5 CERVICAL ENDOSCOPIC DISCECTOMY

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Epidemiology

The most frequent pain syndrome in the musculoskeletal system after the low back pain is the neck and arm pain. Classically, every person out of three suffers neck pain at5 least once in his/her lifetime.[4] The frequency of chronic neck pain can be as high as 70%. The prevalence of acute neck pain is 10% in males, while the same is 13% in females. Frequency of the acute and self-limiting neck pain reaches 18% in clinical practice.

History

Stookey described some neurological pictures related to the cervical disc herniation in 1928. Schmorl, Keyes and Compere carried out studies on the physiopathology of the intervertebral disc in the early 1930s, and established the grounds for the understanding of disc herniation; with this, the causative relations of the disc herniation were more clearly established. Bailey and Badgley published the anterior approach in cervical traumas in 1952 and opened an important route in the surgical treatment. Following this, Cloward and Smith-Robinson separately described the cervical discectomy and fusion as a surgical technique in 1958. Following this, Hirsch reported a series of 7 patients with cervical disc pathologies that they had performed simple discectomy in 1960.[9] Cervical discectomy that became popular gradually gained greater success with the introduction of the surgical microscope to the spinal cases enabling the shift to micro discectomy step. However, the complications related to the classical open surgery and fusion and long recovery periods led to the searches for minimal invasive methods also in the cervical disc herniation. Starting from 1990s, experiences achieved in the arthroscopic surgery and advanced endoscopic instruments together with the laser technology allowed the application of anteroposterior cervical discectomy procedures with percutaneous endoscopy or endoscopic help.[6]

Anatomy and Physiopathology

Cervical intervertebral discs start at the C2-3 level. The facet structuring of the cervical region is the most motile part of the vertebral column; however, this increases susceptibility for trauma and degeneration. In the chronic degenerative process appearing with the advancing age however, the ligamentous and facet hypertrophy together with the intervertebral disc pathology, and following ossifications are introduced to the picture and cause cervical spinal stenosis. Degree of stenosis can dynamically increase with the physiologic loading and motion, and ischemic problems can be added to the mechanical compression leading to a picture of myelopathy resulting in spinal chord injury.[13] In such cases, the myelopathy picture can be seen solely, or radiculopathy related to foraminal stenosis and herniation can be added to the picture. Contrary to the radiculopathy picture related to single-space herniation seen in younger patients, the involvement in this process that appears with age includes the compression pictures occurring in multiple distances.

Clinical picture

Acute disc herniation generally has a course with radicular signs and symptoms accompanying severe neck pain. Some patients characteristically raise their arms over their head to relieve the pain. Neck extension can worsen the pain radiating to the arm. The neck maneuvers during the physical examination increases the pain radiating to the arm, hand and fingers and numbness. Clinical radiculopathy findings appear according to the affected root. The disc herniation seen the least is the C2-3 space. If the C3 root is compressed, pain radiates to the occipital area and sometimes, to the ear. Differentiation from the cervicogenic headache is rather difficult, because there is no motor involvement. The C4 root is affected in C3-4 discopathies. Classically, pain radiates to the shoulder and scapula, however, since there is no motor deficit and the condition gives no EMG findings, diagnosis with clinical examination is rather difficult. C5 root is affected in C4-5 discopathies. Pain radiates to the shoulder and lateral of the arm in epaulet fashion. Difficulties in elevation of the arm related to the deltoid muscle are experienced in relation with strength loss as motor deficit. C6 root is affected in discopathies. Pain radiates to forearm and thumb and second finger, and numbness accompanies pain. Biceps reflex is diminished or lost. Marked motor deficit is present in the biceps muscle. C7 root is affected in C6-7 discopathies. Pain has a pattern radiating from the posterior side of the shoulder to the posterolateral of the arm, and from there to the middle finger. Triceps reflex is diminished or lost. Marked motor deficit is present in the triceps muscle. C8 root is affected in C7-T1 discopathies. Marked numbness in the little finger and motor deficit in the inter osseous muscles are in the forefront.

Differential diagnosis

Cervical disc herniation can simulate several diseases. Radiology and electrophysiology are helpful in this issue; however, the most important diagnostic tool currently is still the neurologic examination.

