from each vertebral endplate and any degenerative annulus. After the subtotal discectomy with cartilaginous endplate removal without disturbing bony endplate using small Cobb elevator, moderate disc distraction and annular tension were obtained by inserting an intervertebral spreader. Reduction of spondylolisthesis was obtained by ligamentotaxis : The tension of anterior longitudinal ligament and annulus fibrosus with spreading intervertebral space reduced the slippage between the vertebral bodies. We did not lord distraction force to the pedicle screws, because this procedure has a high risk to loosen the screws in fragile vertebral body.

Cancellous bone chips from iliac bone were packed into the anterior part of the intervertebral space. A couple of titanium intervertebral spacers were placed as antero-lateraly as possible, and autologous cortico-cancellous bone block and cancellous bone chips were packed between the spacers. ISOLA pedicle screw system (Depuy Spine Inc. Raynham, MA) was used in 20 patients, and S4 pedicle screw system (Aesculap) in 6 patients, for posterior reinforcement.

Postoperative Care

At 3-7 days after the operation all patients were mobilized with a soft lumbar corset. Patients were then instructed in a progressive walking program and were kept in the corsets for 8 to 12 weeks.

Clinical Evaluation

Clinical outcomes were evaluated according to the scoring system of the Japanese Orthopedic Association (JOA score) based on a total of 29 points, before surgery and at the final follow-up. JOA scores evaluate low back pain, leg pain, walking distance, straight leg raising, sensory deficit, motor deficit, activities of daily living, and urological symptoms (Table 1). Clinical recovery rate, which indicates the degree of normalization after surgery, was calculated using the following formula :

Recovery rate = [(postoperative score−preoperative score)/(29−preoperative score)]×100 (%).

Radiographic Evaluation

The regional segmental lordosis and the percentage of posterior disc height were measured at the operated segment in the neutral position on standing lateral films, before surgery, at discharge, post-op 1-year and at the final follow-up. The percentage of slip was also measured in 18 spondylolisthesis cases (Fig. 1). These parameters are important values to evaluate the grade of sagittal and vertical reduction at the fusion site.

Fusion status was recorded for each surgically treated segment at each follow-up. The operating segment was considered to be fused if there was radiographic evidence of bone bridging between the vertebral bodies with no lucency around PROSPACE in CT reconstruction.

Statistical Analysis

One-way ANOVA with Dunnett's t-test was used to compare the measurements on radiograph obtained at each follow-up. The clinical scores were statisti-

Table 1 Assessment of Treatment of Low Back Pain (Japanese Orthopaedic Association)

	Score
Ⅰ. Subjective symptoms (9 points)	
Low back pain	
None	3
Occasional mild	2
Frequent mild or occasional severe	1
Frequent or continuous severe	0
Leg pain/tingling	
None	3
Occasional mild	2
Frequent mild or occasional severe	1
Frequent or continuous severe	0
Gait	
Normal	3
＞500m, even muscle weakness	2
＜500m, due to leg pain, tingling, and/or muscle weakness	1
＜100m, due to same above	0
Ⅱ. Objective findings (6 points)	
Straight leg raising test (including tight hamstrings)	
Normal	2
30–70°	1
＜30°	0
Sensory disturbance	
None	2
Slight disturbance	1
Marked disturbance	0
Motor disturbance (manual muscle test)	
Normal (grade 5)	2
Slight weakness (grade 4)	1
Marked weakness (grade 0–3)	0

Ⅲ. Restriction of activities of daily living (ADL) (14 points)

	Normal	Slightly Restricted	Severely Restricted
Turn over while lying	2	1	0
Standing	2	1	0
Washing	2	1	0
Leaning forward	2	1	0
Sitting (about 1 hr)	2	1	0
Lifting heavy objects	2	1	0
Walking	2	1	0

Ⅳ. Urinary bladder function (−6–0 points)	
Normal	0
Mild dysuria	−3
Severe dysuria	−6
Total score	29 points

cally analyzed by Wilcoxon signed-rank test between the evaluations before surgery and at final follow-up. A P value of <0.05 was considered to be significant.

