



AN INTRODUCTION TO MINIMALLY INVASIVE SPINE SURGERY : THE BASICS

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KEYWORDS :

In the long history of surgery it always has been a basic principle to restrict the iatrogenic trauma done to a patient during surgery to a minimum. No matter which type of surgery we are talking about, Minimally invasive seems to be the catchphrase that we hear a lot these days. Minimally invasive spine surgery has been defined as: a procedure that by virtue of the extent and means of surgical techniques results in less collateral tissue damage, resulting in measurable decrease in morbidity and more rapid functional recovery than traditional exposures, without differentiation in the intended surgical goal. The advances in minimally invasive spinal surgery (MISS) are unparalleled. These advances have occurred throughout the spinal axis from the occiput to the pelvis. With the progress in optics, instrumentation, and familiarity with MISS procedures, MISS can now be seen in all aspects of spine surgery. The aim of every surgical procedure is to resolve the patient's clinical problem by treating the underlying pathology. This pathology can be considered as the target of each surgical procedure. So one of the goals of minimally invasive spine surgery is to carry out efficient "target surgery" with a minimum of iatrogenic trauma. To attain this target, the surgeon has to create an access to it. So practically speaking, either the access part or the target part of the surgical procedure—or both—can be minimally invasive.

The majority of minimally invasive techniques in spine surgery primarily concern the access, and not what is performed in the target region.

The spine as the central axis organ can be reached from different directions through different entrances, access should be :

- adequately placed
- adequate (smallest possible) sized
- Cosmetic aspects should be considered (skin incision follows skin lines)
- Least traumatic surgical route to the target area
- should strictly follow anatomical pathway such as preformed spaces, or,
- should be performed with a minimum of collateral damage to surrounding tissues, or,
- collateral damage should be reparable and have a negligible effect on the clinical outcome)
- function of the abdominal and paravertebral muscles should be preserved
- most important aspect—the adequate exposure of the target area
- target (disc herniation, disc, spinal nerve, tumor) should be clearly visible and identified
- target treatment (discectomy, vertebrectomy, neurolysis, tumor removal) should be possible without any restrictions due to the small approach
- Spinal manipulation (reduction maneuvers) should be possible, as well as the insertion of implants for spinal stabilization
- retreat from the surgical field should leave no or only minor traces (hematoma, "open" annulus fibrosus following discectomy, scar tissue)
- should not be relevant for the outcome (muscle damage)
- staged surgical therapy (dynamic posterior stabilization) or in cases where there is a possibility for a recurrent pathology (disc herniations) the postoperative traces, such as scar tissue, muscle damage, or intervertebral joint damage, should not negatively influence these further therapeutic options

A meticulous preoperative planning is necessary.

- Positioning of the patient - Lateral position, knee chest position (leads to a pressure release in the epidural venous system and thus diminishes the risk of epidural bleeding)
- Localization of entry- under fluoroscopic control
- Special instruments- light and magnification sources (loupe, surgical microscope, headlamp)
- retractor devices (frame or ring retractors, tubes) are necessary
- Preoperative Planning- Clear Topography and volumetry of the target (MRI, CT) (Preoperative vascular topography can be determined with the help of color-coded three-dimensional CT scans which give a clear picture of the individual anatomy in case of anterior exposure as Minimally invasive approaches do not allow a wide exposure and mobilization of these vessels)
- Skin incisions are supposed to be small.
- In endoscopic techniques, the skin localization of the incision is determined by the intended working direction as well as by the view angles necessary during the operation
- Surgical Dissection Techniques- Blunt, muscle splitting techniques are characteristic for MISS. The use of high-speed burrs instead of large rongeurs can preserve bony structures
- The individual mobilization of blood vessels can decrease the vascular complication rate
- The use of hemostatic agents in spinal canal surgery can reduce the risk of epidural hematoma.
- The microsurgical closure of the annulus fibrosis is supposed to promote the low healing potential of this structure
- Instruments and Implants- not possible without optical aids (The minimum requirement is provided by headlamps and loupes)
- Surgical instruments need to be bayonet-shaped and/or long enough to bridge the distance from the skin to the target.
- The branches of instruments for electrocoagulation must be isolated to avoid tissue damage in the access region

The surgical microscope : technical advantages:

- Simultaneous illumination and magnification of the surgical field
- Variable adjustment according to the surgical topography
- Coaxial projection of light
- Three-dimensional-like image
- Sufficient focus depth even with higher magnification

The surgical microscope : surgical advantages:

- Discipline in surgical planning and positioning
- Gentle, careful, and less traumatic surgical preparation
- Surgical training- since the assistant always has the same view of the surgical field, assistance as well as education is more efficient as compared to microsurgical preparation (with loupes)
- Smaller skin incisions and less traumatic approaches decrease peri- and postoperative morbidity and discomfort for the patient
- shorter hospitalization
- shorter rehabilitation periods
- decreased overall cost
- Cosmesis- smaller skin incisions

Learning Curve/ Disadvantages-

- The visual field is limited (an area of less than 1 cm²)
- In deep approaches (transthoracic, retro- or transperitoneal anterior approaches), the "approach track" is not visible after having entered the target area.
- requires surgical discipline in order to avoid direct or indirect injury to structures along the way to the target area.
- requires meticulous preoperative planning and detailed

knowledge of topography anatomy.

- wrong level exploration belongs to the most frequent mistakes in microsurgical approach to the spine it is recommended to routinely use the fluoroscope or computerized navigation techniques
- Magnification of approach and target area- familiarity with micro anatomic landmarks.
- Spinal microsurgery is not “go-and-see” surgery
- Visual axis-adjustment of the visual axis to the axis of the approach as well as to the area of pathology (the target area might be obstructed by the surgeons hand or instruments introduced into the surgical field)
- In approaches which are oblique to the skin surface, the microscope tilt has to be adjusted
- Hand-eye coordination- takes time
- Adjustment of focus- surgical approaches deep into the human body, permanent adjustment of focus depth is necessary (help of the foot switch without interrupting the surgical preparation)

The first consideration should always begin with the proper diagnosis and the appropriate treatment options. We should never put our patients in a compromised position due to inexperience and/or inadequate exposure. The end result, whether it is a decompression or an instrumentation, should be effectively and functionally the same whether done minimally- invasively or in a traditional open manner.