Threaded Fusion Cage for Lumbar Spondylolisthesis

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Abstract

Fifteen patients with Meyerding I spondylolisthesis causing disabling lumbago underwent threaded fusion cage implantation at the unstable segments. Low back pain and intermittent claudication subsided in all patients postoperatively. The preoperative Japan Orthopaedic Association score was 11.5 on average, and improved to 23.5 after surgery. Five patients achieved significant resolution of preoperative symptoms, six improved reasonably, and four required less medication. There was no failure of fixation. No patient required supplemental fixation such as pedicle screws to achieve stable fusion. One patient had an inflammatory course but re-surgery was not necessary. The threaded fusion cage is an effective and promising device for the relief of low back pain when used to promote fusion of the lumbar spine in patients with low-grade spondylolisthesis.

Key words: lumbar fusion, threaded fusion cage, spinal instrumentation, spondylolisthesis

Introduction

Persistent or intractable lower back pain is generally caused by either compression of cauda equina or abnormal motion of the unstable segments of the lumbar spine. The current treatment of choice for intractable low back pain with neurogenic intermittent claudication is complete decompression of the neuronal elements. In contrast with the treatment for herniated disc with intact vertebral arch, lumbar canal stenosis with spondylolisthesis necessitates fusion as well as meticulous decompression. Posterior lumbar fusion has been used for over 50 years to treat such patients with chronic pain as a result of disc degeneration of the lumbar spine. Posterolateral bone grafting in combination with spinal instrumentation is a common procedure, but pseudoarthrosis, graft resorption, and failure of hardware are well-known problems. More recently the threaded fusion cage (TFC) of Ray has been recognized to provide solid fusion of the unstable segment in the central axis of the vertebral column. Furthermore, maintenance of the disc height is significantly increased with this technique.

The study analyzed our experience and initial results with the surgical technique for lumbar fusion using the TFC.

Materials and Methods

Fifteen patients with lumbar spondylolisthesis, nine males and six females, aged from 35 to 78 years (mean 55 years) were treated by TFC implantation. The presenting symptoms were chronic low back pain in all 15 patients, neurogenic intermittent claudication in 13, and sensorimotor dysfunction of the lower extremities in 12. Preoperative lateral radiography showed Meyerding I spondylolisthesis, or segmental motion in flexion and extension studies in all patients. Computed tomography (CT) disclosed various degrees of facet hypertrophy, disc herniation, or posterior spur formation. Magnetic resonance (MR) imaging and myelography followed by CT myelography demonstrated nerve root compression as well as canal stenosis. Spondylolisthesis was caused by lumbar degeneration in 13 cases and by spondylolysis in two.

Ten fusions were carried out at L4-L5, five at L5-S1, and three at L3-L4. Some patients were operated on at more than one level. The patient was placed in a prone position. After separation of the paravertebral muscles with preservation of the spinous process and supra- and interspinous ligaments, partial laminectomy and facetectomy with removal of the yellow ligament and herniated nucleus proposus were performed under an operating microscope to obtain the operating field necessary to implant the TFC (Fig. 1A, B). The dural theca and the nerve roots were gently retracted medially with a nerve retrac-
for (Fig. 1C). The TFC was then screwed into the tapped hole with the help of intraoperative fluoroscopy (Fig. 1D). The same procedure was performed on the contralateral side. Fresh cancellous bone collected from the resected lamina and facet was filled into the cage (Fig. 1E). After confirming the absence of cerebrospinal fluid (CSF) leakage, the wound was closed.

The patients were mobilized out of bed with a corsette a few days after surgery. Radiography was performed 3, 6, and 12 months postoperatively. CT was performed occasionally. The patients were followed up for 9 to 32 months (mean 14 months).

