Technical Note

Use of L5-S1 transdiscal screws in the treatment of isthmic spondylolisthesis: a technical note

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Abstract: Surgical treatment of L5-S1 isthmic spondylolisthesis consists of a combination of decompression and fusion. One previously discussed mode of fusion is via transdiscal screws. Biomechanical studies of transdiscal screws have demonstrated greater rigidity than traditional pedicle screw fixation, which theoretically translates to a higher fusion rate. Furthermore, when compared to pedicle screw fixation, transdiscal screw fixation also demonstrates improved functional and radiographic outcomes. However, transdiscal screw placement can be technically difficult. At this time, a detailed surgical technique has yet to be reported in the literature. Our surgical technique for transdiscal screw placement using intraoperative C-arm at L5-S1 is described. We include considerations for preoperative planning including necessary imaging and appropriate patient selection. We also discuss intraoperative concerns such as setup, surgical approach, proper screw trajectory, and our method for achieving indirect decompression. The results of thirteen consecutive patients treated with transdiscal screw fixation are described. One patient had subcutaneous seroma requiring reoperation (7.7%), three patients had implant failure (23.1%), and one patient had nonunion (7.7%). Our results suggest that transdiscal screw fixation is a safe and acceptable alternative for stabilization and indirect decompression of L5-S1 isthmic spondylolisthesis. Recent innovation in intraoperative navigation and robotic surgery may lessen the technical difficulty of transdiscal screw placement and make it even more effective.

Keywords: Lumbosacral spine; isthmic spondylolisthesis; transdiscal screw

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Introduction

Isthmic spondylolisthesis is the anterior translation of one lumbar vertebra relative to the next caused by an abnormality of the pars interarticularis, most commonly at L5-S1. Symptomatic patients will most frequently experience low back and/or lower extremity pain with varying degrees of neurologic deficit (1,2). Surgical management is indicated for patients who fail conservative treatment, have progressive symptomology, or develop a neurologic deficit (3,4). Generally, surgical management consists of a combination of decompression and fusion, with multiple techniques described (5-9). Currently, no gold standard method for stabilization exists, and the selected technique is based largely upon surgeon preference (10).

L5-S1 transdiscal screw fixation, in which a screw is directed from the sacrum through the intervertebral disc into the vertebral body of L5, has been previously described for the treatment of spondylolisthesis (11-13). L5-S1 transdiscal screws have shown promise by providing

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Figure 1 Preoperative evaluation of CT scan to identify patients who are appropriate for transdiscal screw fixation. The path of the transdiscal screw travels from the inferior aspect of the S1 pedicle to the anterior cortex of the L5 body (line). The path cannot encroach on the foramina (circle) and must intersect the anterior cortex of the L5 body at a point that is >30% of the vertebral body height.

significant functional and radiological improvements for patients when compared to alternative techniques including pedicle screw fixation or interbody fusion (9,12). Compared to pedicle screw fixation, L5-S1 transdiscal screws have demonstrated increased biomechanical stiffness, which may translate to an increased fusion rate (14). Furthermore, L5-S1 transdiscal screws result in an indirect decompression of the L5-S1 foramina, potentially avoiding direct decompression and its associated complications such as dural tear, nerve injury, and epidural hematoma (15-17). Transdiscal screw placement, however, can be considered to be more technically difficult. Improvements in surgical methods may help improve patient outcomes following L5-S1 transdiscal screws (9).

Although L5-S1 transdiscal screws have been reported, there has not been a detailed description on a technique for optimal and safe screw placement. The technical details and the results of 13 consecutive patients treated with this technique are described herein.

Methods

Preoperative evaluation

Preoperatively, long cassette films are obtained to evaluate for clinically significant sagittal imbalance. A CT scan in the supine position is performed to evaluate for correction of spondylolisthesis as well as the appropriateness of utilization of a transdiscal screw for treatment. On a sagittal cut of each pedicle, a line drawn from the inferior aspect of the S1 pedicle to the anterior cortex of the L5 vertebral body must not encroach on the foramina. The line must intersect the anterior cortex of the L5 vertebral body at a point >30% of the vertebral body height (*Figure 1*).

