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of Tennessee  
Memphis, TN**SpineLine Section Editor:****Jeffrey C. Wang, MD**UCLA School of Medicine  
Los Angeles, CA**CURVE/COUNTERCURVE****Discectomy: Endoscopic  
Foraminal or Standard  
Transcanal?****Which approach would you recommend for a  
posterolateral herniated disc at L4-5?**

A 35-year-old healthy active woman presents with a three-month history of progressive right-sided leg pain. The pain is directed along the right-sided L5 dermatome and is associated with some numbness along the lateral leg and into the first dorsal web space. There is some weakness of the extensor hallucis longus (EHL) muscle on the right side with strength graded at 4/5. There is no back pain. The patient has tried physical therapy and anti-inflammatory medications which helped a little initially, but the pain recurred when she resumed her daily activities after one week of rest. The patient had a transforaminal epidural steroid injection at L5-S1 that gave her four days of complete relief of her leg pain, but it has now returned. She has had two further epidural injections with temporary relief. Currently the pain is almost constant; she rates it as 7 out of 10. She is currently working but has difficulty throughout the day and is interested in a long-term solution.

Plain radiographs demonstrate mild narrowing of the disc space height at L4-5 compared to the adjacent levels. Magnetic resonance imaging (MRI) demonstrates a large right-sided posterolateral disc herniation at L4-5 which compresses the right-sided L5 nerve root and extends slightly into the foramen.

The patient is interested in surgery. How would you proceed with treatment at this point?

**WHERE DO YOU STAND?**

In each issue of *SpineLine*, this column presents responses to a controversial case from two or more spine care physicians. Let us know where you stand by taking the survey at the end of this article. Respond on [www.spine.org](http://www.spine.org) or fax your response to (708) 588-1080. We'll report the results in the next issue. (See results from last issue's question at the end of this case.)

**SEND US YOUR IDEAS**

If you have a controversial topic or case you'd like to see discussed in this column, please submit it to: *SpineLine*  
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**ANTHONY T. YEUNG, MD, RESPONDS**

The recent emphasis on minimally invasive surgical approaches to spinal surgery is a trend that is universally acknowledged as desirable if the risk/benefit and cost/benefit ratios justify the new approach. The endoscopic foraminal approach is desirable on both counts. Wolfgang Rauschnig's work on the macro- and micro-anatomy of degenerative disc disease and the importance of preserving the dorsal muscle column serves as a guide for the ideal minimal approach in the lumbar spine.<sup>1</sup> Postsurgical specimens of patients who had posterior lumbar surgery all have extensive scar formation of the dorsal column muscles, even with smaller incisions. According to Rauschnig, not only were the erector trunci muscles affected, but so were the deep short oligosegmental muscles which account for proprioception and fine tuning of segmental mobility. Rauschnig concluded that surgery should avoid traumatizing the dorsal muscle column.

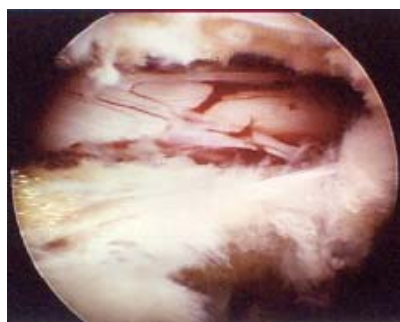
In this case presentation, the assumption is made that the patient has not only failed all nonsurgical methods, but that the myriad of "less" invasive surgical procedures ranging from chemonucleolysis, percutaneous disc decompression and nucleus ablation are not part of the discussion. These "least invasive" alternative techniques are more surgically restrictive, less effective and usually depend on more strict patient selection criteria for clinical success. I will contrast the advantages of a visualized endoscopic foraminal surgical approach to the lumbar

disc against the more traditional transcanal discectomy.

My first treatment suggestion would be to consider a foraminal steroid epidural injection.<sup>2</sup> Assuming that the patient improves with the block but continues to have residuals of continued pain or radiculopathy, the recommendation for surgery will be a shared patient/surgeon decision. Once it is determined that surgical intervention is desired, the debate now centers on the advantages of different surgical approaches in the surgeon's hands, whether it is the traditional transcanal approach (microscope or endoscope assisted, tubular or blade-&-spike retractors) or the transforaminal endoscopic approach.

