Treatment of Lumbar Disc Herniations by Interventional Fluoroscopy-Guided Endoscopy

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Summary

The neurointerventional transforaminal endoscopic approach to sequestered disk herniation is a minimally invasive alternative to established microsurgical techniques. In addition to those techniques approaching the nucleus like APLD, the transforaminal approach allows the removal of dislocated sequesters in the epidural space. The main steps of the procedure are fluoroscopy-guided, so a good experience with fluoroscopy based interventional techniques is helpful, but the technique has a significant learning curve. If familiar with the different steps, it allows nearly every lumbar disc herniation to be treated with a very short hospital stay and short rehabilitation time. The paper describes in detail the steps of the procedure, the difficulties and advantages and gives a short review of the relevant literature.

Introduction

Lumbar disc disease is one of the most frequent causes of patient impairment by back pain and or leg pain with or without radicular symptoms and neurological signs. Besides the established classical microsurgical treatment, there are many different therapeutic approaches such as intradiscal therapies (APLD, LPLD, IDET, etc.). Most of these techniques are not suitable for the treatment of sequestered disc herniations. The methods mainly allow access to the disc but not to the epidural space and foramen.

The technique described here allows the

minimal fluoroscopy-guided interventional treatment of nearly any type of lumbar disc prolapse, especially cranially or caudally sequestered lumbar disc herniations and the treatment of foraminal stenosis.

The contraindication is herniation with sequestration posterior to the dural sac and herniation in combination with severe osseous and ligamentary spinal stenosis.

Concerning endoscopic surgery, different techniques and instruments are available. The approach can be transforaminal from lateral and dorsolateral or transligamental from dorsal. The technique described here uses a dorso-lateral approach and allows access to nearly any type of lumbar disc herniation.

Interventional technique

Using a specially designed carbon table allowing 360° fluoroscopy, the patient can be placed prone or in a lateral position (Figure 1). It is important to place the patient properly because of the need for good fluoroscopic demonstration of the spinal anatomy. If the patient or the spine is twisted or angulated, access cannot be controlled. Lateral positioning is more comfortable for the patient and much easier for the anesthesiologist. However, if a bilateral access is planned, the prone position is better and is more stable regarding possible movements of the patient, who is never fully anesthetized.

Anesthesia is without intubation and without so-called full narcosis / general anesthesia. We prefer analgesedation with propofol and ultiva. The patient should be able to respond which is

Figure 1 A) Lateral positioning of the patient. B) Specially designed endotable.

important for access through the foramen with the instruments and to avoid nerve root damage. If there is a good navigation through the foramen, the patient is free of pain and relaxed. If there is contact with the nerve root, the patient will react strongly. This type of anesthesia with an awake patient provides a high range of safety and protects against neurological complications.

The access point through the skin is defined by the fluoroscopic view and the angle to the foramen and disc level (Figures 2 and 3). At segment L5/S1 it is 14 cm lateral from the midline, at L4/5 10-12 cm, at L3/4 8 cm, at L2/3 6 cm. The craniocaudal angle is dependent on the type of sequestration: cranial or caudal or horizontal. In men, access to L5/S1 can be difficult due to a high iliac crest. In such a situation, one can go closer to the midline and take the access through the bone of the facets (Figure 4). These landmarks are guidelines which can be modified depending on the size of the foramen and the individual patient characteristics.

After having defined the access point on the skin surface and the angle and way to the foramen, local anesthesia of the skin is done. Then an 18 gauge spinal needle is placed to the facet joint and local anesthetic is injected, followed by the insertion of a 2 mm guide rod. With 4 and 6 mm dilators, the fascia and the muscles are widened. The spinal needle is removed and the Tom Shidi needle is placed over the guide-wire. The Tom Shidi instrument has a diamond tip and is now used to define the correct way to the target. This has to be done very carefully under fluoroscopic control because once there is a channel in the bone it is difficult to change angle and direction.

