Microsurgical anterior cervical foraminotomy (uncinectomy) for cervical disc herniation

Report of three cases

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The authors present the long-term follow-up results in three cases in which pure lateral disc herniations were surgically treated via an anterior foraminotomy (uncinectomy) that avoided entering the disc space. The pertinent anatomical details essential for a safe approach are discussed in light of nine cadaveric neck dissections of every segment between C-1 and C-7. The surgical technique was initially studied in the cadaveric specimens and then applied in patients. The long-term results (> 2 years) in the first three patients are as good as our short-term results in another eight cases.

KEY WORDS • anterior cervical foraminotomy • disc herniation • uncinate process

An ideal operation for cervical disc herniation must fulfill two requirements: it must completely eliminate the offending disc disease, whether soft disc or bone spur, thus allowing direct nerve root decompression, and it must preserve motion in the surgically treated segment. Commonly used present techniques, such as posterior key-hole foraminotomy with or without discectomy and anterior cervical discectomy with or without bone fusion, only partly fulfill these two requirements.

Approaching the lateral soft discs or bone spurs via an anterior foraminotomy (uncinectomy) is an alternative technique, first described by Jho, that both eliminates the offending disease and preserves motion in the affected vertebral segment. We started to use this technique in 1996 after thorough cadaveric cervical spine dissection and anatomical workup in nine formalin-fixed cervical spines. We present our late results in three patients followed for 2 or more years. Our short-term results in eight other cases are also satisfactory.

Case Reports

Surgical Anatomy

Nine formalin-fixed cervical spines were removed from adult cadavers (aged 34–67 years) and were wire fixed for microscopic examination and measurements. Measurements were made bilaterally at the C2–3, C3–4, C4–5, C5–6, and C6–7 levels with a protractor to define distances between points and a steel millimeter ruler. Initially all the superficial soft tissues and longus colli muscles were removed under microscopic view, and the VA and costal processes were exposed. At this level of dissection, the height of disc spaces at midline, the width and the height of costal processes (the anterior bone segment of the transverse foramina located laterally from the VB to the anterior tuber) and the length of the VA between the costal processes were measured at all levels. Later, the disc spaces were excised up to the PLL and uncinate processes (the bony prominence extending above the rostral edge of the vertebral arch), and the uncovertebral junction were exposed. The depth and width of the disc spaces and the distances from the medial border and the tip of the uncinate process to the medial border of the VA were measured. The anatomical measurements and variations are the subject of another paper. For clarification of the surgical technique height and width of the costal processes (Table 1), uncinate process–VA distance (Table 2), and length of the VA between costal processes (Table 3) have been tabulated. The guidelines for measurements are shown in Fig. 1. With the completion of all the measurements, uncinate processes were removed at every level, exposing relations of the spinal canal, the nerve root, and the VA (Fig. 2).