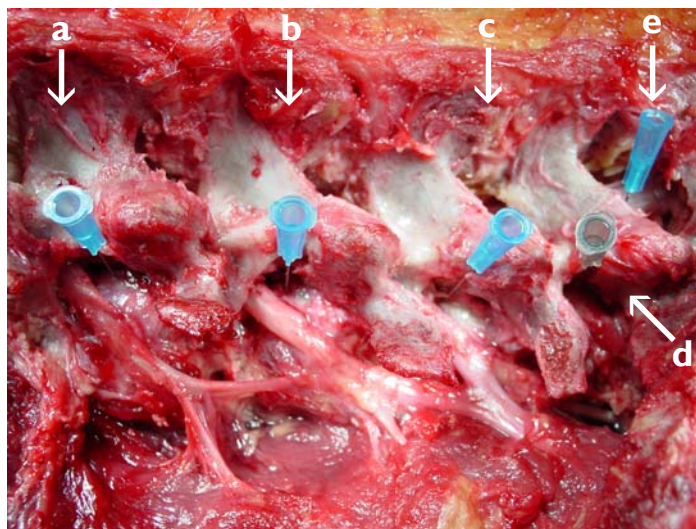
The debate with Dr. Foley in this article will continue the "least invasive" mid 1990s debates of the John McCullough/Parviz Kambin era. McCullough's objection to the endoscopic posterolateral approach was due in part to the steep learning curve and his feeling that the average spine surgeon could not master this approach. I believe McCullough underestimated his own skills as well as the skills of surgeons who can be taught to be comfortable with the endoscope. While neurosurgeons may have limited experience with endoscopy, its use is ubiquitous in orthopedic surgery training. With a standardized technique and with the newer scopes and instruments, surgeons have an approach and technique that is capable of treating the majority of a full spectrum of disc herniations. It's just a matter of getting used to foraminal anatomy.<sup>3-5</sup>

Visualization has been touted as an important factor by traditional surgeons in choosing their method of disc excision. Most who are familiar with the microscope tout it as being unsurpassed for visualization, emphasizing the three-dimensional (3-D) capability of binocular vision, as the best visualized technique. For teaching purposes, the assistant can also see. With the new glass rod lens endoscopes, however, side-by-side comparison of images quickly dispels the notion that visualization is inferior (**Figure 1**). While the microscope is capable of great visual detail, the endoscope can match that detail and provide magnification as well. In a learning situation, the entire operating room (OR) crew can see what is happening on the video screen. The advantage of the endoscope is the ability to



**Figure 1.** Endoscopic view of the foramen in an L4-5 paracentral contained HNP: the traversing nerve is clearly seen after the herniated disc is removed through the foraminal approach.

place the lens and surgical instruments closer to the pathology, which requires less magnification for the same detail. The ability to manipulate the endoscope for viewing the pathology at slightly different angles and the ability to visualize the disc from the inside as well as the foramen overcomes any concern about the lack of 3-D visualization. Accomplished surgeons have also used the endo-



**Figure 2.** Needles are inserted into the discs from L2-3 to L5-S1 (arrow a, L2-3; arrow b, L3-4; arrow c, L4-5; arrow d, L5-S1). Access to each disc is easier the more cephalad the herniation up to T-10. As demonstrated by the needle at L5-S1, (arrow d), it may be necessary to remove the lateral facet to reach the traversing nerve and epidural space, but adjunctive surgical tools such as trephines, burrs and laser, makes this possible for the experienced endoscopist. At L5-S1, access to the disc space is easier with the transcanal approach (arrow e) but an experienced endoscopic surgeon can simply resect the inferior and lateral portion of the superior facet to gain access to the traversing nerve and epidural space and still avoid the dorsal muscle column.

The value of the foraminal approach is the ability to visualize the "hidden zone" described by MacNab<sup>6</sup> and McCullough.<sup>7</sup> Through this approach, lateral stenosis, a common cause of failed back surgery syndrome, is readily addressed. Ultimately, the surgeon should plan the best approach by knowing the foraminal and transcanal anatomy in each individual patient, and by having the ability to utilize both approaches.

scope in all fields of surgery with no problems from the lack of 3-D visualization.

