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CERVICAL ANTERIOR FORAMINOTOMY

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Cervical anterior foraminotomy (AF) is an anterior surgical technique for the cervical spine aimed to decompress intervertebral foramen and lateral side of the spinal canal. This technique aims to remove the offending lesion, either a disc fragment or osteophyte compressing the neural structures, via a bony window at the uncovertebral area; while preserving the structure and functions of the intervertebral disc. For this technique, different terms such as *cervical anterior foraminotomy*, *anterior microforaminotomy*, *uncinectomy*, and *uncoforaminotomy* were used, and all of them refer the same surgical technique.

History

Classical anterior cervical approaches use the surgical plane between medially trachea and laterally great vessels (carotid and jugular vein); and view the spine almost *en face*. These approaches can be called as *anteromedial*. On the other hand, *anterolateral approach* retracts the great vessels *medially*, uses a more lateral angle of view, and views the spine *obliquely*. Verbiest²⁸ used the anterolateral approach, mobilized the vertebral artery, and performed anterior discectomy with or without fusion in 1968. Hakuba⁶ performed this procedure without mobilizing the vertebral artery in 1976 and called as the *transuncodiscal approach*. In 1987, Lesoin¹⁸ operated foraminal disc herniations via a surgical technique called as anterior discectomy. Using a 6 mm cylindrical burr, Snyder and Bernhardt²⁶ performed fragmentectomy by entering from 1/3

lateral of the intervertebral disc, and called this technique as *anterior cervical fractional decompression*. George² published surgical treatment of cervical myeloradiculopathy by the *oblique transcorporeal drilling* in 1993. In this technique, the anterolateral corridor is used; the uncovertebral area is drilled along with the lateral part of the vertebral body and discs, and the anterior aspect of the spinal cord is exposed fully. No fusion is employed. The main indication for this technique is myelopathy. However, accompanying radiculopathy can also be successfully treated.^{3,12}

Hae-Dong Jho⁷ has described AF, in its closest form that we understand today, in 1996. In this technique, Dr. Jho removes unciniate process and the most lateral parts of the neighboring vertebral edges without entering the disc interspace. The same technique is used by another authors with some modifications.^{1,4,5,10,13,14,16,17,20-22,27}

Indications and Patient Selection

AF indicated for cases of unilateral radiculopathy caused by posterolateral osteophytes or herniated disc fragments. Although it could be used for myelopathy or tumor cases by widening the window created, the main indication for AF is radiculopathy. Because soft lateral disc fragments can be removed also by a posterior foraminotomy, the best indication for AS is the uncovertebral osteophytes. The osteophytes have three main locations in the cervical spine: discovertebral, uncovertebral, and facet areas. (Figure 1)

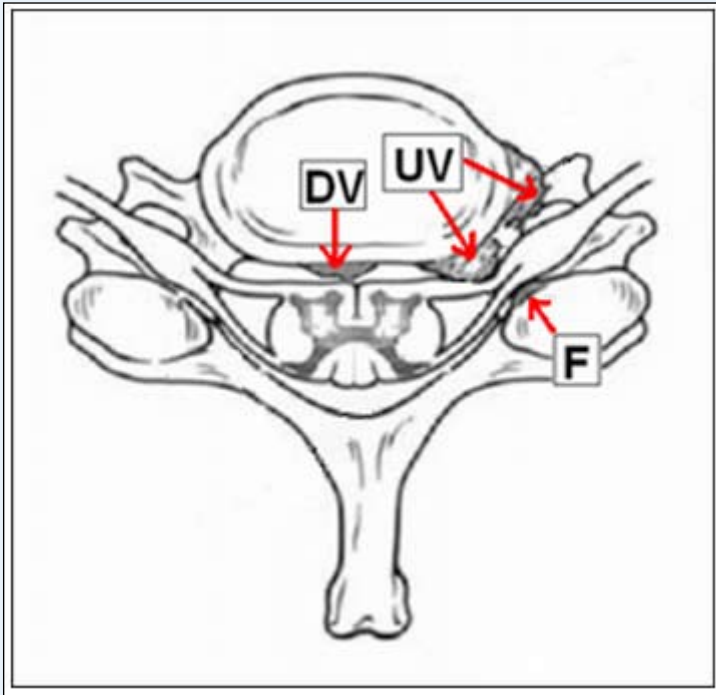


Figure 1: Location of osteophytes in the cervical spine (DV: Discovertebral, UV: Uncovertebral, F: Facetal)

