Ipsilateral pedicle screw placement with contralateral percutaneous facet screws: Early results with an alternative in lumbar arthrodesis

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Abstract: Transforaminal lumbar interbody fusion (TLIF) is a widely used method of surgical treatment for a variety of lumbar spinal disorders. Bilateral transpedicular instrumentation is routinely used in conjunction with an interbody graft to provide additional stability. In this technical note, we describe our fusion construct using ipsilateral pedicle screw placement on the side of TLIF and contralateral facet screw placement. We performed this construct at six levels in four patients. Suggested advantages include: low morbidity, small incision and lower cost. Outcomes parameters included radiographic evidence of solid union at four months and improvement in Oswestry Disability Index. A mean improvement from a preoperative score of 73 to 26 after surgery was observed at one-year follow-up. There were no instrument-related complications. In conclusion, this hybrid screw system minimizes contralateral dissection and is an attractive alternative to standard bilateral pedicle screw fixation.

Keywords: TLIF, facet screw, pedicle screw, lumbar spine fusion

Introduction

Transforaminal lumbar interbody fusion (TLIF) has become a widely used method of surgical treatment for a variety of lumbar spinal disorders. At present, TLIF is frequently utilized when avoidance of complex anterior approaches and diminished posterior trauma to the spinal cord is desired. Bilateral transpedicular instrumentation has been routinely used in conjunction with an interbody graft to provide additional stability to spinal elements. More recently, percutaneous methods of access have evolved with the aim of reducing operative time and the need for sharp dissection. As authors report ongoing success with these techniques for stabilization of the lumbar spine, the desire for combining innovative treatment strategies to optimize a therapeutic approach has evolved. In this small series the authors present their early experience with a strategy that involves combining TLIF with contralateral percutaeous facet screws as a means of obtaining adequate spinal fixation with minimal invasiveness.

Materials and methods

Patients

A retrospective review of charts and radiographs of all patients who underwent minimally invasive TLIF with combined unilateral pedicle screw and contralateral facet screw fixation was conducted. A total of four patients (2 males and 2 females) fused at six spinal levels were included. In two patients, the L3–4 segment was fused. In three patients, the L4–5 segment was fused. In one patient, the L5–S1 segment was fused. Two patients had multilevel fusions at L3–4 and L4–5. One patient had grade 1 spondylolisthesis, two patients had degenerative disc disease, two patients had post laminectomy syndrome, two patients had radiculopathy, and all patients had discogenic back pain. All procedures

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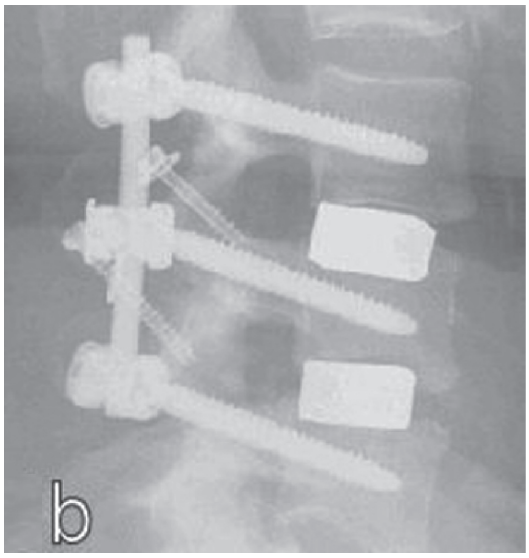

Figure 1 A) AP and radiograph after two level lumbar fusion with minimally invasive TLIF with combined unilateral pedicle screw and contralateral facet screw fixation from L3 to L5. On the left side, a minimally invasive transforaminal approach is performed with autograft and tantalum mesh cages for interbody fusion. A pedicle screw and rod system is used for fixation at L3/4 and L4/5. Posterolateral fusion is performed with autograft. On the right side, two percutaneous facet screws and washers are used for fixation at the L3/4 and L4/5 facet joints. **B)** Lateral radiograph depicting the same configuration.
Abbreviation: TLIF, transforaminal lumbar interbody fusion.

were performed by a single surgeon (SSR). Implants included: Click X pedicle and facet screw systems (Synthes USA, West Chester, PA, USA) and Zimmer Spine (Warsaw, IN) Tantalum mesh cages. Pedicle screws were 7 mm in diameter and 45 mm in length. Tantalum mesh cages were 10 to 12 mm. Facet screws were 30 to 40 mm in length and 4.5 mm in diameter.

Surgical technique

A minimally invasive paramedian incision was made along the interpedicluar line as identified by intraoperative fluoroscopy to expose the corresponding laminae and facets. Pedicle holes were created in the standard fashion using a gearshift. A total unilateral facetectomy and decompressive hemilaminotomy was performed under the operative microscope. The nerve roots and dural sac were identified and preserved. Complete discectomy and end plate decortication were performed followed by transforaminal insertion of an intervertebral tantalum mesh cage with placement of morselized autograft within the disc space. Compression was achieved across the pedicle screws and rod with set screws. Posterolateral fusion was achieved with morselized autograft. Optimal hardware placement was confirmed with intraoperative fluoroscopy.