**Results**

The severity of the chronic low back pain, sciatic pain, and intermittent claudication was reduced in all 15 patients. The preoperative Japan Orthopaedic Association score was 11.5 on average, and improved to 23.5 after surgery. Five patients achieved remarkable resolution of gait difficulty and experienced great reduction in pain, six improved reasonably, and four could control their pain with occasional medication. There were no neurological deficits related to the surgery. Overall, all patients were satisfied with the surgical results and none of the patients had a poor result.

The fusion was evaluated with lateral radiographs in flexion-extension studies and by CT. No evidence of a significant halo around the implants was found. No cage displacement nor dislodgement was seen. There was no discernible movement of the cage or pseudoarthrosis in flexion-extension studies. The height of the disc space was maintained well without further collapse. The overall fusion rate was considered 100% with an average follow-up period of 14 months.

Postoperatively there was no CSF leakage or additional neurological deficits. A superficial wound in-
fication was cured with intravenous antibiotic administration in one case. There were a few complaints of pain around the wound in the early postoperative stage. There were no occurrences of vertebral body fractures, further subluxation, or device dislodgement.

**Illustrative Cases**

**Case 1:** A 70-year-old male was admitted to our hospital with a 3-month history of disabling low back pain and intermittent claudication due to degenerative spondylolisthesis. Plain lateral

![Image](image-url)

**Fig. 2** Case 1. A 70-year-old male with degenerative spondylolisthesis. A: Lateral radiograph showing abnormal segmental motion at L4-5. B: Computed tomography scan showing degenerative hypertrophy of bilateral facet causing lumbar canal stenosis at L4-5. C: Magnetic resonance image showing severe canal stenosis with a herniated disc at L4-5 and moderate stenosis at L3-4. D, E: Radiographs in flexion-extension showing no abnormal movement at L4-5 without a halo around the threaded fusion cage 12 months post-implantation.
radiography showed Meyerding I spondylolisthesis at the L4-5 level with instability (Fig. 2A). CT disclosed canal stenosis at the L3-4 and L4-5 levels due to degeneration of the lumbar spine (Fig. 2B). MR imaging confirmed severe canal stenosis (Fig. 2C). The TFC was implanted at the L4-5 level, in addition to partial laminectomy with removal of herniated discs at the L3-4 and L4-5 levels. Postoperative radiography demonstrated decompressive partial laminectomy with good fusion without movement (Fig. 2D, E). Absence of a halo was confirmed. His neurological deficits were remarkably resolved.

Case 2: A 56-year-old female was admitted to our hospital because of longstanding intractable low back pain due to spondylolytic spondylolisthesis. Lumbar lateral radiography showed Meyerding I spondylolisthesis at the L5-S1 level (Fig. 3A). CT disclosed spondylolysis of the L-5 lamina (Fig. 3B), and MR imaging showed moderate compression of the dural theca at the L5-S1 level (Fig. 3C). Bilateral laminectomy of L-5 with preservation of the interspinous ligament was carried out and the TFC was implanted at the L5-S1. Postoperative radiography and CT revealed stable L5-S1 fusion (Fig. 3D, E). Her
lumbago was brought under control with medication postoperatively.

Discussion

Lumbar interbody fusions are mechanically the most optimal spinal fusions and are indicated for pathological situations such as low-grade spondylolisthesis. The TFC is a hollow-threaded cylinder of titanium alloy with polyethylene endcaps. The implanted cages stabilize the vertebral bodies of the affected motion segment, restore and maintain disc height, and constrain the bone graft. Our initial results using this technique of fusion showed a very high rate of osseous union without major complications.

The procedure to screw this cage into the collapsed disc space posteriorly is technically demanding. One of the major disadvantages of this procedure is sacrifice of a large portion of the facet joint and lamina. Loss of the posterior spinal arch reduces stability, so attempts must be made to preserve the spinous process and the interspinous ligament complex of the lumbar spine as a supportive tissue. Another problem is injury of the nerve roots and dural theca when cutting and tapping the vertebral bodies. To avoid this complication, use of an operating microscope is essential until the neural elements are protected with a special retractor device. Microsurgical technique can achieve satisfactory decompression of neural tissues entrapped by herniated discs, posterior spur, or facet hypertrophy.

