3d ANTERIOR CERVICAL MICROFORAMINOTOMY

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1. Introduction:

Cervical radiculopathy is typically caused by posterolateral disc herniation or spondylotic foraminal stenosis. Standard surgical treatment for cervical degenerative disc disease has been either direct anterior excision necessitating fusion or indirect posterior decompression. Anterior decompression has now become more widely used. It can be achieved using different techniques.

Anterior fusion procedures; Anterior cervical discectomy with fusion is an excellent option for one or two-level spondylosis. Anterior corpectomy may provide an improved decompression and is ideal for patients with kyphotic deformity [(1)]. Anterior cervical discectomy with fusion and corpectomy techniques requires bone fusion with or without spinal instrumentation, and a degenerative change at adjacent vertebral levels frequently results in long-term morbidity. Wada *et al.* [(1)] demonstrated that listhesis exceeding 2 mm developed at 38% of the upper adjacent levels, osteophyte formation occurred at 54% of the lower adjacent levels, and axial pain was observed in 15%. The mean vertebral range of motion had decreased from 39.4 degrees to 19.2 degrees in 49% of patients by the final follow-up assessment. In addition, conventional corpectomy series are excessively focused on greft morbidity and pseudoarthrosis [(1-3)].

Anterior cervical foraminotomi (ACF); The ACF technique involves direct decompression of the nerve root just as the anterior discectomy techniques does, but does not require bone fusion or postoperative immobilization. In addition, ACF preserves the motion unit anatomically as well as functionally. The drilling is much more extended laterally on the operative side, and ACF totally opens the intervertebral foramen. ACF requires considerable technical skill to keep the intervertebral disc intact functionally. To maintain spinal stability, ACF hole has to be small enough to maintain structural integrity. Extensive decompression can easily cause symptoms of spinal instability even flexion-extension radiographs reveal no obvious instability postoperatively.

Jho [(4, 5)] showed that excellent clinical outcomes with fast recovery and adequate anatomical decompression in patients with cervical spondylotic myelopathy and radiculopathy. Johnson *et al.* [(6)] reported the good or excellent outcomes in 85% of patients treated with ACF. However, Hacker and Miller [(5)] retrospectively reviewed 23 patients who underwent ACF, and they found that 30% of patients' required additional surgery and 53% of patients experienced a good or excellent outcome. Reoperation rate is considerably higher than other series of anterior cervical surgery for radiculopathy. Their poor surgery-related outcome seems to be directly due to spinal instability and collapse of the neural foramen caused by their excessive removal of the uncinate process. Katoni *et al.* [(8)] showed that uncovertebral joint resection resulted in decreased stability of the functional spine unit in every plane of motion.

1.a. Advantages

- Minimally traumatizing exposure; supine surgical position, anatomic cleavage dissection, and direct decompression of the nerve root.
- The segment mobility is preserved and prevents the acceleration of degenerative changes at adjacent levels.
- The drilling is totally opens the intervertebral foramen.

- Elimination of bone fusion and immobilization.
- The number of levels has never been considered to be a limitation of this technique.

1.b. Disadvantages

- Approach not familiar to most surgeons.
- Difficulty to maintain spinal stability. Foraminotomy hole has to be small enough to maintain structural integrity. Extensive decompression can easily cause symptoms of spinal instability.
- The potential injury for the vertebral artery (VA).

Preoperatively all patients had radiography (lateral neutral, flexion, and extension views), magnetic resonans (MR) imaging and computerize tomography (CT) scans of the cervical spine. Cervical spondylosis was confirmed on MR imaging and CT scanning.

Although this surgical technique requires meticulous microsurgical skill, advantages of this surgical technique are quickly recover without bone fusion and preserving the motion segments. Preservation of the motion segment avoids fusion of the disc space and potentially the long-term degenerative changes at adjacent disc levels. This surgical technique has shown excellent clinical outcomes with adequate anatomical decompression in patients with CSR. This technique is, therefore, alternative to the anterior transcorporeal approach.

2. Indications:

Absolute:

- Unilateral radicular symptoms due to cervical spondylotic radiculopathy (CSR).
- Imaging studies corresponding to the clinical symptoms.

Relative:

- Foraminal soft disc herniation.