Cadaveric experimental studies comparing the transcanal approach and the foraminal approach clearly showed that both approaches to the lower lumbar discs carry potential risk for injury or violation of blood vessels and spinal nerves. When a surgeon limits his or her exposure, there is a learning curve, and complications may arise because of unfamiliarity with the limited surgical view *in both techniques*. In the foraminal approach, if a spine surgeon can learn how to do his or her own discography and foraminal epidural blocks, he or she will possess the necessary skills for endoscopic spine surgery. The steepest part of the learning curve is accurate placement of the needle into the disc via the triangular working zone. In the transcanal approach, while the surgeon is similarly limited with exposure, he or she is also limited by the approach itself. Resection of lamina, ligamentum flavum and annu-

lus may be necessary to reach the herniation, thus potentially destabilizing the spinal segment. Once there, however, the surgeon cannot see inside the disc to inspect for residual fragments.

The foraminal approach is also more versatile than the posterior approach the more cephalad the herniation level. From T-10 to L-4, the foraminal posterolateral approach offers the greatest and most flexible access to the lumbar disc without the need for laminectomy. (Figure 2) Access to the L5-S1 level can be limited by a high iliac crest, thus individual anatomy must be taken into consideration. The disc can be fully visualized through a 7mm or smaller outer diameter cannula, but there is enough room to insert a cannula as large as 10 mm without retracting the traversing and exiting nerve.<sup>8</sup> The disc can be entered with blunt dilation/fenestration away from the herniation site and nerve root retraction is not required. The most vulnerable nerve is the exiting nerve in the area of the sensitive dorsal root ganglion but experience with the foraminal approach and some endoscopic training will easily allow the surgeon to overcome concerns about this delicate structure.

For an L4-5 mostly contained or paracentral disc herniation, this is a slam dunk approach for endoscopic disc excision. Foraminal access is relatively easy and the risk of injuring the exiting nerve is slim. The traversing and exiting nerve roots do not require retraction. Hinged and flexible rongeurs complement the standard pituitary rongeurs to grasp the base of the herniation from within the disc space, pull the extruded portion back into the disc space and then out the working cannula. If the patient has a sequestered "free fragment" that has migrated, then a standard posterior transcanal approach will more consistently achieve complete herniation removal, although it is possible to accomplish this with the foraminal endoscopic approach.

The transcanal approach, in contrast, may require the partial removal of the lamina of L4 and L5 and a portion of the medial facet, destabilizing the motion segment<sup>9</sup> and creating scarring in the spinal canal by retraction of the L5 nerve root. It will be necessary to remove the hernia at its weakest point, weakening the annulus further and making it more susceptible for a recurrent herniation. Furthermore, the approach will not allow the surgeon to visualize the nucleus inside the disc in order to determine if all of the loose nuclear tissue was removed.

**Once the learning barriers are overcome, however, surgeons who are competent in both techniques will certainly prefer the posterolateral endoscopic disc surgery to microdiscectomy or microendodiscectomy for herniations such as the one presented. It is better for the patient, has less surgical morbidity, has equivalent results, and will not affect a subsequent posterior surgical approach if needed.**

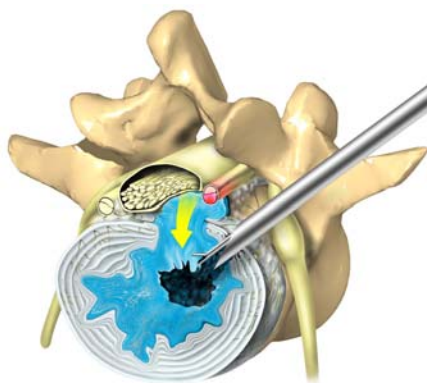
**Anthony T. Yeung, MD**

The only two prospective randomized studies comparing traditional micro-discectomy to posterolateral transforaminal endoscopic discectomy showed equal or better results with the transforaminal endoscopic approach. Hermantin et al performed a prospective randomized study with 30 patients in each group.<sup>10</sup> The mean duration of follow-up was 31 months. Patient satisfaction was 93% in the open surgical group and 97% in the endoscopic group. The endoscopic group returned to work earlier and required a shorter duration of narcotic use compared with the open discectomy.

