Transforaminal Endoscopic Lumbar Procedure for Disc Herniations: A "Between" Technique

Kai-Xuan Liu, M.D, Ph.D.
Atlantic Spinal Care
Edison, New Jersey, USA

Bryan Massoud, M.D.
New Jersey Back Institute
Fairlawn, New Jersey, USA

ABSTRACT

Despite the advancement of surgical techniques in endoscopic spine surgeries, treatment of central and paracentral disc herniations, especially disc extrusions and disc sequestrations, remains challenging. On the basis of our experience with treating disc tears, disc herniations, and other spinal diseases, we have developed a new technique we call the "between" technique. This technique involves positioning the opening of the endoscope access cannula at the edge of the targeted disc with half of the opening being positioned inside the disc and the other half positioned in the epidural space. The "between" technique uses a blunt-ended dilator as a navigating tool in the epidural space to find the ideal access path and initial location for the access cannula. The technique is safe, effective, and easy to use. It has been proven particularly efficacious for the treatment of central and paracentral extruded disc herniations and sequestered disc herniations. The purpose of this Chapter is to describe this technique and introduce its application in removing central and paracentral disc extrusions and sequestrations.
Minimally invasive procedures for the treatment of herniated discs were introduced by Smith in 1963. Later, the safety and efficacy of minimally invasive procedures in treatment of the lumbar spine were demonstrated in randomized double-blinded clinical studies. Since then, minimally invasive spinal surgical procedures have been increasingly attracting more attention and the techniques have evolved gradually over the years. In 1975, Hijioka introduced the first percutaneous discectomy. In 1983, Kambin and Gellman introduced a posterolateral approach, also known as the transforaminal approach. Because the approach provides an excellent cannula access from T-10 to L-5 for foraminal structures and is associated with favorable outcomes, Kambin’s transforaminal approach has been widely used in spinal procedures. The development of innovative surgical instruments for minimally invasive spine surgery (MISS), including spinal endoscopes, intraoperative digital fluoroscopy systems, digital video systems, as well as a range of laser technology, has greatly improved the safety and effectiveness of MISS procedures. MISS has become an increasingly desirable treatment of many spinal conditions among patients and surgeons, because MISS procedures are associated with advantages such as smaller incisions, less tissue trauma, enhanced illumination and visualization, and faster recovery.

Surgical techniques, especially how to reach the target site and subsequently how to manipulate the pathological tissue, have a critical role in MISS procedures. Based on how a pathological site in the spine is accessed and where the operating tool is positioned, currently used approaches for lumbar surgery can be classified into two categories: intradiscal and extradiscal approaches. For intradiscal approaches, the opening of the access cannula is inserted to the inside of the target disc. Intradiscal approaches have been proven safe and relatively easy to use. Also, it provides desirable visualization for intradiscal pain pathologies, including disc tears, disc disruptions, interpositional disc herniations, and neovascularizations. However, for minor disc pathologies such as disc radial tears, intradiscal approaches are associated with excessive disc trauma caused by inserting a large access cannula to the disc. Moreover, these approaches have limited use for extruded and sequestered disc herniations, as well as foraminal and extraforaminal pathologies.

For extradiscal approaches, the cannula opening is positioned outside of the target disc, normally in the foram or epidural space. Compared with intradiscal approaches, extradiscal approaches offer much wider applications, including disc tears, contained disc herniations, extruded and sequestered disc herniations, central spinal stenosis, foraminal stenosis, failed back surgery syndrome (FBSS), as well as spondylolisthesis.

To date, mainly two types of extradiscal techniques have been reported. One is the inside-out technique such as the Yeung Endoscopic Spine Surgery (YESS) technique (the access cannula is first inserted to the inside of the disc and then the opening of the cannula is pulled out of the disc to reach the foram or epidural space), and the other is the outside-in technique (the access cannula is initially positioned in the foram or epidural space and then positioned to the inside of the target disc as needed). Both inside-out and outside-in techniques have made great contributions to the advancement of spinal surgery. However, both approaches are also associated with disadvantages and certain limitations. For example, the inside-out technique removes too much normal disc tissue, and it is technically very challenging to remove disc fragments located in the spinal canal. However, the outside-in technique demands an aggressive cut of the facet(s) under a blind (fluoroscopic) approach with a sharp trephine, which poses a high risk of damaging the nerves and dura.

On the basis of our experience with treating disc tears, disc herniations, spinal stenosis, failed back surgery, and spondylolisthesis, we have developed a new technique called the “between” technique, which involves positioning the opening of the access cannula across the posterior disc margin (half of the opening is inside the disc and half of the opening is in the epidural space). A similar technique (known as the “half-and-half” technique) was first introduced by Lee and

![Diagram of the "between" technique](image-url)
his colleagues in 2007. 23

Lee’s “half-and-half” technique proved highly effective for the treatment of “near-migrated” disc herniations, but it has limited use for “far-migrated” herniations. Although our “between” technique and Lee’s “half-and-half” technique share a commonality in terms of the initial positioning of the access cannula and working sheath, the two techniques have different ways of further reaching and treating the target site. The “between” technique has proven highly efficacious in the treatment of central and paracentral disc extrusions and sequestrations, without cutting an excess amount of healthy disc tissue. In this Chapter, we describe our “between” technique designed for the treatment of extruded and sequestered disc herniations.

OPERATIVE TECHNIQUE

The access cannula is positioned at the edge of the herniated disc with the distal opening being inside of the disc and the proximal opening being outside of the disc (in the epidural space, Fig. 1). The surgical procedures using the “between” technique are based on the conventional transforaminal endoscopic approach, and all the procedures are performed in the prone position under local anesthesia.

