Full Endoscopic Operations of Lumbar Disc Herniations with Transforaminal and Interlaminar Approach

a report by
Sebastian Ruetten

Head of the Department of Spine Surgery and Pain Therapy, Centre for Orthopaedics and Traumatology, St Anna Hospital, Herne

The goal of therapy in symptomatic lumbar disc herniations is a successful, conservative procedure. However, when other possibilities have been exhausted, an operation may be necessary. Conventional procedures show good results. Nonetheless, these result in scarring of the epidural space, which may be unremarkable in the magnetic resonance image (MRI), but become clinically symptomatic in 10% or more of cases. Revision of such scars is demanding, apt to recur and usually not completely possible. Even when a pain syndrome is present, an attempt is made to avoid such procedures. Study results reveal technically possible. Nonetheless, problems in sufficient resection of disc herniations lying within the spinal canal cannot always be ruled out. With the newly developed lateral access, the spinal canal can be reached more sufficiently under direct and continuous visualisation. However, the bony perimeter of the foramen, the pedicle and the exiting nerve can limit the mobility and resection of dislocated herniations. Moreover, the pelvis may block access to the lower levels. Thus, there are limitations to the transforaminal procedure. The full endoscopic interlaminar access has been developed to enable the operation of pathologies inaccessible through the transforaminal technique.

Minimally invasive techniques can reduce tissue damage and its consequences. Endoscopic operations under continuous fluid flow have become the standard in many areas. The most widely used full endoscopic procedure for the lumbar spine is the transforaminal or extraforaminal operation with posterolateral access and predominantly intradiscal and foraminal working area. Laser and bipolar current may be applied. Removal of the intra- or extraforaminal sequester is technically possible. Resection of the sequestered nucleus material within the spinal canal, in the sense of a retrograde resection performed intradurally through the existing annulus defect, has been described. Nonetheless, problems in sufficient resection of disc herniations lying within the spinal canal cannot always be ruled out. With the newly developed lateral access, the spinal canal can be reached more sufficiently under direct and continuous visualisation. However, the bony perimeter of the foramen, the pedicle and the exiting nerve can limit the mobility and resection of dislocated herniations. Moreover, the pelvis may block access to the lower levels. Thus, there are limitations to the transforaminal procedure. The full endoscopic interlaminar access has been developed to enable the operation of pathologies inaccessible through the transforaminal technique.

Open interlaminar access has been described since the early 20th century. Thirty years after its introduction, alternative methods for operating on disc pathologies were developed. The posterolateral access for vertebral body biopsies was described in the late 1940s. Percutaneous operations – in the sense of mechanical intradiscal decompression or via chemonucleolysis – have been applied since the early 1970s. In the late 1970s, a microsurgical procedure using a microscope was developed for interlaminar access. Endoscopes have been used since the early 1980s for inspection of the intervertebral space after completed open surgery. The full endoscopic transforaminal operation with posterolateral access developed out of this. Endoscope-assisted interlaminar procedures were published in the late 1990s. Lateral access for the full endoscopic transforaminal operation for more sufficient access to the spinal canal under continuous vision was developed in the late 1990s. Development of the full endoscopic interlaminar access proceeded at the same time.

Technical problems arose from small and not actively flexible instruments, coupled with a small intraendoscopic work canal. Insurmountable difficulties could arise in the resection of hard tissue, the anatomic access, the mobility and the elevated recurrence rate. New optics with an intraendoscopic 4.1mm work canal and corresponding instruments, as well as shavers and burrs, were developed with the objective of permitting full endoscopic operating under continuous visual control.

Full Endoscopic Transforaminal Approach

The inclusion criteria for the transforaminal approach are all extra- and intraforaminal disc herniations. With respect to limited technical mobility space, the following exclusion criteria apply for disc herniations located within the spinal canal: sequestering towards cranial beyond the lower edge of the cranial pedicle, or towards caudal over the middle of the caudal pedicle; and lateral radiological overlap of the foramen by the pelvis beyond the middle of the cranial pedicle. There is no limitation to

© TOUCH BRIEFINGS 2007
the sagittal or transverse extent of herniation, or in intervertebral space reduction or foraminal or spinal canal stenosis due to the technical possibility of bony resection with the new surgical devices.

The surgical access is created in prone position under orthograde radiological control in two planes. First, the localisation of the skin incision is marked. The aim is to make tangential reaching of the spinal canal possible. For levels L3–4 and L4–5, the dorsal edge of the processus articularis inferior normally limits the area of entry towards ventral in lateral radiation. Especially in the higher levels, safety must take precedence due to prevention of complications in the sense of injury to abdominal or thoracic structures. In such cases, a pre-operative, selective single computed tomography (CT) scan with broad window should be performed to define the safe access pathway. This applies especially for patients in whom retroperitoneal operations have previously been performed. In these cases, a more individual, less lateral access has to be selected.