Mayer and Brock also demonstrated promising results in a prospective randomized study comparing percutaneous discectomy with microscopic discectomy for contained or small subligamentous herniations.<sup>11</sup> The percutaneous group showed comparable or superior results. Long-term disability defined by return-to-work status produced statistically significant differences. In the percutaneous group, 95% returned to their previous occupation compared to 72% in the microdiscectomy group. Each group had 20 subjects.

Yeung and Tsou reported their initial results of posterolateral transforaminal discectomy in their first 307 patients with disc herniations who were candidates for transcanal microdiscectomy.<sup>12</sup> The study included intracanal and extracanal herniations. Recurrent herniations and patients with previous surgery at the same level were not excluded. Results were reported after a one-year follow-up. Ninety-one percent of the patients were satisfied with their results and would opt to undergo the procedure again if they had the same diagnosis and symptoms. The overall complication rate was reported to be 4%.

Tsou and Yeung separated out a subgroup of 219 patients with noncontained herniations and reported the results at one



**Figure 3.** The foraminal approach to the disc is illustrated, utilizing the chromo-discography technique to stain the degenerated disc with indigo-carmin, then extraction of the herniation with the "inside-out" technique with a beveled cannula and working channel endoscope. The beveled cannula allows the surgeon visualization of the epidural space and disc at the same time.





year.<sup>13</sup> Patient satisfaction was 91%. These initial results showed that endoscopic surgery could provide equivalent results to reported results of open microdiscectomy, even with noncontained, extruded herniations.

The greatest barrier to surgeons learning the foraminal approach is the lack of training in their residency. The first learning barrier is the percutaneous approach itself. The posterolateral approach to the disc (**Figure 3**) is not routinely taught in most spine surgery training programs. Dedication to learning the technique is important in establishing and maintaining the skill in recognizing endoscopic anatomy. It is a skill within the grasp of every spine surgeon with proper training. Once the learning barriers are overcome, however, surgeons who are competent in both techniques will certainly prefer the posterolateral endoscopic disc surgery to microdiscectomy or microendodisc-ectomy for herniations such as the one presented. It is better for the patient, has less surgical morbidity, has equivalent results, and will not affect a subsequent posterior surgical approach if needed.

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**The best means of decompressing a symptomatic nerve root, the primary goal of lumbar discectomy, is via an approach that allows for visualization of the root at its site of compression, removal of the offending disc material and exploration of the root to confirm that the primary goal has been accomplished. When the disc herniation is within the spinal canal (as is most often the case), the transcanal approach allows the spine surgeon to reliably accomplish all of this.**

**John W. German, MD and Kevin T. Foley, MD**

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## DISCLOSURE

- FDA Device Status: Yeung endoscopic spine system (YESS) (Richard Wolf Surgical Instrument Co.): approved.
- Author Anthony T. Yeung, MD, reports a consulting relationship with the Richard Wolf Surgical Instrument Company.

## JOHN W. GERMAN, MD AND KEVIN T. FOLEY, MD, RESPOND

The management of lumbar radiculopathy begins with an appropriate trial of nonoperative therapy that may include nonsteroidal anti-inflammatory agents, a short course of oral steroids, epidural steroid injections and physical therapy. If sufficient symptoms persist despite these measures and the patient has radiographic evidence of neural compression that correlates with the clinical syndrome, decompressive surgery is appropriate. How best to accomplish this task is the issue at hand.

The primary goal of surgical treatment of lumbar radiculopathy related to a herniated disc is decompression of the appropriate nerve root. Secondary goals include preservation of the osteoligamentous structures of the spine and minimization of approach-related morbidity. Obtaining the primary goal should result in relief of the radiculopathy; obtaining the secondary goals should limit postoperative pain and accelerate postoperative recovery.

