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Full-endoscopic posterior foraminotomy surgery for cervical disc herniations

Introductory remarks

To date, anterior decompression and fusion have represented the standard procedure for the management of disc herniation in the cervical spine. Despite good clinical results and high fusion rates, specific problems can occur, such as pseudarthrosis and access-related complications [1–3, 7, 17, 27, 28]. Implantation of a disc prosthesis in the cervical spine is a procedure that preserves mobility and is thus an alternative to anterior decompression and fusion [15]. Problems are known to occur with this procedure as well, such as subsidence, spontaneous fusion of the segment and complications related to the anterior access [18].

The most common alternative to the anterior approach is posterior foraminotomy [3, 4, 9]. It preserves segment mobility without additional stabilisation. In addition to lateral disc herniation, neural foraminal stenosis also represents an indication for this procedure. Adverse consequences such as access-related neck pain, access site bleeding and in particular bleeding in the epidural and foraminal area have been described. Reconstruction of the intervertebral space is not possible with a posterior approach [12, 29].

With the aim of minimising the disadvantages of these anterior and posterior surgical techniques, modifications have been described, such as anterior decompression without fusion [16], anterior foraminotomy using various techniques [8, 11] or microscopically or endoscopically assisted "keyhole foraminotomy" [5, 10].

Nowadays endoscopic surgical techniques are standard in many fields of medicine. In the lumbar and thoracic spine, full-endoscopic surgery represents an adequate alternative to conventional surgical techniques [13, 19–23]. A posterior endoscopic procedure in the cervical spine was described as early as 1999, although with no exact specifications [6]. The development of new endoscopes and instruments resolved the technical problems that existed. The development of motor-driven cutters that could be used intraendoscopically made adequate bone resection possible [14]. Full-endoscopic surgery for bony pathologies in the cervical, thoracic and lumbar spine was therefore technically efficient for the first time [24–26]. Along with the anterior approach to the cervical spine, nowadays it is also possible to carry out a posterior foraminotomy with continuous visualisation and instruments that can be used intraendoscopically for the adequate treatment of cervical disc herniation and pathologies of the cervical neuroforamen.

Principle and objective

The technique presented here is a full-endoscopic surgical treatment for cervical disc herniation and neuroforaminal stenosis with radicular symptoms.

Advantages

- Good visualisation, illumination and an extended field of vision through the use of 25° lenses
- Less muscle and soft tissue trauma
- Mobility-preserving procedure
- Low rate of complications (bleeding, infection, wound healing)
- Cost-effective (operation time, hospital stay, follow-up treatment, socioeconomic factors, e. g. recovery of capacity to work)
- Surgical procedure easy to follow intraoperatively (training purposes)
- Good patient acceptance

Disadvantages

- Limited ability to widen access if problems arise
- No possibility to perform an endoscopic dural suture
- Acquisition of new instruments and accessories
- Limited intradiscal accessibility
- Flat learning curve

Indications

- Persistent or intolerable radicular pain and/or neurological deficits due to cervical disc herniation
- Foraminal stenosis
- Zygapophyseal joint cysts with compression of the cervical nerve
- Anterior foraminal residual pathologies following anterior surgery

- Rare posterior pathologies (bleeding, localised abscesses, cysts)

Contraindications

- Neck pain alone
- Medial disc herniation with cervical myelopathy or central nervous symptoms
- Bony central spinal canal stenosis
- Deformity or instability requiring correction

Patient information

- General risks of surgery
- Information on the nature of the degenerative underlying disease and its course
- Explanation of the technical nature of the procedure as well as its relation to microsurgical techniques
- Injury to nerve roots or the spinal cord
- Dural injury and its consequences, with possible revision
- Switching to an open procedure in the event of intraoperative problems
- Undetected obstruction of outflow of the irrigation fluid and subsequent pressure increase in the spinal canal with damage to the spinal cord as a possible consequence
- Motoric and sensory deficits
- Partial/complete tetraplegia
- Bladder/rectal/sexual dysfunction
- Postoperative bleeding with possible revision necessary
- Injury to the vertebral artery
- Infection with sepsis as a possible consequence as well as revision with the possibility of further procedures
- Intraspinal and intraforaminal scarring and its consequences
- Surgically induced instability and its consequences
- Persistent symptoms despite successful sequestrectomy
- Persistence of preoperative neurological deficits
- Recurrent disc herniation
- Progressive neck pain
- Injuries due to the fixing pins of the Mayfield clamp

Abstract · Zusammenfassung

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Full-endoscopic posterior foraminotomy surgery for cervical disc herniations

Abstract

Objective. Surgery for cervical disc herniation with full-endoscopic posterior access.
Indications. Cervical disc herniation and neuroforaminal pathology with radicular symptoms.
Contraindications. Neck pain alone, cervical myelopathy or pathologies with central nervous system symptoms, instabilities requiring correction/instabilities.
Surgical technique. Introduction of a surgical tube to the facet joint at the level to be operated on. Resection of bony and ligamentous parts of the cervical spinal canal under endoscopic guidance. Visualisation of the disc herniation and decompression of the neural structures.
Postoperative management. Immediate mobilisation, specific rehabilitative physiotherapy depending on pre-existing neurological deficits.
Results. A total of 87 patients underwent full-endoscopic posterior surgery and were followed over a period of 2 years. Significant improvement was observed. No serious complications occurred. In all, 5 patients underwent revision in the follow-up period. Of the patients, 93% would undergo the procedure again.