The Tom Shidi needle is hammered through or along the bone of the superior facet entering the foramen and the spinal canal. When entering the spinal canal, the resistance diminishes and hammering should be stopped. The diamond tip can be changed to a blunt tip and the device can be advanced to the target point depending on the location of the sequester. The whole procedure is controlled by fluoroscopy. An important landmark is the inner peduncular line which is the border to the spinal canal. Medial from this line, the instruments are inside the spinal canal and care has to be taken not to damage the dura.

The Tom Shidi is removed and the first drill is used (4 mm). This drill is a single use instrument while the other drills can be sterilized and used several times. With the following drills – all with atraumatic blunt tips to protect against nerve root or dura damage – the foramen can be widened and the route for the endoscope is prepared. The last drills are 8 or 9 mm in diameter. Normally 8 mm are sufficient, if there is the need for more radius of the endoscope, a 9 mm drill can be used. For the drills see Figure 5. The whole drilling procedure has to be done very softly without much force to avoid kinking of the guiding rod and to avoid stress for the patient. At the end the 8mm working cannula can be placed, guided by the formerly used dilator.

Now the endoscope can be introduced. It has a 3.5 mm working channel. To improve the view the flushing system is managed by a low-pressure pump and saline solution.

The endoscopic survey starts and with a small forceps and the disc material is removed. At this point, the nerve root is not visible be-

Figure 2 A-C) Access to the disc L3/4 and to L5/S1. Navigation is always at the caudal margin of the foramen to be safe. The nerve root is anatomically at the cranial margin of the foramen. D) Using the spinal puncture needle, additional discography can be performed before starting the navigation with the reamers.

A

B →

Figure 3 A,B) Positioning of the working tube at L3/4 to obtain access to a caudally sequestered L3/4 or a caudal sequestered L5/S1.

cause it is covered by the sequester. Sometimes there is one large fragment which can be removed in one piece and sometimes there are multiple smaller fragments. When the larger fragments are removed, the nerve root is visible. During the working process, the position of the forceps can be controlled by short fluoroscopy (Figure 6).

The view of the endoscopy is dorsal and medial – cranial or caudal to see the fragments. After removal of all free disc material, the working cannula and the endoscope are rotated 180 degrees and the longitudinal ligament and the disc can be inspected. With a small forceps, the hole in the annulus can be passed and

the inner disc space is controlled to remove other loose fragments or disc material inside the disc space. At the end the endoscope and the working tube are removed and the incision is closed with a suture. An antibiotic is given intravenously.

Throughout the procedure, the patient is awake and able to answer questions. If he responds with radicular pain, it is a strong sign to change the access route.

Post interventional management is easy. The patient remains for one hour in the recovery room and is then managed as an inpatient for one night. In special cases the procedure can be done in outpatients. However, in our expe-

Figure 4 Removal of a sequester at L5/S1 with documentation of the position of the forceps in AP and lateral projections.

rience, it is better for the control of possible postoperative pain and side-effects of anesthesia to manage the patient in-house for 24 hours.

A neurological examination has to be performed before and after the procedure. Electrophysiological monitoring can be done during the procedure, but with the described type of analgosedation and the awake and responding patient, we have the best neuromonitoring possible.

Rehabilitation of the successfully treated patient is done in an outdoor environment. The patient receives advices on how to move and behave and a complete physiotherapeutic

and gymnastic program for the next weeks. Return to work is possible after three to seven days.

Difficulties and hazards, possible complications

The main difficulties arise during the beginning of the procedure while defining the access to the foramen and spinal canal. If the patient is not placed properly, if the direction of reaming is wrong, the target point will be missed. The endoscope is not flexible and has a limited field of view. Therefore, the interventional

Figure 5 A,B) Examples of removed sequesters. C) Documentation of the decompressed nerve root S1.

fluoroscopic navigation to the target is the most important step of the whole procedure. Compared to this, grasping the disc piece with the forceps is simple. It is important to do the fluoroscopy not only in one plane. Strong AP and strong lateral x-ray is mandatory. Do not trust a single plane because it gives only information on one direction and no spatial room details. Never continue if the patient is not awake. Too much sedation resulting in a sleeping patient leads to a loss of control and nerve damage is

possible if the instrument is too close to the nerve. If the access is too dorsal, damage to the dural sac can occur. If it is done with the guiding rod or the Tom Shidi instrument and a small amount of CSF fluid is visible, stop and try to gain a new access. Never continue with drilling.

