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Clinical Study

Fusion rates of a morselized local bone graft in polyetheretherketone cages in posterior lumbar interbody fusion by quantitative analysis using consecutive three-dimensional computed tomography scans

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Abstract

BACKGROUND CONTEXT: Posterior lumbar interbody fusion (PLIF) using harvested local bone inserted into a polyetheretherketone (PEEK) cage is a commonly used procedure, but the accurate fusion rate of a cage, cage to bone contact area ratio, and the changes in fusion rate with time after surgery are unknown.

PURPOSE: The aim was to conduct a quantitative analysis of the fusion rates and the cage to bone contact area ratios at each period of time using a PEEK cage in PLIF using a consecutive three-dimensional (3D) computed tomography (CT) scan.

STUDY DESIGN: This was a prospective study using a consecutive 3D thin-section CT scan.

PATIENT SAMPLE: Thirty patients aged between 37 and 73 years set to undergo elective PLIF with PEEK cages and pedicle screw fixation were included in the study.

OUTCOME MEASURES: The assessments included the Korean Oswestry Disability Index (K-ODI), Short Form (SF)-36 questionnaire, Visual Analog Scale (VAS) pain score, and dynamic plane radiographs, preoperatively and at 6 and 12 months after surgery.

METHODS: Three-dimensional CT scans were performed at 6 and 12 months after surgery. Three-dimensional CT assessments of the following were performed: fusion rate of the cage, cage to bone contact area ratio, and fusion rate of the interbody bone graft besides the cage.

RESULTS: The 6-month fusion rate of the segment was 86.7%, which increased to 90.0% at 12 months. The fusion area ratio between the cage area and end plate showed a significant increase from 52.0% at 6 months to 58.5% at 12 months. Regarding the fusion area ratio between the cage and end plate, the ratio between the lower surface of the cage was significantly higher than that of the upper surface. In addition, the K-ODI, SF-36, and VAS values were similar at 6 and 12 months after surgery.

CONCLUSIONS: The fusion rate of the PEEK cage used in PLIF measured at 12 months was higher than that measured at 6 months. Therefore, an assessment on the complete fusion of local bone at 12 months after surgery is more accurate.

Keywords: Posterior lumbar interbody fusion; PEEK cage; Fusion rate; Computed tomography; Localized bone

FDA device/drug status: not applicable.

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EVIDENCE & METHODS

Context
The use of local bone graft in posterior interbody fusion has been demonstrated to be equivalent to iliac crest bone in randomized clinical trials. The use of rhBMP-2 in this setting has been associated with osteolysis, cage migration, and ectopic bone growth into the spinal canal and foramen.

Contribution
The authors have provided a case series of patients treated with interbody fusion using PEEK cages filled with locally harvested autograft. Evaluation of the fusion using dynamic lumbar radiographs and fine-cut computed tomography (CT) revealed fusion rates of 87% at 6 months and 90% at 12 months following surgery. Reliability of fusion assessment was higher with thin-cut CT than with plain films. Patients had clinically relevant and statistically significant improvements in pain and functional outcome.

Implication
This paper provides level IV evidence (case series) that the use of locally harvested autograft inside a PEEK cage is associated with high fusion rates and improvement in pain and functional outcomes, confirming reports from randomized clinical trials. It provides further evidence supporting the superior reliability of fine-cut CT for determining fusion status as opposed to plain radiographs.

—The Editors

Introduction

Posterior fixation using pedicle screws and interbody fusion using a cage is performed widely as a surgical treatment for degenerative spinal disorder owing to its high fusion rate and biomechanical advantages. Many types of cages are used as interbody fusion devices. Polyetheretherketone (PEEK) is a polymer that is biomechanically similar to cortical bone. In addition, it is radiolucent and easy to manufacture to the desired size and shape. A range of fusion rates for posterior lumbar interbody fusion (PLIF) using a PEEK cage have been reported [1,2]. Although some authors claim that there are no interrelationships between the level of fusion and the clinical results [3–6], instability caused by nonunion is an important factor behind the degradation of the condition and the need for revision surgery [7–10]. Therefore, determining the success of fusion after surgery is clinically important. In most studies, fusion is defined as the absence or near absence of motion in flexion-extension radiography [11]. Improvements in computed tomography (CT) have led to increased accuracy in evaluating fusion [12]. Recently, thin-section multidetector-row CT, which determines the extent of ossification by imaging the sagittal and coronal planes in high definition, is being used increasingly to evaluate interbody fusion [12–15] and is becoming the best method for determining fusion [11,16–18]. There are two methods for determining the success of fusion: ''sentinel signs'' [19] and ''posterior sentinel signs'' [20]. Sentinel signs are basically the formation of bone on the cage between vertebrae. Some authors claim that such signs are a simple indication of the generation of bone fragments and not necessarily evidence of the fusion of vertebrae [17]. In addition, the fusion area between the cage and end plate is important for determining the solidity of fusion, as well as for determining fusion itself [21]. In addition, the fusion segment becomes more stable with increasing fusion area, which is beneficial mechanically to load transmission, even with the segment determined to have fused. However, there are no precise standards for determining the success of fusion. Compared with fusion performed by an autogenous cancellous bone, fusion by a localized autograft acquired from surgery is anticipated to be relatively slower. In addition, there are no methods for determining the level of fusion to achieve the final fusion rate. This study compared the radiographic perspectives for determining the success of fusion after performing three-dimensional (3D) thin-section CT and simple radiography prospectively at 6 and 12 months after surgery. In addition, the fusion area between the cage and end plate was quantified using 3D CT to determine if there was any increase in fusion rate between 6 and 12 months after surgery and to compare the level of fusion.

Materials and methods

Between June 2006 and December 2007, 30 patients (49 segments) with severe spinal stenosis or Grade 1 or Grade 2 spondylolisthesis, who underwent wide decompression and one- or two-level PLIF using PEEK OIC (Stryker Spine, NJ, USA) filled with excised laminar and facet joint bone with additional pedicle screw fixation, were enrolled prospectively. This study was approved by the institutional review board of our hospital. The inclusion criteria were one- and two-level PLIF with pedicle screw fixation and a PEEK cage. The exclusion criteria were pregnancy, malignancy, infection, abnormal laboratory findings, a liver function abnormality, or metabolic bone disease contraindicating spinal instrumentation or with the potential to inhibit osteogenesis. Thirty patients (49 segments), who initially agreed to participate in this prospective study, completed the study using a PEEK cage. A 4° PEEK cage was inserted into all patients with monoaxial pedicle screw fixation. Three, 6, and 12 months after surgery, the Korean Oswestry Disability Index (K-ODI) and Visual Analog Scale (VAS) were performed to determine the level of pain. At 6 and 12 months after surgery, lumbosacral standing anteroposterior, lateral, lateral flexion, and lateral extension radiographs were taken and analyzed twice by two orthopedic surgeons. Both surgeons determined the presence of