Operative Technique

The surgical technique consists of an anterolateral approach to the lateral one third of the vertebral unit, exci-
sion of protruded disc material, and nerve root decompression via a foraminotomy at the uncinate process; special care is required for minimum disruption of the disc material. The operation is performed after the induction of general anesthesia, with the patient in a supine position that is similar to that in an anterior discectomy. A cervical traction device is used, and a bolster is placed behind both shoulders for gentle extension of the neck. The vertebral level responsible for the radicular pain is approached from the side ipsilateral to the protruded disc; this is similar to that performed in an anterior discectomy but with a slight lateral extension toward the anterolateral angle of the VB. Once the disc space is confirmed with fluoroscopy, a Cloward retractor system is applied. Two smooth blades are used: one retracting the esophagus and the other laterally placed over the longus colli muscles beneath the carotid artery and vagus nerves. After application of the retractor, pulsation of the carotid artery is confirmed distally. At this stage, the medial border of the exposed longus colli muscles lie at the center of the operative field. Whereas the VBs form the medial border, muscle mass over the carotid artery forms the lateral border of the exposed field. Then an operating microscope is brought to the field and the medial one third to one half of the longus colli muscle is excised to expose the medial half of the costal processes of the vertebrae above and below the disc space. The medial surface of the VA lateral to the uncinate process is cleaned between the upper and lower costal processes. Exposure of the VA may pose a problem at C6–7 because of its location. At this level the VA is located anterior to the transverse process of C-7 and enters the C-6 vertebral foramen. At the C6–7 level, to prevent VA injury, longus colli muscle excision must start at the upper border of C-6 and must proceed down to the level of C-7. In this manner the VA can be easily exposed anterior to the C-7 transverse process. During dissection the medial surface of the VA is deliberately exposed, and cleavage is prepared between the artery and uncovertebral joint. A retractor suitable for the segment is placed between the artery and the uncinate process, and the uncovertebral joint is drilled between the transverse processes by using a high-speed microdrill. Drilling is performed in a lateral to medial direction down to the lateral portion of the PLL. As drilling advances posteriorly it must be inclined medi-ally, and care must be taken not to enter the spinal canal. The uncinate process can be drilled completely between the lateral border of the disc and the retractor. Identification of the lateral border of the PLL shows that the posterior border of the uncinate process is reached, and then the bone margin adherent to the VA can be drilled or broken to expose the proximal medial border of the spinal canal. The transverse diameter of the hole is approximately 7 to 8 mm, and additional enlargement at the transverse level requires some disc excision at its lateral border. The vertical diameter of the hole varies with the height of the disc spaces and uncovertebral joints in different vertebral levels. It is usually approximately 10 to 12 mm in most of the cases and is enough for satisfactory decompression and removal of extruded disc or bone spurs. Curettes can be used to extract any hidden disc fragment. Since the PLL partly covers the proximal parts of the nerve roots, its lateral border must be excised, preferably using a bone punch to expose the lateral one third of the ipsilateral spinal cord. The root can then be exposed from its origin to its entrance into the neural foramen behind the VA. 

### TABLE 1

<table>
<thead>
<tr>
<th>Measurement</th>
<th>C-2</th>
<th>C-3</th>
<th>C-4</th>
<th>C-5</th>
<th>C-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>height (mm)</td>
<td>6.5 ± 1.5</td>
<td>6.1</td>
<td>6.2</td>
<td>6.4</td>
<td>7.2</td>
</tr>
<tr>
<td>width (mm)</td>
<td>11.1*</td>
<td>10.1</td>
<td>11.8</td>
<td>11.8</td>
<td>13.2</td>
</tr>
</tbody>
</table>

* Width of C-2 is difficult to measure from the lateral border of the vertebra (median border of the uncinate process) due to its operative surface.

### TABLE 2

<table>
<thead>
<tr>
<th>Measurement</th>
<th>C-3</th>
<th>C-4</th>
<th>C-5</th>
<th>C-6</th>
<th>C-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>uncinate–VA distance (mm)</td>
<td>1.2</td>
<td>1.4</td>
<td>1.5</td>
<td>1.4</td>
<td>1.2</td>
</tr>
</tbody>
</table>

### TABLE 3

<table>
<thead>
<tr>
<th>Measurement</th>
<th>C2–3</th>
<th>C3–4</th>
<th>C4–5</th>
<th>C5–6</th>
<th>C6–7</th>
</tr>
</thead>
<tbody>
<tr>
<td>VA length between costal processes (mm)</td>
<td>10 ± 2</td>
<td>11 ± 2</td>
<td>13 ± 2</td>
<td>14 ± 2</td>
<td>14 ± 2</td>
</tr>
</tbody>
</table>

Fig. 1. Artist’s drawing showing the anatomical landmarks for the measurements. CP = costal process; W = width of the costal process; h = height of the costal process; l = length of the VA between the costal processes. The asterisk indicates the distance between the VA and the tip of the uncinate process.
3). Excision of the PLL was performed in all cases and posed no problem if it was elevated with a microhook. Once the nerve root decompression is achieved, the operative field is closed and homeostasis is induced in a fashion similar to that used in anterior disc operations.