Hemorrhage. In the lower segments, we have never seen any bleeding. The epidural space does not contain large veins and small bleedings are stopped by a short increase in the flushing pressure. In the higher lumbar seg-

ments L1/2 and L2/3, the epidural venous plexus is more prominent and here absolute care is needed to work atraumatically. We have seen only one epidural hemorrhage and it was delayed at level L2/3. It required a change to the open surgical procedure and was without any neurological problems in the follow-up.

Infections. The whole procedure has to be performed in a sterile environment. Do not use an angiography table or interventional rooms without operating room conditions. We administer peri-interventional iv antibiotics and the rate of post interventional discitis or spondylodiscitis is 1:30,000.

Short overview and results of the literature

There are several papers comparing endoscopic versus open surgical therapies. An up-to-date and comprehensive review of the literature was given by Birkenmaier et al. in 2013. They focused on five studies (four randomized, one controlled) and evaluated the results independently.

In summary, the review reached the following conclusions. Compared to microsurgery, the endoscopic operating times were shorter. There was less blood loss and reduced postoperative pain. The duration of hospital stay was reduced, the postoperative rehabilitation process was much shorter and the return to work was earlier than after the microsurgical techniques. Overall, the complication rate was lower in the endoscopic series (statistically significant in two studies; seen as a trend in the others). There were no significant differences in the main clinical outcome

Personal experience

Using endoscopic intervention techniques to treat sequestered disc herniations since 2005, we started with the THESSYS equipment. The instruments and technique were designed for the pure transforaminal approach. However, access to L5/S1 was difficult and the reamers were not atraumatic. There was a risk of damaging the dura or nerve root by the sharp teeth. In 2007,

we changed to the MaxMore System with newly designed reamers and a better possibility to make foraminal osseous decompression and to use reamers with blunt tips thereby significantly reducing the risk of nerve or dura perforation.

Based on our personal experience, we can confirm the results of the literature review cited above. In particular, the post interventional course is markedly shorter than with microsurgery. Concerning blood loss and operating time, we had a different experience. The microsurgery done by an experienced neurosurgeon is similar or even shorter in the difficult level L5/S1 and the fluoroscopy time needed is reduced in microsurgery. The long-term clinical outcome is similar but the rehabilitation process and the return to work is shorter in endoscopic intervention.

The learning curve is relatively long and it needs 50 to 70 procedures to reach an advanced level. It might be more difficult to become familiar with the technique than with microsurgery. The authors' experience based on the personal organization and performance of training workshops is that neurointerventionally trained doctors have fewer problems than microsurgically trained neurosurgeons. Neuroradiologists are very familiar with fluoroscopy-guided procedures from endovascular surgery.

One should start at the easier levels L3/4 and L4/5 with caudal sequestered herniations and treat L5/S1 or L2/3 after obtained good experience. Cranial sequesters at L5/S1 can be especially challenging.

In practice, we established a decision-making process for every patient undergoing invasive spine and disc treatment with neuroradiologists, neurosurgeons and orthopedic surgeons. Based on the individual patient characteristics (risk profile, age, gender, etc.) and the anatomy of the spine and the type of sequestration, we decide to adopt the endoscopic or microsurgical pathway. Even if some unexpected difficulties arise during the endoscopic intervention, we can switch to microsurgery in the same procedure.

In summary, the endoscopic technique is an important tool in the management of patients with disc disease and in many cases a good and equivalent alternative to microsurgery.

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