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Clinical Study

Posterior interbody fusion using a diagonal cage with unilateral transpedicular screw fixation for lumbar stenosis

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ABSTRACT

Few reports have described the combined use of unilateral pedicle screw fixation and interbody fusion for lumbar stenosis. We retrospectively reviewed 79 patients with lumbar stenosis. The rationale and effectiveness of unilateral pedicle screw fixation were studied from biomechanical and clinical perspectives, aiming to reduce stiffness of the implant. All patients were operated with posterior interbody fusion using a diagonal cage in combination with unilateral transpedicular screw fixation and had reached the 3-year follow-up interval after operation. The mean operating time was 115 minutes (range = 95–150 min) and the mean estimated blood loss was 150 mL (range = 100–200 mL). The mean duration of hospital stay was 10 days (range = 7–15 days). Clinical outcomes were assessed prior to surgery and reassessed at intervals using Denis' pain and work scales. Fusion status was determined from X-rays and CT scans. At the final follow-up, the clinical results were satisfactory and patients showed significantly improved scores ($p < 0.01$) either on the pain or the work scale. Successful fusion was achieved in all patients. There were no new postoperative radiculopathies, or instances of malpositioned or fractured hardware. Posterior interbody fusion using a diagonal cage with unilateral transpedicular fixation is an effective treatment for decompressive surgery for lumbar stenosis.

1. Introduction

Bilateral pedicle screws are standard instrumentation constructs used in various lumbar pathologies, that confer several advantages, including an excellent fusion rate, avoidance of external immobilization, and facilitation of early ambulation.[1,2] However, due to the excessive rigidity of the system, this instrumentation is also suspected to cause decreased mineral content in the fixed area and degeneration of adjacent segments.[3,4] Following the work of Kabins et al., who obtained nearly identical clinical outcomes with the use of either bilateral or unilateral instrumentation, some investigators have studied the rationale and effectiveness of unilateral pedicle screw fixation from biomechanical or clinical perspectives, aiming to reduce the stiffness of the implant.[5] Suk et al. reported comparable clinical outcomes and fusion rates for unilateral versus bilateral pedicle screw instrumentation; however, a significant reduction in operating time, duration of hospital stay, and medical expenses was reported with unilateral instrumentation.[6] In this series, metal failures were more common in the unilateral group (12.8%) than in the bilateral group (5.0%). This may be attributed to the inherent asymmetry of the construct and the likely inability to provide enough rigidity when excision of the disc is required for decompression, even when posterolateral fusion was performed. Recently, some authors have advocated employment of this unilateral pedicle screw system in combination with lumbar interbody fusion rather than posterolateral fusion. From a biomechanical perspective, interbody fusion produces a significantly more rigid construct that protects the posterior instrumentation from failure. It can also provide load-sharing during fusion and allow improved biological healing with autologous bone graft. However, to our knowledge, only studies with a small sample size and short follow-up have been reported for this type of fixation.[7–9]

From April 2005 to February 2007, we performed posterior interbody fusion using a diagonal cage with unilateral transpedicular screw/rod fixation for lumbar stenosis while maintaining minimal invasion of the posterior structures. This study reports the outcomes of 79 patients who had reached the 3-year follow-up interval.

2. Materials and methods

This study comprised 79 patients (62 men and 17 women) with lumbar stenosis, whose mean age was 51.5 years (range = 42–59). All patients underwent single level posterior interbody fusion using a diagonal cage with unilateral transpedicular screw/rod fixation. The criteria for inclusion were as follows: (i) lumbar canal

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stenosis involving only one level; (ii) aged between 40 and 60 years; (iii) having a history of persistent or recurrent low back pain and neurologic claudication or sciatic pain over at least 3 months resulting in a significant influence on life quality and unresponsive to conservative treatment; (iv) abnormal sagittal mobility of >5 mm in lateral flexion and extension radiographs taken with the patient standing; and (v) disc pathology requiring excision for decompression. Exclusion criteria were as follows: (i) history of addiction to alcohol or tobacco or any other major psychopathology; (ii) previous operation on the lumbar spine; and (iii) other spinal pathologic conditions, including spondylolisthesis, scoliosis or infection, osteopenia, adjacent level degeneration, or gross obesity.

2.1. Surgical technique

Patients were positioned prone on a Jackson table. An incision was made overlying the affected level and continued down through the posterior lumbar fascia. The symptomatic side of the paravertebral muscle was dissected and retracted laterally to the outer edge of the facet joint, exposing the lamina and facet joint. In patients with bilateral symptoms, surgery was typically performed on the clinically and radiologically predominant side. Pedicle screws were placed up and down the decompressed level.

Decompression was performed via unilateral partial resection of the inferior aspect of the cranial hemilamina and, usually to a minimal degree, from the superior aspect of the caudal hemilamina. After medial facetectomy, the entire nerve root and ipsilateral intervertebral space were exposed. Adequate decompression of the stenosis was accomplished simultaneously.