3. Contraindications:

Absolute:

- Significant spondylotic stenosis causing spinal cord compression.
- Contralateral foraminal stenosis.
- Predominantly posterior compression.
- Patients whose dynamic plain radiographs show more than 2 mm of movement between two connective vertebral bodies.
- Severe mechanical neck pain.

Relative:

- Thyromegaly.

4. Surgical Procedure:

4.a. Surgical Equipment:

Operating table suitable for spine surgery, operating microscope, biplanar C-arm, high speed drill and cervical microforaminotomy surgical tools are the main parts of this surgical equipment (figure 1a, 1b, 1c).

4.b. Operating Room set up:

The commander part of C- arm and operating microscope is located opposite to the surgeon. The high speed drill is prepared and located at the nurse desk. The position of surgeon depends on the pathology of cervical spine. The surgical assistant is positioned opposite to the surgeon and operation technician or nurse is located between the surgeon and assistant (figure 2).

4.c. Patient Positioning:

The supine position with a slight extension of the neck is suitable for anterior cervical microdiscectomy operations. The operation level is marked with C-arm and operation area is washed and draped in a usual sterile fashion. Prophylactic antibiotics may be initiated before the operation to avoid from the infection (figure 3a, 3b).

4.d. Surgical Technique:

The detailed surgical technique has been reported by Jho [5]. Some modification was performed. The anterolateral aspect of the cervical spine is approached from the symptomatic side. The skin incision is made transverse in one or two levels and longitudinal in three or more levels. A transverse skin incision is made about 3 to 6 cm long at the anterolateral neck along a skin crease (figure 4a). A longitudinal skin incision is made along the medial edge of the sternocleidomastoid (SCM) muscle for 5-7 centimeters in mid-portion of lesion. The subcutaneous tissue and the platysma muscle are incised. The loose connective tissue layer

Figure 1a, b, c:
Operating microscope, biplanar C-arm, high speed drill and cervical microforaminotomy surgical tools.

under the platysma muscle is cleanly undermined to provide space in which to work. A combination of sharp and blunt dissection is used to access the anterior column of the cervical spine. SCM muscle, carotid artery, and jugular vein are retracted laterally. Esophagus and trachea are retracted medially, and protected by a wide blade retractor. In this technique, retraction is minimal, because the surgical exposure remains laterally. The sympathetic chain is recognized under the prevertebral aponeurosis. The aponeurosis and sympathetic chain are retracted laterally. The medial portion of longus colli muscle is excised to expose the transverse processes of the upper and lower vertebrae and the lateral aspects of the vertebral bodies. Before starting the drilling, the VA is identified, and a retractor is placed between VA and uncinate process while drilling (figure 4b). The VA occasionally enters the transverse foramen at a different level. Careful preoperative assessment of the VA in CT scans will aid in avoiding unexpected findings intraoperatively. The far lateral margin of the uncinate process and the medial portion of the transverse foramen of the superior vertebra are drilled. The uncinate process is not completely excised. The medial wall of the uncinate is preserved to keep the disc intact. The intervertebral foramen is fully opened (figure 4c). Disc frag-

Figure 2:
Operating microscope is located opposite to the surgeon. The high speed drill is located at the nurse desk. The position of surgeon depends on the pathology of cervical spine. The surgical assistant is positioned opposite to the surgeon and operation technician or nurse is located between the surgeon and assistant.

Figure 3a:
The supine position with a slight extension of the neck is suitable.

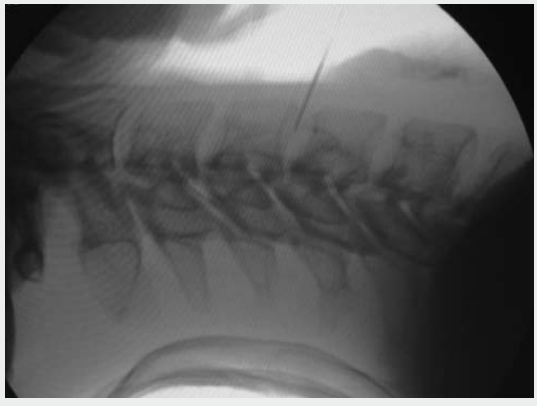

Figure 3b:
operation level is marked with C-arm.