Keywords

Cervical disc herniation · Foraminal stenosis · Microsurgery · Endoscopic surgical techniques

Vollendoskopische dorsale Foraminotomie zur Operation des zervikalen Bandscheibenvorfalls

Zusammenfassung

Operationsziel. Operation zervikaler Bandscheibenvorfälle mit einem dorsalen vollendoskopischen Zugang.
Indikationen. Zervikale Bandscheibenvorfälle und Pathologien im Neuroforamen mit radikulärer Symptomatik.
Kontraindikationen. Reiner Nackenschmerz, zervikale Myelopathie oder Pathologien mit zentralnervöser Symptomatik, korrekturbedürftige Instabilitäten/Instabilitäten.
Operationstechnik. Einbringen einer Operationshülse auf das Facettengelenk der zu operierenden Etage. Unter endoskopischer Sicht Resektion von knöchernen und ligamentären Anteilen des zervikalen Spinalkanals. Darstellen des Bandscheibenvorfalls und Dekompression der neuralen Strukturen.
Weiterbehandlung. Sofortige Mobilisation, weiche Halsorthese bis zur Wundheilung, spezifische rehabilitative physiotherapeutische Maßnahmen in Abhängigkeit von vorbestehenden neurologischen Defiziten.
Ergebnisse. Insgesamt wurden 87 Patienten vollendoskopisch dorsal operiert und über 2 Jahre nachuntersucht. Dabei zeigte sich eine signifikante Verbesserung. Schwere Komplikationen traten nicht auf. Im Nachbeobachtungszeitraum wurden 5 Patienten revidiert. Den Eingriff würden 93 % der Patienten erneut durchführen lassen.

Schlüsselwörter

Zervikaler Bandscheibenvorfall · Foramenstenose · Mikrochirurgie · Endoskopische Operationsmethoden

Preoperative workup

- Conventional X-rays in two planes
- Magnetic resonance imaging (MRI)
- Further/alternative investigations depending on the findings: computed tomography (CT), functional myelography/myelo-CT, functional MRI, conventional functional imaging
- Neurological and electrophysiological investigation with nerve conduction velocity (NCV), somatosensory and motor evoked potentials (SEP, MEP)
- Shaving the operation site if necessary
- "Single-shot" antibiotic prophylaxis in accordance with the standard

- Image amplifier (C-arm) in the operating theatre

Instruments

- General equipment for endoscopic surgery: monitor, camera unit, light source and cable, documentation system, irrigation fluid including feed system
- Motor for the bone cutter
- Radiofrequency generator
- 25° rod lenses with an external diameter of 5.8 mm
- Access instruments with dilator and oval working tube with an external diameter of 6.9 mm
- Endoscopic surgical instruments: rongeurs, scissors, punches, dissector etc.
- Various bone cutters with a diameter of 3 mm
- Bendable bipolar radiofrequency electrode
- For the technique described herein, lenses and instruments from the firm Richard Wolf GmbH (Knittlingen, Germany) were used
- Image amplifier
- Radiolucent standard operating table
- Arm extension aids

Anaesthesia and positioning

- Intubation anaesthesia
- Stomach tube, eye protection
- Prone position
- Fixation of the head in the Mayfield clamp with straightening of the cervical spine
- Lengthwise extension of the arms with 3 kg of traction on each arm
- Operating field must be accessible for the image amplifier in two planes during the operation
- General precautions to protect the patient from positional injury

Surgical technique

(Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16)

