# В ПОМОЩЬ ПРАКТИКУЮЩЕМУ ВРАЧУ. ЛЕКЦИИ

***Глубокоуважаемый читатель!***

*В последнее время в практике хирургии позвоночника все большее распространение получают малоинвазивные и эндоскопические вмешательства. В связи с этим коллективом известных специалистов в этой области была подготовлена статья как руководство для использования в практической медицине. Работа подготовлена по заказу и при поддержке правления международного общества малоинвазивной хирургии позвоночника и утверждена на его заседании в качестве руководства.*

*Думаю, статья будет полезна для всех, интересующихся этой проблемой.*

*Президент ISMISS профессор В. А. Радченко*

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# Guidelines for percutaneous endoscopic spinal surgery

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*Randomized controlled trials have demonstrated equal effectiveness of the endoscopic procedures compared to the microsurgical reference procedures in cervical as well as in lumbar applications. Some of these studies also showed lower complication rates with endoscopy and none had higher complication rates with endoscopy. In these trials, spinal endoscopy generated less postoperative pain and faster rehabilitation than the microsurgical procedures. However, all these trials with one exception were performed by the same team of highly experienced endoscopic spinal surgeons. It is conceivable, that surgeons with less experience may not necessarily be able to achieve the same results. RCTs from other groups will have to prove or disprove this assumption. Sofar, no long-lasting advantages of endoscopic spine surgery over the microsurgical technique have been demonstrated. There is some experimental evidence that the effects of reduced access trauma can be measured, but interestingly, there seems to be no advantage of using a microtubular retractor system over standard microsuraical techniaue and instruments.*

*Рандомизированные контролируемые исследования показали одинаковую эффективность эндоскопических и микрохирургических вмешательств на шейном и поясничном отделах позвоночника. Некоторые из исследований свидетельствовали о снижении количества осложнений после эндоскопических операций, но ни одно — о его повышении. Согласно полученным результатам после эндоскопических операций на позвоночнике отмечена меньшая интенсивность послеоперационной боли и более быстрая реабилитация, чем после микрохирургии. Однако все исследования, за исключением одного, проведены одной и той же группой высокопрофессиональных хирургов. Поэтому возможно, что менее подготовленные специалисты не получат аналогичные результаты. Для подтверждения или опровержения этого предположения необходимы другие исследования. Пока никаких преимуществ эндоскопической хирургии перед микрохирургической техникой не продемонстрировано. Существует ряд экспериментальных доказательств возможной объективной оценки эффекта снижения травматичности доступа. Но предположительно нет преимуществ применения микротубулярной ретракторной системы перед стандартной микрохирургической техникой и инструментарием.*

**Key words:** spinal pain, disc herniation, cervical, lumbar, endoscopic

**Foreword to the second issue**

Since these guidelines were first published in 2008, we have seen remarkable technical advances in our field. But also and in our view more importantly, a number of well-designed clinical trials have been published, that truly have expanded our knowledge about endoscopic spinal surgery. This certainly doesn't mean, that there are no questions left unanswered.

But with regards to several important issues, we now have knowledge based on quality studies where only 2 years ago we had to rely mostly on expert opinion.

These guidelines have been adapted to reflect the technical advances as well as the increase in knowledge that has accumulated during the past 2 years.

We recommend that you also read the «Evidence» section at the end of these guidelines, where we discuss some important «knowledge vs. belief» — issues and where we address some of the resulting problems.

**Background**

Endoscopic spine surgery aims to reduce tissue trauma, prevent iatrogenic problems and preserve spinal motion and stability.

While some proof is still lacking, the most obvious advantages of endoscopic procedures over open surgery are:

- smaller incisions and less tissue trauma;
- minimal blood loss;
- improved illumination and visibility;
- earlier return to activities and work;
- easier operative approach in obese patients;
- easier revision surgery because of less scar tissue in the access portal;
- lower complication rates;
- local or regional anesthesia combined with conscious sedation can be used;
- in most cases, less postoperative pain medication is required;
- as a consequence, outpatient procedures are possible;
- lower costs due to shorter operating times and shorter inpatient stay.

