Microdiscectomy can be described as the technique of performing a lumbar disc excision using an operating microscope, using standard microsurgical techniques, through a small incision. The concept was first described by Caspar and Yasargil independently in 1977.\textsuperscript{1–5} In the United States, the technique was first described by Williams\textsuperscript{6} and subsequently by Wilson.\textsuperscript{7,8} Following its initial description, the procedure has evolved to incorporate the technological advances that have happened with the operating microscopes, micro-instruments, and retractor systems.

The technique certainly has a steep learning curve. However, its proven safety and efficacy over the past 40 years has made the procedure the gold standard for performing a lumbar disc excision. This is the technique against which all procedures, particularly the newer minimally invasive techniques, will have to be measured for their outcome profile.

Preoperative

Proper patient selection is the most important criterion for a successful surgical outcome. Impeccable matching of the clinical findings with radiology is a prerequisite to surgery. The author’s unit follows the World Health Organization (WHO) Surgical Safety Checklist\textsuperscript{9} to ensure surgery at the correct level and the correct side.

Anesthesia

Microdiscectomy has been traditionally performed under general anesthesia. In recent times, there has been greater use of local and regional anesthetic techniques, especially epidural anesthesia with newer minimally invasive surgical techniques to reduce length of hospitalization.\textsuperscript{10–13} The author continues to use general anesthesia because of better patient compliance and predictability. At induction of anesthesia, a dose of ceftriaxone (30–50 mg/kg), amikacin (15 mg/kg), and dexamethasone (16 mg) is usually administered if not contraindicated (use of steroids is not standard but optional based on surgeon’s bias).

Positioning

The original descriptions of microdiscectomy were with the patient in prone position. Although there have been many subsequent reports of the procedure being performed in the lateral position,\textsuperscript{10,13} the author prefers the prone position because of its ease of use, practicality, and the ability to tackle bilateral pathology.

While positioning the patient, some fundamental principles should be followed. Firstly, the abdomen should be allowed to hang free of any compression. Increased intra-abdominal pressure increases spinal epidural venous congestion and bleeding. Next, the lumbar spine should be flexed at the appropriate level of surgery. This opens up the interlaminar space and makes for an easier approach. Lastly, care should be taken to avoid any pressure on the eyes and to safeguard all potential pressure areas such as the knees, elbows, chin, toes, etc. (Figs. 6.1–6.3).

For prone positioning of patients during surgery, various frames are available such as the Wilson frame, four-post Relton–Hall frame, Montreal mattress, etc. A pair of cylindrical bolsters can also be used. The author prefers to use a modification of the Montreal mattress (Fig. 6.4) because it is easy to use, easy to clean, and does the job well.

The surgical approach is traditionally from the side of the extruded fragment—a left sided disc prolapse is approached from the left side...
and a right-sided prolapse from the right. The surgeon should stand on the side of the surgical approach, with the assistant across the patient on the other side. The scrub nurse should ideally be on the right hand side of the surgeon. The anesthesia machine and the anesthetist are at the head end of the patient. The microscope is usually toward the foot end, either on the side of the surgeon or opposite depending on available space, with the Contraves Stand positioned to afford maximum manoeuvrability (Fig. 6.5).

Operating Microscope

This instrument is now an essential requirement for any modern operating room (OR) and is a primary requirement for performing a microdiscectomy. An operating microscope provides focused illumination and magnification of the operating field, thereby providing unparalleled visualization of the dura, nerve root, and disc through the narrow and often deep corridor of a small incision. This level of vision is not achievable with the naked eye or even with a surgical loupe. The other important advantage is that it enables the surgeon to change the field of view by tilting the microscope or the patient, especially useful when trying to get lateral to the root or medially into the disc space, without having to enlarge the bony or skin openings.

Modern operating microscopes are available in various configurations and from many manufacturers such as Zeiss (Carl Zeiss Meditec AG, Jena, Germany), Leica (Leica Microsystems, Mannheim, Germany), and Haag-Streit (Haag-Streit Medical Devices, Zug, Switzerland). They are available as floor- or ceiling-mounted...
models. The ceiling mounting potentially frees up floor space but restricts the microscope to one specific OR. The operating table and patient positioning should also be done within the movement arc of the microscope. The floor standing microscopes are more mobile and versatile. They can be positioned according to requirement and can be potentially moved between ORs (Fig. 6.6).

The standard microscope nowadays comes with a counterbalanced floor stand that supports the microscope head on a long arm, so that the stand can be clear of the operating field. The main eye piece provides binocular vision, enabling a three-dimensional (3D) view. Ideally, there should be a binocular assistant’s eye piece, to allow a similar view to the principal assistant. The microscope provides focused, brilliant illumination to the operative field. This is done through a fiberoptic system with a xenon light source (halogen in the older systems), which provides cold white light. The standard magnification is 4X to 12X, and the usual working distance in most models ranges between 200 and 400 mm.

