Cervical Nucleoplasty

K. Birnbaum

Contents

J. Jerosch (ed.), *Minimally Invasive Spine Intervention*,
https://doi.org/10.1007/978-3-662-63814-9_17

17.1 Indication

The indication for nucleoplasty of the cervical spine is clear. This includes a monoradicular radiation of pain from the cervical spine into the right or left arm depending on the form of the disc protrusion or prolapse.

An exclusion criterion is acute nerve root compression with motor paresis.

Pain in the cervical spine alone is not an indication for nucleoplasty, since in the majority of cases it reflects pain originating in the facet joints. An MRI of the cervical spine is used preoperatively to confirm the indication for surgery. The clear indication is disc protrusion and non-sequestered disc prolapse with matching clinical symptoms of discomfort.

In many cases, floor diagnostics can help to determine the indication. This means that if the practitioner is unable to establish an unambiguous indication, floor diagnostics can make a significant contribution to the decision on therapy. This includes the repeated clinical-neurological examination in the course of at least 6 weeks of intensive conservative therapy, which would precede the nucleoplasty.

Conservative therapy primarily includes treatment with nonsteroidal anti-inflammatory drugs (NSAIDs), analgesics and, if necessary, muscle relaxants in combination with intensive physiotherapeutic exercise treatment (KG) with training of the cervical spine-stabilizing muscles and acupuncture. If necessary, physical therapy measures with massages, electrotherapy and thermal baths are also used.

If these therapeutic measures do not show any improvement in the symptoms, the next step is targeted injections in the cervical spine, which may be performed during the course of the ongoing KG. In the first step, these include facet infiltrations and subsequently nerve root infiltrations of the cervical spine or the affected disc levels and nerve roots. The targeted injections should be performed under C-arm control or under computed tomographic control. This allows a safe floor diagnosis and at the same time a clear documentation. If the targeted C-arm-assisted nerve root infiltration—matching the affected disc floor or matching the disc protrusion or prolapse—contributes to a passive pain reduction, the indication for disc decompression (nucleoplasty) is clear.

If the pain persists despite the exhaustion of conservative treatment measures, nucleoplasty may be indicated.

17.2 Disc Decompression (Nucleoplasty): What Is it?

Nucleoplasty is a low-temperature plasma excision and thus a controlled, non-heat-controlled procedure. This allows temperatures that are at a maximum of 50 °C at the probe tip of the nucleoplasty catheter, thus making damage to the surrounding tissue, especially nervous structures, almost impossible.

Bipolar radiofrequency energy is directed to a conductive medium—in this case disc tissue or nucleus pulposus. This generates a precisely focused plasma field which breaks the molecular bonds in the tissue and thus enables volumetric ablation of the intervertebral disc tissue.

High voltage is applied to the conductive liquid—in this case intervertebral disc tissue. The intervertebral disc tissue is thereby transformed into an ionized vapor layer (plasma). The plasma field contains ions that hit the tissue at high speed and break molecular bonds. The tissue is transformed into predominantly gaseous molecules, which can escape through the trocar of the nucleoplasty probe (Chen 2003).

This technique, which has been used in minimally invasive disc therapy for more than two decades, allows controlled and localized ablation of disc tissue at low temperatures. It involves effective pressure relief of the disc and promotes the scientifically proven self-healing process by initiating an anti-inflammatory, interleukin-mediated biochemical process (O'Neill et al. 2004).

17.3 Preoperative Diagnostics

A conventional x-ray of the cervical spine in 3 planes should be performed on the one hand to assess foraminal narrowing and facet joint arthrosis and on the other hand to exclude

inflammatory or tumorous changes. In addition, an MRI of the cervical spine should be obtained to assess the intervertebral discs and exclude cervical myelopathy.

If there are possible disc changes over several motion segments, a few days before the actual surgery planned discography of the disc floors for the surgeon and the patient can provide clarity about the floor to be treated.

17.4 Reconnaissance

The minimally invasive surgical procedure of nucleoplasty of the intervertebral discs of the cervical spine has a very low surgical risk.

As with any surgical procedure, the possibility of infection and injury to nerves, vessels and adjacent structures must be explained.

17.5 Surgical Technique

The best possible preparation guarantees a safe success of the surgical procedure.