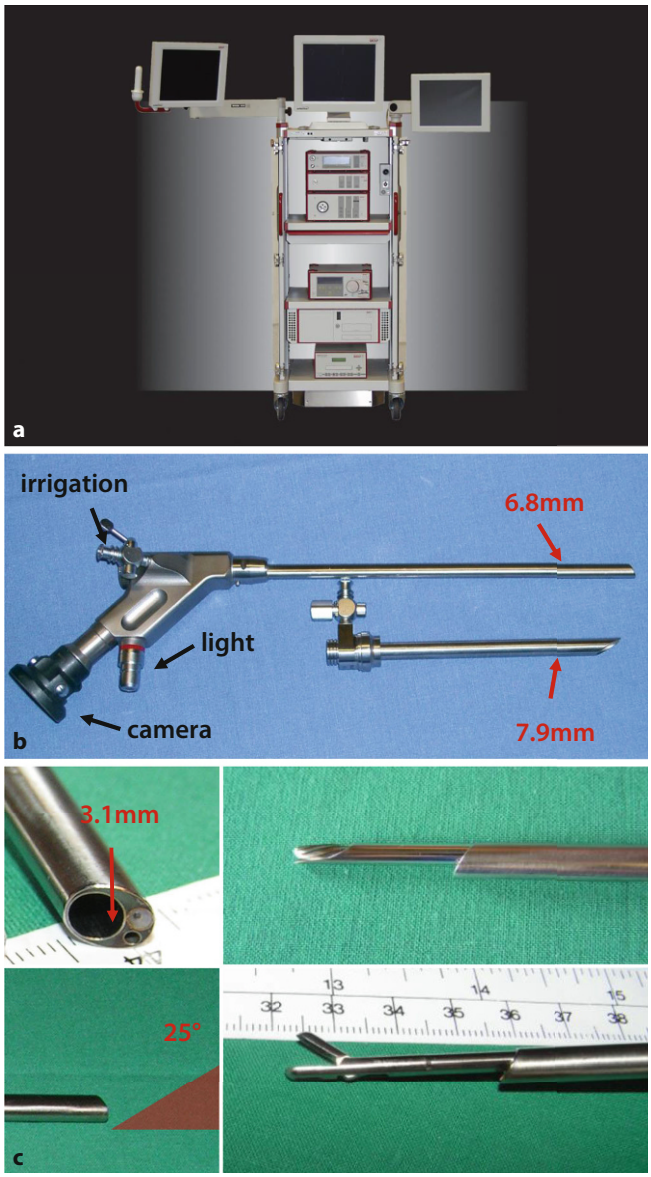

Fig. 1 ◀ Set up in the operating room: **a** monitor, camera unit, light source, motor unit for the bone cutter, irrigation pump, documentation system. **b** Endoscope and operating canula, **c** instruments

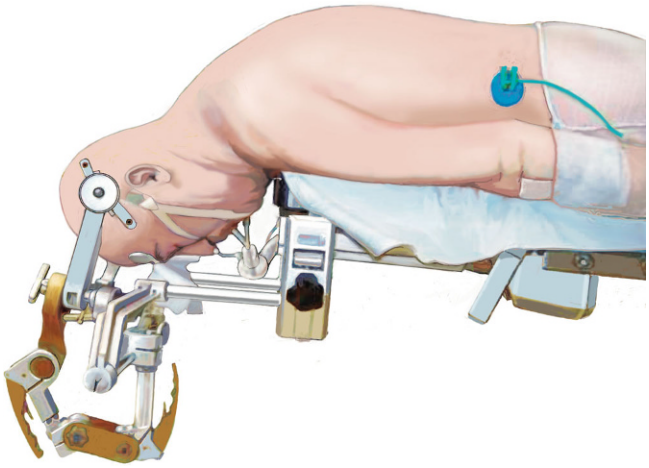

Fig. 2 ◀ The authors prefer the fixed fixation of the head in the Mayfield clamp. Please note the free accessibility and the opacity of the operating area in the anteroposterior and lateral direction of the C-arm

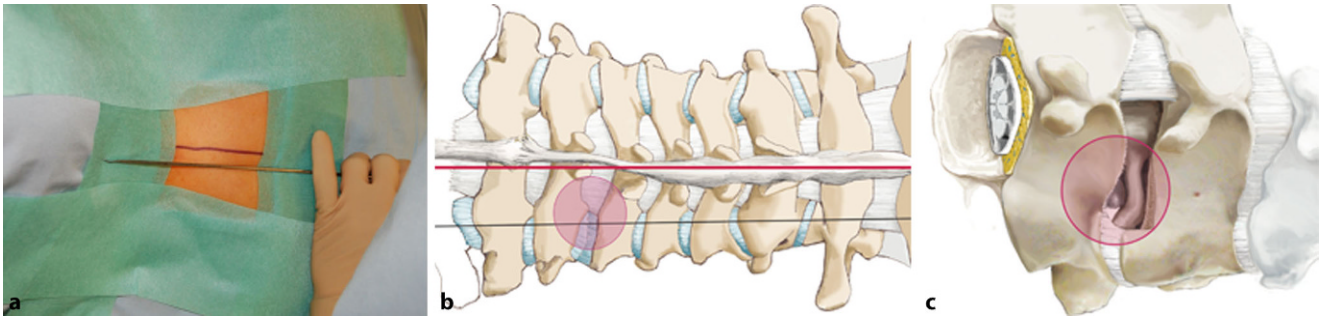

Fig. 3 ▲ The C-arm is used at the beginning of the operation in anteroposterior position. **a**, **b**, **c** Centre the cervical spine. Mark the midline and the centre line of the lateral mass

Fig. 4 ▲ Thereafter, the C-arm is pivoted for lateral projection

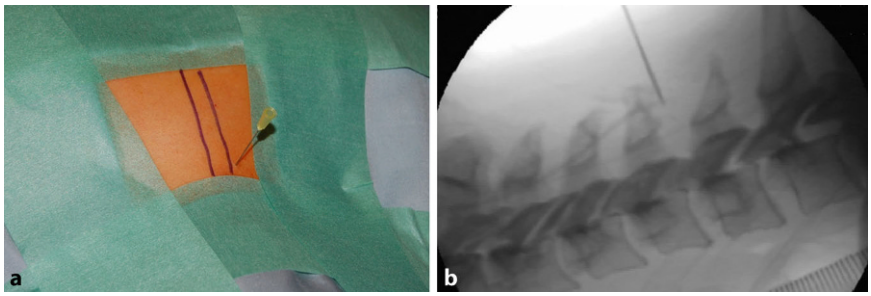

Fig. 5 a,b ▲ Under radiographic control the level to be operated with the cannula is marked over the lateral mass. Please note the alignment of the cannula orthograde on the intervertebral space

