Contained Herniated Lumbar Disc: CT- and Fluoroscopy-Guided Automated Percutaneous Discectomy—A Revival

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Abstract

The combination of a new device and dual guidance (computed tomography [CT] and fluoroscopy) is similar to other percutaneous devices in achieving a mechanical decompression of the disc. The difference, however, is that the target of the decompression with the current technique is the herniated disc itself. The goal of this combined technique is to create a space, an "olive" around the probe, allowing a decrease in pressure inside the hernia. Percutaneous discectomy under combined CT and fluoroscopic guidance is a minimally invasive spine surgery that should be considered as an alternative to surgery in properly selected patients.

Keywords

- percutaneous
- discectomy
- computed tomography
- disc herniation
- fluoroscopy
- spine
- interventional radiology

Objectives: Upon completion of this article, the reader will be able to describe the patient selection process, technical considerations, and possible complications associated with percutaneous discectomy.

Lower back pain related to disk herniation results in many office visits to general practitioners, and is one of the leading causes of morbidity in industrialized nations. The associated economic impact is significant and pertains to treatment-related expenditures as well as associated time off the job.[1,2]

The recommended treatment plan comprises, as a first step, conservative treatment with a duration varying between 2 and 6 months; such treatment includes medical treatment with anti-inflammatory drugs and analgesics, rest, and physical therapy.

In case of treatment failure, or as a second step, the only alternative recommended for treating this type of pain is surgical discectomy. Surgical discectomy is an "open" surgical procedure performed under general anesthesia. As with any surgery, there are risks related to its invasive nature, including infection, treatment failure, relapse, or postoperative fibrosis.[3,4] Due to advances in interventional radiology, new techniques have been developed that overcome the lack of therapeutic options offered between medical and surgical treatments. Several percutaneous discectomy techniques for herniated disks have been developed in the past few years,

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and provide an alternative to the treatment of lower back pain with disk and nerve root involvement.

The reason these techniques work is postulated to be a reduction in intradiscal pressure and prolapsed disc retraction, thus allowing indirect nerve decompression and, potentially, resolution of radicular pain. These mechanisms are based on the study of Hijikata in 1975 concerning the role of intradiscal pressure, which stated, "Reduction of intradiscal pressure reduced the irritation of the nerve root and the pain receptors in the annulus and peridiscal area."[5] According to several studies, the success rate of these techniques varies between 75 and 80%.[6,7]

The purpose of combining a new device with dual guidance (computed tomography [CT] and fluoroscopy) is similar to other percutaneous devices, achieving a mechanical decompression of the disc. The difference, however, is that the target of the decompression is the herniated disc material itself. The purpose is to treat the herniated disc the way it would be done by a surgical approach, but by removing only the herniated material and with the advantages of a percutaneous approach. This approach uncovers the potential of a percutaneous approach for treatment of lumbar herniated discs, adding the advantage of sparing the nucleus pulposus contained in the disc.

Materials

The device (Herniatome) is composed of an introducing cannula with a side window of approximately 1 cm in length in the distal portion. It fits inside a suction system (motorized probe) connected to a collector. The motorized component is linked to an Archimedean screw. The rotation frequency of the screw allows mechanical reduction in the viscosity of the herniated disc, as well as to aspirate the liquefied material. The binder placed on the superior part of the probe allows the operator to evaluate the amount of herniated material that has been aspirated. The cannula has an angle of approximately 30 degrees in the distalmost portion so that, by rotating it 360 degrees, it can create a complete suction and decompression area. This technique allows decompression via two mechanisms: physical, managing to liquefy the herniated nucleus pulposus, and mechanical, via the suction of the liquefied material.

The procedures are performed under CT and fluoroscopic guidance. The double radiological guidance allows a safe and controlled pathway directly to the herniated material, and a constant visual control of the device (►**Fig. 1**). Patients are placed in the prone position on the CT table, with a bolster placed under the abdomen to decrease the lumbar lordosis.

CT centered on the lumbar discs is then performed, with slice thickness of 1.25 mm. Three-dimensional reconstructions using workstation allow the operator to plan the devices path and choose the safest entry point (to avoid damaging the vascular and nerve structures; ►**Figs. 2a** and **2b**).

After the administration of cutaneous and subcutaneous local anesthetic (1% lidocaine), a 20G guiding wire is advanced until it penetrates the hernia. There are two ways to access the disc, depending on the position of the hernia. In the case of foraminal hernias, the most practical access is posterolaterally. In the case of a median hernia, the most practical access is through the interlaminar space (►**Figs. 3a** and **3b**) (►**Fig. 4**). For paramedial hernias, access depends on the shape of the hernia and the possible approaches are variable (although preferably by a posterolateral approach to avoid the risk of dural sac tear).

