Guidelines for Endoscopic Spinal Surgery

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Background

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

The most compelling advantages of endoscopic procedures over open surgery are:

- Smaller incisions and less tissue trauma
- Minimal blood loss
- Earlier return to activities and work
- Easier operative approach in obese patients
- 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

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, who 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 as needed.

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.

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.

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

Contraindications

Clinically relevant instabilities

Central spinal canal stenosis

Relative contraindication: Large disc herniations with cauda equina syndrome or a fresh motor deficit. With the exception of cases with large interlaminar windows and good interlaminar endoscopic access, adequate decompression may not be possible.

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 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 disc in MRI or CT.

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.

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 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 effects, 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 is a good option.

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 complete abandoning of the procedure, endotracheal intubation, repositioning and renewed preparation of the operative field.

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

Endoscopic Approaches To The Lumbar Spine

Anatomical And Technical Considerations

Endoscopic spine surgery utilizes dilatation technology to create the surgical access through the soft tissue (including skin, subcutaneous fat and muscle/fascia) instead of cutting in order to minimize tissue 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 it is being used for.

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 therefore are 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.

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 interlaminar 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 at the disc level.

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 can only be reached in its lateral aspect.

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.

Other than with traditional microsurgery, the disc space can then be passed without performing a discectomy.

Herniectomy 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 of advantage in cases of a central spinal canal stenosis primarily caused by posterior structures (primarily ligamentum flavum or a recessed laminar edge) or in cases of far lateral disc herniations.

The approach and the surgical technique are similar to traditional surgery, but it is performed by using a working tube of varying diameter and the typical endoscopic instruments mentioned for the anterior approach.

Complications

Minimally invasive surgery does not necessarily imply minimal complications and 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.

One the one hand, such experience is required for being able to manage potential complications in an adequate fashion.

On the other hand, surgeons experienced in 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 performing such procedures in a clinical situation.

Evidence

A recent 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 (2).

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

A systematic review by Maroon concludes 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).

So clearly there is a need for well-designed randomized trials comparing endoscopic techniques to microsurgical microscopic disc surgery.

The vast majority of clinical papers on endoscopic spinal procedures report the results of (mostly retrospective) case series, technical innovations or personal experience.

There are, however, a few controlled and randomized controlled studies that can give an indication as to the possible benefits of endoscopic disc surgery:

One randomized controlled trial with selected patients (single-level herniations not exceeding ½ of the sagittal spinal canal diameter, no canal stenosis) finds similar clinical outcomes for endoscopic and for open discectomy with reduced postoperative pain and shorter rehabilitation in the endoscopic group (4).

Another controlled trial finds advantages for endoscopic disc surgery over the microsurgical technique with regards to sciatica, low back pain and return to work (5).

There is proof, that endoscopic spine surgery not only produces smaller incisions, but that it also causes less tissue damage and hence a lower systemic inflammatory response (6).

A controlled trial comparing endoscopic and open technique found significantly less intraoperative nerve root irritation with endoscopy by means of intraoperative electromyographic monitoring (7).

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