The first step is good positioning that is comfortable for the patient. The patient lies supine on a radiolucent table. Establishment of an i.v. line, pulse oximetry and ECG for monitoring. If necessary, supplementary stand-by by the anaesthesiology department of the hospital as well as supplementary sedation of the patient if necessary. Intubation anaesthesia is not indicated in any case.

Subsequently, the X-ray image intensifier (intensifier) should be precisely adjusted to the cervical spine motion segment to be treated and the tilt (gentry) of the intensifier should be marked. The surgical risk decreases all the more significantly, the more the surgeon observes a safe radiographic setting of the disc level to be treated intraoperatively. This includes the clear line-shaped adjustment of the cover or base plate of the adjacent vertebral bodies in the X-ray image of the monitor located at the foot end or opposite.

Now retract the BV and sterilely cover the surgical site. It is important to maintain continuous contact with the patient, as the sterile covering of the surgical site significantly restricts the awake patient's field of vision during the minimally invasive surgical procedure.

The next step is to set the operating table. A sterile pen, another skin disinfection, a local anaesthetic for the stitch canal anaesthesia as well as the nucleoplasty catheter and the nucleoplasty needle (needle trocar) are required.

Now mark the anatomical landmarks—in particular the common carotid artery laterally and the trachea and oesophagus medially (Fig. 17.1). Medial to the artery, one senses a gap between the trachea and the vessel. In this natural low-resistance area, the needle trocar should be positioned at the level of the disc level to be treated (Fig. 17.2).

The hand position of the trocar needle and the nucleopasty catheter are as follows for the minimally invasive intervention: The trocar needle is clamped between the second and third finger and inserted into the disc space under continuous BV control.

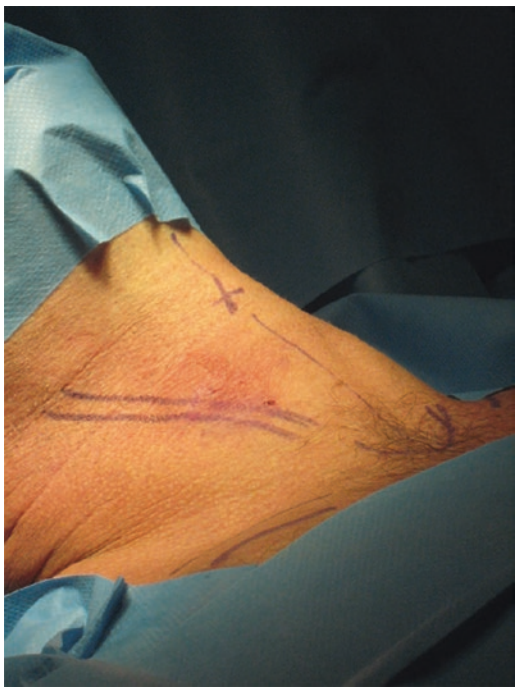

Fig. 17.1 Intraoperative view of the surgical site of the cervical spine from ventral with sterile draping at the level of the mandible and rib cage. Marking of the anatomical landmarks: Midline with underlying trachea and esophagus and common carotid artery