Positioning the Needle

Under the guidance of a fluoroscope, a spinal needle is inserted to reach the medial margin of the pedicles on the anterior/posterior view and the posterior disc margin on the lateral view. The needle is then advanced to the disc until the tip of the needle reaches the center of the disc on the anteroposterior (AP) view (Fig. 2a) and the posterior annulus of the disc on the lateral view (Fig. 2b).

Positioning a Blunt-Ended Dilator

A guiding wire is then inserted through the needle to the disc. Over the guiding wire, a blunt-ended dilator is introduced to reach the posterior disc margin on the lateral view (Fig. 3a) and the medial margin of the pedicle on the AP view (Fig. 3b). At this time, the guiding wire is removed.

Navigating the Blunt-ended Dilator in the Spinal Canal

After the guiding wire is removed, the blunt-ended dilator is manually advanced to the spinal canal with the
dilator being nearly parallel to the posterior margin. After the tip of the dilator reaches the edge of the disc herniation, the tip of the dilator is pointed slightly lateral to enter the disc (Fig. 4).

Positioning the Access Cannula

After the blunt-ended dilator is located at a satisfactory position, the endoscope access cannula is advanced to the disc over the dilator. Ideally, the access cannula reaches the target area with the distal opening being positioned inside the disc and the proximal opening being positioned in the epidural space (Figs. 1 & 5).

Control of the Access Cannula

Depending on the locations of the disc herniations, the opening of the access cannula is manipulated to face either posteriorly for non-sequestered disc herniations or cephalad or caudad for sequestered disc herniations. The opening of the access cannula is further advanced into the disc, if the disc herniation is located near the disc, or into the epidural space, if the disc fragment has moved away from the disc. After the opening of the cannula is satisfactorily positioned, the disc herniations are then removed (Figs. 6-8).

DISCUSSION

Despite the advancement of endoscopic spinal surgical techniques in the past decade, safely accessing and treating central and paracentral disc extrusions and sequestrations without cutting healthy disc tissue remains challenging. Whereas the inside-out technique has difficulty reaching the central and paracentral disc extrusion and sequestration without cutting healthy tissue, the outside-in technique poses a great risk of spine and nerve damage.

Specifically designed for the treat-
ment of central and paracentral disc extrusions and sequestrations, our “between” technique involves two unique concepts: the first is positioning the opening of the access cannula, across the posterior disc margin, at the edge of the disc herniation with the distal opening of the cannula inside the disc and the proximal opening in the epidural space; the second is using a blunt-ended dilator to reach the target herniation manually in the spinal canal without having to cut healthy disc tissue or facets.

The first concept has been proven valuable by Lee’s “half-and-half” technique and the procedures using the concept have been proven safe and highly effective for the treatment of disc sequestrations. The second novel concept of using a blunt-ended dilator as a navigating tool in the epidural space is to reduce the risk of healthy disc tissue damage as well as spine and nerve injury. Both concepts have been tested in our practice and have been proven to be safe.

Figure 5. Intraoperative fluoroscopic view showing the position of the access cannula.

Figure 6a. MRI showing a large left paracentral disc extrusion.

Figure 6b. Intraoperative endoscopic view demonstrating the epidural space and intradiscal space.

Figure 6c. An entire herniated disc fragment removed using the "between" technique.
Compared with the outside-in and inside-out techniques, the “between” technique offers a number of unique advantages. First, by positioning the opening of the access cannula, through a blunt-ended dilator, the technique provides an easy access to the epidural space without having to cut the facet in most of the cases. Second, because the dilator has a blunt end, manipulation of the dilator in the epidural space is less likely to cause spinal nerve and dura damage. Third, by positioning a half of the opening of the access cannula inside a disc, the technique provides more room for the extraction of large disc fragments and an excellent exposure of annular defect for annuloplasty. Furthermore, the technique allows the access cannula to rotate as needed to expose the sequestered disc fragments that have already migrated in the caudal or cephalad direction of the spinal canal.

Our “between” technique and Lee’s “half-and-half” technique share a commonality regarding the initial position of the operating tool(s). But the subsequent surgical steps of the two techniques are very different, which lead to different surgical applications and outcomes. By using Lee’s technique, a large portion of the target disc (approximately one third of the posterior nucleus pulposus and annulus for the near-migrated disc fragment) has to be removed to create a working space. There is no need for the “between” technique to remove healthy disc tissue in most of the cases, because our “between” technique uses a blunt-ended dilator to find the ideal position for the access cannula. Furthermore, the “between” technique offers flexibility for safely accessing a wide range of target sites, whereas Lee’s “half-and-half” technique was recommended to use only for the “near-migrated” disc fragments.

Like any surgical procedure, the “between” technique is associated with certain risks, especially for surgeons without adequate experience. The potential risks of the “between” technique include potential injury to the epidural veins, dura, and nerve roots caused by the needle, dilator, access cannula, grasper, and other instruments. But in experienced hands, the risks can be minimized.

CONCLUSION

Positioning the opening window of the access cannula at the edge of a targeted disc provides an easy access to pathological tissue either inside the disc or in the epidural space. Using a blunt-ended dilator as a navigating tool in the epidural space is less traumatic and poses fewer risks of nerve or dura damage. Our “between” technique is safe, effective, and easy to use. It is particularly useful for the treatment of central and paracentral disc extrusions and sequestrations.
Figure 8a. MRI demonstrating a disc herniation with caudal migration on the sagittal view.

Figure 8b. MRI showing a large central disc sequestration on the axial view.

Figure 8c & 8d. Intraoperative endoscopic view showing the transverse spinal nerve root and the herniated disc material in the epidural space.

Figure 8e. Extruded disc fragments removed using the "between" technique.
REFERENCES