Operative technique

Intraoperatively, a C-arm must be set up to obtain AP and lateral views. Most adults will require two segments of proximal fixation (L3-S1), whereas children may only require one segment (L4-S1) of proximal fixation given their ability for more robust bone formation and overall superior bone quality. Through a midline incision, the cephalad levels are exposed out to the transverse processes. We suggest including both L3 and L4 for adults, while including only L4 for adolescents may be appropriate. The reasoning behind this recommendation is that the larger body habitus of adults may potentially place undue stress on the screws, which may result in a lower fusion rate than in the smaller pediatric patients. At L5, exposure of only the lamina and facet joints is recommended. In most cases, a laminectomy of L5 is often not required due to the indirect decompression that is obtained utilizing the described technique. Therefore, a posterior fusion, rather than posterolateral intertransverse fusion, is preferred. Using this approach then allows the surgeon to avoid the more complex and higher risk exposure of the L5 transverse process, which is often deep and anterior.

A separate lateral incision is made at the level of the iliac crests just medial to the posterior superior iliac spine. The starting point for the transdiscal screw will be the same as an S1 pedicle screw at the inferior border of the superior facet of S1 (*Figure 2*).

A burr is used to create a starting pilot hole. A pedicle probe is then placed through the lateral incision and is directed towards the S1 superior cortex at a path that medializes towards the center of L5. Next, the probe is sequentially malleted through the S1 endplate and up to the endplate of L5. The probe is then malleted through the L5 endplate. As the probe passes through the L5 endplate, distraction of the foramina should be noted which ensures indirect decompression is achieved (*Figure 3*).

Mallet until reaching the anterior cortex of L5. On an AP

view confirm that there is medialization of the tap (*Figure 4*).

If position is appropriate, measure the length of the screw. The probe is then removed, and a screw tap is introduced through the same trajectory, while visualizing via fluoroscopy. In general, a 7.5 mm diameter screw should be used for adults. Repeat this process on the contralateral side. Rods are contoured into an S-shape (*Figure 5*). At this point, the lamina is decorticated and iliac crest bone graft is placed over the lamina.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of the University of Pittsburgh (STUDY20110338) and informed consent for this retrospective analysis was waived.

Results

Between January 2012 and October 2020, thirteen patients underwent L5-S1 transdiscal fixation. These patients had a mean age of 34.2 years (range, 12 to 69 years) and mean BMI 28.8 (range, 18.4 to 39.8) at time of surgery. There were 4 (30.7%) male patients and 9 (69.3%) female patients. There were 4 adolescent patients (30.7%), 1 male (25.0%) and 3 female (75.0%), ranging from 12 to 14 years old. Preoperatively, mean Meyerding grade was 2.7 (range, 2 to 4). Of the 13 procedures performed, 11 (84.6%) were primary surgeries and 2 (15.4%) were revision surgeries. Mean patient follow up was 20.4 months, ranging from 2.7 to 58.9 months.

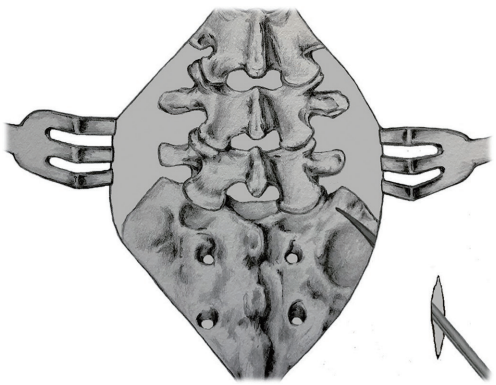

Figure 2 Drawing demonstrating the use of a separate lateral incision to obtain the starting point for the transdiscal screw.

No intraoperative complications were noted. One patient (7.7%) had a subcutaneous seroma that required irrigation and debridement 6 days postoperatively. There were three instances (23.1%) of implant failure including two instances (15.4%) of broken transdiscal screws and one instance (7.7%) of a broken L4 pedicle screw. One patient (7.7%) had nonunion related to a broken transdiscal screw with revision surgery recommended, but the patient was lost to follow-up. No patients had new neurological deficit, although two patients (15.4%) did have continued radicular pain postoperatively. No patient underwent revision surgery.

Discussion

The optimal surgical technique for management of high-grade isthmic spondylolisthesis of L5-S1 is a debated and unresolved topic. Our L5-S1 transdiscal screw fixation technique proved to be safe with no major postoperative complications; additionally, the technique was effective as only 1 patient (7%) was recommended to undergo revision surgery.

