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Surgery for Degenerative Spondylolisthesis: Open Versus Minimally Invasive Surgery

Charles A. Reitman MD

Degenerative spondylolisthesis with stenosis is common. Surgery for it, when indicated, has traditionally been performed

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as a posterior decompression and fusion with instrumentation, and relief of symptoms generally results. More recently, some spine surgeons have advocated for less-invasive approaches to the treatment of this condition. This has theoretical advantages, and it is very marketable and popular with the lay population. While the outcomes appear to be good with either technique, as new technology is introduced, it is important to compare the advantages, safety, and expenses of the new approaches to the more established techniques.

To help address some of these issues, I have invited two well-known experts in the field to discuss and defend their preferences. Jeff Fischgrund MD is a faculty member at William Beaumont Hospital and an authority on this subject, having authored several of the sentinel papers on posterior decompression and fusion with and without instrumentation. D. Greg Anderson MD is a Professor in the Department of Orthopaedic Surgery at Thomas Jefferson University. He is a skilled minimally invasive surgeon who has been teaching these techniques to other spine surgeons for the past decade.

I presented a scenario to both surgeons: a 60-year old female patient with no other significant, uncontrolled medical problems. Her chief complaint is

bilateral lower extremity pain and numbness radiating to her ankles and dorsum of her feet. She failed nonoperative treatment, and she can only walk or stand for less than 5 minutes before she needs to take a break. She finds relief by bending and sitting down. She has good distal pulses and her standing sagittal balance is slightly positive. Otherwise, her exam is unremarkable. AP and lateral standing radiographs (Fig. 1A–B) show a low-grade degenerative spondylolisthesis with overall acceptable lordosis and no other significant deformity. Representative MR images, including a midsagittal cut and an axial cut through the L4, 5 disc space (Fig. 2A–B), confirm severe stenosis at L4, and L5 and primarily one level disease.

Charles A. Reitman MD: *The primary goal of surgery will be to decompress the neural elements, optimize sagittal alignment, and stabilize the spine with a fusion. How safely and effectively are you able to accomplish these goals? Are there circumstances in which you could not accomplish these goals?*

D. Greg Anderson MD: The scenario described here is common in clinical practice. Assuming we are going to perform surgery, the goals are to decompress the neural elements and to stabilize the

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Fig. 1A–B (A) AP radiographs and (B) lateral standing x-rays show a Grade 1 spondylolisthesis at L4 and L5 and good sagittal and coronal alignment.

degenerative spondylolisthesis. The traditional open surgical technique is certainly capable of achieving these goals. However, there are certain advantages of considering a minimally invasive transforaminal lumbar interbody fusion (TLIF) procedure. The minimally invasive procedure can achieve the same goals with reduced blood loss and a reduced risk of surgical site infection compared to open surgery. These two benefits have been shown in multiple studies [3, 5, 9] comparing the minimally invasive approach to an open

technique. There also is less pain and reduced hospital stay for patients treated with the minimally invasive approach [3, 5, 9]. The disadvantage of the minimally invasive technique is related to the learning curve, and the increased usage of intraoperative fluoroscopy [3, 5, 9]. Multiple studies [3, 5, 9] have demonstrated similar long-term clinical outcomes and comparable fusion rates between the traditional open and minimally invasive techniques.

A key point with a minimally invasive TLIF is to perform an

adequate interbody disc space preparation and grafting to ensure an acceptable fusion rate. The surgeon should ensure that as much of the endplate surface area as possible (~70%) is denuded of cartilaginous material. This will require wand or multiple adjustments of the angle of the tubular retractor from lateral towards midline to reach various portions of the disc space. The disc space should be thoroughly packed with quality bone graft material. Using local bone is insufficient in quantity and

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Fig. 2A–B (A) In this T2 image, the midsagittal cut is in the lumbar spine, confirming degenerative spondylolisthesis at L4 and L5, which in this supine image is slightly less than the standing x-ray, and consistent with a dynamic component of the spondylolisthesis. (B) The axial cut through L4 and L5 demonstrates severe stenosis at this level with fluid in the facet joints — also an indicator of a dynamic spondylolisthesis. The remaining axial images showed isolated stenosis to this level.

quality for a minimally invasive procedure. I prefer to use a small trephine to harvest eight to 10 cc of iliac crest bone graft from a small separate incision, which provides an adequate amount for fusion of the disc space and the contralateral facet joint.