Results

Clinical Outcomes

The JOA scores before surgery were 12.6 ± 5.1 (mean$\pm$SD) points and increased to 23.1 ± 3.8 points at the final follow-up ($P<0.001$). Finally, the postoperative recovery rate was $61.2\pm26.8\%$ on average. The rate in 3 cases of two-level PLIF was 35.9% on average, and showed it was lower than one-level cases. According to the pathologies, the rates were 68.2%, 49.1%, and 40.3% on average in spondylolisthesis, DLS, and LSS, and the two latter pathologies showed to be lower than the former. There was no significant difference in the recovery rate between two kinds of posterior instruments and fusion level.

One patient experienced transient ankle dorsiflexor weakness after surgery. One patient had inveterate

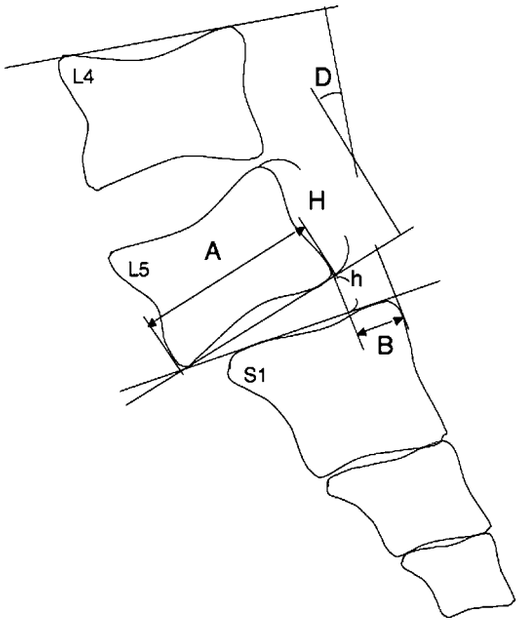

Fig. 1 Measurements on radiograph.
Percentage (%) of slip (B/A×100); Percentage (%) of posterior disc height (h/H×100); D: regional segmental lordosis (degrees).

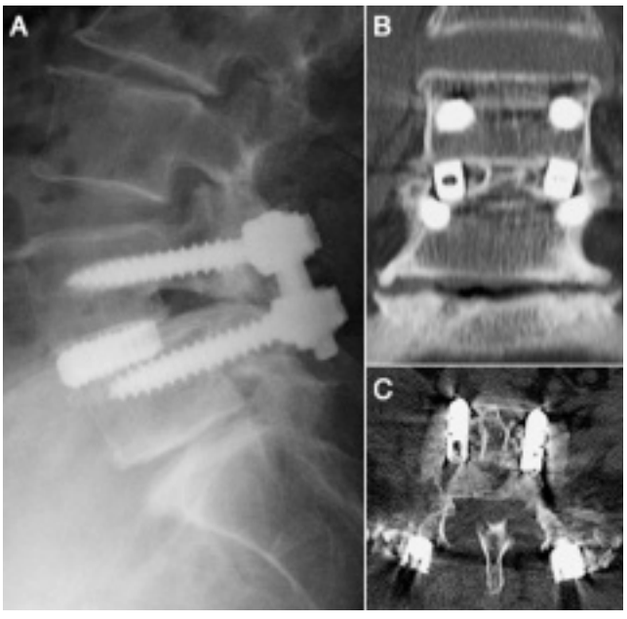

Fig. 2 A case of 76-year-old woman with L4 spondylolisthesis.
A, Post-op lateral radiograph of the lumbar spine at follow-up. The slip was reduced and the disc space height was improved.
B, Coronal reconstruction of CT scan. The union of intervertebral grafted bone could be confirmed.
C, Axial view on CT scan. Titanium intervertebral spacers were placed antero-lateraly.