**Mission statement**

The International Society for Minimal Intervention in Spinal Surgery (ISMISS) is an association of spine care professionals from all continents with the common goal to reduce access trauma and iatrogenic problems in spinal procedures. While the membership comprises experts in all fields of spinal therapies, from minimally invasive pain interventions to disc arthroplasty and fusion surgery, the founding members are pioneers of endoscopic spinal surgery.

Since its inception in 1989, ISMISS has worked to advance the tools and techniques of endoscopic spinal surgery as well as the understanding of the underlying pathological conditions.

ISMISS is affiliated to SICOT (International Society of Orthopaedic Surgery and Traumatology) and supports the SICOT aims of promoting science, clinical skills and education in the field of spinal procedures.

With new procedures, devices and techniques being invented, published and marketed at an ever-faster pace, ISMISS has recognized that the adequate evaluation of this wide range of treatments has become increasingly difficult.

In order to offer some orientation for spine care professionals aiming to base their clinical practice on the best available knowledge, ISMISS has begun to develop non-binding guidelines for a variety of minimally invasive spinal procedures.

These guidelines are based on thorough evaluations of the available literature and the cumulated expertise of select ISMISS members worldwide, which are considered experts in their respective fields.

The focus of this first issue of ISMISS guidelines is endoscopic spinal surgery.

**Disclaimer**

The field of endoscopic spinal surgery is still young and rapidly evolving.

As a consequence, experience and views may differ significantly between cultures, world regions and individual surgeons.

We therefore claim neither completeness nor exclusiveness of these guidelines.

This is a work in process and regular updates will follow as new techniques and technologies are being introduced, studied and evaluated.

We have set biannual update intervals, but earlier updates may be issued.

You are encouraged to join the effort and to communicate your clinical experience or research to us, using the contact at the end of this document.

**Gold standards**

The majority of endoscopic spinal procedures is concerned with the surgical treatment of lumbar and cervical disc herniations, for which microsurgical intervention using an operating microscope currently is the gold standard when conservative treatment fails or when it is not indicated. Microsurgical microscopic disc surgery, also termed «microdiscectomy» therefore has to be the reference to which endoscopic disc surgery is compared.

With regards to posterior cervical foraminotomies (key hole foraminotomy), the microsurgical microscop-

ic technique is also considered the reference procedure.

With regards to anterior cervical disc surgery, the currently accepted standards are either anterior cervical decompression and fusion (ACDF) or, more recently, decompression followed by disc arthroplasty.

For many other conditions, such as spinal canal stenosis or painful degenerative disc disease, no undisputed gold standard treatment has yet been established.

In either case, the technical advancements of endoscopic spinal surgery need to maintain patient safety as the core issue.

As a direct consequence, all endoscopic spinal procedures aiming to improve patient comfort and to reduce invasivity need do so while not increasing complication rates and risk profiles, when compared to the traditional procedures for the same indication.

This entails, that a surgeon who indicates for and performs endoscopic spinal procedures must know and be able to perform the corresponding open or microsurgical procedures.

**Indications**

Endoscopic strategies have been and are being employed predominantly for the treatment of the following conditions:

1. Lumbar, thoracic and cervical disc herniations with radicular symptoms.

2. Lateral spinal canal (recess) and foraminal stenoses with radicular symptoms.

3. Degenerative facet joint cysts with radicular symptoms.

4. In experienced hands also central spinal canal stenosis with claudication or radicular symptoms.

**Contraindications**

*Cauda equina syndrome*

Clinically relevant instabilities, deformities or back pain that is not due to neural compression are contraindications for endoscopic spine surgery as they are for microdiscectomy.

Very large disc herniations with or without a fresh motor deficit may be contraindications for less experienced endoscopic surgeons.

**Diagnostic standards for establishing an indication**

With each of the above-mentioned conditions, a clear clinical picture complemented by the patient history and a thorough physical and neurological examination is the minimum standard.

Given the prevalence of degenerative changes seen on radiographs and magnetic resonance imaging (MRI) in asymptomatic individuals, imaging studies alone can be extremely misleading when the pathological findings on such studies are not clearly matched to specific clinical symptoms. With cervical as well as with lumbar spinal pain syndromes, the clinical examination needs to also cover the shoulder girdle and the upper extremity or the pelvis, the sacroiliac joint and the hip joints, respectively.