Contralateral facet screw fixation was accomplished with a minimally invasive percutaneous stab incision. A Jamshidi needle was introduced along the expected trajectory of the facet screw under intraoperative fluoroscopy, followed by K-wire and sequential dilation. Facet screws were placed with washer via the technique of Boucher.[1] Optimal hardware placement was then confirmed with intraoperative fluoroscopy. Stability of the construct was assessed by review of lateral flexion and extension radiographs performed at four months postoperatively. The criteria used for successful arthrodesis included 1 degree or less of angular change or less than 2 mm of relative motion between segments as well as visualization of radiopaque osseous tissue bridging adjacent vertebrae.

Results

Radiographic evidence of solid osseous union was observed in all cases at four months. Clinical outcome was determined by improvement in Oswestry Disability Index and there was significant improvement at one year follow-up. Mean preoperative score of 73 was improved to 26. Clinical improvement in symptoms included discontinuation of narcotic pain medication, improved radiculopathy and back pain, and improved walking (to the point of discontinuation of the use of a walker in one case). Subjective improvements included patients feeling "better" and "extremely pleased." There were no instrument related complications. A wide range of estimated blood loss (EBL) was recorded with results spanning from 150 ml for one level fusion to 2,000 ml for two levels. Average operative time was 5 hours 13 minutes.

Discussion

We describe a fusion construct using ipsilateral pedicle screw placement on the side of TLIF and percutaneous facet screw

placement on the contralateral side. Proposed advantages to this configuration over traditional bilateral pedicle screw placement include: decreased surgical morbidity, small incision, and lower cost. Despite such benefits few patients receive this fusion construct as little is known regarding its mechanical stability *in vivo*. Several authors have reported biomechanical studies comparing percutaneous transfacet fixation with contralateral pedicle screw placement in human cadavers. This analysis has shown this configuration of instrumentation to be equivalent to traditional methods with respect to stiffness, range of motion, and extension.[2–4] Ferrera and colleagues reached this same conclusion and observed a decrease in flexion potential in systems reliant upon transfacet fixation, a possible benefit for inter-body arthrodesis.[5] Various authors have assessed similar fusion constructs for bony fusion at 6 to 24 months.[6] It is encouraging that each of our patients exhibited evidence of solid fusion at only four months, a sign of rigid fixation. Despite these early results, a lengthened further follow up period and increased experience with this configuration are needed to assess its true efficacy.

TLIF is a novel approach for posterior fusion and is indicated for operative management of spondylolisthesis, degenerative disk disease, and select cases of disc herniation.[7–10] Traditional decompression and inter-body fusion with TLIF has been shown to be safe and may result in relief of pain in as many as eighty percent of patients.[5] Modern surgical practice has been in favor of minimally invasive techniques whenever possible. The configuration described above provides the benefit of fixation of the contralateral vertebral elements while diminishing the need for extensive dissection. A simple stab incision is used in the placement of each facet screw, an approach which obviates extensive postoperative scaring. Best and colleagues demonstrated the efficacy of percutaneous translaminar facet screw placement in a series of 105 patients. The authors compared the average operative time of patients undergoing translaminar facet screw placement to those receiving traditional pedicle screws. Procedures wherein facet screws were utilized had an average duration of 113.95 minutes compared to 132 minutes in the pedicle screw group.[11] These results as well as those observed in our series are difficult to compare to other series wherein TLIF has been utilized as the measurement of procedure duration is heavily operator dependant. Additionally, whether such a reduction in operative time ultimately proves to be advantageous with respect to the postoperative course of these patients remains unknown.

While unilateral pedicle screw instrumentation alone has been proposed as an effective option to reduce morbidity when bilateral access is not required, doubts remain about the stability provided by such constructs.[12] Additionally, the use of translaminar facet screws has been shown to enhance the stability of spinal motion segments when used in combination with threaded cages.[13–15] This configuration maintains the advantage that a pedicle screw and plate systems offer in fusion and may be associated with reduced operative blood loss when compared to controls.[16,17] In 2005, Kang and colleagues reported a computed tomography-guided percutaneous facet screw fixation in the lumbar spine. In their report of percutaneous facet screw fixation as supplement to anterior lumbar interbody fusion, the authors cited a negligible intraoperative blood loss as evidence of diminished invasiveness of these techniques.[18] In combining these techniques with a transforaminal approach, we seek to gain the same benefit. This fact is supported by the minimal blood loss observed during the percutaneous portion of each of these procedures. This early experience with this arrangement suggests that this configuration will likely prove an attractive alternative to bilateral transpedicular fixation; particularly, in those patients who stand to benefit from minimized surgery such as those with a history of previous paraspinal muscle dissection and multiple medical comorbidities.

Conclusion

Our early results with ipsilateral pedicle screw placement used in conjunction with contralateral percutaneous facet screw fixation suggest that this arrangement is likely an effective alternative to traditional bilateral fixation. Extended radiographic and clinical follow up are needed to evaluate the long-term biomechanical response to this form of stabilization.

Disclosure

The authors report no conflicts of interest in this work.

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