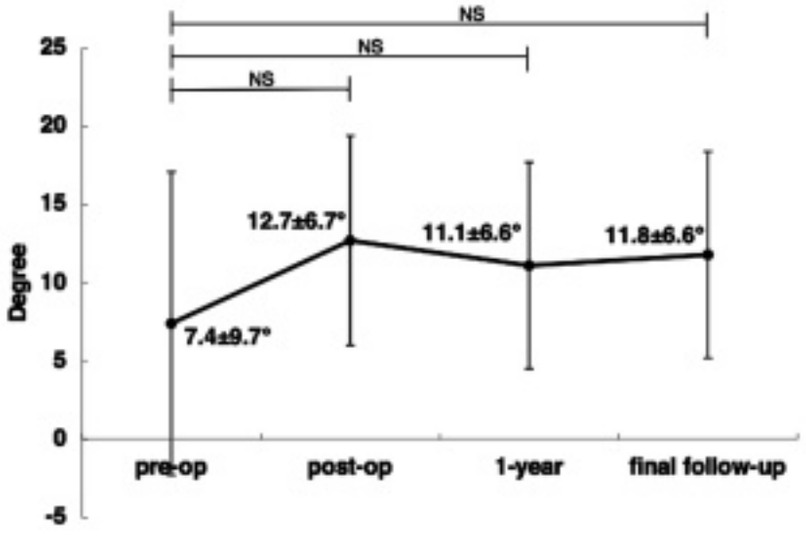

Fig. 3 Change of the regional segmental lordosis angle. (n=29)
There was no statistical difference between each measurement period.

low back dullness at follow-up. In one patient, the pain of the lower extremity persisted but decreased after the surgery. Additional surgery was required in one patient for adjacent segment disc herniation.

Radiologic Results

All patients had radiographic fusion at the follow-up (Fig. 2). There was no statistical difference in the angle of the regional segmental lordosis of the operative segments between each measurement period (Fig. 3).

The percentage of posterior disc height was significantly improved after the surgery at discharge, and was maintained until the final follow-up (Fig. 4). Three cases with injured bony endplate at the operation showed decreased more than 10% in the percentage of posterior disc height at follow-up, with marked vertical migration of the spacers into the vertebral body (Fig.

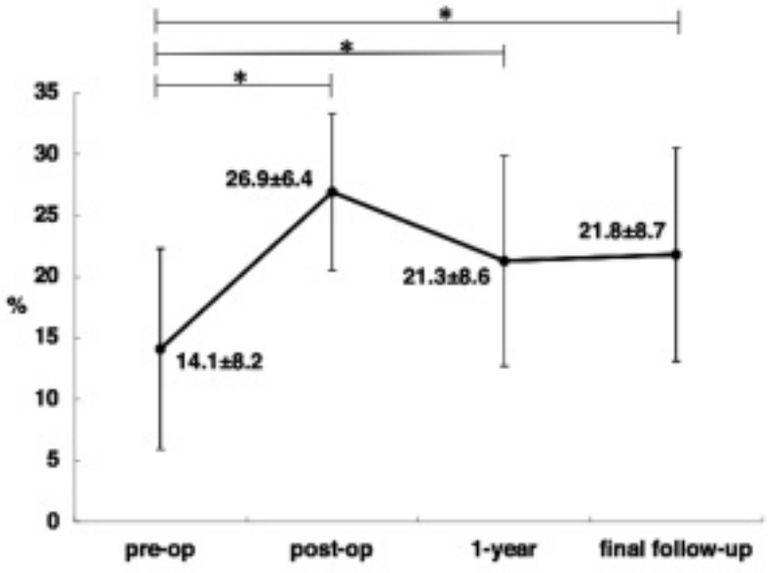

Fig. 4 Change of the percentage of posterior disc height. (n=29)
The percentage was significantly improved after the surgery at discharge (post-op), and was maintained until the final follow-up (* : $P<0.05$).

