Surgical Anatomic Evaluation of Cervical Uncinate Process for Ventral and Ventrolateral Subaxial Decompression

By

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Summary: An anatomical study was designed to investigate the cervical uncinate processes morphology and their variations. Linear and angular measurements were performed on 145 vertebrae (29 spines) from C3 to C7. The dimensions and variations of the uncinate processes were measured to obtain some morphologic data for an effective neurovascular decompression via the ventral and ventrolateral approaches. Four researchers performed the linear and angular measurements including uncinate process height, width, length, sagittal angle with the superior margin of the vertebral body, inter-uncinate process distance, vertebral body anteroposterior diameter and width measurements. The data were presented as mean value, standard deviation and range values. These data provide a three-dimensional orientation and anatomical knowledge, and contribute to perform more effective neurovascular decompression with minimizing the surgical complications.

Materials and Methods

This morphometric study included measurements performed on 145 vertebrae (29 adults’ carefully preserved, dried and disarticulated cervical spines from C3 to C7), from the Department of Anatomy. None of the individuals had evidence at postmortem examination of infectious, neoplastic, traumatic, or degenerative diseases involving the cervical spine, and we observed no evidence of congenital or developmental spinal malformation in any of the specimens.

Linear and angular measurements were performed from the C3 to C7 level, and all paired structures were measured on each side, as illustrated in Figures 2 through 3. All measurements were obtained by an experienced neurosurgeon (MB) and three experienced anatomists (AO, ZA, KS) who measured the specimens together. The approaches for removal of the compressing cervical uncinate process.

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appropriate measuring site for every parameter, as well as the accuracy of measurement, was determined by consensus by all of them. All linear measurements were performed by hand, with precision calipers (0.1 mm), identifying easily recognizable points or structures on each vertebra. Angular measurements in this study were performed using standard goniometers (precision 1 degree).

This study included the following six linear parameters and one angular parameter for 145 vertebrae (four paired parameters and three unpaired parameters; total 1595 measurements) regarding cervical uncinate process and its intimate structures morphology (Fig. 1-3):

1. the height of the cervical uncinate process (distance between the tip of the uncinate process and the base of the uncinate process or the superior surface of the vertebra)
2. the width of the cervical uncinate process (distance between the medial and lateral margins of the uncinate process at its base or the superior surface of the vertebra)
3. the length of the cervical uncinate process (anteroposterior diameter of the uncinate process)
4. distance between the anterior innermost point of the each cervical uncinate process at their bases or the superior surface of the vertebra
5. the midline anteroposterior diameter of the vertebral body
6. the width of the vertebral body at its inferior surface in the midline in the coronal plane
7. the angle between the medial side of the cervical uncinate process and the superior surface of the vertebra.

Analysis of all measurements were performed, and calculated the range, the mean value and the standard deviation for each parameter.

Results

A total of 145 vertebrae from 29 cervical spines were studied between the C3 and C7 levels. All symmetric structures were measured bilaterally. As normally expected, there were differences between right and left measurements, but they were not statistically significant for the series. The mean values, standard deviations and ranges for linear and angular parameters are presented in Table 1.

Morphometric data demonstrated that the cervical uncinate process dimensions ...

Discussion

Ventral and ventrolateral subaxial decompress-
Table 1. Morphometric data from 145 cervical vertebrae measured for uncinate process and intimate structures