Intradural and epidural cervical tumors cause soft tissue damage and can create similar findings through their direct mass effect or bleeding and inflammation. One of the most important conditions that must be considered is the lung tumors with apical location that present itself with Horner syndrome in general (Pancoast tumor). Brachial plexus invasion and monolateral upper extremity paralysis can be seen. Cerebral tumors located in the motor cortex can rarely present with contra-lateral pain and monoparesis.

One of the conditions confused with cervical disc hernias most frequently in the clinical practice is the nerve entrapment neuropathies. Differential diagnosis of the neuropathies of entrapment neuropathies can be made with EMG.

Vascular conditions including the thoracic outlet syndrome can also be confused with cervical disc hernias. Rotator cuff tears, bursitis, tendinitis, degenerative arthritis and chronic instability of the shoulder also can be confused with cervical discopathy in the differential diagnosis.

Radiologic Evaluation

The first step in the evaluation of the cervical disc disease consists of plain x-rays. Standard anteroposterior and lateral cervical plain x-rays allow evaluation of the bony structure in the sagittal and coronal planes. Height loss in the disc space, diameter of the spinal channel, osteophytic formations, degenerative deformities and axial misalignment are the pathologies that can be seen at the first look. Computerized tomography (BT) and BT-myelography and MRI are the most frequently used diagnostic methods in the diagnosis of cervical disc hernias. Use of CT and MRI together is continuing particularly to determine the foraminal disco-osteophytic formations of bony structures, ossification of the posterior ligament complex (OPLL) and in the differential diagnosis.

Endoscopic Surgical Treatment

Many factors including the cervical disc herniation being soft disc or osteophytic calcified disc, central or posterolateral location, clinical picture being in the form of radiculopathy or myelo-radiculopathy, accompanying instability and sagittal plane deformities affect the decision for the endoscopic surgical approach. Familiarity of the surgeon with the endoscopic techniques and availability of the modern OR equipment that will allow the application of these

techniques are other requirements for the application of the endoscopic interventions.

The most important advantage of the endoscopic surgery is that it is generally applied with local anesthesia and discharge of the patient on the same day. It is accepted that the hospital costs are lower as compared to classical surgery, because it does not require fusion, surgical trauma is very small, it does not require blood transfusion and other advantages. It has been suggested that adjacent segment degeneration and graft-related complications are not seen due to the fact that fusion is not applied. The learning curve, that is, experience and selection of the suitable patients is the most important factor in endoscopic surgery that affects success.[2] Therefore, debates on the preference of options particularly in the percutaneous anterior endoscopic surgery are going on. Chomenucleosis, laser decompression or manual discectomy and laser vaporization applications can be used together. Success rates have been reported between 51 and 95% in several series.[5,10,11] The current literature till today is not very satisfactory as regards the evidence-based data accumulation related to the efficiency and safety of endoscopic cervical discectomy, and therefore many surgeons are still approach this issue with suspicion. Visibility of the disc through a small incision with the help of an endoscope and performing the disc decompression using laser rather than mechanical tools is an issue that is not very clear. Endoscopy has a limited vision area during the surgery and the disc fragments causing compression can be overlooked in non-experienced hands.

Indications of the surgical treatment can be listed as the radicular and axial pain resistant against conservative treatment, worsening neurological elements and radiologic appearance that is compatible with the clinical picture. In addition, availability of minimal invasive intervention options ensured by the percutaneous methods has included the soft disc herniation causing cervicogenic headache among these indications.[3]

Contra-indications in general include the symptomatic channel stenosis, cases with developed myelopathy, sequestrations migrated to the superior or inferior, degenerative deformities and cases with instability findings in the dynamic studies, and reoperations.[1,2]

Technique

Posterior

General indication is the foraminal soft sequestration. This is a method preferred particularly in young and active patients without instability, and allows the patients to return to daily activities within a short period. The disc space is not narrowed, and fusion is not necessary.[1,12] This is a motion-preserving surgical method; however, application on patients who had undergone lamino-foraminotomy at the same level can be problematic.

In contrast with the anterior endoscopic technique, the posterior key-hole lamino-foraminotomy technique is applied under general anesthesia.