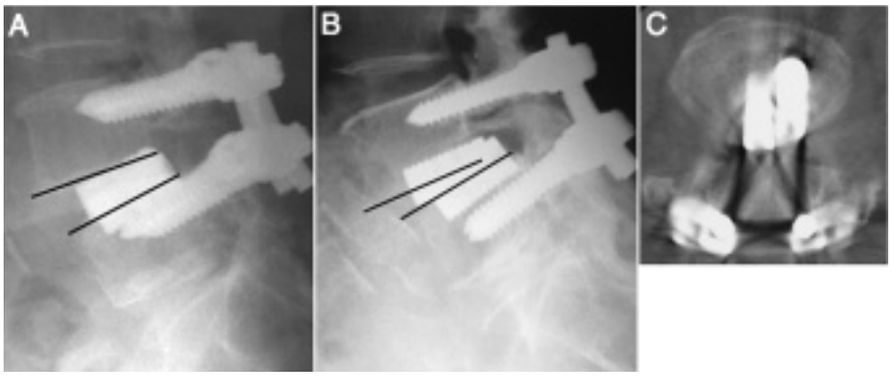

Fig. 5 A 72-year-old woman with L4 spondylolisthesis : A case with injured bony endplate. The lower bony endplate of L4 was injured during the surgery.
A, Post-op lateral radiograph. The slip was reduced and the disc space height was improved.
B, At follow-up. Subsidence of intervertebral spacers into L4 body was shown. The slip of L4 body was increased with remarkable loss of disc space height.
C, Axial view of CT scan. Intervertebral spacers have moved postero-medialy.

5). No case with intact bony endplate developed into subsidence of the spacers.

In 18 patients with spondylolisthesis at one or two level, the percentage of slip was significantly improved after the surgery, and was maintained until the final follow-up (Fig. 6).

Discussion

We performed PLIF on the cases of sever instability, unstable spondylolisthesis, foraminal compression requiring restoration of disc space height and coronary realignment for segmental scoliosis. In young patients, we performed PLIF using autologous cortico-cancellous bone graft, and in elderly patients, we used PROSPACE together with autologous bone as the props of intervertebral space.

However, there are few reports of PLIF with intervertebral spacers in elderly patients. It is considered that one of the reasons is the risk of several possible complications. One of the most common complications is subsidence of the intervertebral spacers into the vertebral body. In elderly patients, the risk of subsidence is supposed higher than in young patients presumably due to their bone fragility.

Cvijanovic et al reported the region-dependent changes that occur with aging in trabecular and cortical bone of the human vertebral body.6 Their conclusions were as follows : 1) In humans, the strength and stability of vertebral bodies are maintained until about age 50 years. 2) Progressive deterioration in verte-

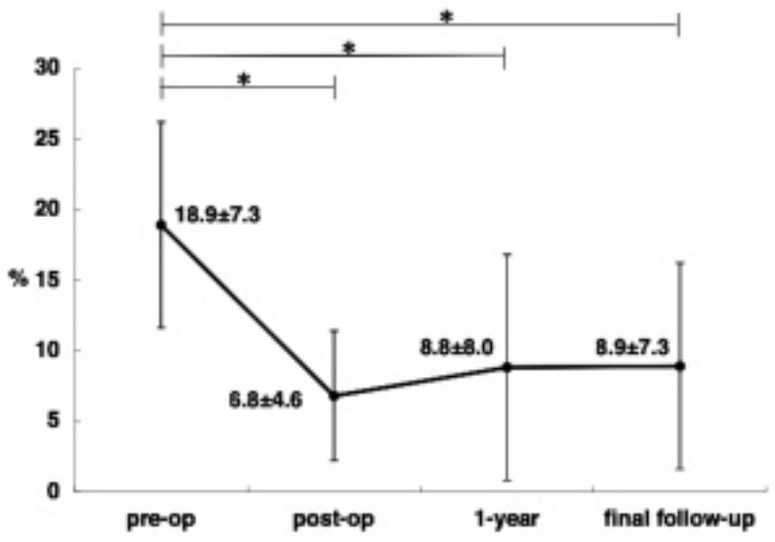

Fig. 6 Change of the percentage of slip in spondylolisthesis cases. (n=18)
The percentage was significantly improved after the surgery at discharge, and was maintained until the final follow-up (* : $P<0.05$).

bral bone begins at about age 50. 3) Trabecular bone architecture is maintained longer in the lateral *versus* the central vertebral regions. 4) Between about ages 61 to 70 cortical bone becomes thicker in lateral regions.