It is not rare, that painful conditions in these adjacent regions mimic symptoms caused by spinal conditions.

In equivocal situations, we advocate the use of fluoroscopy-guided, contrast-enhanced diagnostic injections in order to ascertain a diagnosis that is amenable to endoscopic spinal surgery.

Adequate and recent diagnostic imaging studies are required (see below) and an up-to-date spinal MRI or computed tomography (CT) wherever MRI is not an option no older than 3 months should be available for surgery. In cases with changing symptoms, a repeat study prior to surgery is recommended.

Supplemental neurophysiologic studies (electromyography, neurography, etc.) may be helpful if the diagnosis of a monoradicular lesion is still uncertain based on patient history, clinical examination and imaging studies.

**Considerations for imaging studies**

*Plain radiographs*

Plain radiographs in 2 planes and performed in the upright position are still considered a standard for 2 reasons:

– on the one hand, they allow for a quick assessment of spinal alignment, osseous integrity and potential instabilities;
– on the other hand, they will permit for the detection of transitional vertebrae in situations where radicular symptoms do not match the level of an affected nerve root in MRI or CT and thus prevent wrong-level surgery.

With suspected or demonstrated instabilities, functional radiographs may also be required.

In select cases, functional myelography may still be an extremely valuable study, even today (see below).

*Computed tomography (CT)*

While MRI has largely replaced CT for the imaging of soft tissues and the detection of edema, infection, cysts and other fluid-related conditions, there are some diagnostic situations where CT still is of importance, especially when MRI is not applicable (e.g.: patients with pacemakers). Other than MRI, it allows for the reconstruction of alternative and also of non-standard planes from the original data set, which may be of help in assessing foraminal situations.

Many foraminal problems are based on osseous structures, which frequently cannot be adequately visualized by the resolutions currently available with MRI.

This is especially apparent in the cervical spine.

Whenever an MRI cannot be performed, post-myelography CT is an extremely valuable imaging

study with a resolution that is superior to MRI. For cervical problems, filling from a lumbar puncture using hyperbaric contrast is an alternative option to suboccipital puncture.

*Magnetic resonance imaging (MRI)*

Most modern magnets will yield images that give very good detail when it comes to disc tissue, ligaments, fluids, neural structures and structural fat, depending on the selected sequences.

However, sagittal sequences frequently are not being performed far enough laterally beyond the foramina in order to visualize extraforaminal disc sequestrations.

In combination with axial images that have not been acquired exactly parallel to the affected disc level, this may result in extraforaminal sequestrations to be overlooked.

With the exception of very few centers where functional MRI is available, CT and MRI are performed in a supine or sometimes in a prone position with no axial load and with no positional effects acting upon the spine.

In some cases, as an effect of body weight, instability and postural changes, the situation in an upright position may look considerably different than in the CT or the MRI that was performed in a supine position.

Whenever this is suspected, a standard myelogram with functional views and a subsequent post-myelography CT should be considered.

The alternative of functional MRI seems promising in the future. For now, some limits of position-tolerance in pain-afflicted patients may introduce artifacts and hence adversely affect image quality.

**Anesthesia**

While many surgeons will prefer general anesthesia as for the traditional techniques, local anesthesia with or without conscious sedation is an option for most endoscopic approaches.

However, one consideration should be that in a patient in the prone position, a conversion from local to general anesthesia would require to completely abandon the procedure, perform endotracheal intubation, reposition the patient and prepare the operative field again.

Especially with cervical procedures, unconscious head and neck movement are difficult to control and may incur additional risks.

**Anatomical and technical considerations**

Endoscopic spine surgery utilizes dilation technology to create the surgical access through the soft tissue (including skin, subcutaneous fat and muscle/fascia) instead of cutting, in order to minimize access trauma.

Beyond the reduced access trauma, the main difference between the endoscopic and the microsurgical microscopic techniques are 2-dimensional versus 3-dimensional vision and an angulated, close-up perspective versus a straight but remote optical perspective.

A number of instrument sets for endoscopic spine surgery are available on the market and they vary considerably in their technical specifications as well as in the indications they are designed for.

It is each individual surgeon's responsibility to ascertain that she or he is using an instrument set that is well suited for the procedure that is being planned.