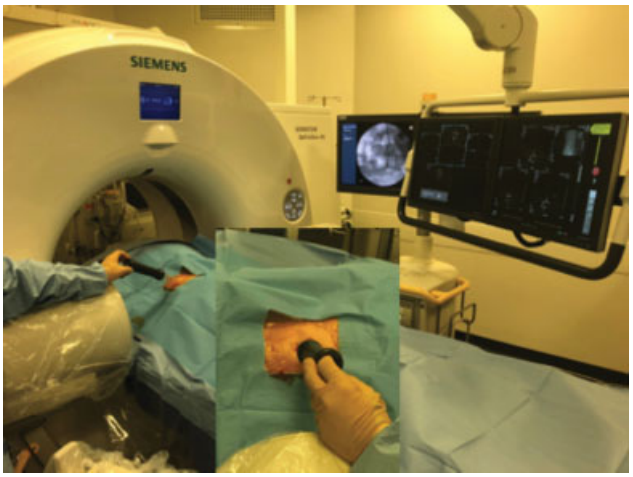

Fig. 1 A helical probe is activated. It penetrates the herniated disc and causes the pulpous material to be mechanically evacuated through the probe under fluoroscopic control during the procedure.

The injection of a few milliliters of iodine contrast product in the disc via the guiding wire permits confirmation of the proper positioning, and allows a discography test to be performed (which is positive if the patient reports the onset of pain that simulates their typical back pain; ►**Figs. 5–7**). If there is nonoptimal distribution of the contrast, the needle is repositioned. Once in the appropriate position, the proximal part of the needle is removed to use it as a guide wire for the cannula. Once the cannula (18G) is in place, the device is introduced and engaged. The duration of probe activity is decided by the operator; the probe is carefully moved by pushing and pulling it with a 360-degree rotation. The goal of this initial portion of the procedure is to create a space, an "olive", around the probe, allowing a decrease in pressure inside the hernia. It is best to collect the herniated material in the binder (►**Fig. 8**). There is no need to have an olive completely devoid of disc material; by aspirating disc material, the change in material composition can be sufficient. The herniated material once under pressure becomes soft and is no longer felt by the operator as resistance against the device. The procedure is complete when successive rotational movements do not remove any further pulpous material. The entire procedure, including patient positioning, lasts approximately 30 minutes for experienced operators. No sutures are necessary. The patient is hospitalized for 48-hour surveillance. Anti-inflammatory medication may be prescribed for a period of 3 days after the procedure.