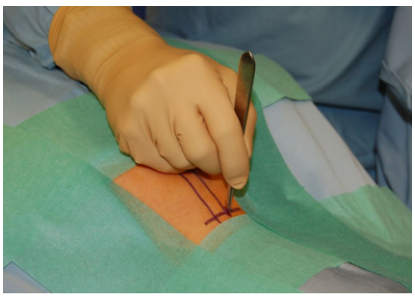

Fig. 6 ▲ The needle incision is performed after removal of the cannula. The depth of the incision should be chosen so that the fascia is also incised

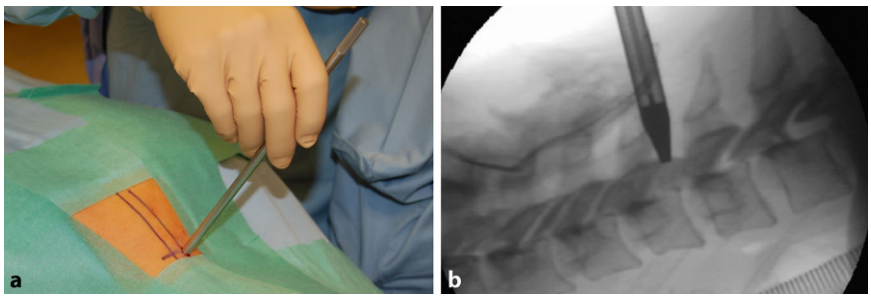

Fig. 7 a,b ▲ The dilator is inserted to the lateral mass under slight rotational movements. Here the bony resistance of the joint parts can be palpated

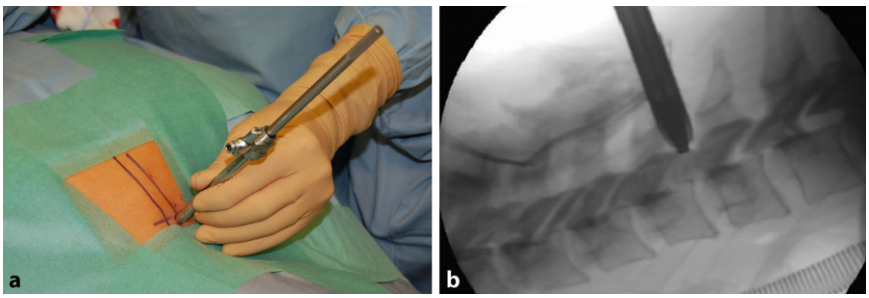

Fig. 8 a,b ▲ The operating sleeve is pushed over the dilator

Fig. 9 ▲ After removing the dilator, the endoscope is inserted. The left hand of the operator changes the position of the endoscope in all directions (comparable to a joystick) and also controls the distance of the endoscope

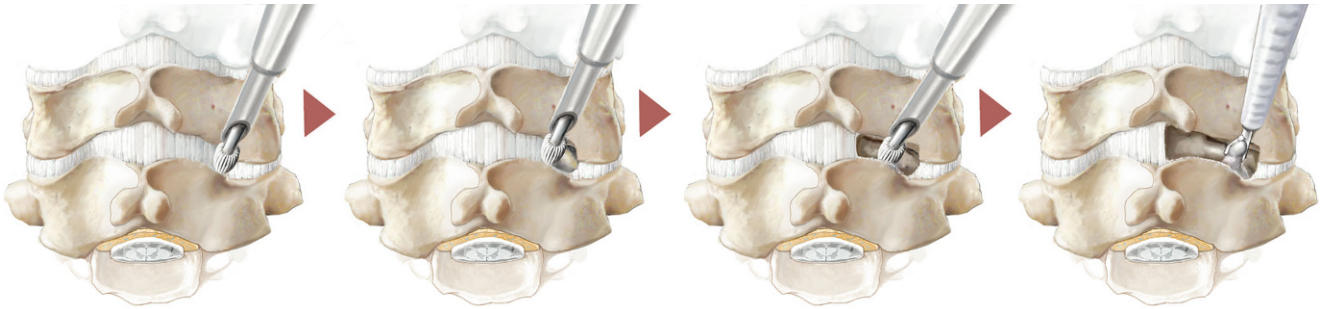

Fig. 10 ▲ After the removal of residual soft tissues with subtle haemostasis, the facet joint with the cranial and caudal joint partner is prepared first. The resection of the remaining soft tissue from the ligamentum flavum is then performed medially. The bone resection always begins at the descending facet. Subsequently, the bone of the caudal joint portion is removed. Bone resection must not be performed completely with the cutter, but thin the bone to the opposite cortex. This can then be removed later with cavity punching. The ligamentum flavum remains intact as an anatomical landmark and protective layer. The extent of cranial, caudal and lateral bone resection is to be adapted in accordance with preoperative imaging and pathology

