Endoscopic Techniques for the Management of Spinal Trauma

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Abstract

Background: In the past few years, endoscopic operations on the spinal column have developed from representing exceptional interventions to becoming standard procedures in spinal surgery. Operating techniques and instruments have been standardized and unified, making it possible now to perform safe endoscopic surgery, as the results of more than 350 operative treatments in a 5-year period show.

History: This development was aided by the scarcely satisfactory results of purely dorsal treatment concepts, which intensified the demand for reconstruction of the anterior load-bearing spinal column. It was the high access morbidity of the conventional open procedure which stood in the way of a broader use of open ventral operations in spinal surgery and which limited the indication for open interventions to a few cases showing marked destruction or malformation in the anterior section of the spine. For this constellation, the endoscopic procedures could provide a solution based on the reduced access morbidity typical for endoscopic procedures without the need to accept diminished surgical effectiveness.

Indications: The possibilities of endoscopic spinal surgery have been developed continuously during the past few years, so that today nearly all operations in spinal traumatology can be performed endoscopically. Endoscopic splitting of the diaphragm also made it possible to open up the upper sections of the lumbar spine, so that the area between the third thoracic vertebra and the third lumbar vertebra is now accessible to endoscopic surgery. The potential indications include repositioning, the incision and resection of ligaments and intervertebral disks, the removal of fragmented sections of vertebrae including anterior decompression of the spinal canal, the replacement of vertebral bodies with biological or alloplastic materials and, last but not least, the minimally invasive insertion of an implant for ventral stabilization.

Key Words

Spinal trauma · Endoscopic techniques · Minimally invasive spine surgery

Introduction

The truncal spine lies centrally embedded in the human body, covered dorsally by strong muscles and surrounded ventrally by vital organs and pathways. Its distance from the surface of the skin is smallest in a dorsal direction and largest ventrally and laterally. More than 60% of all injuries [15] exclusively affect the anterior section of the spine, a section which previously was only accessible and presentable via large skin and soft tissue incisions. From this central position of the spine resulted the typical funnel-shaped formation of an extensive open access to a comparatively small operating site, which was necessary to open up the target area on the spine to conventional direct manual treatment. In this context, thoracophrenolumbotomy as access to the thoracolumbar transition represented the most extensive standard intervention.

The chronic pain syndromes affecting up to 50% of patients [24] after having undergone open access to the spine were the expression of profound and lasting damage to the structures of the lateral thoracic and abdominal wall caused by the access alone, representing an additional burden to the patient on top of the actual
accident injuries and their consequences. In an attempt to minimize this, many different routes have been followed in the past, leading essentially into two surgical techniques, nowadays known as the endoscopic – minimally invasive – and the microsurgical – less invasive – technique.

The latter represents the result of determinedly reducing the size of the original open access to a minimum. Using special spreaders for skin, ribs and soft tissue and retractors for the lung and the diaphragm, a 4–6 cm long skin incision is sufficient for the treatment of monosegmental lesions [21, 22]. Multisegmental treatments require osteotomy or the removal of rib sections. Image transmission is via a surgical microscope or additional video optics system.

The endoscopic – minimally invasive – procedure is based on the surgical technique known as VATS (video-assisted thoracic surgery). It uses the thoracic cavity with its firm bony roof structure as a natural preformed operating arena and the intercostal spaces as relatively flexible entry points for the operation portals and a 30° angled optic linked to a high-resolution video camera. This endoscopic operating technique, now established as a standard procedure in spinal surgery, its development and the results from more than 350 consecutive operations form the subject of the following report.

**Historical Overview**

The development of thoracoscopy began in 1910 with the report of the surgeon Jacobaeus on the use of a rigid cystoscope to investigate the chest cavity [10]. The procedure subsequently advanced from purely diagnostic to therapeutic application, with treatment of pleural adhesions and callosities and sympathetic chain resections being performed endoscopically. Since the beginning of the 1990s, following developments in other areas of surgery, classic operations in thoracic surgery such as resection of lung tissue [8] and pericardiectomy have increasingly been performed using the endoscopic method.

The first reports on the use of thoracoscopy on the spinal column date from 1993, when Mack et al [19] described using the procedure for the diagnosis and treatment of various diseases of the thoracic spine. As early as 1994 there were accounts of possible applications in degenerative and metastatic diseases [27]. The first edition of an atlas of endoscopic spinal surgery by Regan et al appeared in 1995 [26].

In parallel, and partly based on these reports, we carried out the first endoscopic operations in our clinic to treat fractures of the thoracic and lumbar spine in 1996, after a preparation period of 1 year, and subsequently described the now standard techniques of bone and intervertebral disk resection, decompression of the spinal canal, and reconstruction of the anterior spinal column through vertebral body replacement and a plate implant as an overall concept for the endoscopic treatment of spinal column fractures [2, 4, 25].

**Technical Requirements**

The application and refinement of an endoscopic method is closely associated with the technologic development of image transmission systems and instruments. The more demanding nature of surgery compared to the open procedure requires the availability of instrumentation specially adapted to the technique, as well as the development of implants which on the one hand are designed for endoscopic application while on the other hand satisfying the high biomechanical requirements of spinal surgery.

**Image Transmission.** The image transmission system consists of a rigid 30° angled optic linked to a three-chip camera with remote release of the digitally recorded image. A xenon cold light source with high light transmitting capacity is essential to illuminate the whole of the thoracic space. Using light sources with lower transmitting capacity, such as are used in arthroscopy, is not recommended, since the electronic image creation and resolution are insufficient even with a good-quality camera. The image is transmitted onto two monitors; we have found that using one monitor and an additional pull-out flat screen for the surgeon has proven to be a good idea (Figure 1). Since the assistant is working “against the camera”, he or she receives a mirror image in two respects, which requires a great deal of mental adaptation when using the instrumentation. A device for digitally reflecting the image makes it much easier to become familiar with handling the instrumentation under endoscopic control, especially in the initial stages. Image recording systems can be added to the video tower if desired. Obscuring of the optic in the warm, moist environment of the thoracic cavity can be prevented by moistening the tip of the optic with a sterile anti-misting cloth or fluid.

**Instruments.** Today, there are useful sets of instruments available for the endoscopic technique for bone and soft tissue resection on the spine, which can be added if desired. In choosing instruments, one should look for a scale marked on both sides of the instruments for bone