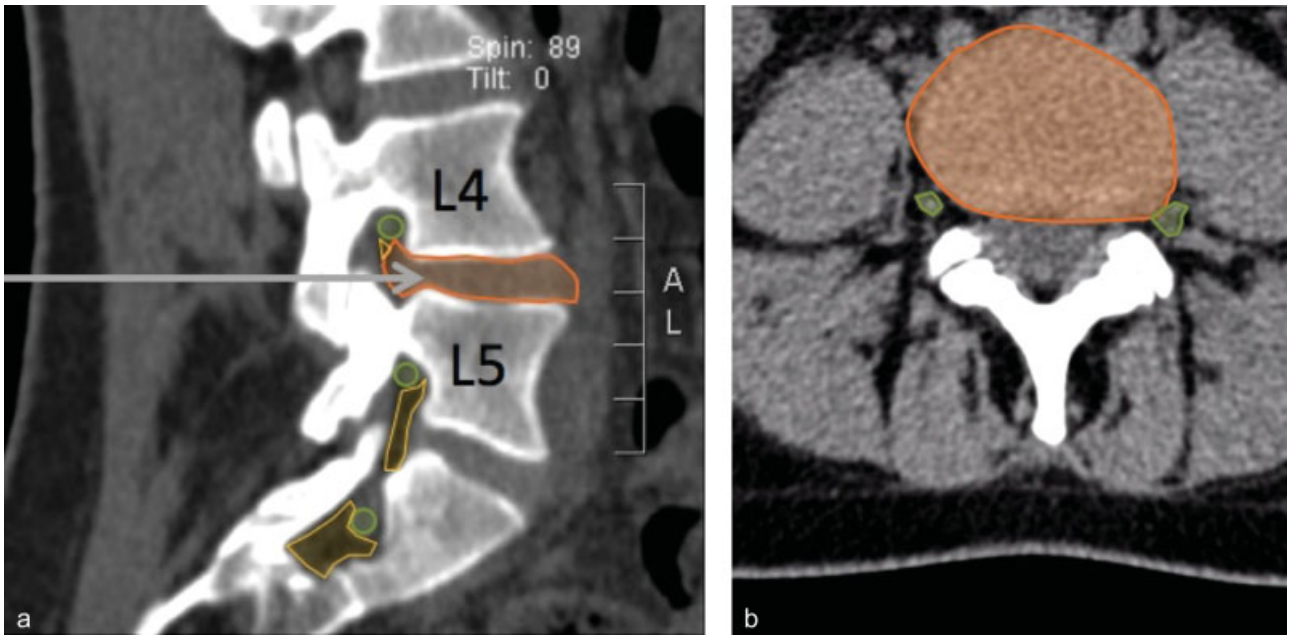

Fig. 2 Patient with left lumbar radiculopathy related to disc herniation demonstrated by MRI. Sagittal (a) and axial (b) CT scan confirmed a L4-L5 left foraminal hernia with associated oedema of the nerve root.

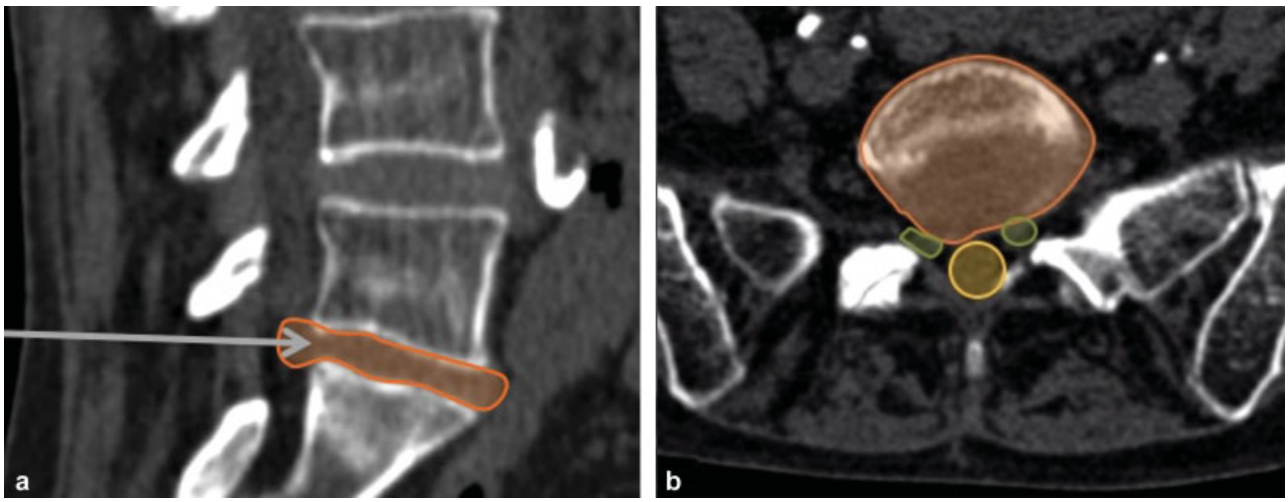

Fig. 3 Patient with right radiculalgia (paresthesia in the calf radiating to the heel). Sagittal (a) and axial (b) CT scan confirmed a right L5S1 paramedial disc herniation with mass effect on the right nerve root.

Results

In the literature, many articles describe good results for percutaneous lumbar discectomy. In particular, Liu et al[8] reported on the difference in the duration of hospitalization and cost between percutaneous discectomy and microendoscopic operative discectomy.[12]

In the authors' experience, the duration of hospitalization for percutaneous discectomy in properly selected patients may be even less than 1 day, thus resulting in shorter hospitalizations than conventional surgery.

The Cochrane database compares microdiscectomy and minimally invasive percutaneous procedures; these findings suggest that infectious complications are lower in CT-guided percutaneous discectomy than in open surgery.[8] Manchikanti et al in 2013 authored an updated review of 19 studies reporting on automated percutaneous mechanical lumbar discectomy for the contained herniated lumbar disc. According to the results of this review, 80% of the patients showed positive results lasting 1 year or longer.[9]

Discussion

In 2013, Manchikanti et al[9] first described in their review how automated percutaneous mechanical lumbar discectomy for the contained herniated lumbar disc may provide