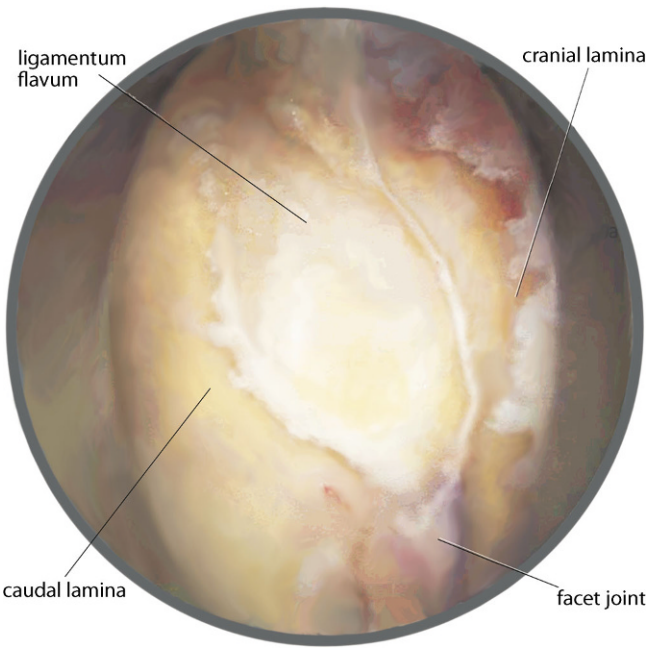

Fig. 11 ◄ Intraendoscopic view with thinned bone resection of the joint partners and the laminae

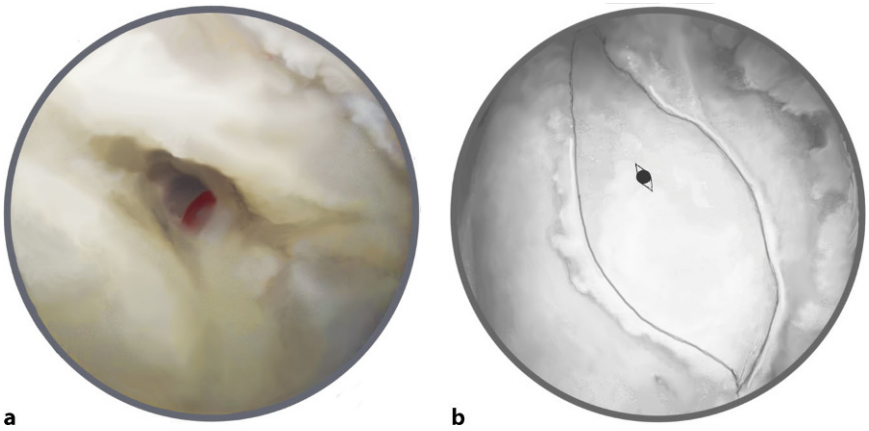

Fig. 12 a,b ▲ The ligamentum flavum is opened medially and subsequently removed laterally

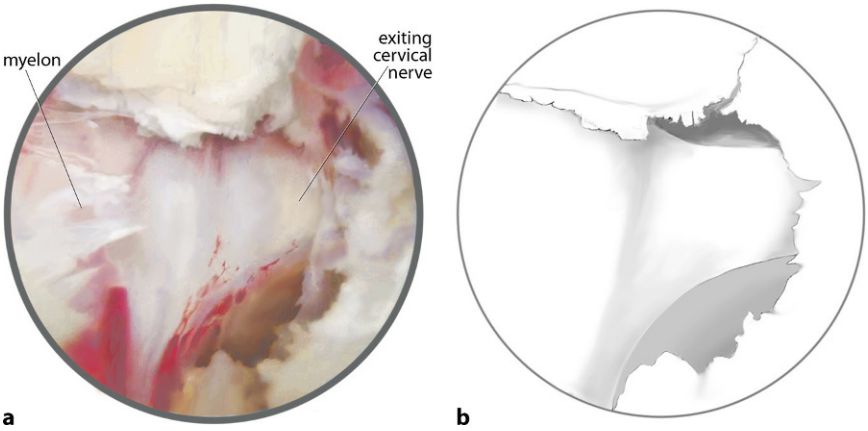

Fig. 13 a,b ▲ After resection of the ligamentum flavum, the lateral margin of the dural sac is visible. It serves as an anatomical guiding structure, on which the further preparation takes place, in order to find the exiting cervical nerve

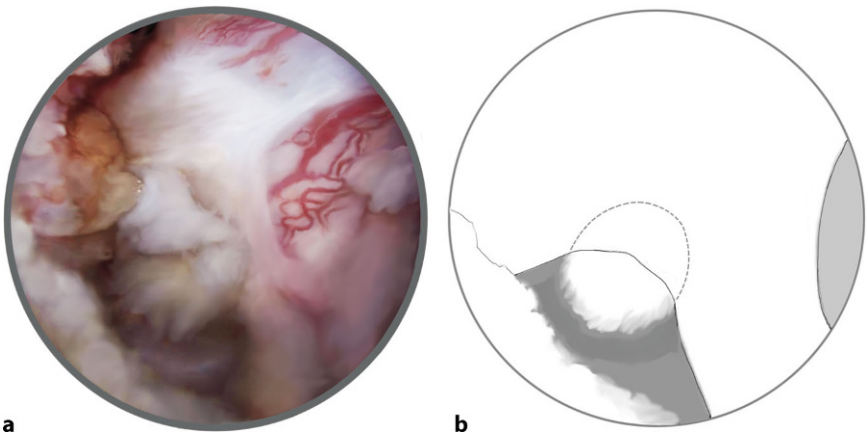

Fig. 14 a,b ▲ The herniation is directly below the cervical nerve in the axillar area