Jeff Fischgrund MD: It is my firm belief that the open procedure has significant advantages compared to minimally invasive approaches, including the ability to adequately decompress the nerves, the availability of sufficient local bone graft, obviating the need for bone graft

harvesting, and the consistent ability to obtain a solid fusion. The primary objective of the procedure is decompression; patients undergo this surgery for relief of neurogenic claudication. Although the most skilled minimally invasive surgeons may be able to perform a bilateral decompression from a unilateral “port,” adequate decompression of the contralateral recess and foramina can be challenging. In patients with radicular complaints, an open decompression allows for technically “less challenging” and more adequate

decompression. Dr. Anderson addresses my second strategic point: the adequacy of disc space preparation for fusion. Specialized instruments and techniques are required to adequately prepare the disc space; too often minimally invasive surgeons are content to perform a limited “channel discectomy,” with resultant limited surface area for fusion.

The issue of sagittal alignment continues to gain popularity in the literature and amongst spinal surgeons. I certainly would concede that the addition of an interbody graft to this surgical

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procedure would aid in reduction of the slip and possibly improve lordosis. However, significant slip reduction is often obtained intraoperatively through patient positioning, the effect of the decompression, and pedicle instrumentation [6]. The more central issue is the clinical relevance of the sagittal balance in this patient population. Assuming an adequate decompression is performed and a successful fusion is obtained, the patient will typically have an excellent clinical outcome, independent of the sagittal balance improvement (or lack of improvement). The theoretical issue of adjacent level disease progression, due to sagittal malalignment, has not been clinically proven.

Dr. Reitman: *How difficult is it to address the usual intraoperative complications associated with the respective techniques? Are the risks of surgery different between the two techniques?*

Dr. Anderson: From the standpoint of intraoperative complications, a dural laceration is challenging to repair with a minimally invasive procedure, but is feasible in most cases. I prefer to utilize a double-armed 6-0 Gortex suture (W. L. Gore & Associates, Inc., Flagstaff, AZ) with the micropituitary instrument used as a needle driver. After passing the suture through the dural edges, knots are tied using a standard, arthroscopic knot pusher.

Interestingly, the risk of a symptomatic cerebro spinal fluid leak or dural-cutaneous fistula appears to be reduced with the minimally invasive technique compared with open surgery, presumably due to the reduced dead space with the minimally invasive wound.

Dr. Fischgrund: Intraoperative and postoperative complications are relatively similar between the two techniques. The literature is contradictory in regards to adjacent (nonfused) facet impingement from pedicle screw placement. I believe careful technique should minimize this issue in either procedure. I fully agree with Dr. Anderson's comments regarding intraoperative dural tears — they certainly are easier to repair during an open procedure. Finally, recent literature on the use of topical vancomycin [8] prior to wound closure has had a dramatic effect on lowering the incidence of postoperative infections. At our institution, this has become routine for all posterior lumbar procedures. I suspect that future studies will show the lowered rate of infection will approach that of minimally invasive surgery.

Dr. Reitman: *Which procedure do you think provides the best value (outcomes divided by cost)? Things to consider could include operative time, blood loss, hospital stay, time to return to work, implant costs, and long-term outcomes.*

Dr. Fischgrund: This typical scenario describes a female with classic symptomatic degenerative spondylolisthesis and spinal stenosis. Although somewhat younger than the patients reported from our institution (the average age we see is about 68), it is appropriate to treat her with the standard posterolateral instrumented fusion and decompression. This well-studied condition has shown to fare better with surgical intervention compared with nonoperative treatment [10]. Long-term studies from our center have shown that a solid posterolateral fusion leads to quality long-term (5 to 14 years) results [2]. When deciding whether to add “new technology” to treat this patient, one must carefully balance the perceived advantages to the patient versus the added morbidity and cost of these techniques.