While an endoscopic approach to the spine reduces the (visible) trauma of the surgical approach, this minimal invasiveness comes at a price — reduced and two-dimensional visibility in and limited expandability of the surgical field.

The approach and the trajectory chosen in combination with the local anatomy to a large extent define the entry into the spinal canal or the foramen.

These anatomical limitations are mostly caused by osseous structures such as the facet joints, the pedicles and the laminae, but also by the exiting nerve root for foraminal approaches and the vertebral arteries for cervical approaches. Together with the characteristics of the optical system (angle of view, magnification, etc.), the size of the working channel and the tools available, this imparts clear limitations as to which places can be viewed and which lesions can be treated safely.

There are burrs, trephines and rongeurs available that allow for the endoscopic resection of bone in order to expand the operative field and to enlarge access.

However, whenever repositioning of instruments through additional access portals, blind reaming with trephines and excessive bony resection is necessary, the advantages of the minimally invasive procedure over a traditional microsurgical approach are reduced and in some cases may even turn into a disadvantage.

A clear surgical strategy and precise targeting are therefore essential.

Biplanar fluoroscopy for accurate planning of the approach and for intraoperative control and documentation of instrument position is a prerequisite.

When, as it is often the case, tissue modulation technologies such as laser and radiofrequency bipolar devices are utilized in endoscopic spinal surgery, these devices and their potential complications need to be fully understood.

**Endoscopic approaches to the lumbar spine**

*Interlaminar approach*

This approach is very similar to the traditional microsurgical approach.

The spinal canal is entered by means of a limited flavotomy and the risks of damaging the dura or neural structures are similar to the microsurgical approach.

Depending on the angle of entry into the interlami-

nar window in the sagittal plane and the level treated, it may be easy or difficult to actually reach the posterior aspect of the disc. The interpedicular region is very difficult to reach if at all, as is the contralateral side of the ventral epidural space.

Whenever the interlaminar window is very small, this approach may not be feasible without resection of the laminar edge and/or the medial aspect of the facet joint, especially with some of the more modern endoscopes that have a larger working channel, but also a larger outer diameter. One clear advantage is the easy convertibility to an open approach.

*Posterolateral approach*

This is the best-known foraminal approach to the lumbar spine and it can be used for foraminal and extraforaminal disc herniations as well as for intradiscal procedures.

It uses an angle of about 60 degrees to the sagittal plane and approaches the foramen either in the horizontal plane or via a slightly descending trajectory.

It can be performed with the patient in a prone or in a lateral decubitus position.

The main intraoperative risks are damage to the exiting nerve root (especially when there is advanced loss of disc height) and to blood vessels.

Especially in patients with short pedicles and even without the presence of osteophytes at the facet joint, reaming of the lateral aspect of the superior articular process is often required in order to achieve adequate access.

The ventral epidural space cannot be reached in its full width.

*Far or extreme lateral approach*

This approach is a more recent development and has largely been pioneered by Ruetten.

Using this approach, the ventral epidural space with the exception of the interpedicular area can be reached in addition to the foraminal and the extraforaminal areas.

It approaches the foramen at an angle of slightly less than 90 degrees to the sagittal plane, penetrating the skin at about the level of the facet joints in the coronal plane and requires a prone position.

Because of that, there is less interference with the facet joint than with the posterolateral approach, but short pedicles and a large bulging disc can still make the access to the ventral epidural space difficult.

The operative risks are much the same as with the posterolateral approach with a higher risk of injury to the dura and the added risk of injury to retroperitoneal organs at the upper lumbar levels.

The retroperitoneal anatomy at the level of interest therefore needs to be looked at by means of CT or MRI prior to performing this approach at higher lumbar levels.

**Endoscopic approaches to the cervical spine**

*Anterior approach*

The anterior approach is very similar to the traditional microsurgical approach with the neurovascular sheath being positioned lateral to the working channel and the visceral structures medial to the working channel.

The tip of the working sleeve is positioned against the anterior longitudinal ligament and the edge of the anterior part of the adjacent vertebral bodies.

While traditional microsurgery requires a discectomy, traversing the disc space with an endoscope requires the resection of only a small amount of disc tissue.