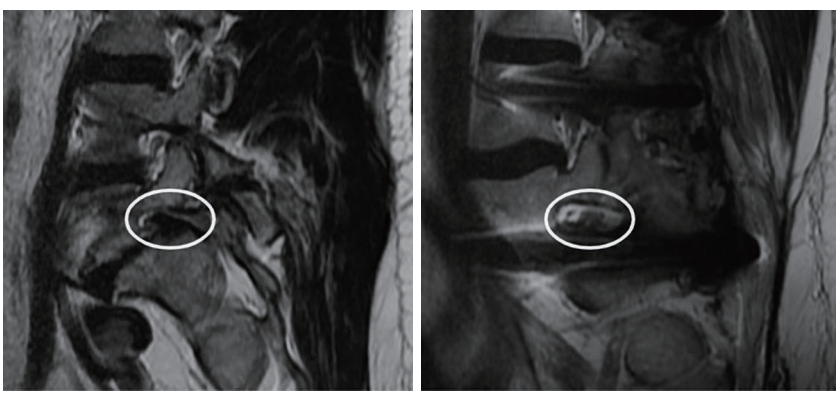

Figure 3 Preoperative and postoperative MRI demonstrating decompression of the L5-S1 foramina (circle). MRI, magnetic resonance imaging.

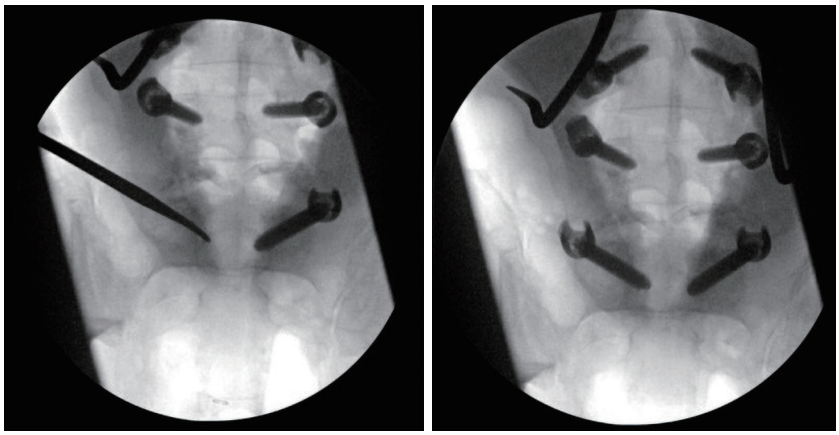

Figure 4 Intraoperative fluoroscopy demonstrates appropriate medial trajectory of transdiscal screw.

Figure 5 Postoperative lateral radiograph demonstrating the preferred S shaped contour of the rods.

Our cohort had a higher instance of implant failure at 23.1% than the 0–8% that has previously been published (8-12). However, a majority of these studies were case reports. Furthermore, despite implant failure, only one instance of nonunion was noted, which is more comparable to the published literature values.

The use L5-S1 transdiscal screws is promising as it offers comparable or superior stiffness compared to pedicle screw fixation while providing the benefit of reducing surgical time and avoiding additional fusion levels (12,14). Although originally described for management of patients with moderate L5-S1 spondylolisthesis and minimal lumbosacral kyphosis, L5-S1 transdiscal screws have been effective for both adult and adolescent patients with grade II to IV spondylolisthesis (18).

The L5-S1 transdiscal method of posterior spinal fusion is effective in managing L5-S1 spondylolisthesis but is more technically challenging than traditional pedicle screws. The use of radiological imaging both preoperatively to evaluate a patient's appropriateness for surgery and intraoperatively to guide screw trajectory has reduced perioperative complications (9).

A limitation of the described technique is that it requires good quality intraoperative c-arm images. With the growing obesity epidemic, there is an increasing number of patients whose body habitus will prevent adequate imaging. Our recommendation is that individuals with BMI >40 are not appropriate for this technique. Perhaps intraoperative navigation and robotic technology will provide the means to more effectively place these technically challenging screws in a minimally invasive fashion (8,19). However, the authors have no personal experience with using these techniques for transdiscal screws.