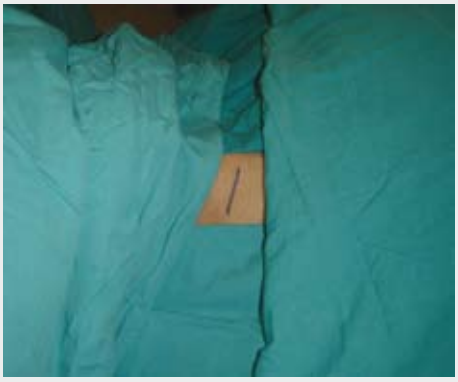

Figure 4a:
Transverse skin incision is made at the anterolateral neck along a skin crease.

ments and/or bone spurs are excised via a foraminotomy hole by using curettes. The nerve root is decompressed from its origin in the spinal cord to the point were it passes behind the VA laterally. The size of the hole that is made by drilling at the uncovertebral joint is usually approximately 4 to 5 mm wide transversely by 5 to 7 mm wide vertically (figure 4d)**.** Neither bone grafting nor osteosynthesis is used.

The hemostasis should be obtained with a bipolar cautery and/or suitable chemical hemostatic gel foam agents can be used. There is no need to use a drain if you ensure from the hemosthasis. After the irrigation of area, a routine closure of the platysma and skin is performed. The platysma is closed with reabsorbable 3-0 Vicryl stitches and subcutaneous layer of the skin is closed with suitable absorbable or non-absorbable stitches. Steri-Strips® or Dermabond® can be used to keep the skin edges closely for 5 to 7 day period (figure 4e).

5. Postoperative Care:

There is no need to use a postoperatively cervical collar. Muscle relaxants and non-steroidal anti-inflammatory drugs may be given if the patient has postoperative subjective complaints. The patients may be allowed to mobilize in the same day and discharged the day after surgery. The patient may return his job in 2 weeks after surgery if he is free from the postoperative problems.

6. Complications and Avoidance:

Axial pain: The risk of further spinal instability is smaller, because only the lateral part of the vertebral body is drilled and the anterior longitudinal ligament, posterior longitudinal ligament and the medial portion of uncinate process are preserved. In this technique, the risk of instability is mainly related to the resection of the nucleus pulposus of well hydrated discs [9, 10]. In the publication by Hacker *et al* [7], high incidence of recurrent herniation (13%) also seems to be due to the excessive iatrogenic disruption of the

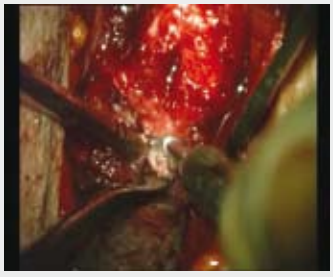

Figure 4b:
Medial portion of longus colli muscle is excised to expose the transverse processes of the upper and lower vertebrae and the lateral aspects of the vertebral bodies. The VA is identified, and a retractor is placed between VA and uncinate process while drilling.

Figure 4c:
The medial wall of the uncinate is preserved to keep the disc intact. The intervertebral foramen is fully opened.

Figure 4d:
The size of the hole that is made by drilling is usually approximately 4 to 5 mm wide transversely by 5 to 7 mm wide vertically.

Figure 4e:
Subcutaneous layer of the skin is closed with suitable absorbable or non-absorbable stitches.

disc integrity. However, when the disc is already dehydrated and collapsed, as is commonly observed in spondylosis of the cervical spine, no grafting or osteosynthesis is necessary. This has well been demonstrated in cases of cervical spondylotic myelopathy treated by decompression with oblique corpectomy [9-12]. This procedure is most appropriate for older patients with more degenerated discs.

Temporary Horner's syndrome: The medial portion of longus colli muscle had only to be excised. Before dividing this muscle, the sympathetic nerve running under the aponeurosis must be identified and gently retracted laterally. If the sympathetic nerve is manipulated, the patient may exhibit Horner's syndrome postoperatively. However, if the main trunk of the sympathetic nerve is kept intact, no or mild Horner's syndrome occurs, and it recovers rapidly. Because the sympathetic nerve passes along the lateral portion of the longus colli muscle, to prevent the incidence of Horner's syndrome, the longus colli muscle is not incised laterally to the anterior tubercle of the transverse process. Transient Horner's syndrome occurred in 5.3% [13].