In patients with bilateral symptoms, contralateral decompression was further performed as described in the literature (Fig. 1A).[10] After undercutting the base of the spinous process by medial angulation of the operative microscope, the contralateral hemilaminae and the hypertrophied medial facet were partially removed after bilateral flavectomy. The lateral recess and neural foramina were decompressed contralaterally.

A thorough discectomy and endplate preparation were performed using the Lumbar I/F Cage System Set (DePuy Spine Inc., Raynham, MA, USA). Iliac crest marrow was harvested and mixed with morcellized local bone saved from the excised lamina and facet. An appropriately sized carbon-fiber reinforced polymer cage was filled with the prepared bone and inserted diagonally at the mid-portion of the intervertebral space, with the center of the cage placed as close as possible to the midline (Fig. 1B). Finally, a rod was connected with the pedicle screws, and the screws were subsequently compressed. The rod was secured with locking caps torqued to the manufacturer's specifications.

2.2. Postoperative management

A surgical drain was placed and closure was performed in layers. Patients were nursed in the supine position and log-rolled for comfort during the first 2 days. Suction drains were removed when the level of fluid collected was less than 100 mL over 24 hours. Ambulation was permitted with the protection of a customized semi-hard brace on the seventh postoperative day. Isometric muscle exercise was commenced 3 weeks after surgery.

2.3. Clinical and radiological assessment

Clinical status was assessed prior to surgery by an independent assessor (Y. Yao) and outcomes reassessed at 1, 3, 6, 12, 24, and 36 months postoperatively by the same assessor. Clinical results were evaluated by telephone interviews uisng to Denis' pain and work scales (Tables 1 and 2). The results were statistically analysed using the Wilcoxon signed-rank test to compare scores obtained before surgery and at final follow-up.

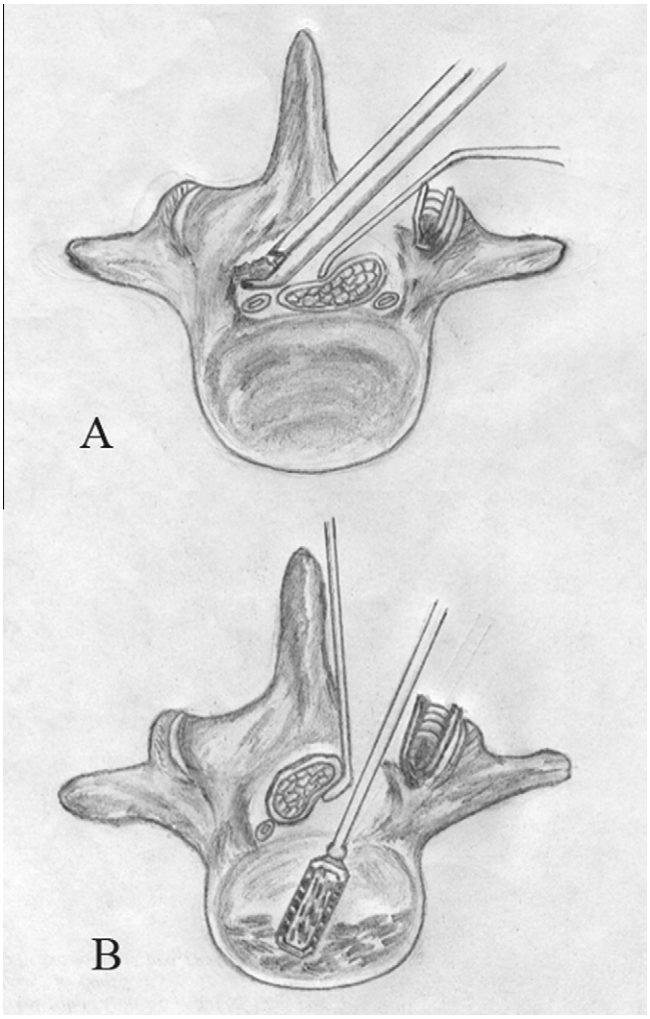

Fig. 1. Drawings of the surgical procedure showing: (A) direct contralateral decompression – through a microscopic unilateral laminotomy – in patients with bilateral symptoms; and (B) after bone grafting, a single cage was inserted diagonally.

Table 1
Denis pain scale

P1	No pain
P2	Occasional minimal pain with no need for medication
P3	Moderate pain with occasional medication but no interruption of work or significant change in activities of daily living
P4	Moderate to severe pain with frequent medication and occasional absence from work or significant change in activities of daily living
P5	Constant or severe incapacitating pain, chronic medication

Table 2
Denis work scale

W1	Returned to previous employment
W2	Able to return to previous employment (sedentary) or return to heavy labor full time with lifting restrictions or job modifications
W3	Unable to return to previous employment but able to work full time at a new job
W4	Unable to return to previous employment, work part-time or frequently absent from work because of pain
W5	Unable to work (completely disabled)