Amongst them, uncovertebral ones have a distinct position, because they are more difficult to reach. Uncus (*processus uncinatus vertebrae cervicalis*), is a pair of bony eminence protruding from the lateral aspects of superior surfaces of bodies of the 3rd-7th vertebrae, and sometimes of the 1st thoracic vertebra. To accommodate the convex tip of the uncus, the lateral aspects of the inferior surface of the upper vertebra are concave. While the intervertebral disc fills the space between the vertebral bodies, there is a cleft filled by loose fibrous tissue between the uncus and its corresponding concave surface. During the second decade of the life, this loose fibrous tissue is resorbed and reaches its form that is in the adulthood. Luschka¹⁹ was the first to define these tissues as a joint. Today, these tissues (and for some authors, together with the neighboring uncinatous process) are called as Luschka joint (=uncovertebral joint, =neurocentral joint). Due to loss of disc height with aging, bony surfaces come together, and osteophytic spurs formed on the uncinatous processes. These osteophytes can be reached and removed without disrupting the

disc, and they constitute the main indication of this technique.

The procedure can be applied to a single or multiple levels. The patient selection and indication criteria are the same with that of classical anterior cervical discectomy (with- or without fusion, or with disc prosthesis) for radiculopathy; and AF should be offered an alternative. Contraindications of this technique include bilateral radiculopathy, severe neck pain, instability, malalignment, and posterior compression of the nerve roots due to osteophytes originated from the facet joints.²⁴

Preoperative Evaluation

When combined with clinical findings, a magnetic resonance imaging (MRI) and direct roentgenogram (neutral, functional, and oblique) of the

cervical region are enough in most of the patient to identify the compressed root and the offending lesion. A thin-slice computed tomography (CT) and/or electrodiagnostic studies, and very rarely a myelo-CT can be required in some cases. Electrodiagnostic studies can be helpful to identify the level of surgery when clinical and radiographical findings are ambiguous, or there are multiple-level radiological lesions. Like every case, a functional cervical X-ray is the essential part of the surgical planning. Cases with instability are not suitable for this operation.

MRIs should be examined not only to determine nerve root compression, but also to plan the surgery. The shape and location of the transverse foramen, the entrance level of the vertebral artery, tortuosity, a possible variation or anomaly should be identified before the surgery. Osteophytes affecting the shape of the anterior surface of the spine should be carefully evaluated.

Surgical Technique

The AF can be performed using microscope or endoscope. Other than standard microsurgical tools; high-speed drill, microcurettes and thin-footed Kerrison rongeurs are needed. The surgery is performed in a supine patient under general anesthesia. The position and preparation are the same with that of classical anterior cervical discectomy. A transverse neck incision for single or two levels, and a vertical incision placed over the anterior border of the sternocleidomastoid muscle are suitable. The level of skin incision is best determined by the intraoperative scopy, and placed at starting 1 to 2 cm from the midline on the symptomatic side, and extends 3-4 cm transversally. Thus, the middle point of the incision is generally corresponds to a point which is 3 to 4 cm from the midline, and the surgeon views the spine with an angle of 20 degrees from lateral to midline.⁹ Skin, subcutaneous tissue and the platysma are incised in the standard fashion; the carotid is retracted laterally; the spine is reached using sharp and blunt dissection using the classical corridor, and the deep cervical fascia is opened. A lateral X-ray is taken to confirm the level. For that, we use to a hemostat grasping the medial part of the longus colli muscle instead of placing a needle into the disc, because needle puncture may accelerate disc degeneration. Unnecessary dissection towards the lateral aspect of the longus colli muscle should be avoided, because the sympathetic chain lies at the lateral edge of the ventral surface of the muscle.

In this technique, the target area is the uncovertebral joint, and it is covered by the longus colli entirely. There are several ways to pass over the muscle and expose the area. The selection of the method depends on the preference of the surgeon and the retractor system in use. The first method includes mobilization of the longus colli muscle from its attachments, and retracting it laterally. This may be difficult because it requires

the mobilization of the muscle widely in the cranio-caudal direction, and retract it strongly. The second method involves resection of the muscle in an extent to expose the target bony anatomy, and can be applied easily. (Figure 2) The third method involves splitting the muscle longitudinally at the point the transverse processes started, and retract the medial part medially. Each method requires a well-suited retractor system for a smooth procedure.

Dissection of the longus colli muscle is advanced laterally to the medial aspects of the transverse processes of the upper and lower vertebrae, and lateral edge of the target uncus. The vertebral artery is just lateral to the uncus; and either it can be seen directly or its pulsations are sensed. Longus colli cut and retraction at the level of C6-C7 should be carefully executed because the vertebral artery is situated in front of the transverse process. It should be remembered that the vertebral artery might enter the transverse foramen at the C5, or even C4 level.