Conclusions

We describe our method of L5-S1 transdiscal screw placement which has previously been lacking in the literature. In our series, L5-S1 transdiscal screws offer a safe and effective alternative method for stabilization of high-grade isthmic spondylolisthesis at L5-S1 and provides indirect decompression of the neural foramina. No patients had major postoperative complication, and only 1 of 13 patients was recommended to undergo revision surgery.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Review Board of the University of Pittsburgh (STUDY20110338) and informed consent for this retrospective analysis was waived.

References

1. Kreiner DS, Baisden J, Mazanec DJ, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of adult isthmic spondylolisthesis. Spine J 2016;16:1478-85.
2. Randall RM, Silverstein M, Goodwin R. Review of Pediatric Spondylolysis and Spondylolisthesis. Sports Med Arthrosc Rev 2016;24:184-7.
3. Dubousset J. Treatment of spondylolysis and spondylolisthesis in children and adolescents. Clin Orthop Relat Res 1997;(337):77-85.
4. Jones TR, Rao RD. Adult isthmic spondylolisthesis. J Am Acad Orthop Surg 2009;17:609-17.
5. Jacobs WC, Vreeling A, De Kleuver M. Fusion for low-grade adult isthmic spondylolisthesis: a systematic review of the literature. Eur Spine J 2006;15:391-402.
6. Möller H, Hedlund R. Instrumented and noninstrumented posterolateral fusion in adult spondylolisthesis--a prospective randomized study: part 2. Spine (Phila Pa 1976) 2000;25:1716-21.
7. Remes V, Lamberg T, Tervahartiala P, et al. Long-term outcome after posterolateral, anterior, and circumferential fusion for high-grade isthmic spondylolisthesis in children and adolescents: magnetic resonance imaging findings after average of 17-year follow-up. Spine (Phila Pa 1976) 2006;31:2491-9.
8. Ho AL, Varshneya K, Medress ZA, et al. Grade II Spondylolisthesis: Reverse Bohlman Procedure with Transdiscal S1-L5 and S2 Alar Iliac Screws Placed with Robotic Guidance. World Neurosurg 2019;132:421-428.e1.
9. Collados-Maestre I, Lizaur-Utrilla A, Bas-Hermida T, et al. Transdiscal screw versus pedicle screw fixation for high-grade L5-S1 isthmic spondylolisthesis in patients younger than 60 years: a case-control study. Eur Spine J 2016;25:1806-12.
10. Joaquim AF, Patel AA. Posterior L5-S1 transdiscal screws for high grade spondylolisthesis - a systematic review. Rev Assoc Med Bras (1992) 2018;64:1147-53.
11. Abdu WA, Wilber RG, Emery SE. Pedicular transvertebral screw fixation of the lumbosacral spine in spondylolisthesis. A new technique for stabilization. Spine (Phila Pa 1976) 1994;19:710-5.
12. Logroscino CA, Tamburrelli FC, Scaramuzzo L, et al. Transdiscal L5-S1 screws for the treatment of adult spondylolisthesis. Eur Spine J 2012;21 Suppl 1:S128-33.
13. Rindler RS, Miller BA, Eshraghi SR, et al. Efficacy of Transsacral Instrumentation for High-Grade Spondylolisthesis at L5-S1: A Systematic Review of the Literature. World Neurosurg 2016;95:623.e11-9.
14. Minamide A, Akamaru T, Yoon ST, et al. Transdiscal L5-S1 screws for the fixation of isthmic spondylolisthesis: a biomechanical evaluation. J Spinal Disord Tech

2003;16:144-9.
15. Kalevski SK, Peev NA, Haritonov DG. Incidental Dural Tears in lumbar decompressive surgery: Incidence, causes, treatment, results. Asian J Neurosurg 2010;5:54-9.
16. Kou J, Fischgrund J, Biddinger A, et al. Risk factors for spinal epidural hematoma after spinal surgery. Spine (Phila Pa 1976) 2002;27:1670-3.
17. Yoshihara H. Indirect decompression in spinal surgery. J Clin Neurosci 2017;44:63-8.
18. Palejwala A, Fridley J, Jea A. Transsacral transdiscal L5-S1 screws for the management of high-grade spondylolisthesis in an adolescent. J Neurosurg Pediatr 2016;17:645-50.
19. Delgado-Fernández J, Pulido P, García-Pallero MÁ, et al. Image guidance in transdiscal fixation for high-grade spondylolisthesis in adults with correct spinal balance. Neurosurg Focus 2018;44:E9.

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