<table>
<thead>
<tr>
<th>Parameter</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
<th>C7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1R</td>
<td>5.1/1.3/3.4–7.3</td>
<td>5.4/0.9/3.7–7.6</td>
<td>5.4/1.1/3.6–8.2</td>
<td>6.1/1.7/3.6–9.4</td>
<td>5.9/1.3/3.5–8.9</td>
</tr>
<tr>
<td>1L</td>
<td>5.2/1.3/3.6–7.3</td>
<td>5.3/1.0/3.4–7.2</td>
<td>5.6/1.0/3.9–7.8</td>
<td>6.2/1.4/4.1–9.4</td>
<td>5.9/1.2/3.7–8.5</td>
</tr>
<tr>
<td>2R</td>
<td>4.5/0.8/2.8–5.8</td>
<td>4.9/1/1.2/9–6.7</td>
<td>5.2/1/2.3/1–7.3</td>
<td>6.0/1/4.3/5–9.1</td>
<td>6.1/1/0.4/2–8.8</td>
</tr>
<tr>
<td>2L</td>
<td>4.8/1/1.3/6.1</td>
<td>5.0/1/2.3/1–6.6</td>
<td>5.3/1/1.3/3–7.5</td>
<td>6.0/1/5.3–2.3</td>
<td>6.2/1/1.4/1–9.0</td>
</tr>
<tr>
<td>3R</td>
<td>11.9/1/0.9/2–16.4</td>
<td>12.1/1.5/8.2–15.9</td>
<td>12.0/1.3/8.4–15.5</td>
<td>12.1/1/1.9/0–16.1</td>
<td>12.5/1/3.9/2–17.0</td>
</tr>
<tr>
<td>3L</td>
<td>11.8/1/2.9/4–16.1</td>
<td>12.0/1/4.8/5–16.1</td>
<td>12.4/1/5.8/7–16.9</td>
<td>12.3/1/4.8/9–16.0</td>
<td>12.3/1/2.9/0–16.6</td>
</tr>
<tr>
<td>4</td>
<td>12.4/1/6/8.9–16.2</td>
<td>12.6/1/3.9/4–15.9</td>
<td>13.0/1/2/10.1–16.1</td>
<td>11.4/1/6.8/9–15.3</td>
<td>12.1/1/5.8/8–15.8</td>
</tr>
<tr>
<td>5</td>
<td>12.7/1/2.9/9–16.3</td>
<td>14.4/1/4/10.5–17.4</td>
<td>14.7/1/6/10.4–18.0</td>
<td>15.3/1/3/12.1–18.4</td>
<td>16.0/1/1/3.1–19.3</td>
</tr>
<tr>
<td>7R</td>
<td>112°/16/95°–152°</td>
<td>109°/21/90°–148°</td>
<td>114°/11/95°–142°</td>
<td>120°/18/90°–156°</td>
<td>124°/16/94°–162°</td>
</tr>
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</table>

Abbreviations: SD = standard deviation, R = right, L = left.

sion of the spinal cord and/or the nerve roots may be indicated in a variety of clinical conditions, including cervical trauma with ventral disc herniation and/or bone fragments, cervical disc herniation, cervical spondylolisthesis, ossification of the posterior longitudinal ligament, neoplastic processes, and infection. Ventral decompression may be required for vertebral artery stenosis secondary to tumor, spondylosis, or compression of the cervical nerve roots. Out of these pathologic lesions, the uncinate process or posterolateral disc herniation is the most common cause of nerve root compression, within the confines of the intervertebral foramen. A posterolateral osteophyte and/or disc herniation may impinge on the nerve root, spinal cord and vertebral artery. Anterior cervical disectomy and osteophyte removal for neurovascular decompression, with or without interbody grafting, has been suggested for these patients. Regarding the surgical technique, inappropriate removal of the osteophytes from the uncovertebral joints has been reported to cause a poor surgical outcome in cases of cervical spondylolisthesis. For these cases, a corpectomy certainly provides lateral decompression; however, if no evidence of central cervical stenosis or myelopathy exists, excessive transdiscal bone resection and loss of the cervical segment are unnecessary. Hakuba et al. described the transuncodiscal approach to dumbbell tumors of the cervical spinal cord, and they suggested that it is possible to expose the ventralateral portion of the spinal cord safely and without retracting the spinal cord at all. Although these decompressive surgical procedures, via a ventral or ventrolateral approach, are quite effective and generally safe, they, nevertheless, may be associated with a number of complications that might be serious and devastating. Anatomic consideration of the cervical uncinate process and cervical vertebral body is therefore critical to ensure adequate removal of the uncovertebral joint without compromising stability or damaging the spinal cord, nerve roots, or vertebral artery.