Case Summary

In this study, we present only three of our patients in whom the aforementioned technique was used and for whom the follow-up period was more than 3 years. The other more recently treated eight patients are fine and under clinical control. The three patients were women in their third decade of life (37, 31, and 39 years of age, respectively). All suffered from constant severe neck and radicular pain. Symptoms were right sided in two cases and left sided in one. All experienced mild weakness (4/5) of the left deltoid and biceps muscles, decreased biceps reflex, and hypalgesia along the C-6 dermatome. Magnetic resonance imaging of the cervical spine revealed lateral disc protrusion at the C5–6 disc space on the right side in two cases and on the left side in one case (Fig. 4 upper). The approach was made ipsilateral to the side of the protrusion. An early postoperative control axial computerized tomography scan was obtained to assess the extent of bone removal (Fig. 4 lower). The three patients were symptom free in the immediate postoperative period, and their follow-up examinations demonstrated findings within normal limits at 37, 36, and 36 months, respectively, after surgery.

Discussion

Posterior laminectomy for the treatment of disc herniation was first described by Mixter and Barr in 1934, and this technique has evolved into a small key-hole foraminotomy. It has been proven to be safe and effective in over 90% of the cases. Although motion in the affected segment can be maintained, it is an indirect approach to the pathological process and effective only in cases of lateral soft disc herniations.

Initial poor results with the posterior approach led Robinson and Smith and Cloward to pioneer anterior cer-
vical discectomy for the treatment of central and lateral cervical discs and bone spurs. The technique evolved to such an extent that results similar to those in the posterior approach are now achieved by microsurgical anterior disc-ectomy with or without interbody fusion. Its main disadvantage is the fusion of the intervertebral space and loss of function in a motion segment. Although this fusion is deliberately performed by some surgeons, it may occur even without the application of intraoperative bone graft. Whereas it may be acceptable for the treatment of central soft disc protrusions and hard bone spurs, it becomes a biased operation for laterally placed lesions.

The Smith–Robinson and Cloward techniques involve a direct anterior approach to the center of the disc space. Verbiest’s lateral approach, Hacuba’s trans-uncodiscal approach, and the modification of anterolateral foraminotomy described by Leosin, et al., are similar in that they all approach the disc space anterolaterally by excising the longus colli muscles and exposing the costal processes and the nearby VA to some extent. Although these approaches are superior in exposing the lateral border of the disc spaces they also result in an immobile segment. In 1989 Snyder and Bernhardt first described anterior fractional interspace decompression via an anterolateral approach in which removal of all the disc material and placement of a bone graft interbody device were not required. In 1996 Jho used the same lateral approach to the target area and removed only the lateral border of the bone element, the uncinate process. Jho emphasized the need to preserve the intervertebral disc as a functioning motion segment. Our technique is similar to Jho’s, both in its approach to the target area and in its lateral approach to the offending disease. In our technique, exposure of the VA between the costal processes and preparation of its medial surface bordering the uncinate process is more extensive. We create a dissection plane between the VA and uncovertebral joint, placing a retractor between the joint and the VA. Because the retractor is curved, the uncus can be drilled safely in an anteroposterior and slight lateromedial direction. The most feared complication of the technique is injury to the VA, which can occur in three sites: 1) at the C6–7 level, where the VA runs between the transverse process of C-7 and the longus colli muscle; 2) where it passes lateral to the uncinate process; and 3) at the transverse process. A thorough knowledge of anatomy and the use of meticulous technique can avoid all these risks. Placing a slightly bent narrow retractor between the artery and uncovertebral joint eliminates the unwanted VA injury while drilling. Although we moved in too medial a direction in our first case because of inexperience, we were able to protect the intervertebral discs in all of our patients. This technique, similar to posterior key-hole technique, preserves motion in the affected segment and provides direct access to the offending pathological entity.

Fig. 4. Upper: Preoperative axial magnetic resonance image obtained in a patient with lateral C5–6 disc protrusion. Lower: Postoperative axial computerized tomography scan demonstrating the extent of bone removal.

References
Anterior cervical foraminotomy