Interbody fusions have become much more common over the past decade due to improved techniques and surgical implants. The recent introduction of expandable interbody cages has allowed the surgeon to insert larger cages through smaller incisions. Interbody fusions are an attractive option due to the presumed increased fusion rate, and ability to indirectly increase the foraminal height by interbody “distraction.” However, the presumed advantages must be weighed against the prolonged operating time, increased complications (due to nerve

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root retraction), and additional implant cost. Ultimately, the addition of an interbody fusion, in this patient population, must show improved outcomes to justify the increased morbidity and expense. Unfortunately, high-quality evidence does not exist to support this technique. Importantly, an analysis of the Spine Patient Outcomes Research Trial data [1] shows the clinical outcome and fusion rates at 4 years are not improved by the addition of an interbody implant.

Dr. Anderson: Dr. Fischgrund makes several important and valid points. Good long-term results have been shown for open decompression with posterolateral fusion for this type of spinal pathology. Minimally invasive approaches, while offering certain theoretical advantages, can potentially add costs and risks that must be considered.

Several studies have analyzed the value obtained by a minimally invasive fusion. Parker et al. [7] prospectively studied 15 open and 15 minimally invasive TLIF procedures, and calculated values in terms of quality adjust life years at the 2-year time point. Parker and colleagues found no cost savings with the less-invasive approach, but Lucio et al. [4] studied a much larger group of 101 open posterior interbody fusion cases in comparison to 109 minimally invasive approaches during the

perioperative period and found a statistically significant cost saving of USD 2825 per case. Complications and blood transfusions were higher in the open cases in this study. Neither study demonstrated an advantage in clinical outcomes between the open or minimally invasive groups.

Choosing the optimal procedure for a given patient is complex and dependent on many factors including pathology, bone quality, obesity, medical comorbidities, and surgeon experience. Of these factors, surgeon experience may be the most important factor. This is particularly the case when choosing a minimally invasive approach (which is more technically demanding) compared with an open decompression and fusion.

Dr. Reitman: *As we think about disseminating new technology, we need to be mindful of technical differences and learning curves. For most surgeons, would you expect differences in this regard between the techniques?*

Dr. Fischgrund: Minimally invasive surgery is an attractive option for spinal surgery. Although the definition of “minimally invasive” varies, the attempt is made to perform the procedure that minimizes tissue damage by either “mini-open” procedures, or through tubular retractors. Many patients are drawn to this technology by misleading marketing, promoting

improved outcomes and faster rehabilitation. These technically demanding procedures require specialized training, operating room equipment, and surgical implants. As with most procedures, there are surgeon champions among us who excel at these techniques. Conversely, there are many surgeons who lack the skills to achieve a successful decompression and fusion through these limited incisions. Prior to recommending this as the “new standard” for the treatment of degenerative spondylolisthesis and stenosis, long-term data is needed to demonstrate superiority and justifying the increased implant cost. In summary, this condition is one of the better-studied pathologies in the spinal literature. Prior to the promotion of new techniques and technology, high-quality outcomes data are necessary.

Dr. Anderson: Minimally invasive surgery has a well-documented learning curve. The learning curve of other surgical techniques has not been as well-studied or highlighted, but clearly this is an important topic. Unfortunately, no studies of which I am aware compare the learning curves of open and minimally invasive surgery for degenerative spondylolisthesis. It is logical to assume that each surgeon, based on prior training and experience, will have a specific comfort level with each surgical technique. This likely will vary substantially between surgeons. For this reason, it is not possible

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to define one surgical technique as superior to the other at the present time. Additional research may one day provide a better answer to which technique is best. In the interim, surgeons should perform the technique that is the best in their hands.

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