The ventral approach is basically appropriate for ventral cervical disectomy, vertebrectomy, fusion, and instrumentation. In this approach, in case of the necessity the resection of uncinate process, drilling/resection of the uncinate process or osteophyte is usually carried out medial to lateral direction. Our measurements suggest that the width of the uncinate process increases gradually with segmental level from C3 to C7 (4.5 on the right and 4.8 on the left at C3 level while 6.1 on the right and 6.2 on the left at C7 level), and averagely 4–6 mm uncinate process resection in width is required. Very similarly to our results, Lu et al., in their study, demonstrated that 5 mm to 6 mm medial to the lateral margin of the uncinate process resection could be accomplished. Technically, it requires exposure and lateral retraction of the vertebral artery to provide visualization of the pathology, whereas, resection of the uncinate process, 5 to 6 mm medially, can be safely performed with protection of the vertebral artery by transversectomy and without insufficient neural foraminal decompression, particularly since partial posterior uncinate process resection is usually necessitates to gain direct identification of foraminal disc herniation.

The ventrolateral approach, nevertheless, is more suitable for decompression of the vertebral artery in the transverse foramen or between the foramina or spinal nerve roots outside the spinal canal. The ventrolateral approach can be performed using different techniques. Verbiest's approach is performed through the same plane as is the ventral approach; still, further exposure is provided lateral to the

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longus colli muscle on the ipsilateral side. Hodgson's ventrolateral approach is performed lateral to the sternocleidomastoid muscle and the carotid sheath. The transuncodiscal approach, described by Hakuba et al., and which consists of the anterior discectomy, and the removal of the uncinate process and posterolateral corners of the vertebral bodies (uncoforaminotomy that combines uncectomy and anterior foraminotomy), is an approach combining the ventral and ventrolateral approaches to the anterior cervical spinal canal with fusion. In these ventrolateral approaches, in conjunction with better exposure of the neurovascular structure and lateral retraction of the vertebral artery, safe resection of the uncinate process osteophytes and effective neurovascular decompression are provided than in the ventral approach. The elegance of such an approach resides in two facts: 1) the nerve root can be completely exposed and decompressed without removal of a significant amount of disc interspace material, and 2) a fusion or spacer is not even a consideration, much less a necessity.

The dimensions of the uncinate process as well as the angle between the uncinate process and the superior margin of the vertebra are critical when dealing with neurovascular decompression. In our series, the data from measurements demonstrated that the height of the cervical uncinate process ranged from 3.4 mm to 9.4 mm, averagely from 5.1 mm to 6.2 mm, and the diameter was increasing gradually from C3 vertebra to C7 vertebra. The anteroposterior diameter of the uncinate process was relatively constant in the average, little increased gradually from C3 vertebra to the lower segments, and this increase was parallel with the the midline anteroposterior diameter of the same vertebra. The angle between the uncinate process and the superior margin of the vertebra varied in a wide spectrum, becoming more horizontal in the lower cervical segments (Table 1). Panjabi et al. demonstrated that the interface of the uncovertebral joint was angled approximately 30° cephalad from the horizontal line of the intervertebral disc. This variability should be taken into consideration when drilling the uncinate process for the safe direction. Distance between the anterior innermost point of the each cervical uncinate process at their bases or the superior surface of the vertebral body was measured as parameter 4, showed variations in a wide spectrum, appearing to related with osteophyte formation. This parameter was about two-third of the parameter 6 (the width of the vertebral body at its inferior surface in the midline, in the coronal plane) for C3–C5 vertebrae, and half of the parameter 6 for C6 and C7 vertebrae.

Understanding the variations of the cervical uncinate processes in their dimensions, and orientation the surgical anatomy in three-dimensionally provide the surgeon to be more effective in treating the pathological lesion, and keep him/her away from complications.

References