There are some optional extras that one can consider which add value (and cost) to the system. The most useful is the ability to take photographs of the procedure, both still and videos, which can be saved to hard drives for subsequent use by the surgeon and/or patients. The newer models are compatible with the currently available spine navigation systems for seamless integration.

Premade sterile drapes are available for most microscope models, both from the manufacturer and local suppliers. It is better to use sterile drapes rather than relying on formalin fumigation of the scopes. Sterile drapes are more user friendly, allow rapid turnaround of the instrument, and do not damage the optics. There is a learning curve to using an operating microscope, and it is best to learn in a center that regularly performs microsurgery.

**Technique of Surgery**

After positioning of the patient, the level of surgery is ascertained first. This is confirmed by inserting a needle at the appropriate interlaminar space and taking a lateral X-ray with the C-arm. To avoid an inadvertent dural puncture, this needle is inserted 1 inch laterally from the midline on any one side. It is important to avoid angling the needle and to always insert it perpendicular to the patient because even small angulations can lead to deviation by one or more levels, especially in obese patients (Figs. 6.7a, 6.7b).

A 1- to 1.5-inch linear midline incision is made and deepened through the subcutaneous tissue to expose the lumbodorsal fascia. The lumbodorsal fascia is incised with electrocautery from the rostral edge of the spinous process above to the caudal edge of the spinous process below. The erector spinae muscle attachment is stripped off the two adjacent spinous processes and laminae. This is made easier by accessing the subperiosteal plane with the electrocautery initially and then continuing the dissection bluntly with a Cobb elevator. The muscles are dissected off till the facet joint, taking care not to damage the facet joint capsule.
The superior and inferior lamina and the interlaminar space with the ligamentum flavum are now exposed. We always confirm the level again by attaching a pair of Allis tissue forceps to the soft tissue on the superior and inferior laminar edges and taking an X-ray before proceeding any further (Fig. 6.8). If one is perhaps at the wrong level, this is time to know that, before excision of any bone or ligamentum.

The microdiscectomy retractors are now positioned to maintain the interlaminar exposure once the level is confirmed. The retractors are available in many different designs. The author uses the Caspar retractor, which has two opposing blades: a hook-ended single spoke on the medial side and a two-pronged blade (available in a set of different lengths) laterally (Fig. 6.9). The soft tissues on the adjacent lamina and the intervening interlaminar space are removed with blunt pituitary rongeurs to display the ligamentum flavum clearly. Hemostasis is meticulously performed to achieve a bloodless field, because even small trickles of blood will be a source of immense irritation later.

The operating microscope is brought in at this stage. Under the illumination and magnification provided by the microscope, the ligamentum flavum is dissected off the ventral surface of the caudal end of the superior lamina. A limited bone resection is now performed by removing 4 to 5 mm of the lower border of the upper lamina taking care not to encroach into the facet joint. This can be done with 3-mm Kerrison rongeurs or using a high-speed drill.

**Fenestration**

The ligamentum flavum needs to be excised to visualize the dura and epidural tissues. This can be done in a variety of different ways. Our preferred method is to incise the ligamentum

![Fig. 6.7 (a) Localizing the involved spinal segment prior to incision. (b) Localizing needle must be placed perpendicular to the skin at the level of the herniated disc, approximately 1 inch away from the midline.](image)

![Fig. 6.8 Confirmation of the pathologic level before performing the fenestration.](image)

![Fig. 6.9 The Caspar microdiscectomy retractor.](image)
with a number 15 scalpel blade on a long bayonetted handle. It is crucial to have a clear bloodless field to be able to see the bluish sheen of the dura through the incised yellow of the ligamentum flavum. The incision can be widened with a blunt Penfield dissector and the flavum excised with 2- or 3-mm Kerrison rongeurs or the entire ligamentum can be excised sharply with the scalpel.

The dural sac, usually covered with a layer of epidural fat (with epidural veins running through it), should now be displayed. It is difficult to be sure whether this is the nerve root or the dural sac initially. The epidural soft tissue should be gently dissected with a blunt dissector off the dura. This will usually also involve bipolar coagulation (set at very low power) of the epidural veins running through this tissue and cutting them with bayonetted microscissors to expose the underlying dura. It is essential to identify the lateral edge of the dural sac and trace that rostrally and caudally to identify the nerve root. The nerve root is usually pushed dorsally and laterally by the underlying disc prolapse. However, sometimes the root can be pushed medially by a posterolateral prolapse. Gentle palpation with a dissector will help identify the location of the disc space and often the prolapsed fragment too, which will have a softer feel.