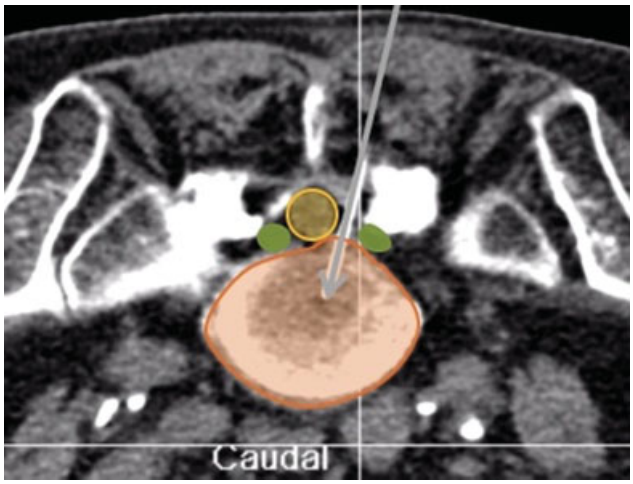

Fig. 4 A juxtadural postero-lateral approach is used for posteromedial or postero-lateral herniated discs.

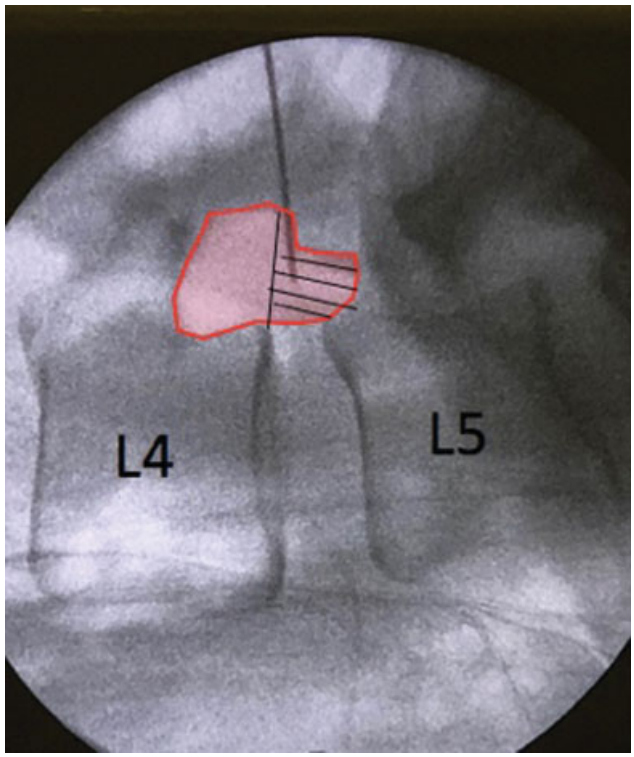

Fig. 5 The procedure is performed under dual guidance with fluoroscopy and CT. The needle path is planned to pass in the lower portion of the foramen.

appropriate relief in properly selected patients. Nevertheless, Hirsch et al,[10] in a systematic review of automated percutaneous lumbar discectomy for the contained herniated lumbar disc, concluded that, based on U.S. Preventive Services Task Force (USPSTF) criteria,[11] the evidence for automated percutaneous lumbar discectomy was only at level II for short- and long-term relief. Moreover, the authors opined that it is difficult to perform a study with enough power to demonstrate a significant difference between techniques. One year later in 2014, Rasouli et al from the Rothman Institute in Philadelphia reported in a Cochrane review[12] that minimally invasive discectomy (percutaneous technical minimally invasive discectomy [MID]) may be inferior in terms of the relief of leg pain, low back pain, and rehospitalization rate than open discectomy; however, differences in pain relief appeared to be small and may not be clinically important.[12]