Rigid internal fixation with the TFC decreases the time required for osseous union in patients with spondylolisthesis. Reconstruction of the lumbar alignment is not always necessary and not always possible in patients with low-grade spondylolisthesis. We recommend use of a TFC with a diameter that is more than 2 mm greater than the disc height. This is necessary as the screw of the cage is in the endplate to maintain rigid fixation against the translation force of the vertebral body.

Several orthopedic surgeons and neurosurgeons prefer pedicle screw fixation for the treatment of spondylolisthesis, and emphasize good fusion rates. It is obvious that pedicle screw devices offer rigid fixation, but this posterosilateral fusion still leaves inadequate support for the anterior column, and postoperative pseudoarthrosis or implant failures have been reported. The TFC stabilizes the central axis of the vertebral column together with satisfactory maintenance of the disc height and is not a self-tapping device, so provides superior pull-out resistance. We emphasize that the TFC in combination with intact interspinous ligaments provides anteromedial stabilization and together create the immediate and rigid reconstruction of the lumbar spine in patients with low-grade spondylolisthesis.

Our radiological follow-up studies showed no abnormal movement of the lumbar spine on flexion-extension radiography or a significant halo around the cage at 6 and 12 months post-implantation. Although our experience is rather limited, the TFC provides rigid fusion for patients with Meyerding I spondylolisthesis. For spondylolisthesis greater than Meyerding II, fusion devices such as pedicle screws and plates or rods should be employed to support the TFC mechanically.

References

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Commentary

First of all, I would like to congratulate the author on his excellent surgical results for TFG despite his early experience. However, in his paper the background of the patient population was poorly described. What kind of selection criteria for surgical intervention was used? Just describing chronic low back pain or neurogenic intermittent claudication does not seem to be sufficient to readers. There are so many low back pain patients with spondylolisthesis or with spondylolysis who can be well treated nonoperatively with physiotherapy and muscle strengthening exercises. We would like to know how intractable the low back pain was, in terms of time span, posturing and exercises, also regarding neurogenic intermittent claudication, was it greater than 500 meter, 100 meter, or less? Also in Japan, as is often seen, if chronic low back pain is present in association with spondylolysis or with spondylolisthesis, a majority of patients were recommend-
ed by practicing orthopedists to wear some kind of corset for chronic use which would result in atrophy of abdominal and paraspinal muscles. I wonder if mechanical low back pain syndrome was appropriately treated prior to surgical treatment in his 15 patients. If so, how many months or years Dr. Mizuno allowed or waited for that purpose. I am very interested in his response.

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The authors have used the threaded fusion cage of Ray for posterior lumbar interbody fusion in 15 patients with Myerding I spondylolisthesis. Spondylolisthesis was caused by lumbar degeneration in 13 cases and by spondylolysis in 2 cases. Ten fusions were carried out at L4-L5, 5 at L5-S1, and 3 at L3-L4. In all 15 patients, the severity of the chronic low back pain, sciatic pain, and intermittent claudication was reduced. There were no neurological deficits related to the surgery. The authors evaluated the fusion with lateral radiographs in flexion-extension studies and by CT. Neither cage displacement nor dislodgement was seen. There was no discernible movement of the cage or pseudoarthrosis in flexion-extension studies. Overall, the authors presented good surgical results.

We share the same impression that posterior lumbar interbody fusions have distinct mechanical and surgical advantages. The most common method for lumbar spine interbody fusions has long been posterior lumbar interbody fusion. The posterior approach has been preferred because of concern over potential vascular, visceral, or autonomic nerve injuries inherent in anterior lumbar fusion approaches. Conceptually, interbody techniques should provide more stability and faster fusion development. So it is also our belief that rigid internal fixation with the threaded fusion cage decreases the time required for osseous union in patients with spondylolisthesis.

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