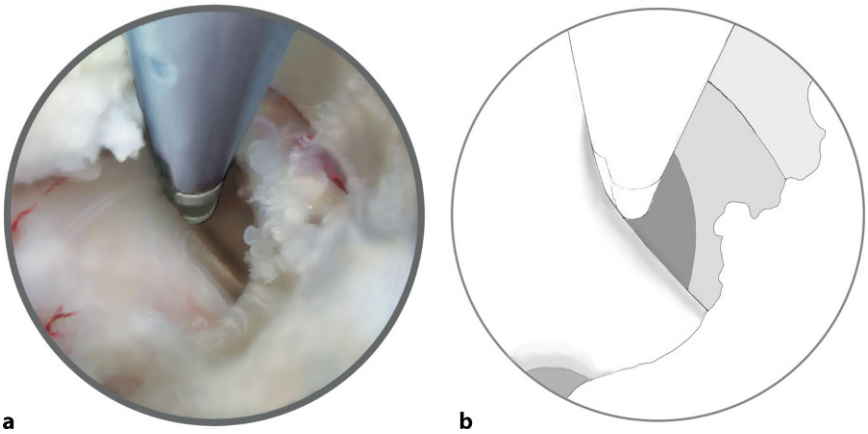

Fig. 15 a,b ▲ The cervical nerve can be mobilized to remove the herniated disc. It should always be examined cranially and caudally for further incidental parts. Medial mobilization of the myelon is forbidden

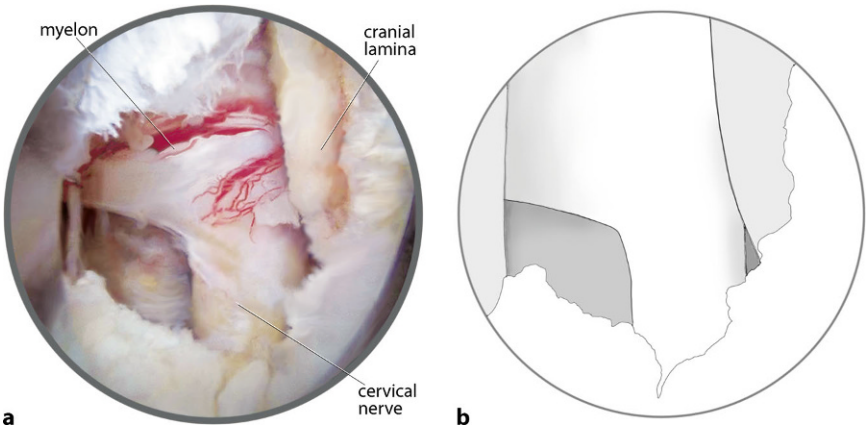

Fig. 16 a,b ▲ Intraendoscopic view after successful removal of the herniation

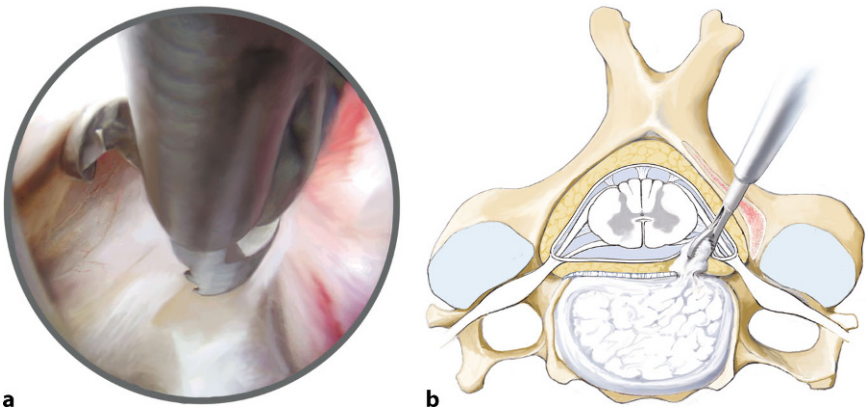

Fig. 17 a,b ▲ Removal of disc material located below the medial margin of the dural sac with the arm of the rongeur to avoid shifting the myelon to the medial aspect

Special considerations

- Bleeding obstructs the intraoperative view. Subtle haemostasis should be ensured during preparation with the radiofrequency electrode. The intraendoscopic drainage channel can be sealed temporarily by means of a rubber membrane. The associated pressure increase at the surgical site results in a good overview once more. However, this expedient should only be used to locate bleeding vessels to ensure prompt and effective haemostasis and to therefore counteract the theoretical risk of a pressure increase in the spinal canal.
- Bone resection always starts at the descending joint facet or the cranial lamina, as here the insertion zone of the ligamentum flavum extends a long way in the cranial direction. Resection of the caudal joint and laminal portions is carried out by means of subtle, layer-by-layer trimming of the bony parts as far as the cortical bone. This can then be easily removed using the available punches.
- The extent of the bone resection is always in line with the extent of the pathology as determined in the preoperative diagnostics, in both a craniocaudal as well as a lateral orientation.
- In the case of decompression of the neuroforamen, the line of circumference of the intervertebral disc space must be taken into consideration in order to avoid preparation too far in an anterior direction and therefore contact with the vertebral artery.
- Opening of the ligamentum flavum is always performed medially and should be carried out entirely in a lateral direction. This is also appropriate in the case of caudal or cranial opening at the lamina edge, as the lateral margin of the dural sac of the spinal cord must be identified. It represents the landmark for locating the cervical spinal nerve.
- Herniated parts located under the spinal cord are removed under visual control by passing the mobile arm of the rongeur under the spinal cord. In this manner, it is possible to remove compressing herniated parts without moving the spinal cord in a medial direction.
- In case of disc material located below the medial margin of the dural sac, the arm of the rongeur can be used to remove these fragments, thus, avoiding a shift of the myelon to the medial aspect (**Fig. 17a and b**).