Vertebral artery injury: VA injury is a rarely described complication. VA control permits the safe drilling of the lateral corner of the vertebral bodies and control of the distal nerve root. The VA occasionally enters in to the transverse foramen of C5 instead of C6. In that case, the VA runs in the middle of the longus colli muscle at C6, which can be severed inadvertently when the C6-7 disc is surgically treated [14]. Injury to the vertebral artery during anterior approaches can be avoided by preoperative identification of anomalous arteries and by intraoperative attention while work very close to the VA. When the artery is injured, primary repair may be the optimal management strategy.

Injury of the cervical roots: Dural tears may be caused by accidental drilling. A surgeon must be mindful of the nerve root's proximity to the uncinate process while removing it with drilling.

Controlateral foraminal stenosis: Controlateral foraminal stenosis is uncommon at the level of the surgery. Anterior discectomy and fusion must be undergone.

7. Case Illustrations:

7.a. Neuroradiological evaluation:

Sagittal alignment was obtained by measuring the Cobb angle from the base of C2 to the superior endplate of C7. Spinal instability was quantitated by the increased intervertebral angle difference in flexion-extension of more than 12 degrees or displacement of the vertebral body over 3.5 mm in flexion [15]. Before discharged, the extent of drilling was evaluated by CT. Spine stability was demonstrated at 1.5, 3, 6 and 12 months by dynamic radiographies (flexion-extension).

7.b. Clinical Results

78.9% of patients with CSR demonstrated excellent results, 10.5% of patients demonstrated good results, and 5.3% of patient experienced a fair result and 5.3% of patient experienced worse result. Motor-weakness and sensory deficit improved dramatically immediately postoperatively, and improved to normalization in the majority of patients within 6 months [13].

7.c. Natural Course:

Most of these patients had experienced advanced spondylotic changes with limited motion at the involved intervertebral motion segments [16]. The intervertebral motion segments are more likely expected to be fused eventually by advanced spondylotic

changes and by the surgical effect of substantial bone resection. Despite the advanced spondylotic changes, the preservation of motion units may still be a better surgical strategy than bone fusion (figure 5a, 5b).

8. References:

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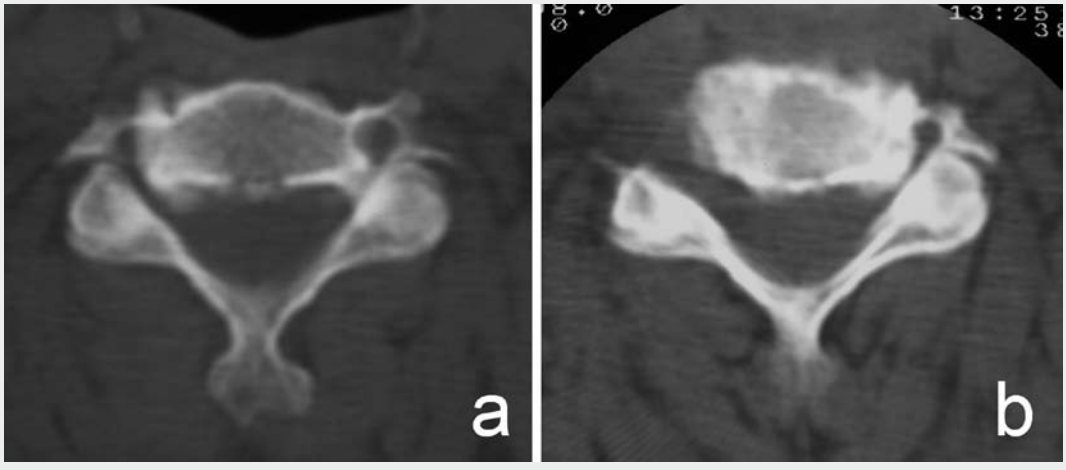

Figure 5a, b:
Most of these patients had experienced advanced spondylotic changes with limited motion at the involved intervertebral motion segments.

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