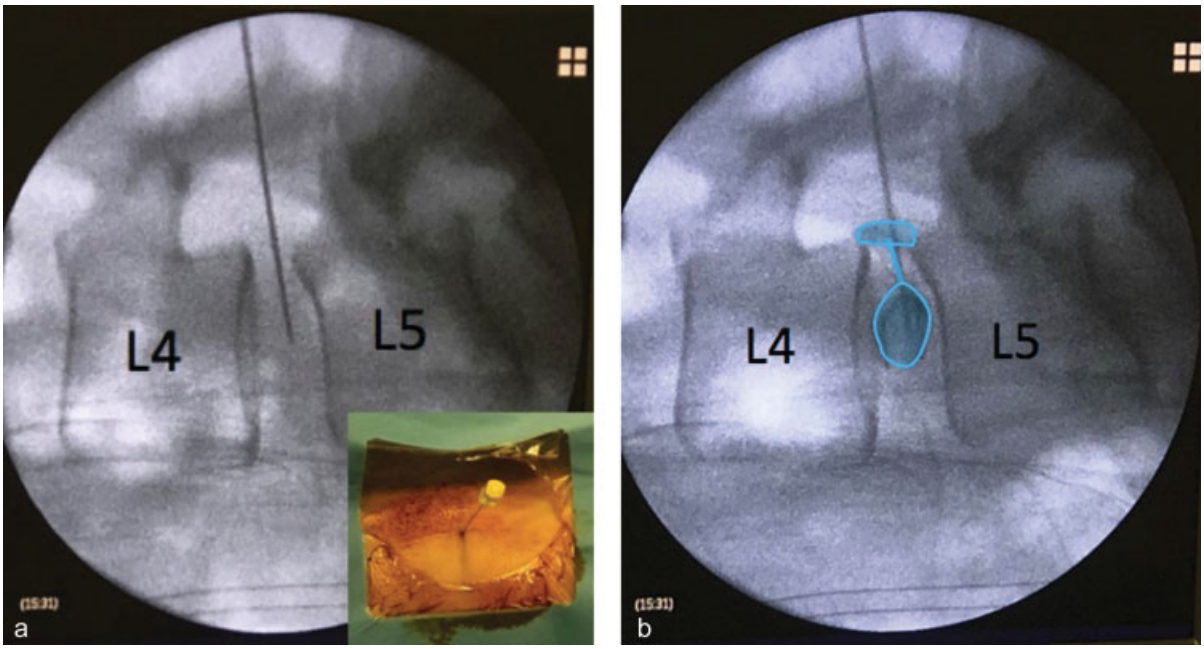

Fig. 6 Discography: Disc opacification facilitates the optimal positioning of the distal tip of the probe in the herniated disc. Accurate needle tip positioning (Image **a**) is confirmed by contrast media injection (Image **b**).

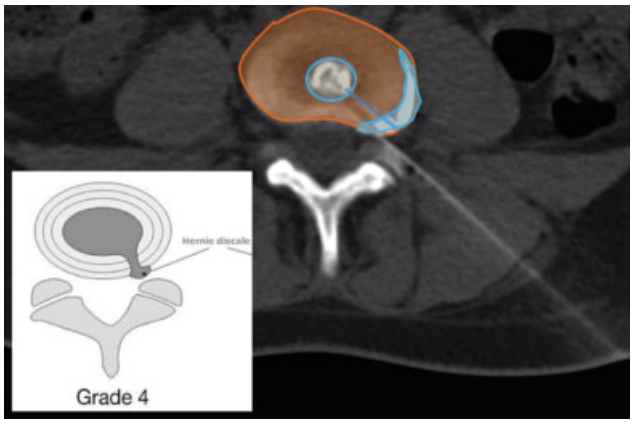

Fig. 7 In case of foraminal or extra-foraminal herniated disc, a postero-lateral approach is used. Axial CT scan image confirm the correct positioning of the needle and CT-guided discography demonstrates the foraminal hernia.

The theoretical advantages of minimally invasive discectomy are a lower risk of surgical site and other infections[12–15] and possible shorter hospital stays, but the evidence is inconsistent. Given these potential advantages, more research is needed to define appropriate indications for MID as an alternative to standard surgery.

In 2009, in the Journal of Cardiovascular and Interventional Radiology, a Chinese team compared percutaneous lumbar discectomy (PLD) with microendoscopic discectomy (MED). These authors showed that in the MED cohort, the cost and length of hospitalization are greater than that in the PLD without complication for the same treatment efficiency.[12]

Fig. 8 Visualization of an intra herniated disc material sample at the end of a procedure allows a qualitative judgement of the decompression. The phisiologic size of a nucleus approaches this of an olive core.

Conclusion

Percutaneous discectomy under combined CT and fluoroscopic guidance is a minimally invasive spine intervention that should be considered as an alternative to surgery in properly selected Patients. Percutaneous lumbar discectomy has been shown in the literature to produce a lower risk of infection and shorter hospitalizations, with at least 80% of patients demonstrating results lasting for 1 year or longer.[8] This technique presents several advantages: the small diameter of the probe allows a cutaneous incision of only a few millimeters (leading to a lower risk of surgical site infection), and a transcanal approach can be possible; it also decreases the risk of ligamentous injury and does not cause an osseous defect of the posterior arc or of the adjacent muscular structures allowing a shorter time of recovery after intervention compared with surgery.[16–21]

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