Postoperative management

- Simple adhesive bandage
- Suture removal after 10 days
- Immediate mobilisation depending on the effects of anaesthesia
- Mobilisation-appropriate thrombosis prophylaxis
- Immediate isometric/co-ordination exercises
- In the case of paresis, active and passive neurostimulatory and myostimulatory interventions
- Functional exercises starting from week three
- Functional strength building starting from week six
- In the presence of adequate co-ordination/strength, active sport from week eight
- In-patient rehabilitation only in special cases (e. g. in the case of high-grade functional paresis)
- The use of an orthosis is not necessary. If desired, a soft orthosis should be used at most until the end of wound healing
- Postoperative incapacity to work for approximately 3 weeks depending on symptoms and the nature of the work

Errors, hazards, complications

- Injury to vessels, organs and other structures while achieving access
- Technical difficulties with the endoscopic procedure: switch to an open procedure
- Injury/irritation of spinal nerves/spinal cord: corresponding neurological symptoms such as dysaesthesia/hypoaesthesia, paraplegia, paresis, pain syndromes
- Dural injury: cover with an external matrix or gluing; in the case of more extensive injury, switch to an open procedure and dural suture; in the presence of a postoperative cerebral spinal fluid fistula, open revision and dural suture
- Undetected pressure increase in the spinal canal due to obstruction of outflow of the irrigation fluid with a theoretical risk of spinal cord and nerve damage. To date, no such relationship has been proven unequivocally. Any deliberate increase in the irrigation pressure should only be for a limited time
- Postoperative intraspinal bleeding: neurological deficits and/or pain syndromes; revision or conservative approach
- Infections: antibiotic treatment or additional surgical treatment
- Impaired wound healing: await secondary wound healing or revision with direct suture
- Surgically induced segmental instability: surgical therapy depending on the findings
- Persistent symptoms: imaging and re-evaluation

Results

In this prospective study, the technical possibilities of full-endoscopic posterior foraminotomy for lateral cervical disc herniation with radicular symptoms were investigated. The goal was the evaluation of adequate decompression, specific complications and the technical aspects of achieving access, as a function of the pathology and anatomy.

A total of 100 patients (61 women, 39 men) were included. The average age of the patients was 44 years (range 31–72 years). The patients reported pain duration of 1 to 151 days (average 29 days). In all, 81 patients were treated conservatively for at least 3 weeks; 19 patients underwent direct surgery because of unendurable pain or progressive paresis. A total of 71 patients displayed numbness or paraesthesia of the upper limbs, and 43 patients had motor deficits. Overall, 9 operations were carried out at the level C4/5, 21 at C5/6, 58 at C6/7 and 12 at C7/T1.

Inclusion criteria were as follows: unilateral arm pain with lateral or foraminal disc herniation in the segments C2/3 to C7/T1 verified by MRI/CT. Patients with associated foraminal stenosis were also included. Exclusion criteria were marked instability or deformity and medial location of the disc herniation. Patients with cervical pain alone or foraminal stenosis without disc herniation were not included in the study.

Follow-up examinations were carried out on day 1 (100 patients) and after 3 months (98 patients), 6 months (91 patients), 12 months (93 patients) and 24 months (87 patients). Follow-up was performed by two physicians who had not been involved in the operations, using the following measuring instruments: the visual analog scale (VAS) for cervical and arm pain, the German version of the North American Spine Society Instrument (NASS) and the Hilibrand criteria according to Smith and Robinson. At the end of follow-up, MRIs were obtained for all patients. Statistical evaluation was performed externally with SPSS and with positive significance at <0.05.

A total of 87 patients were followed for 24 months, 3 patients could not be traced, and 8 patients did not respond to phone calls or written contact. Two patients underwent revision surgery with anterior decompression and fusion.

In 87 patients (87%), new disc tissue was observed intraoperatively; 23 of these patients also had osteophytes in the neural foramen. In 13 patients (13%), there was compression of the cervical nerve due to protruding annulus material and osteophytic foraminal stenosis. In all, bony foraminal stenosis was present in 36 patients (36%).

The mean operation time was 37 min (range 28–48 min). There was no measurable blood loss. In all patients it was necessary to carry out bone resection in order to achieve access. Obstruction due to intraoperative bleeding did not occur due to the continuous irrigation and the availability of bipolar radiofrequency preparation. From a technical perspective, all operations were able to be carried out; in no case was it necessary to convert to conventional surgery.

There were no complications such as postoperative bleeding, haematomas, injury to neural structures, spinal cord damage or paralysis. In all, 3 patients reported transient (4–6 weeks) dysaesthesia in the supply area of the affected nerve. Other complications such as infections, spondylodiscitis or thrombosis were not observed. No deterioration of preoperative symptoms occurred.

During the follow-up period, 3 patients (3.4%) suffered recurrent disc herniation following a pain-free interval. All recurrences were located laterally and were operated on using the same technique. In all, 2 patients underwent anterior decompression and fusion surgery due to persistent pain. These patients belonged to the group of patients who did not demonstrate any loose disc tissue.