In this technique performed using a micro-endoscopic retractor, Mayfield skull clamp is placed on the patient in supine position, and the operation table is given the sitting position to prevent hypotension. Trans-esophageal Doppler and central venous access is required for the follow-up of air embolism and for intervention whenever required. The most important advantage of the sitting position is falling of shoulders and the easy fluoroscopic distance control. Another advantage is the lack of obstruction of view in the surgical area related to the hemorrhagic leakage. Discectomy between C2-3 level to C7-T1 level is possible with posterior lamino-foraminotomy in sitting position. As is known, some difficulties of access to C2-3 and C7-T1 levels in the anterior approach are experienced in relation with the mandibular and sterno-clavicular anatomical limitations.

Another option is the discectomy method performed using horseshoe clamp in prone position using only the endoscopic working channel. Here, the micro-endoscopic retractor system is not used and the possible problems of the sitting position related to anesthesia are not seen.

Position of the C-arm is adjusted to take symmetric lateral radiologic images from the patient in both techniques. After draping the patient with standard sterile methods, the marking needle is used to mark the target area by directing the needle upwards from the adjacent lower level under the fluoroscopy control. The marking needle is placed so as to reach the posterior of the facet complex at a distance of 1,5-2 cm from the midline. After determining the entry

point, an incision of about 1,5 cm is made, and the lateral mass over the targeted disc space is reached with the guide wire under the fluoroscopy control, and the endoscopic working retractor is placed in the area that lamino-foraminotomy will be performed under the guidance A/P and lateral fluoroscopic images with the help of sequential dilators. After placing the endoscope within the retractor on the cranial side, the fixation arm is fixed to the operation table.

In the other technique, first the dilator will be placed in the distance under fluoroscopic control, and then the endoscopic working area will be placed over it. Diameter of the working area changes according to the endoscope used. After placing the endoscope in the working channel, the remaining portion of the procedure is performed under direct endoscopic vision. Continuous or interrupted irrigation with saline must be performed to keep the endoscopic vision clear. Endoscopic vision between 0 and 25 degrees is provided based on the system used.

After removing the soft tissue on the laminofacet junction, dura of the spinal chord's dura and root is exposed by using high-speed TUR and 1-2 mm Kerrision bone cutters, like in the open technique. Foraminotomy will be extended and epidural venous bleeding will be stopped using cautery, irrigation and hemostatic agents. Lamino-foraminotomy will be limited with the one-thirds of the facet to prevent iatrogenic instability. Procedure will be completed at this stage if the surgical indication is foraminal stenosis. However, if foraminal sequestration is the issue, the free piece under the root will be mobilized with the help of a blind hook and micro dissectors and will be removed using disc forceps. (Figure 1) Especially, since the C5 root has a very tense anatomic course within the foramen, the smallest movement in this technique can result in paresis. There is nothing to be done to prevent this morbidity, which improves spontaneously within a couple of months. Another anatomic issue is the possibility of motor and sensory branches leaving within the same dural sheath in the lower cervical levels. This must be kept in mind in the root retraction and both must be retracted at once.

Following the hemostasis, a long-acting local anesthetic is administered, and the layers are closed in sequence without placing a drain, and the procedure is thus completed. The patient can use a soft collar for a few days. Patients who develop no complications can return to their daily activities and jobs in the end of period of a few days.