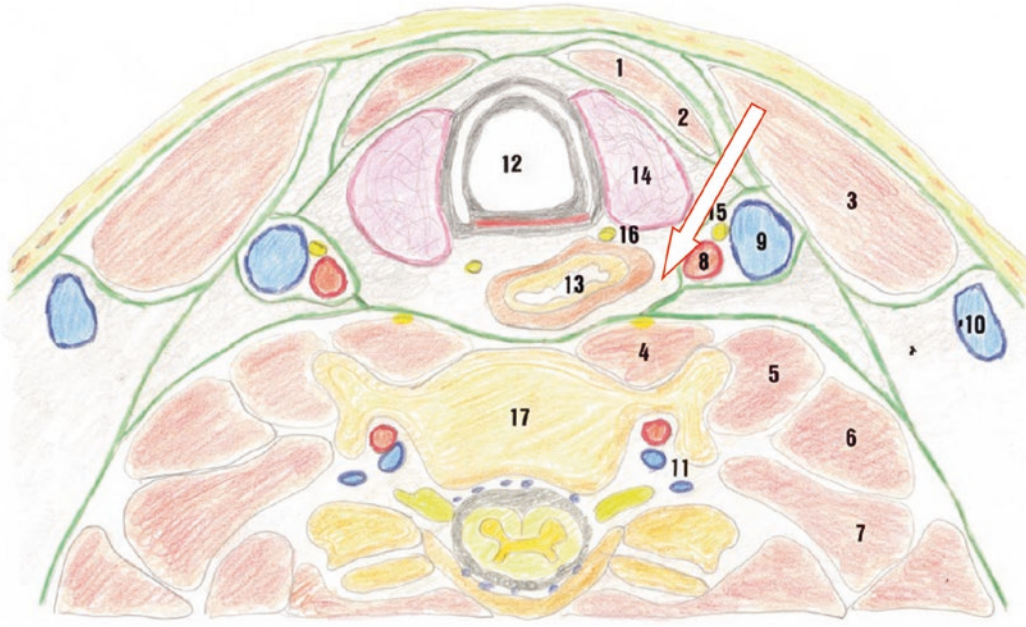

Fig. 17.2 Drawing of the cervical spine in cross-section showing the important anatomical structures and illustrating the ideal percutaneous access route (*arrow*) between the trachea medially and the common carotid artery laterally. *1* Sternohyoid muscle; *2* Sternothyroid muscle; *3* Sternocleidomastoid muscle; *4* Longus colli muscle; *5* Anterior scalenus muscle; *6* Medial scalenus muscle; *7* Posterior scalenus muscle; *8* *Common carotid artery;* *9* Common carotid artery. Carotis communis; *9* V. jugularis interna; *10* V. jugularis externa; *11* Vasa vertebralia; *12* Trachea; *13* Esophagus; *14* Glandula thyroidea. *Arrow* = optimal angle of entry of the trocar needle into the intervertebral disc

The following **surgical steps** are performed:

Search of the puncture site under C-arm control in p.a. and lateral view: in a.p.-centre position fine-line drawing of the base and cover plates of the disc to be treated visible; in lateral view disc also clearly visible in the area of the cervicothoracic transition.

Asking the patient to bring his arms down.

Subcutaneous instillation of local anesthetic (Fig. 17.3).

Insertion site between artery and trachea anterolaterally: Depending on the position of the trocar needle, the surgeon can enter the disc space either ipsilaterally, medially or contralaterally. The entry angles of the insertion needle in relation to the midline of the cervical spine motion segments (Fig. 17.4) are as follows

- 10–15° for the ipsilateral side of the disc,
- 15–20° for the mediodorsal region of the disc,
- 20–25° for the contralateral side of the disc.

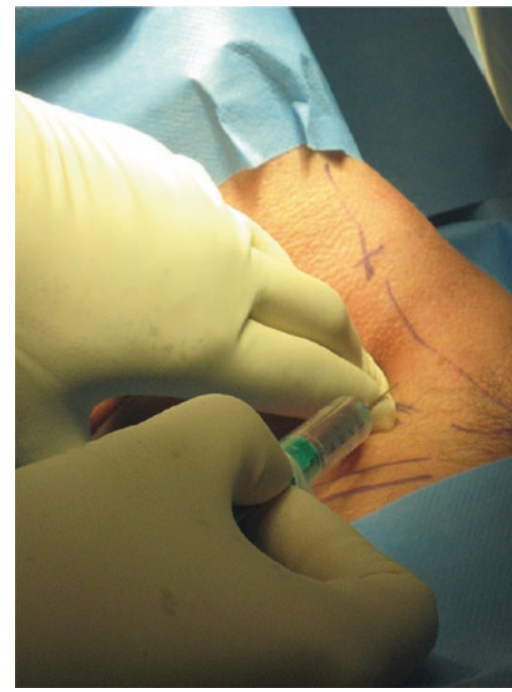

Fig. 17.3 Subcutaneous instillation of local anaesthetic between the medial trachea and the lateral common carotid artery prior to trocar insertion