Sequestrectomy and when required removal of osteophytes is achieved by using a wide range of special instruments including burrs, trephines, microresectors, various types of forceps, drills, hooks and bipolar microelectrodes.

By means of this approach, the foraminal areas and the spinal canal, but not the interpedicular space can be reached with excellent control of the operating field.

More so than in the other segments of the spine, the anterior endoscopic approach facilitates the effective anatomical decompression of the spinal canal and/or the nerve roots (plus in select cases even the vertebral artery) without the requirement to replace the disc by means of a fusion or an arthroplasty.

In general, there is no need for a drain or for postoperative immobilization. *Posterior approach*

The posterior approach is very similar to the traditional microscopic-assisted «keyhole-foraminotomy» approach, just that it is performed using endoscopic equipment and through a smaller approach.

Indications are predominantly lateral soft disc herniations with radicular symptoms, most of which can be addresed with this technique.

However, adequate experience in endoscopy and bone resection with drills is necessary due to the risks and consequences of damaging the central nervous system.

After insertion of the working sheath and the endoscope, preparation of the medial aspect of the facet joint and of the ligamentum flavum is performed to clearly identify the anatomical landmarks.

The foraminotomy is begun by bone resection at the medial aspect of the facet joint, resection of the lateral ligamentum flavum.

Then, the lateral edge of the spinal cord and the branching spinal nerve are identified.

Bone resection is necessary in nearly all cases and is performed under direct visual control using drills

and bone punches, inserted through the endoscope's working channel.

Bipolar radiofrequency coagulation of the epidural venous plexus and preparation of the spinal nerve under particular attention to possibly separate motor and sensory fascicles comes next.

Depending on the pathology in the individual case, the foraminotomy can be extended towards lateral or cranio-caudal.

At the ends of the procedure, direct closure of the skin is done and no drain is required.

**Complications**

While recent studies have shown that endoscopic spinal surgery can be performed with lower complication rates than microsurgical spine surgery, the complications of minimally invasive spine surgery are not necessarily «minimal» when they do occurr.

Also, the learning curve for endoscopic spinal surgery tends to be flatter and longer than for traditional approaches.

Dural tears, nerve root damage, bleeding and infection, operating on the wrong level or on the wrong side are as real with endoscopic techniques as they are with open techniques.

With thoracic approaches, pneumothorax is also a possibility.

In addition, some injuries may be underestimated or even go unnoticed, such as a dural tear under the low-pressure irrigation of an endoscopic system.

Meticulous selection of suitable cases, careful surgical technique, perioperative single-shot antibiotics [1] and careful postoperative follow-up are therefore strongly recommended when a surgeon begins to perform endoscopic spinal surgery.

When complications occur, they need to be addressed in the same way as with open surgery and, if required, by conversion to an open technique.

**Surgeon qualification**

Only surgeons who have sufficient experience with the traditional techniques for each respective indication should begin performing endoscopic procedures. On the one hand, such experience is required for being able to manage potential complications in an adequate fashion. On the other hand, surgeons experienced ip both techniques will be able to appropriately decide in which individual cases an open approach might be better and safer than an endoscopic approach and vice versa.

Adequate training in endoscopic techniques and technical versatility with the instruments to be used need to be acquired prior to independently performing such procedures in a clinical situation.

**Evidence**

*Why we need it*

Considering the great interest in this key question, there is surprisingly little hard proof, that minimally invasive spine surgery not only produces smaller incisions, but that it has measurable and clinically relevant advantages over more invasive, more «open» procedures that serve the same goal.

While some evidence to that effect has accumulated during recent years, most if not all of the observed advantages relate to perioperative and early postoperative parameters.

As of yet, no study has shown an advantage in mid- or long-term outcome, which runs parallel to what has been observed with the minimally invasive techniques in hip arthroplasty surgery.

Still, less tissue damage, less blood loss, less postoperative pain, early mobilization and smaller incisions are advantages — as long as they do not come at the cost of increased risks.

Some proponents of the «standard» techniques are making the case, that because endoscopic spine surgery is currently very much «en vogue», long and flat learning curves aren't openly mentioned and complications are underreported [2].

The easy reply would be, that such claims can be made against any new or established surgical technique, many of which don't rest on a solid basis of evidence.