The best means of decompressing a symptomatic nerve root, the primary goal of lumbar discectomy, is via an approach that allows for visualization of the root at its site of compression, removal of the offending disc material and exploration of the root to

confirm that the primary goal has been accomplished. When the disc herniation is within the spinal canal (as is most often the case), the transcanal approach allows the spine surgeon to reliably accomplish all of this. The secondary goals of the surgery relate to decreasing its morbidity and returning the patient to functional activity in a timely fashion. Modifications of the transcanal approach, including microdiscectomy and minimally invasive discectomy via a tubular retractor,<sup>1,2</sup> achieve these secondary goals without compromising the main reason a surgeon operates: to decompress the nerve root. The foraminal arthroscopic approach to lumbar discectomy, on the other hand, suffers from several limitations when it comes to addressing the primary goal of disc surgery. These include a limited applicability to all forms of lumbar disc pathology (including other compressive pathology that can coexist with herniated discs) and limits to exploration of the neural structures to confirm that an adequate decompression has been accomplished. These points will be discussed in more detail below.

**Limited Applicability.** The foraminal arthroscopic approach is limited in its ability to address certain types of disc herniation and other compressive pathology. First, access to some spinal levels may be difficult. For example, a high iliac crest may limit access to the L5-S1 level. This level certainly accounts for a large percentage of symptomatic lumbar disc herniations. In contrast, the transcanal approach can be applied to all levels of the spine including the L5-S1 level. Second, a migrated disc fragment may not be adequately addressed using the foraminal arthroscopic approach. "Turning the corner" after entering the foramen to remove a superiorly or inferiorly migrated disc fragment can be difficult, if not impossible. The transcanal approach gives the spine surgeon the ability to fully navigate the rostral-caudal extent of a lumbar segment through a single, small incision and is ideal for removing migrated disc fragments as well as herniations at the level of the disc space. Because of its limited working space and use of extremely small instruments, the foraminal arthroscopic approach has limited utility for addressing compressive pathology that may coexist with a herniated disc, such as bony lateral recess stenosis. This can easily be handled using the transcanal approach.

**Limited Exploration.** The transcanal approach provides a greater ability to explore the spinal segment and assess the presence and degree of neural compression. Frequently, visualization of the neural elements and compressive pathology is combined with tactile feedback and exploration (such as can be accomplished with a microball-tipped probe). In fact, disc surgeons recognize that such factors as their ability to easily retract a nerve root (or not) can have significant bearing on their assessment of the adequacy of the decompression that has been achieved. Often, following removal of an offending disc fragment, further exploration discloses the presence of other fragments that were not predicted by the preoperative imaging studies. In addition, exploration of a nerve root following discectomy may reveal the presence of significant lateral recess or foraminal stenosis that must be dealt with concomitantly

in order to ensure a good operative result. With the foraminal arthroscopic approach, the surgeon's ability to explore the spinal segment is much more limited. Notwithstanding the previously mentioned difficulties in finding and removing migrated disc fragments, the longer, smaller instruments and smaller working space provided by the foraminal arthroscopic approach significantly limit tactile feedback to the surgeon.

It is conceded that far lateral disc herniations are best dealt with via an extracanal approach. While the foraminal arthroscopic approach is an example of this, it should be noted that far lateral disc pathology can be nicely addressed through a minimally invasive technique using a tubular retractor system or a speculum.<sup>3,4</sup>

**Equivalent Approach-Related Morbidity.** Proponents of the foraminal arthroscopic approach suggest that the technique is minimally invasive and limits approach-related morbidity. While this is true, equivalent reductions in approach-related tissue trauma can be accomplished with modifications of the transcanal approach. Transcanal and, for that matter, extracanal approaches can be performed in a minimally invasive manner using percutaneous access via a tubular retractor. Similar results can be achieved with a limited incision, magnification and illumination (microdiscectomy). These approaches allow the spine surgeon to operate and to address the pathology using instruments with which he or she is most likely to be familiar. Their results are quite good in terms of achievement of neural decompression, they can be routinely performed on an outpatient basis and they allow for an early return to activity.<sup>5,6</sup>

In conclusion, the role of the foraminal arthroscopic approach in treating lumbar radiculopathy is limited when compared to that of current minimally invasive transcanal approaches. As with any novel surgical procedure, time will be the ultimate arbiter.

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## DISCLOSURE

- FDA Device Status: tubular retractor: approved.
- Author Kevin Foley, MD, reports a consulting relationship with Medtronic Sofamor Danek.