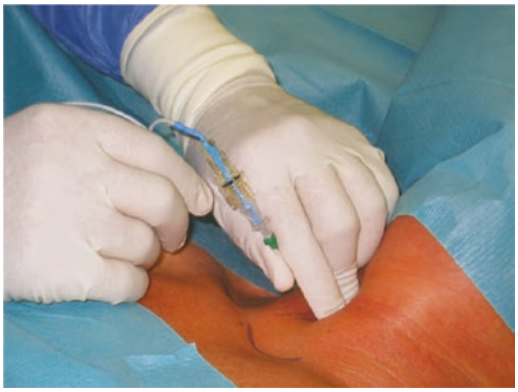

Fig. 17.4 Intraoperative hand position of the trocar with the nucleoplasty catheter. The needle trocar is inserted into the disc under lateral X-ray control. In the next step, with the needle correctly positioned intradiscally in the posterior third of the disc space in the lateral radiographic projection of the motion segment, the needle is withdrawn into the middle third of the disc space. In the following step, the nucleoplasty catheter is inserted under continuous lateral X-ray control in order to prevent the catheter tip from entering the spinal canal in any case

17.5.1 Intradiscal Section

First, the intradiscal placement of the trocar needle is performed under continuous radiographic control in a.p. (anteroposterior) and lateral projection. Orthograde radiographic visualization of the intervertebral disc space in the ventral and lateral beam paths is important for accurate positioning of the needle. The base plate of the upper vertebral body and the cover plate of the lower vertebral body must be visible as a line-like boundary in the radiograph (Fig. 17.5a, b).

After correct positioning of the trocar needle tip in the posterior third of the intervertebral disc in lateral X-ray projection and projection of the needle tip in the middle third of the intervertebral disc in ventral X-ray, the needle is retracted to the middle of the intervertebral disc. This must be done because when the nucleoplasty catheter is inserted and locked via the Luer lock of the

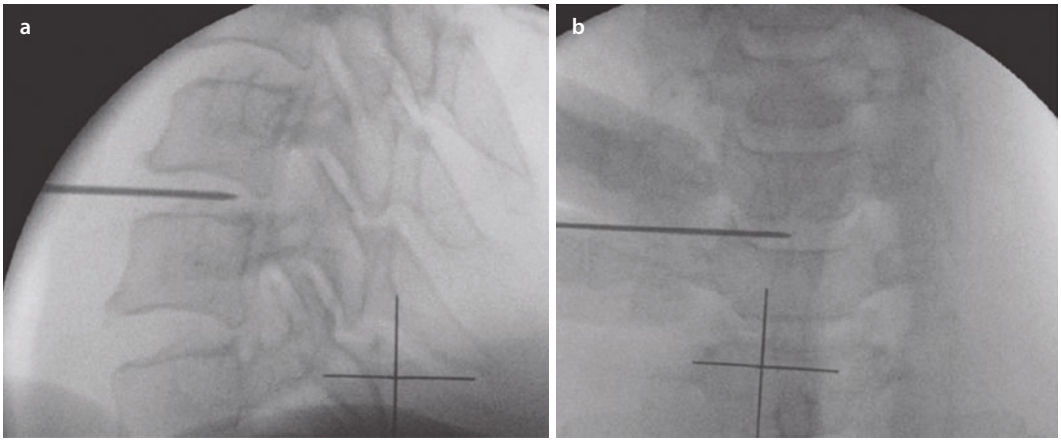

Fig. 17.5 **a** Lateral X-ray of the cervical spine showing the needle trocar in the posterior third of the disc space to be treated. **b** X-ray of the cervical spine from ventral (a.p. projection) showing the needle trocar in the middle of the disc space to be treated. For the correct position of the needle trocar, it is important that the needle tip is in the posterior third of the disc space in the lateral X-ray projection. At the same time, a central projection of the needle tip should be visible in the ventral X-ray projection

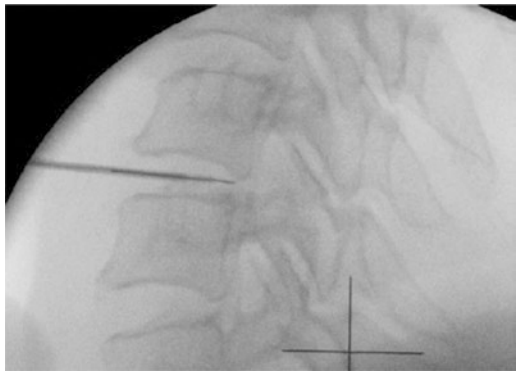

Fig. 17.6 Lateral X-ray with intradiscal visible connected nucleoplasty catheter in the posterior third of the disc to be treated. In this position, the **first** coblation is performed with the controller set to level 2 for 2–3 s with simultaneous rotation of the nucleoplasty catheter by 360°