It is important not to incise anything until the anatomy of the dural sac and the location of the nerve root are identified with certainty. In the presence of a large extruded fragment, the nerve root may be stretched so thinly over the fragment that it can resemble the posterior longitudinal ligament (PLL). Until the nerve root is located, it is safer to assume that it is hidden laterally under the facet joint and out of the line of sight of the microscope.

Once the nerve root is located, it is useful to dissect away the overlying epidural soft tissue with a dissector and delineate the lateral edge of the root. Overlying ligamentum flavum can be now excised with a 2-mm Kerrison rongeur carefully to improve visibility and access lateral to the root. The junction of the lateral edge of the nerve root with the dural sac is referred to as the “shoulder” of the root whereas the junction of the medial border of the root with the dural sac is called the “axilla” of the root.

Removal of the disc fragment (sequestrectomy) or excision of the disc (microdiscectomy) is best performed by retraction of the shoulder of the root medially and utilizing the corridor between the lateral edge of the laminotomy and the shoulder of the nerve root. If this space is too narrow, visualization can be improved by tilting the patient toward the surgeon. The nerve root should be gently dissected off the underlying prolapse and retracted medially with a nerve root retractor held by the assistant. Often, a sequestrated fragment will start to extrude into the space created lateral to the shoulder. If this happens, the fragment can be gently teased out progressively with a micro blunt hook or gently tugged out by holding it with a narrow pituitary rongeur. Sometimes, the extruded fragment will be under an intact PLL. In that case, the PLL will need to be incised with a number 15 or 11 scalpel blade. The assistant should retract the nerve root and dural sac medially with the nerve root retractor. It is safest to start the incision immediately lateral to the dura and extend it outward and laterally. Two such incisions are made in a cruciate fashion to create a window within the PLL. This should usually cause the extruded fragment to start herniating out of the window created. The fragment can then be fully removed by teasing it out progressively and grabbing it with a narrow pituitary rongeur.

The nerve root and dura will become distinctly slack as soon as the bulk of the disc fragment is removed. The root retractor can be repositioned to explore the ventral dural surface for any other fragments. The nerve root can now be traced distally to rule out the presence of any fragments tracking along into the foramen. A long nerve hook can also be inserted parallel to the root to confirm the absence of any obstruction.

Sequestrectomy versus Microdiscectomy

Sequestrectomy is the removal of the extruded fragment. This also usually includes visualization of the capsular rent and feeling through the rent for any obvious loose fragments, which can then be pulled out and removed. Microdiscectomy involves excision of the disc material in the disc.
space in addition. This will need insertion of instruments into the disc space. If the capsular rent is large enough to permit insertion of curettes and rongeurs, one can proceed with that. However, most often, a formal opening of the capsule will need to be performed. With the nerve root retracted by the assistant, a square opening is made in the capsule immediately lateral to the dural edge with a number 15 scalpel blade. The first incision is parallel to the root into the disc space from superior to inferior. The next two cuts are perpendicular to this incision along the upper and lower endplates of the disc, and the final incision joins these cuts as far laterally as is feasible. This square of capsule and attached disc is removed with pituitary rongeurs. Now, the disc space can be entered under vision. Progressively larger straight pituitary rongeurs are gently inserted into the disc space, opened inside, and closed to grab the disc material and pulled out. Care should be taken not to damage the endplates. Upward and downward angled pituitary rongeurs are also used to get maximal clearance of the disc material. It is of crucial importance to remember that the average disc space is 2.5 to 3 cm deep. It is disastrous to go past the anterior longitudinal ligament (ALL)—likely to cause injury to the aorta, inferior vena cava, or iliac vessels depending on the level of surgery. Some disasters can also lead to bowel injury. One of the tips of avoiding this calamity is to never insert the rongeurs more than a few millimeters beyond the hinge into the disc space.

Very occasionally, the disc fragment is protruding through the axilla of the root, and it is impossible to get to the shoulder of the nerve root. In such a situation, the disc fragment may be removed through the axilla of the nerve root. As soon as the fragment is removed, it should be possible to retract the nerve root medially and perform the rest of the procedure over the shoulder of the root. It is very easy to cause a dural tear at the axilla, often with even minimal manipulation.