*continued on next page*



## SECTION EDITOR'S COMMENTS

This Curve/Countercurve is a continuation of the classic debate between transcanal and transforaminal discectomy for the treatment of a routine lumbar herniated disc. This debate has existed for decades and brings to mind many of the early national and international spine meetings where Parvis Kambin and the late John McCollough, both pioneers in the field of microdecompression through minimally invasive or small incisions, openly and vehemently spoke their minds in a sometimes animated fashion. Both Dr. Yeung and Dr. Foley continue this argument in this issue.

What this debate illustrates is the validity of both approaches to gain access to the disc space and provide for a decompression and discectomy which can lead to excellent clinical results. Obviously, each surgeon is an expert in his chosen technique and one must understand that either technique can lead to poor results if the surgeon is not properly trained. Each is a minimally invasive method for neural decompression, but the end result of each approach must accomplish the same goals as a traditional open discectomy. Each approach must also visualize the anatomy (including the nerve roots) and the pathological disc herniation in order to be effective. These are the basic principles of any type of surgical technique.

Dr. Foley's technique represents more of the mainstream approach to the disc via the epidural space. Through the development of specialized retractors and better visualization with a microscope or endoscope, this surgery is much like the open traditional discectomy, but allows for a smaller incision. The canal and the disc space can be thoroughly explored for other migrated fragments. However, like the open surgery, this does require some retraction of the nerve root and part of the cauda equina, and certainly there exists a small potential for a neurapraxia or stretch injury.

Dr. Yeung's technique is a less traditional approach and relies on an endoscope for visualization. There is no retraction of the nerve root or cauda equina, but perhaps more of the disc may need to be removed – working from the inside of the disc outwards – in order to visualize the herniated fragment. There is also the possibility of new radicular pain in a different dermatome caused by pressure on the exiting nerve root by the cannula. This is usually temporary, but nevertheless worrisome, as it can lead to different symptoms than those that prompted the surgery. In addition, very medial disc herniations or fragments that have migrated superiorly and inferiorly in the canal may not be as accessible from the foraminal approach or may require more resection of the facet joint for visualization.

With either technique, incomplete decompression, recurrent herniations and infections can result as a standard part of any procedure or during the early stages of the learning curve. The surgeon should have a low threshold to convert the procedure into a more open surgery with a larger incision if needed to accomplish the goals of the surgery.

I wish to thank the authors for their time and efforts in writing their viewpoints for this Curve/Countercurve column.

*Jeffrey C. Wang, MD*

## CURVE/COUNTERCURVE SURVEY

### Tell us what you think . . .

#### If this were your patient, which surgical approach would you recommend?

- a. endoscopic foraminal approach
- b. transcanal approach
- e. other: \_\_\_\_\_

#### Much of the choice depends on the training of individual surgeons. Please choose one of the following:

- a. I am only trained to perform the transcanal approach
- b. I am only trained to perform the transforaminal approach
- c. I am trained and able to perform both approaches
- d. I am not a surgeon

#### I believe the transforaminal approach can achieve the same discectomy/decompression as the transcanal approach for a standard posterolateral herniated disc:

- a. true
- b. false

Please vote by visiting the NASS Web site at [www.spine.org](http://www.spine.org) or fax your response to *SpineLine* at (708) 588-1080. Results will be reported in the next issue of *SpineLine* with the next installment of "Curve/Countercurve."

#### Results from last issue, *Controversies in Surgical Treatment of LBP: Fusion or Disc Replacement?*

#### After reading arguments for both sides, the treatment of choice for this patient at this time would consist of:

- a. xx% recommend total disc replacement
- b. xx% recommend surgical fusion
- c. xx% recommend no surgery
- d. xx% recommend other motion-sparing device other than disc replacement
- e. xx% recommend other: \_\_\_\_\_

#### If surgical fusion was indicated, the preferred method of fusion would be:

- a. xx% prefer posterolateral fusion alone
- b. xx% prefer anterior fusion
- c. xx% prefer anterior and posterior fusion
- d. xx% prefer posterior fusion with interbody device
- e. xx% prefer other: \_\_\_\_\_