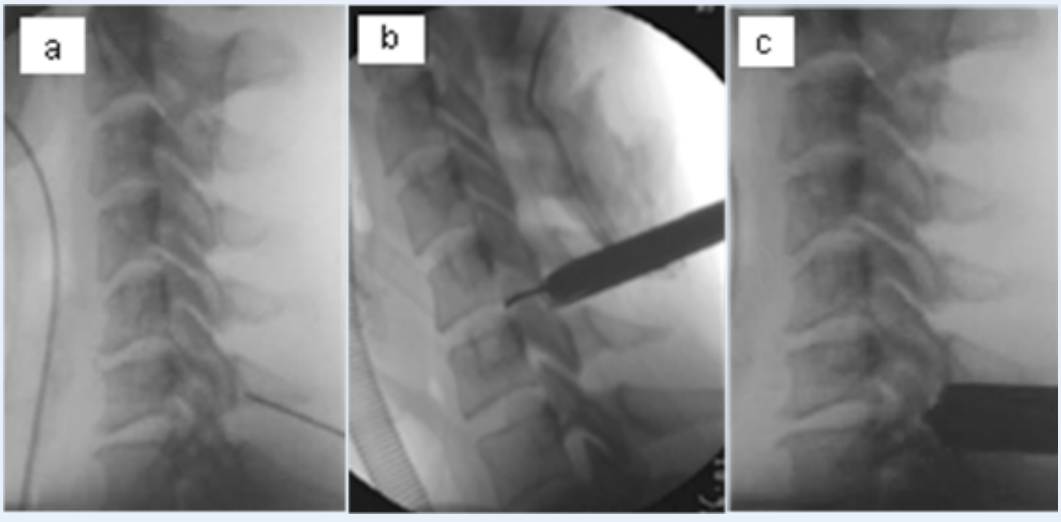
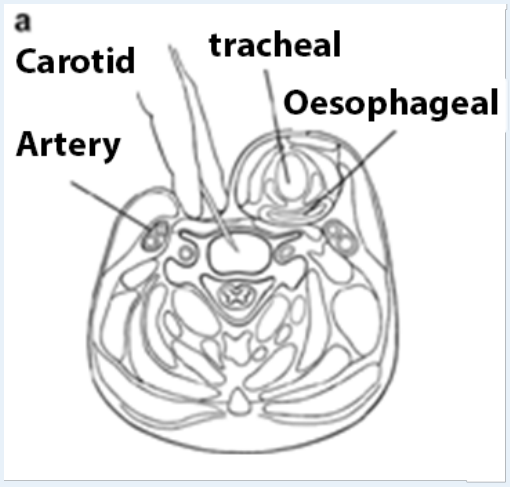


Figure 1: *Steps of the posterior endoscopic approach:*
a) *marking the laminofacet junction with guide wire,* **b)** *placement of the sequential dilators,*
c) *removal of the foraminal sequestration through the endoscopic working channel following the laminoforaminotomy*

Anterior

Indications include the soft midline herniation and posterolateral herniation. Patients with cervicogenic headache with positive discography and that is relieved after epidural blockage is also accepted among the indications.[3] Anterior cervical endoscopic discectomy is applied in supine position with the head in slight extension, like in the classical procedure. A soft support is placed under the shoulders. The head can be fixed with a plaster to prevent the head movements. Likewise, shoulders can be pulled down with the help of plaster to facilitate the determination of space under fluoroscopic control and perioperative imaging. After administering sedatives to the patient, cutaneous and subcutaneous tissue will be infiltrated with local anesthesia. Medial border of the sternocleidomastoid muscle is determined by palpating, and pressure is applied to mobilize the trachea and esophagus to the medial with second and third fingers and carotid to the lateral and progress is continued till the anterior face of the vertebral body is palpated. The ability of these anatomic structures to mobilize easily allows unproblematic performance of the procedure in general. Later, the disc space is entered with a spinal needle no. 18 and checked with fluoroscopy. Administering contrast substance can perform discography and meanwhile, mixing the contrast substance with a dye like indigo carmine can stain the disc. This procedure will allow visualization of especially the disc fragments extending in the subligamentous area more easily with the endoscope. However, discography is not obligatory. A small skin incision is made based on the diameter of the working channel used. A guide wire is passed forward within the spinal needle, the disk space is marked, and the endoscopic working area is placed in the disc space over the former with the help of sequenced dilators. (Figure 2) Circular or oval working areas can be used again depending on the system used. Endoscopic visual area can be between 0 and 25 degrees. Instruments used together with the endoscope include the hand tools design specifically for the working channel like micro curettes, palpation hook, trepan, disc forceps, 1- and 2-mm Kerrisson rongeurs and laser probe. (Figure 3)