On the MRI examinations after 24 months, no patient displayed new disc damage. In 9 patients, there was progression of disc damage that had already existed preoperatively. There were no signs of progressive kyphosis or instability in the operated segment in any of the patients. In comparison to the preoperative MRI, 28 patients (32%) showed signs of progressive degeneration in terms of fluid loss or narrowing of the intervertebral space by a maximum of 2 mm.

Surgery-related analgesia was not required. Mobilisation was started as soon as the effects of anaesthesia had worn off. Rehabilitative measures were not required, except in cases of pre-existing paresis. On average, the postoperative period of work incapacity was 21 days (range 3–48 days).

The measured scores showed a constant and significant ($p < 0.001$) improvement in arm pain and activities of daily living. After 2 years, 76 patients (87.4%) stated that they no longer had arm pain, 8 (9.2%) had occasional pain and 3 patients (3.4%) had experienced no improvement.

Surgically induced cervical pain occurred in 5 cases. These patients did not require pain medication, and the pain resolved after a maximum of 5 days. Pre-existing neurological deficits were reduced by a significantly greater extent ($p < 0.001$) if they had been present for less than 7 days. All other findings were independent of general parameters such as age, gender, height, weight, profession and comorbidities.

A total of 81 patients (93%) reported subjective satisfaction and stated that they would undergo the procedure again. In all, 5 patients experienced a bad result (3 with no pain reduction, 2 requiring anterior decompression and fusion). Including surgery for recurrence, a total of 5 patients underwent revision.

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Compliance with ethical guidelines

Conflict of interest. M. Komp, S. Özdemir, P. Hahn and S. Ruetten declare that they have no competing interests.

This article does not contain any studies with human participants or animals performed by any of the authors.

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66. Jahrestagung der Vereinigung Süddeutscher Orthopäden und Unfallchirurgen e.V.

26. bis 28. April 2018 in Baden-Baden

„Mobilität durch Fortschritt" – dieses Motto haben die beiden Kongresspräsidenten, Prof. Dr. Ruchholtz (Marburg) und Prof. Dr. Rudert (Würzburg) gewählt. Damit spiegelt es die Kernaufgaben des Faches O&U wider: Die Erhaltung bzw. Wiedererlangung der Mobilität

Den 3.000 erwarteten Fachbesuchern wird ein hochkarätiges wissenschaftliches Programm geboten. Folgende Schwerpunktthemen stehen dabei im Fokus:

- Alterstraumatologie
- Osteologie
- E-health
- Endoprothetik
- Sportverletzungen und Sportschäden
- Freie Themen

Sowohl niedergelassenen als auch klinisch tätigen Orthopäden und Unfallchirurgen wird während der drei Kongresstage ausreichend Gelegenheit gegeben, sich umfassend auszutauschen, weiterzubilden und sich mit praktischen Anregungen und interessanten Neuerungen für die eigene Tätigkeit auseinanderzusetzen.

Mobilität durch Fortschritt

2018 werden in sogenannten „Fortschrittsblöcken" zukünftige Entwicklungen in der Therapie aufgezeigt. Inwieweit diese Neuerungen dann Einzug in den klinischen und wissenschaftlichen Alltag finden, wird die Zukunft zeigen.

„Dr. House" in O&U

Als eines der Highlights der Frühjahrstagung 2018 berichtet der als „deutscher Dr. House" bekannt gewordene Prof. Schäfer (Marburg) zusammen mit Kollegen aus O&U über interessante Fälle und seltene Erkrankungen, die einen Blick über den Tellerrand des Fachgebiets hinaus verschaffen sollen.

Nachwuchsförderung

Die Nachwuchsförderung ist dem VSOU seit Jahren ein wichtiges Anliegen. Die Nachwuchskräfte haben in den Kursen „AE-Basis-Kompaktkurs Hüfte und Knie" und „AOTrauma Workshop-kompakt" die Möglichkeit, praktische Fertigkeiten zu trainieren und Tricks von Profis zu erlernen. Hierzu ist eine separate Anmeldung erforderlich.

Beim **Tag der Vorklinik** am 26.04.2018 erhalten 40 Studierende die Möglichkeit, das weitreichende Fachgebiet O&U näher kennenzulernen. U.a. werden den Studierenden praktische Grundfertigkeiten im Sinne von „hands on"-Kursen vermittelt. Diese Aktion richtet der VSOU traditionell in Zusammenarbeit mit dem Jungen Forum O&U und den YOUngster's O&U aus.

Einbindung der Industrie

Neben der klassischen Fachausstellung der Industrie organisieren 2018 erstmalig deren Vertreter wissenschaftliche Sitzungen zu selbstgewählten Themen.

VSOU-Kongress-App

Passend zum Motto „Mobilität durch Fortschritt" gibt es erstmals eine Kongress-App. Diese ermöglicht den Kongressteilnehmern ihren individuellen Zeitplan zu erstellen und sich mit anderen Teilnehmern vor Ort zu vernetzen.

Tagesausklang

Ob beim *Get-together* nach der Eröffnungsveranstaltung, beim *Thursday Night-Fever* oder beim *Festabend Casino Royal* – es gibt viele Möglichkeiten zum geselligen Austausch unter Kollegen und Freunden.

Weitere Informationen unter:
www.jahrestagung2018.vsou.de

Organisation und Kongressleitung

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