Posterior lumbar interbody fusion using spinous process and laminae


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Posterior lumbar interbody fusion (PLIF) is indicated for many patients with pain and/or instability of the lumbar spine. We performed 36 PLIF procedures using the patient’s lumbar spinous process and laminae, which were inserted as a bone graft between two vertebral bodies without using a cage. The mean lumbar lordosis and mean disc height to vertebral body ratio were restored and preserved after surgery. There were no serious complications. These results suggest that this procedure is safe and effective.

Lumbar interbody fusion is indicated for patients with pain and/or instability and has traditionally included posterior decompression, including laminectomy or partial facetectomies and foraminotomies, with or without discectomy. Secondary indications include patients with recurrent disc herniation, where extensive removal of bone has been necessary for exposure of the disc in those with lateral or massive disc herniations, failed lumbar fusion or discogenic low back pain. However, the cause of spinal pain remains incompletely understood, and the surgical treatment of such conditions remains controversial. The cause of spinal pain is often referred to as ‘lumbar segmental instability’, which can be due to degenerative discs or facet joint syndrome, particularly when there are no signs of increased movement or of a spondylolisthesis. Biochemical mediators have been implicated in low back pain. In addition, the symptoms may be clouded by sociological and psychological factors. Although most patients find that low back pain is transient and usually relieved by conservative means, approximately 5% develop chronic and disabling pain, which can result in the need for surgery. Fusion is not routinely undertaken in patients undergoing primary lumbar disc excision, but it may, however, be indicated in those who have instability associated with a herniated disc.

The advantage of posterior lumbar interbody fusion (PLIF) is that intervertebral separation enables the restoration of the spinal alignment and disc space height by interbody fusion and indirect neurological decompression of the neural foraminae and lateral recesses. PLIF has several advantages over posterolateral or anterior interbody fusion but also has some disadvantages, such as a high risk of damage to the neural tissues, a longer operating time, a risk of more bleeding from the epidural venous plexus, and the risk of subsequent perineural fibrosis.

Normally this technique involves the insertion of intervertebral cages. We have developed a natural cage by using the lumbar spinous process and laminae, which are inserted between two vertebral bodies in order to achieve fusion. We describe here our experience with this technique.

Patients and Methods

A total of 36 PLIFs using this technique were undertaken by a single surgeon (YS) between December 2005 and December 2007. The clinical data are summarised in Table I. The patients fulfilled the following criteria: persistent low back pain (for between three and five years) and/or sciatica after routine conservative treatment; radiological evidence of instability or a spondylolisthesis and the presence of degenerative stenosis; and complete medical records. Patients who underwent three or more levels of fusion were excluded.

Surgical procedure. All patients were given antibiotics (cefazolin, 2.0g intravenously one hour pre-operatively). After exposing the spinous process and both laminae, the surrounding soft tissues (such as ligamentum flavum and interspinous ligaments) were removed. En bloc resection of the spinous process and laminae was performed using an osteotome. The dura and nerve roots were protected using a nerve-root retractor. All disc material and the articular cartilage from the superior and inferior apophyseal joints was...
removed, until subchondral bleeding bone was seen. Bone blocks, harvested from the excised laminae, were cut into either large blocks or several small pieces. Using a bone-grafting funnel, smaller pieces were inserted and impacted into the intervertebral disc space. Larger blocks were then introduced and impacted and interpedicular screws were inserted and rods connected with cross-link devices.

Post-operative care. All patients were mobilised a week after the operation wearing a lumbosacral support with metal pieces. Radiographs were performed post-operatively and at three-monthly intervals after surgery. Functional outcome was assessed using the Kirkaldy–Willis criteria\(^2^1\) (Table II).

Radiological assessment. The intervertebral disc height was calculated as the ratio between the disc height and the height of the superior vertebral body. The height of the vertebral body and the intervertebral disc were measured in the anterior and posterior aspects of the vertebrae and the disc space, respectively. The ratio of anterior disc height to anterior vertebral height was defined as AHR and the ratio of posterior disc height to posterior vertebral height was defined as PHR (Fig. 1). The angle between the upper and lower edges of the intervertebral disc was defined as regional lordosis (RL) (Fig. 1). The data were analysed independently by three clinicians (ZL, YZ, CC). Fusion was determined by CT scanning.\(^2^2\) All patients underwent 3 mm thin-section helical CT scanning with sagittal and coronal views of the involved lumbar segments using a high-speed helical scanner (Sensation 16; Siemens, Beijing, China). The helical CT scans were reviewed independently by two radiologists who were not authors and who were blinded to the patient’s clinical history.