Lowe et al reported a biomechanical study of regional endplate strength to compressive load.[7] Data from their study suggested that the best endplate region to place structural interbody support is the posterolateral, lateral position, and additionally the anterolateral position in the lumbar spine.

Shao et al reported the radiographic changes occurring in the lumbar intervertebral discs and lumbar vertebrae with age.[8] They measured the concavity index of vertebrae, that was established for each vertebral body by dividing the central vertebral height by the anterior vertebral height. This index decreased linearly with increasing age. Their report suggests that the intervertebral spacers should be placed anteriorly on the large concave lumbar vertebrae of the elderly patient to obtain adequate lordosis. We tried to insert the spacers into the disc space as anterolateraly, and considered that the above-mentioned reports supported our surgical intention.

Oxland et al reported the results of a biomechanical investigation using indentation tests in human cadaveric lumbar vertebrae, and noted that the removal of the vertebral endplate significantly reduced the local strength and stiffness magnitudes in the lower lumbar vertebral bodies.[9] We used small Cobb elevator to strip off and tried to remove of the cartilaginous endplate with discretion so as not to injure the bony endplate.

Unfortunately three cases in this study with injured bony endplate at the operation showed decreased the percentage of posterior disc height at follow-up, with marked vertical migration of the spacers into the vertebral body. In addition no case with intact bony endplate developed into subsidence of the spacers. These data suggest that the preservation of bony endplate of vertebral body is important to maintain the disc space height after surgery.

Bronsard et al described three-column spinal fusion using PROSPACE. From a biomechanical point of view, fusion across the posterior spinal facet joints (zygopophyseal joints) is a logical choice and perhaps an efficient solution because it makes use of the lumbar spine (the two posterior columns, according to Louis' classification).[10] However, in the case of degenerative spondylolisthesis with ventral subluxation of inferior facets, narrow neuroforamen, and facet joint osteoarthritis, total facetectomy is generally indicated. In that case, the anterior column is the sole pillar, and the wide contact surface of the intervertebral spacers and bone graft is necessary for sharing the compressive axial load, especially in elderly patients. This is the main reason why we chose PROSPACE as a spacer even in the elderly patients. In our concept, we use PROSPACE as a prop to maintain the intervertebral distance with wide contact surface, and bony union should be obtained by grafted bone around the spacers.

In this sturdy the JOA scores were significantly improved after the surgery at the final follow-up, and the post-operative recovery rate was 61.2% on average. Our recovery rate of elderly patients is lower than other

reports of PLIF cases in younger patients (Hashimoto, et al : 83.1% in the mean age of 44 years, Kai, et al : 76.0% in the average 53.2 years).[11,12] Nakayama et al reported about surgical treatment for lumbar canal stenosis in elderly patients over 70 years (55 cases), and the mean recovery rate was 36%.[13] Konishi reported about posterolateral lumbar fusion for lumbar canal stenosis in elderly patients over 70 years (42 cases) with the mean recovery rate of 46.6%.[14] The recovery rate in our sturdy is higher than these in their reports.

Conclusion

Posterior lumbar interbody fusion using titanium spacers is valuable even in the elderly patients. We suggest that the preservation of bony endplate of vertebral body, and the insertion of spacers as anterolateraly as possible in the intervertebral space, are important for successful fusion with the maintenance of disc space height, slip correction and adequate fusion alignment.

Declaration of interest : The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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