At this stage, the microscope (or endoscope) is brought the surgical area, and the uncus is started to be removed using a 1,8-2 mm burr. The drilling

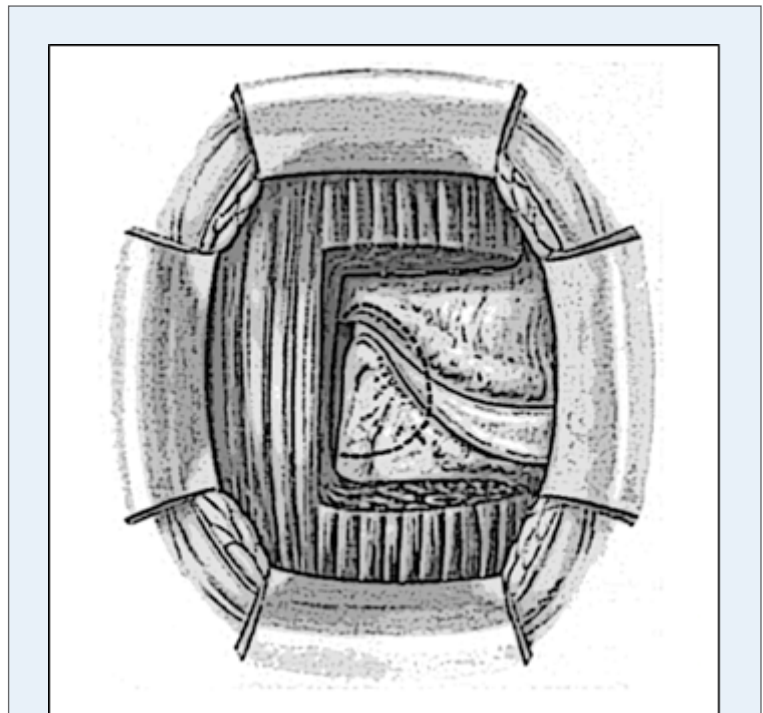


Figure 2: Exposition of the uncovertebral area by resection of the longus colli muscle.

starts at the base and medial part of the uncus, and proceeds upward and laterally. Medially, the endplates are kept intact, and disc interspace is not entered. Lateral wall of the uncus was preserved, and the transverse foramen was not entered. When the drilling depth approaches to the posterior cortex, it is safe to switch to a 2-3 mm diamond burr. However, frequent irrigation is required to prevent heating effect of the diamond burr. Towards upward, at the tip of the uncus, which corresponds to the Luschka joint, it is generally encountered with a soft tissue mass consisted of periosteum, cartilaginous tissue, and degenerated fibrous tissue, and frequently with osteophytes. After enough thinning of the posterior cortex, small hooks or curettes are used. The compressing lesions along with the neighboring endplate of the upper vertebra are removed with 1-2 mm Kerrison rongeurs and fine curettes. The osteophytes are removed, and bony decompression is completed. (Figure 3)

The area of drilling is about 6-8 mm in diameter, and its height is generally more than its width. Although Jho⁷ recommended breaking and removing the lateral wall; Saringer²² suggests preserving this wall as a protective barrier of the vertebral artery, unless a compressing osteophyte does exist. If the reason of the radiculopathy is foraminal stenosis due to spondylotic changes, the decompression procedure ends at this stage. If there is a soft disc herniation, the posterior longitudinal ligament should be removed in a lateral to medial direction using a

fine Kerrison to see the dura. Opening of the ligament is frequently followed by a venous bleeding and may be problematic. This bleeding can be controlled using bipolar coagulation, hydrogen peroxide, and some haemostatic materials. It is recommended to take out haemostatic material (Surgicel™, etc) after the hemostasis is achieved. Reverse Trendelenburg position is useful in controlling these epidural venous bleedings.

Following decompression and hemostasis, the layers are closed in a standard fashion. A drain is not necessary in most cases. No postoperative collar use is necessary. The patients may be mobilized at the 6th hour postoperatively, but the activity should be constrained. The patients are advised to refrain from excess neck movements for two weeks. A functional cervical X-ray is taken at 6th-8th weeks postoperatively. If no problem is detected on this X-ray, the patient can return to all previous life activities.