Statistical analysis. Statistical analysis was performed using SPSS v13.0 (SPSS Inc., Chicago, Illinois), and all data were expressed as mean and standard deviation (SD). The data regarding RL, AHR and PHR before surgery, at the time of discharge and at the time of final follow-up were analysed by Student’s \(t\)-test. A value of \(p < 0.05\) was considered statistically significant.

Results All 36 patients had relief of pain at the final follow-up (although a visual analogue scale was not performed), and the functional outcome at a mean follow-up of 19.5 months (14 to 36) was excellent in 19 (52.8%), good in 11 (30.6%) and fair in six (16.7%). There were no poor outcomes.

Five patients (13.9%) had a dural tear, which was repaired at the time of surgery using a fat pad. One (2.8%) had a superficial wound infection, which responded to a short course of oral antibiotics. There were no deep infections.

Table I. Summary of clinical data

<table>
<thead>
<tr>
<th>Demographic</th>
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<tr>
<td>Mean age (range)</td>
<td>47.5 (45 to 65)</td>
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<tr>
<td>Mean follow-up (months) (range)</td>
<td>19.5 (14 to 36)</td>
</tr>
<tr>
<td>Gender (n, %)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>23 (70.0)</td>
</tr>
<tr>
<td>Female</td>
<td>13 (30.0)</td>
</tr>
<tr>
<td>Diagnosis (n, %)</td>
<td></td>
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<tr>
<td>Spondylolisthesis</td>
<td>15 (41.7)</td>
</tr>
<tr>
<td>Degenerative stenosis</td>
<td>8 (22.2)</td>
</tr>
<tr>
<td>Degenerative instability</td>
<td>13 (36.1)</td>
</tr>
<tr>
<td>Locations and levels (n, %)</td>
<td></td>
</tr>
<tr>
<td>L3/4</td>
<td>4 (11.1)</td>
</tr>
<tr>
<td>L4/5</td>
<td>17 (47.2)</td>
</tr>
<tr>
<td>L5/S1</td>
<td>6 (16.7)</td>
</tr>
<tr>
<td>L3/4, L4/5</td>
<td>7 (19.4)</td>
</tr>
<tr>
<td>L4/5, L5/S1</td>
<td>2 (5.6)</td>
</tr>
<tr>
<td>Smoker (n, %)</td>
<td>13 (36.1)</td>
</tr>
<tr>
<td>Hypertension (n, %)</td>
<td>4 (11.1)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3 (8.3)</td>
</tr>
<tr>
<td>Complications (n, %)</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>1 (2.8)</td>
</tr>
<tr>
<td>Dural tear</td>
<td>5 (13.9)</td>
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Table II. The modified criteria for functional outcome

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tr>
<td>Excellent</td>
<td>The patient has returned to their normal work and other activities with little or no complaint</td>
</tr>
<tr>
<td>Good</td>
<td>The patient has returned to their normal work but may have some restriction in other activities, and may on occasion after heavy work have recurrent back pain requiring a rest for a few days</td>
</tr>
<tr>
<td>Fair</td>
<td>The patient has to reduce their working capacity, taking a lighter job or work part-time, and may occasionally have recurrence of pain requiring absence from work for one to two weeks, once or twice a year</td>
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<tr>
<td>Poor</td>
<td>The patient does not return to work</td>
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Diagram showing the measurement of the ratio of anterior disc height to anterior vertebral height (AHR), the ratio of posterior disc height to posterior vertebral height (PHR) and regional lordosis (RL).
Fusion occurred in 35 patients (97.2%) at between eight and 12 months post-operatively. In the final patient fusion occurred at 18 months.

The mean lumbar lordosis and mean disc height to vertebral body ratio were restored and preserved (Table III).

