Treatment Outcome of Transforaminal Lumbar Interbody Fusion (TLIF) Using Unilateral Pedicle Screw Fixation for Lumbar Foraminal Stenosis

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Abstract: Transforaminal lumbar interbody fusion (TLIF) for both anterior/posterior and superior/inferior decompression of foramina can be indicated. The purpose of this study was to examine the outcome of unilateral TLIF and pedicle screw (PS) fixation for lumbar foraminal stenosis. The subjects were 24 consecutive patients who underwent monosegmental fusion for lumbar foraminal stenosis; there were 14 men and 10 women. All subjects underwent fusion at L5-S for unilateral L5 radiculopathy. A titanium cage was used in 10 subjects (titanium group) and a carbon or polyetheretherketone (PEEK) cage was used in 14 subjects (carbon/PEEK group). Clinical conditions and radiological findings were examined pre- and postoperatively, and at the final follow-up. The mean Roland and Morris Disability index improved from 8.5 preoperatively to 3.8 points. Excellent and good patient satisfaction was obtained in 2/3 of the patients. The mean disc height was increased by 2.0 mm immediately after surgery and by 1.1 mm at the final follow-up compared with the height before surgery. Subsidence of the cage of more than 3.0 mm was observed in 60% patients of the titanium group and in 14% patients of the carbon/PEEK group (P < 0.05). Unilateral TLIF and PS fixation was demonstrated to be less invasive for paravertebral muscles with a lower incidence of adjacent lumbar foraminal stenosis, resulting in a good outcome. Although there was no significant difference in clinical outcomes, subsidence of the cage was 4-fold higher in the titanium cage group than in patients receiving the carbon/PEEK cages. These findings indicate that unilateral TLIF and PS fixation are useful procedures.

Key words: unilateral TLIF, titanium cage, PEEK cage

Introduction

Lumbar foraminal stenosis often accompanies a marked decrease in disc height. For such a condition, transforaminal lumbar interbody fusion (TLIF) is often indicated when anterior/posterior and superior/inferior decompression of the foramina is possible1). In recent years, various interbody fusion cages have been developed, thereby increasing the potential success and
reliability of TLIF\textsuperscript{2,3}, although concern remains regarding issues such as cage subsidence\textsuperscript{4-6} and retropulsion in cases with fragile vertebral bodies (recipient beds), including in elderly patients.

Polyetheretherketone (PEEK) has gained attention as a medical implant material which has excellent biocompatibility. The characteristics of PEEK include high strength, rigidity, and durability, with a modulus of elasticity similar to that of cancellous bone. The difference in strain magnitude is also less between cortical bone and a PEEK cage compared with the difference between cortical bone and titanium alloy; in general, PEEK cages are considered to be not as prone to subsidence\textsuperscript{7}. The purpose of our study was to examine, by cage type, the outcome of unilateral TLIF using pedicle screw (PS) fixation to treat lumbar foraminal stenosis.

**Materials and methods**

The subjects were 24 consecutive patients who underwent monosegmental fusion for lumbar foraminal stenosis from April 2006. These patients comprised 14 men and 10 women (age range: 42–82 years; mean age: 64.8 years). All subjects underwent fusion of L5-S for L5 radiculopathy. Screws were used for unilateral fusion in all subjects and one cage was used per subject. There were no bilateral cases. Twenty subjects had an S1 pedicle screw that perforated through the anterior sacral cortex. A titanium cage was used in 10 subjects (titanium group, mean age: 63.8 years) and a non-titanium cage was used in 14 subjects (carbon / PEEK group, mean age: 65.7 years). One day after surgery, the patients received after-treatment care consisting of ambulation while wearing a support. The mean postoperative follow-up period was 2 years, 6 months (range: 6 months-4 years) in the titanium group and 2 years, 5 months (range: 6 months-3.8 years) in the carbon / PEEK group. Clinical conditions and radiographic findings were examined pre- and postoperatively, and at the final follow-up. Changes in disc height were compared statistically between the groups using an unpaired t-test. A \( P \)-value less than 0.05 was considered statistically significant.

**Results**

Lower leg pain was evaluated using a visual analogue scale (VAS; 0–100 mm). The VAS score improved from preoperative 58 mm (47–78 mm) to postoperative 24 mm (range: 0–58 mm) in the titanium group and from preoperative 52 mm (47–78 mm) to postoperative 27 mm (0–48 mm) in the carbon / PEEK group. There was no difference between the cages. The mean Roland and Morris Disability Score improved from 8.5 preoperatively to 3.8 points postoperatively (maximum of 24 points). There was no subject who had complications or who required reoperation. Radiographs showed instability of the fused segments at the final follow-up (no changes in the L5-S1 angle in radiographs in standing flexion and extension). The mean disc height increased 2.0 mm soon after surgery and 1.1 mm at the final follow-up compared with the height before surgery. The disc heights were compared between subjects with titanium cages and those with carbon / PEEK cages. In the carbon / PEEK group, the mean disc height increased 2.1 mm soon after surgery and 1.7 mm at the final follow-up compared with the height before surgery, indicating relatively well-maintained height. In the titanium group, the mean disc height
increased 1.9 mm and 0.8 mm, respectively, indicating reduced height and a tendency for subsidence (Fig. 1, 2, 3).

**Discussion**

A spinal PEEK cage has been commercially available in Japan since September 2009, showing
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A modulus of elasticity lower than that of cortical bone and similar to that of cancellous bone. Vadapalli et al\(^7\) reported that PEEK cages provided stability similar to that of titanium cages with posterior instrumentation, with less stress on the vertebral endplates adjacent to the PEEK cages.

In our study, the incidence of postoperative subsidence was approximately four times higher in the titanium group than in the carbon / PEEK group; however, there was no demonstrated correlation with the clinical data. One possible reason for this is that the disc height was higher compared to that in the preoperative state even in the titanium group. It is also possible that decompression occurred in the inferior nerve root by removal of the disc or osteophyte alone, enabling fusion to be achieved at that position.

Our results suggest that carbon / PEEK cages should be selected for lumbar foraminal stenosis from the viewpoint of superior / inferior foraminal decompression. In particular, these procedures...
would be useful when unilateral TLIF and PS fixation are used in patients with small preoperative segmental instability and a marked decrease in disc height on the symptomatic side. In our study, there was significant cage subsidence of at least 3 mm in 6 of 10 subjects in the titanium group and in 2 of 14 subjects in the PEEK group. The preoperative disc height was 70 mm in the group without subsidence and 5.6 mm in the group with subsidence. Thus, the preoperative disc height tended to be lower in the latter group. The postoperative increase in disc height was 1.4 mm in the group without subsidence and 2.5 mm in the group with subsidence, indicating a large increase soon after surgery in the latter group (Fig. 4).

In conclusion,
1. Twenty-four consecutive patients underwent unilateral TLIF and PS fixation for lumbar foraminal stenosis.
2. The incidence of cage subsidence in the titanium cage group was approximately four times higher than that in the carbon/PEEK cage group.
3. The incidence of cage subsidence was high in subjects with low preoperative disc height and greatly increased postoperative disc height.
4. There was no difference in treatment outcome by cage type, and good results were obtained.

Conflict of interest disclosure
The authors have no conflict of interest to declare.

References
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[Received March 25, 2016: Accepted April 19, 2016.]