The drilling method given here had modifications over the time by its developer Jho⁸, as well as other authors. We had reviewed these modifications previously.¹¹

Risks and Complications

Starting to drill too medial is one of the most frequent mistakes. In this setting, the target lesion can be missed, or too much bone is removed to reach the uncus laterally for enough decompression. In

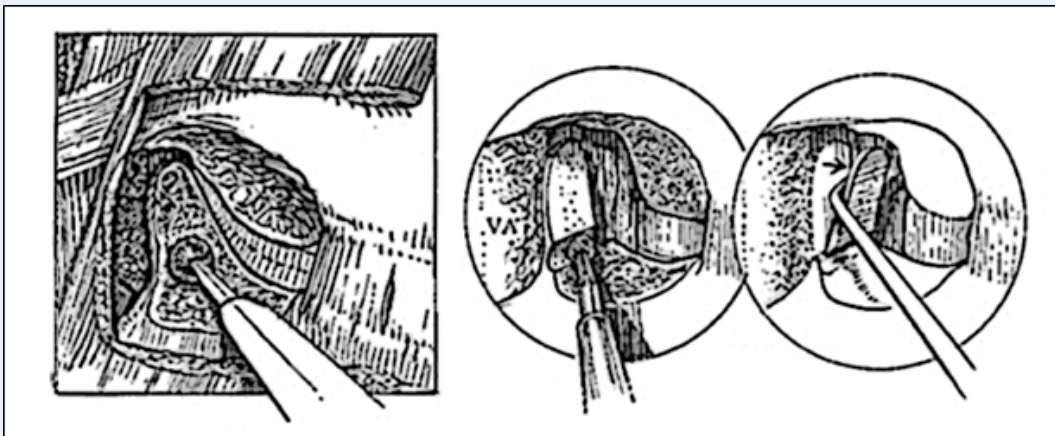


Figure 3: Steps of decompression by uncovertebral drilling.

fact, Jho⁹ suggested employing a lateral to medial drilling direction in order to minimize the amount of drilled bone. However, it is clear that this is dangerous in terms of vertebral artery, and requires experience.

Uncovertebral area is important in the kinematics of the subaxial cervical region, and has effects on the neck's range of motion. The uncus is especially restrictive on rotation, extension, and lateral bending.¹⁵ Therefore, overdrilling may cause instability. It is reported that unilateral uncoforaminotomy technique (as described by Jho) increases the mobility in this segment significantly compared to its preoperative status.²⁵ Increased mobility is especially evident in lateral bending and rotation. It is clear that drilling more than required put the patient into the risk of instability. In their series of 23 patients operated with AF technique, Hacker and Miller reported that 1/3 of the patients subsequently underwent fusion surgery due to instability, deformity, and severe neck pain.⁵

All of complications of the anterior cervical surgery are also possible for this technique. Due to close proximity with the vertebral artery, the most important complication of this technique is the injury to this artery. Some authors suggest putting a retractor to the medial of the vertebral artery to protect it during the drilling. Indeed, none of the surgeons employing AF technique have reported a vertebral artery injury so far. The reason for that may lie in the fact that the surgeons employing the AF technique may start to use this technique after they get some experience on spine surgery. In case of any injury, the AF is superior to classical anterior approach in terms of having enough exposure for direct repair.⁷

The Horner's syndrome can be encountered as a result of injured sympathetic chain. However, it is frequently temporary. Because dissection passing the midline in this technique is less than that of conventional approach, the risk of injury to the recurrent laryngeal nerve is low in this technique.

Results

The results of patients who had been operated with this technique are strikingly good. The sum of good and excellent results in the published series are generally around 90%.^{1,7,8,10,14,16,23,27} Complication rates

are low. Compared to classical anterior cervical approaches, AF yields equal or better results. The exception for that is the results of Hacker and Milne's.⁵ They reported only 50% good or excellent results, and 30% reoperation rate. Even though lack of similar series in the literature makes us think that there may be something wrong in the authors' technique; their study demonstrates that the technique may not be understood and performed by everyone, and unsuccessful results are possible.

Summary

AF is an anterior cervical surgical technique that aims to remove the lesions compressing the nerve root such as disc fragment or osteophytes at single or multiple levels through a bony window at the uncovertebral area, while preserving the structure and functions of the intervertebral disc. By that way, it aims to achieve the treatment of radiculopathy in a less invasive and functional manner by preserving motion. The procedure includes the exposition of the uncovertebral area beneath the longus colli muscle at the affected side, and drilling of the uncinat process and lateral edges of the neighboring vertebrae without entering the disc interspace. The technique can be performed using microscope or endoscope. The advantages of this technique includes its ability to reach directly to the anteriorly situated compressing lesions, direct decompression of the affected nerve root, and no necessity for any fusion or arthroplasty procedure because the technique preserves the integrity of the disc.

Although it is a promising technique and good results have been reported, it has not been popular yet. While the drilled area should be wide enough to remove the target lesion; it should not be unnecessarily large, because excess bone removal may lead to instability. Also, the vertebral artery and the disc, which in close proximity, should be preserved. Thus, its learning period relatively long and it requires experience and meticulous labor. It is not suggested to a surgeon to perform this technique unless he/she mastered enough on the classical anterior cervical techniques. AF had modifications over time, and it is not performed uniformly by the surgeons acquired this technique. Its future popularity is possible by reporting the long-term results and encouragement of the technique.

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