Discussion
In the 1950s Cloward developed the posterior lumbar interbody fusion using impacted blocks of bone taken from the iliac crest. It is an effective surgical technique for degenerative discs and spondylolisthesis. The greatest advantage of PLIF is that it allows for simultaneous decompression of the neural structures and fusion of the movement segment.

Comparison of the rates of union, outcome and pain relief between PLIF and PLF have been the subject of controversy. Kim et al. reported that there were no significant differences in clinical results and the rate of union between these two techniques. However, advantages were noted in favour of PLIF, including better sagittal balance, elimination of donor site pain, shorter operating times and less blood loss. Although there are few clinical studies to support this, the rate of fusion following PLIF should be higher than after PLF because the bone is inserted into the anterior portion of the disc space. Bone in the anterior portion fuses better because there is a larger surface area of bone than in the posterolateral gutter, and also because the bone is inserted under compression. Bone under compression heals better because it responds to stress, whereas bone under tension, as in PLF, is subjected to less stress.

Both PLF and PLIF reduce low back pain, although pain relief has been reported to be better after PLIF. There may be residual pain after PLF because the exposure needed to insert the bone graft is greater than for PLIF, and also the paravertebral musculature is more likely to be damaged.

As disc degeneration causes back pain, many investigators have advocated complete removal of the intervertebral disc at the time of fusion. Most PLFs use grafts taken from the iliac crest with associated donor morbidity. The rate of complications also has been controversial. In recent studies, the rate of complications has been found to be higher in PLF than in PLIF.

Translaminar interbody fusion (TLIF) may also be used. The risk of damage to structures within the spinal canal is less. However, it is unclear whether TLIF results in an improved outcome.

Three techniques are available for undertaking a PLIF: one involves bilateral laminectomy and the implantation of two
cages, a second involves unilateral laminectomy and implantation of two cages, and the third involves unilateral laminectomy and implantation of one cage.\textsuperscript{39,41} Kim, Jeong and Lee\textsuperscript{42} reported that PLIF using a unilateral single cage filled with local morcellised bone graft not only had the advantages of a shorter operating time, less blood loss and a shorter hospital stay than PLIF using bilateral cages for treating degenerative disease of the lumbar spine, but also provided excellent outcomes both clinically and radiologically. Several authors have reported successful fusion in up to 90\% to 95\% of patients using PLIF. Ray\textsuperscript{43} reported a 96\% fusion rate at two years with 86\% satisfactory relief of low back or radicular leg pain. Agazzi, Reverdin and May\textsuperscript{44} reported that PLIF with cages is safe and effective, with a 90\% fusion rate. Barnes et al\textsuperscript{45} found significantly lower rates of nerve root injury when using impacted allograft wedges than with their earlier experience using allograft in cylindrical threaded cages (0\% and 13.6\%, respectively), and it is worth noting that cages are expensive. Siddiqui and Jackowski\textsuperscript{46} reported the change in interbody-height ratio at six months was not significantly altered by using either a cage or a graft, although a slightly smaller interbody-height ratio was observed using a tricortical graft. It has also been reported that pain relief is better after fusion with graft compared with fusion using a cage.\textsuperscript{46} Raman et al\textsuperscript{47} reported no advantage to using an interbody cage to treat single-level degenerative spondylolisthesis compared with interbody fusion without a cage. Thus, especially in developing countries, using a cage for a PLIF is not the first choice when treating patients with low back pain.

A most important part of the PLIF procedure using a natural cage is to remove all soft tissue on the bone grafts. Also, when inserting the graft, the smaller portions are introduced into the front of the intervertebral space and the larger grafts, consisting of cortical bone, into the back in order to restore disc height.

There were few complications in our series, and although five patients had a dural tear these were repaired with a fat graft without further cerebrospinal fluid leak.

A shortcoming of this study is the small sample size, but with further development of this technique it is expected that the clinical results will become more reliable. Another limitation is that there is no formal post-operative clinical assessment.

We conclude that a satisfactory fusion rate can be achieved and the intervertebral height restored and maintained after performing a PLIF using a natural cage made of bone graft taken from the patient’s laminae and spinous processes. Our results suggest that this natural cage is effective and safe.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