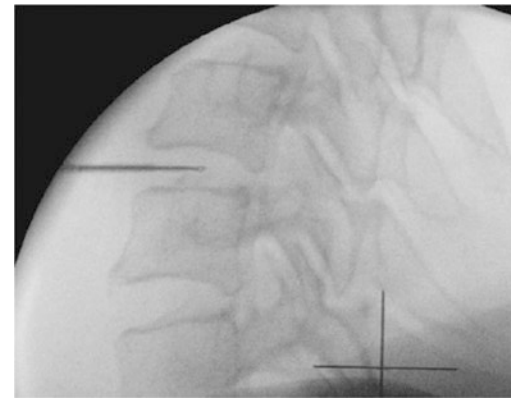

Fig. 17.7 Lateral X-ray with intradiscal visible connected nucleoplasty catheter in the middle third of the disc to be treated. In this position, the **second** coblation is performed with the controller set to level 2 for 2–3 s with simultaneous rotation of the nucleoplasty catheter by 360°

trocar needle, the tip protrudes 7 mm beyond the trocar needle (Fig. 17.6).

After insertion of the nucleoplasty catheter, the controller unit is connected, which activates the plasma field. After connecting the controller, the short stimulation with the coagulation mode is carried out for a maximum of 1 s in order to exclude possible nerve irritation during the subsequent coblation mode (generation of the plasma field). If the patient does not complain of any discomfort, the coblation can be performed.

Coblation (generation of the plasma field) is performed with the Level 2 controller for 2–3 s in the posterior and middle thirds of the disc space with simultaneous 360 ° rotation of the nucleoplasty catheter (Figs. 17.6 and 17.7).

When activating the plasma field (coblation), the catheter should not be advanced, as this may result in bending and possibly shearing of the tip. In any case, contact of the vertebral body end plates with the tip of the nucleoplasty catheter should be avoided, as otherwise a thermal influence on the base and cover plate of the adjacent vertebral bodies may result.

All steps should be performed under C-arm control and documented step by step. After coblation of the intervertebral disc, first the nucleoplasty catheter and then the trocar needle are removed. The final skin disinfection and the sterile dressing complete the operation.

17.5.2 Postoperative

Perioperative antibiotic prophylaxis is given. The hospital stay usually lasts 4–5 h. An anatomical neck brace should be worn by the patient for 1 week at night (Dunning bandage). The inability to work is 4–5 days.

17.6 Results

Cervical nucleoplasty is an outstanding procedure for the sufficient treatment of disc protrusion and non-sequestered disc prolapse after conservative therapy measures have been exhausted. With the correct indication, it represents a successful alternative to monosegmental spondylodesis.

In-house results in 86 patients who had a mean baseline pain score of 8.6 on the visual analog scale (VAS) at baseline showed a pain reduction of 1.8 on the VAS at follow-up 2 years after cervical nucleoplasty compared with physical therapy and nerve root injections.

Overall, the data base of publications on the topic of cervical nucleoplasty is very manageable and the value of the publications is moderate.

A study by Yan et al. (2010) compared the treatment of non sequestered cervical disc hernia with nucleoplasty (n = 81) versus nucleotomy (n = 95). Pain severity was evaluated by VAS 2 weeks postoperatively and 1, 3, 6, and 12 months postoperatively. Thereby, 12 months postoperatively showed a comparable pain reduction in both surgical procedures: In the nucleotomy patients, the pain score was on average still 2.74 (preoperative 7.12), in the nucleoplasty patients 2.71 (preoperative 7.18).

References

Chen YC (2003) Histologic findings of disc, end plate and neural elements after coblation of nucleus pulposus: an experimental nucleoplasty study. Spine J 3:466–470

O'Neill CW et al (2004) Percutaneous plasma decompression alters cytokine expression in injured porcine intervertebral discs. Spine J 4:88–98

Yan et al (2010) Percutaneous cervical nucleoplasty and percutaneous discectomy treatment of the contained cervical disc herniation. Arch Orthop Trauma Surg 130(11):1371–1376