A 1.5mm atraumatic spinal cannula is inserted via the skin incision directly into the target area. After insertion of an 0.8mm lead wire, the cannulated dilator with an outer diameter of 6.9mm is pushed in. At this point, the target wire may be removed so that further position correction can be made safely with the blunt dilator. Next, a surgical sheath with bevelled opening and an outer diameter of 7.9mm is placed over the dilator. From that time on, decompression is carried out under visual control and constant irrigation. If further penetration into the epidural space is necessary, it is performed under visual control to protect neural structures. If the anatomical bony diameter of the foramen intervertebrale does not permit direct entry into the spinal canal, expansion is made by bone resection using burrs. If the position of the exiting nerve is not clear, for example in intra- or extraforaminal herniations or in foraminal stenosis, an extraforaminal access is made on the caudal pedicle as a safe zone, and further preparation towards the herniation is carried out under visual control (see Figure 1).

**Full Endoscopic Interlaminar Approach**

The inclusion criteria for interlaminar access are the remaining disc herniations located mainly inside the spinal canal, which were technically limited for operation using the transforaminal technique due to the above-mentioned criteria. There are no limitations set for extent or dislocation of the herniation due to the technical possibility of bony resection with the new surgical devices.

The surgical access is created in the prone position under orthograde radiological control in two planes. The skin incision is made as close to medial as possible in the cranio-caudal middle of the interlaminar window. A dilator, 6.9mm in outer diameter, is inserted bluntly to the lateral edge of the interlaminar window, then an operation sheath with 7.9mm outer diameter and bevelled opening is directed towards the ligamentum flavum. The latter procedure is performed under visual control and constant irrigation. A lateral incision of about 3–5mm is made in the ligamentum flavum; further widening for penetration into the spinal canal is achieved by the elasticity of the ligament. The operating sheath with bevelled opening can be turned and used as a nerve hook. Mobility within the spinal canal is controlled via optics using the joystick principle. If the anatomical bony diameter of the interlaminar window does not allow direct penetration into the spinal canal through the ligamentum flavum, expansion is created by bone resection with a burr. In cases of wide dislocated sequesters that cannot be completely resected from one level without extensive bone resection, additional access to the spinal canal can be achieved via the neighbouring level (see Figures 2 and 3).

**Instruments**

The rod lens optics have an outer diameter of 6.9mm and a usable length of 165mm for interlaminar, and 205mm for transforaminal, access. The
VERTEBRIS
the full-endoscopic spine instrument set from RICHARD WOLF extends in a unique manner the application spectrum for operations of disc herniations and spinal stenosis with minimally invasive surgical techniques.

RICHARD WOLF is your experienced partner for full-endoscopic spine surgery. Thanks to its modular design, this instrument set offers you an exceptionally wide spectrum of application.

Sebastian Ruetten
The results of studies show that sufficient decompression under visual control in a short operation time is possible using the full endoscopic transforaminal and interlaminar technique. Nonetheless, open and maximally invasive procedures are necessary in spinal surgery today and will remain so in future. These must be mastered by surgeons in order to master problems and complications of full endoscopic procedures. The development of full endoscopic techniques is not a replacement of existing operative standards, but rather a supplement and alternative to the overall concept of spinal surgery.

3. Annerzt M, Jonsson B, Stromqvist B, Holtas S. No relationship of the lateral access is often necessary. The new endoscope with its 4.1mm work canal and corresponding instruments has largely overcome the technical problems. The following advantages are offered: facilitation for the operator thanks to excellent presentation of anatomical structures, good illumination and expanded field of vision with 25° optics; economical procedure thanks to short operating time, rapid rehabilitation and low post-operative costs of care; reduced traumatization; reduced bleeding; facilitated revision operations; a monitor image for training assistants; and high patient acceptance.

The following must be considered disadvantages: limited possibilities for extending surgery in the event of unforeseen hindrances; partially limited preparation of the intervertebral space; high learning curve; theoretically elevated risk of injury to exiting nerve in the transformaminal technique; and narrow indication criteria due to limited mobility in dispensing with extensive bone resection.

The full endoscopic techniques are satisfactory and safe supplemetations and alternatives to conventional procedures. With the new endoscopes and instruments, and the possibility of selecting an interlaminar or transformaminal posterolateral to lateral procedure, all lumbar disc herniations outside and inside the spinal canal can be operated satisfactorily in the full endoscopic technique, taking the appropriate criteria into account.