However, in the best of our patients' interest and while further developing endoscopic spine surgery, we must objectively evaluate its value against standard techniques.

And amongst the parameters studied, the rates and the gravity of complications if they occur are at least as important as pain scales and functional scores.

*Systematic reviews*

A 2002 systematic review by Maroon concluded that none of the minimally invasive techniques that have been developed for the treatment of symptomatic lumbar disc disease has yet been demonstrated as being superior to microdiscectomy [3].

It also states that there is insufficient evidence on all forms of percutaneous discectomy to draw firm conclusions (with the exception of chemonucleolysis).

The 2007 update of the Cochrane Collaboration's systematic review on surgical interventions for lumbar disc prolapse found that surgical discectomy (open and microsurgical) for carefully selected patients with sciatica provides faster pain relief than conservative treatment [4].

For this review, there were no qualifying randomized controlled trials (RCTs) on endoscopic disc surgery available and hence no statement as to its value could be made. The most recent systematic review on the topic was published in 2009 and it found the open,

the microscopic and the endoscopic posterior discectomy surgical techniques equally effective [5].

However, this review considered only 1 RCT published in 2007 and none published in 2008 or 2009, so it had virtually the identical data available as the 2007 update of the Cochrane Collaboration's systematic review.

The same systematic review also criticized that no conclusions could be drawn from the RCTs regarding the safety of all 3 surgical techniques, due to insufficient reporting on postoperative complications.

So clearly there is a need for well-designed randomized trials comparing endoscopic techniques to the respective standard techniques, where possible.

*Randomized controlled trials*

A large number of clinical papers on endoscopic spinal procedures report on case series, technical innovations or personal experience.

In recent years, however, several controlled and randomized controlled studies have been published which provide evidence on endoscopic spine surgery.

One RCT with selected patients (single-level lumbar herniations not exceeding ½ of the sagittal spinal canal diameter, no canal stenosis) found similar clinical outcomes for endoscopic and for open discectomy with reduced postoperative pain and shorter rehabilitation in the endoscopic group [6].

Comparing interlaminar or transforaminal endoscopic discectomy to standard microsurgical technique in lumbar disc herniations, a RCT on 178 patients (follow-up 2 years) found no difference with regards to outcome and recurrence rates, but demonstrated less pain, faster rehabilitation and a lower complication rate for the endoscopy group [7].

In lumbar lateral recess stenosis, a RCT compared microsurgical decompression with interlaminar endoscopic decompression in 161 patients and found no difference in clinical outcome, but a reduced complication rate with the endoscopic technique [10].

In 175 patients with unilateral arm radiculopathy due to foraminal or lateral cervical disc herniation, a RCT (follow-up 2 years) found no differences in outcome between ACDF and endoscopic posterior foraminotomy, but reduced trauma and operating time with the endoscopic procedure [8].

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A RCT on 175 patients with mediolateral cervical disc herniations and unilateral arm radiculopathy

compared ACDF to anterior endoscopic decompression without fusion and found no difference in clinical outcome for up to 2 years [9].

It should also be noted, that a recently published RCT comparing micro-tubular discectomy (using a 14–18 mm METRx tube) to standard microdiscectomy (25–30 mm incision) found small advantages for microdiscectomy, some of which were significant [11].

*Physiological and biological studies on «Minimal Invasiveness»*

An early study on 15 patients compared pulmonary function and body temperature in patients undergoing open laminectomy and discectomy to that of patients undergoing microdiscectomy [13].

It found significantly depressed pulmonary function for 20 hours post surgery and febrile temperatures for 48 hours post surgery in patients operated on with the open technique but not in patients undergoing microdiscectomy.

A small RCT comparing an endoscopic technique (using a mini retractor system with 17 mm external diameter) to standard open surgery (incisions averaged 6.3 cm) found less tissue damage, less blood loss and a lower systemic inflammatory response with the endoscopic technique [14].

A controlled trial comparing endoscopic and open technique found significantly less intraoperative nerve root irritation with endoscopy by means of intraoperative electromyographic monitoring [15].

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# РУКОВОДСТВО ПО ПОДКОЖНОЙ ЭНДОСКОПИЧЕСКОЙ ХИРУРГИИ ПОЗВОНОЧНИКА

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