Dural Tear

The incidence of incidental durotomy during a virgin microdiscectomy is 1 to 3% in most studies. The incidence is higher with surgery for recurrent discs because of scarring. The common causes of the durotomy are inadvertent inclusion of the dura while biting off the ligamentum with Kerrison rongeurs; separating adhesion of the dura to inflamed epidural tissue, PLL, or disc material; and while attempting to deliver a disc fragment through the axilla of the nerve root. If the durotomy happens before the disc is removed, the nerve roots tend to prolapse out of the tear along with cerebrospinal fluid (CSF) due to the local increased tension within the dural sac. It is best to cover the rent with a wet cottonoid and proceed with the discectomy. The dural rent is much easier to visualize and deal with once the dural sac is lax after removal of the offending fragment. If the tear is well visualized and accessible to suturing, it should be sutured with interrupted 6–0 Prolene. The repair is then buttressed with a patch of fat (harvested from the epidural space or from the subcutaneous tissue) and tissue fibrin glue (Tisseel, Baxter International Inc, Deerfield, USA). More often, if the tear is in a location where primary closure by suturing is not feasible like in the ventral dura or in the axilla, then the tear is on-laid with a patch of fat graft and covered thoroughly with Tisseel. Self-adhesive dural substitutes are also available, which can be used instead, with or without the fat graft. In the event of a durotomy, flat bedrest for 48 to 72 hours is usually advocated postoperatively. A wound drain should not be inserted.

Closure

Meticulous attention is given to hemostasis of both the epidural space and erector spinae muscles. A drain is usually not needed. The fascia is closed with interrupted or continuous number 1 Vicryl. The subcutaneous tissue is approximated with 2–0 Vicryl, and the skin is closed with subcuticular 3–0 undyed Vicryl. The patient can be ambulated the same day after recovery from anesthesia. The patient can usually be discharged the following day, although same day discharge has also been well documented. (The author prefers to give three doses of intravenous antibiotics, usually ceftriaxone 2 g (first dose at induction of anesthesia and two further doses 12 hourly). Patients are not prescribed any lumbar belts or corsets postoperatively. They are asked to
Lumbar Disc Herniation

Avoid squatting on the floor, repetitive forward bending, and lifting more than 10 kg for the first month after surgery.

Summary

Microlumbar discectomy is currently the gold standard among surgical procedures performed for lumbar disc herniation (LDH). The microscope provides excellent illumination in the depth of the wound, even through a small incision and in obese patients. Illumination and magnification provide clear visualization of the ligamentum flavum, dural sac, nerve root, disc, and epidural vessels, thus enabling safer surgery. Tilting of the microscope or table allows visualization of various parts of the spinal canal—rostrally, caudally, laterally, and medially across the midline when necessary. Besides, the microscope is a fantastic teaching aid and also allows recording of the pathology/procedure for documentation and research. Using microsurgical techniques, surgery for LDH can be performed as daycare or short stay because of lesser postoperative pain and immediate mobilization.

Key Points

- Meticulous patient selection—correlation of clinical findings and radiology.
- Proper positioning—abdomen to be free, care of pressure areas and eyes.
- Confirm correct side. Approach should be from the side of disc herniation.
- Mark level of incision with C-arm and reconfirm level after exposure.
- Preserve facet joint capsule during muscle dissection.
- Preserve facet joint during bone removal.
- Meticulous hemostasis at all stages of the operation.
- Gently dissect the ligamentum flavum off the dura, before excising it.
- Always identify dural sac and nerve root before any disc removal or incision.
- Preferably, approach disc from “shoulder” of the nerve root.
- Intraoperatively, if the disc prolapse does not match magnetic resonance imaging (MRI) appearance, suspect wrong level/wrong side.

Pitfalls

- Pressure on the abdomen or a full bladder can result in congestion of epidural veins and bleeding intraoperatively.
- If the localizing needle is placed at the level of the disc space rather than the interspinous interval, there is a tendency to drift up into the cephalad disc space.
- In chronic disc herniations, adhesions between the flavum and dura can result in dural tears during flavectomy.
- Iatrogenic instability due to excessive removal of pars or medial facet, more likely in the upper lumbar segments.
- Learning curve for using operating microscope and micro-instruments.
- Tissue differentiation is sometimes difficult under the microscope.
- A small disc fragment appears very big when visualized through the microscope, resulting in a mistaken impression of having performed an adequate disc excision.
- Avoid inserting instruments deep (> 1–1.5 cm) into the disc space to avoid penetrating the ALL and injuring anterior vascular structures.
- Remember anatomical variants such as conjoint roots.

Must-have Paraphernalia for Microdiscectomy

- Operation checklist for correct patient confirmation, availability of all imaging studies, blood reports, etc.
- Mattress for prone positioning.
• Microdiscectomy retractors.
• Operating microscope with assistant view.
• Micro-instruments.
• Bipolar diathermy.

Optional Extras

• High-speed drill or bone scalpel.
• Neuromonitoring.
• Tissue fibrin glue (Tisseel).

References