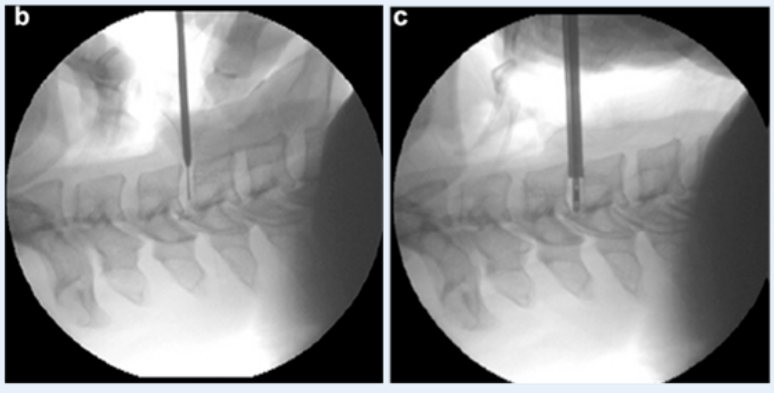


Figure 2: *Steps of the anterior endoscopic approach:*

a) *marking the disc space with percutaneous digital retraction,*

b) *placement of the dilator over the guide wire,*

c) *application of discectomy with 3-mm endoscopic working channel*

Total discectomy and if required, fusion with minimal invasive method can be performed under endoscopic view and with fluoroscopic control.[10,11] The latter means the intervention on the herniation or the sequestrated piece by progressing to posterior only through the disc. Since particularly the anterior part of the disc can be mostly preserved in the latter method, the risk of kyphotic development will be low. The

Figure 3: *Endoscope and disc forceps in the oval endoscopic working channel*

most important advantage is that this is a motility-preserving procedure. The disc height is preserved, and anatomic structures including the longus colli muscles, anterior longitudinal ligament and anterior annulus are not damaged. Again, clear vision is ensured by continuous irrigation as a standard in endoscopic surgery. Another purpose of irrigation is to protect the neural tissues from thermal effects if laser vaporization is applied. It must be kept in mind that the distance of impact of laser is between 0.3 and 0.5 mm. Decompression can be ensured by using mechanical disc forceps instead of laser. Placement of drainage generally will not be needed at the end of operation. The patient is kept under observation for a few hours as the standard after closure of the wound, and then can be discharged on the same day. A soft collar can be used for a short period.

Complications and Outcome

To list the potential perioperative complications, the most serious complication is the injury of can spinal chord and nerve roots, followed by dural tear and related CSF fistulas, vascular injuries and loss of endoscopic vision orientation. In the postoperative period, complications including infections, permanent or temporary neurologic deficits, worsening of the disc degeneration, recurrent herniation or continuance of complaints in relation with the failure in the removal of the fragment can be seen. As mentioned above, the experience gained during the learning period of endoscopic surgery reduces the possibility of such complications. In a large series of classical anterior approach, the rate has been reported to approximately 0.1%.[8] However, in endoscopic series, reoperation with a rate of approximately 3%, CSF fistula between 2% and 8%, vascular injury with 5% (carotid artery and jugular vein), discitis with 2% and laryngeal nerve injury with 2%.[2,7]

One of the most functional scales used for the postoperative follow-up is the MacNab criteria (Table 1).

Table 1:
MacNab Scale

Excellent	No pain or functional restriction
Good	Pain that rarely affects the normal works and daily activities
Medium	Functional improvement is present, however, there is pain that requires the changes in normal works and daily activities
Poor	There is no improvement or worsening is present; new surgical treatment can be required

The most important factor affecting success is the selection of suitable patients. Patients with radicular pain, with mild disc degeneration or no degeneration, with disc herniation-sequestration posterolateral or foraminal location or and without kyphotic deformity make the ideal group.[2] The success rates according to MacNab scale in different series have been reported as excellent in 40-85%, good in 30-40%, medium in 8-15% and poor in 10-20%.[2,5,10,12]

When these rates are compared to the classical microscopic surgery or open surgery, it is possible that they do not meet the expectations; however, we are facing as an undeniable fact that minimal invasive methods will be gradually more common as compared to the classical microscopic surgery or open surgery with reasons including the developing technology, the preferences of patients, and efforts to lower the costs. Clinical studies based on evidences about the learning curve and patient selection will ensure the increase of success rates.

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