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Evaluating Intervertebral Foramen Measurements for Patients with Anterior Cervical Disc Surgery in Oblique CT

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Abstract

Objective: It is particularly difficult to determine the level of radiculopathy pain. Because radicular pain usually doesn't fit the dermatomal map. unlike the foramen lumbar vertebrae, where the cervical nerve root is exerted, it has a slope of approximately 45 degrees to the vertebrae in the axical plane and 10-15 degrees in the horizontal plane. Due to this structure of cervical foremen, the evaluation of conventional ct results in incorrect or incomplete diagnosis. In our study, we compared the change in cervical foramen patients with anterior cervical discectomy and cage (fusion) to oblique ct reconstructive and preop and postop.

Methods: CT images were acquired in a 64 slice CT system (60–80 mAs, 120 kVp, FC86 reconstruction core and 2.0 mm slice thickness at 2.0 mm intervals). Oblique sagittal images were created with OsiriX Lite v. 12.0.1 version and measurements were performed. For each level, the area has been measured in addition to the short and long axle length of the neural foramens from the pre-op and post-op oblique sagittal images.

Results: In our study, 98 cervical intervertebral foramen oblique CT de preop-postop, long axle, short axle and field measurements were evaluated with 43 patients from 16/01/2019 to 03/02/2020, 3 patients with two levels of anterior ceral discectomy + interbody cage. Right side, long axle, short axle, and area respectively; 13,37%, 5,99%, 16,87% increase. Left side, long axle, short axle, and area respectively, increased by 14,27%, 7,11%, 23,20%

Conclusion: The cage, which is placed on the intervertebral level, will increase the area of the foramen, increase the space of the foramen, and allow the nerve to decompression. This is why it is necessary to insert the material with the highest height of the intervertebral disk level that can be placed during surgery.

Keywords: Surgery, Cervical Intervertebral Disc, Oblique CT

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INTRODUCTION

Cervical Disk heniation due to foraminal and spinal channel shorthand, incompetence in hand movements based on neck pain, myelopathy and radiculopathy, difficulty walking, balance and coordination disorder leads to a loss of power in the extremities with sensory pathologies such as needles in hands and feet – tingling (1). These complaints are caused by the axial loading of the cervical spine and the degenerative process resulting in disc herniation and bone spur formation. In particular, radiculopathy is a clinical form of a neural compression in the intervertebral foramen. The location of the cervical region that caused the complaint is important for the treatment algorithm. It is particularly difficult to perform level determination in radiculopathy. Because radicular pain usually doesn't fit the dermatomal map (2,3). Therefore, it needs EMG and advanced imaging techniques. In his surgery, it is important to keep the decompression of neural elements and the shape of the spine intact.

Anterior Cervical Discectomy and Fusion (ACDF) are the most common surgical method used today. It was first defined by Robinson and Smith and Cloward in 1950 (4,5). It was first used with the fusion agent to use autogenous bone gref, and then went into surgery with the development of interbody cage. High surgical results were found using the anterior interbodycage method used for ACDF (6).

However, unlike the foramen lomber vertebrae, where the cervical nerve root is exerted, it has a slope of approximately 45 degrees to the vertebrae in the axial plane and 10-15 degrees in the horizontal plane (7).C3-C7 is found in a groove where the intervertebral foramen medialde stops the pedincule limit, where the transverse process ends in laterality. In the medial segment of the canal, superior to the nerve root, there is the uncinate process posterolaterally to the peduncle of the adjacent vertebra, and the superior articular process inner point anteromedially. More laterally, after the nerve root is divided, the ventral and spinal nerves continue in the groove, and the posterior surface of the vertebral artery is adjacent to the anterior surface of the superior articular process. (Figure 1.3).

Due to this structure of cervical foramen, the evaluation of conventional ct results in incorrect or incomplete diagnosis. We're in the study we compared the change in cervical foramen measurement of patients we have administered ACDFin obliq ct reconstructive and preop and postop.

Anatomy

Cervical vertebral shows a different structure. Anatomically, especially C1, C2 and C3-C7 are very different. In daily practice, C3-C7 spine pathologies appear more often (Figure1.1)

In cervical vertebral bodies (C3-C7), the spinal canal increases caudally. Abuzayed, B et al., in a study group of 48 healthy volunteers, measurements of the corpus of the cervical vertebrae were made and it was observed that the width gradually decreased between the C3-C7 vertebrae (8). In the same study, it was emphasized that the anterior posterior diameter gradually increased (8) Anteroposterior diameter is especially important in anterior cervical discectomy and guides the neurosurgeon about the corpus borders while performing discectomy. Another important measure is the sagittal and transverse diameter of the cervical spinal canal. In a study by Yu et al., while the transverse diameter gradually increased between C2-C6, it was observed that the diameter decreased at the C7 level and was measured at the narrowest C3 level (9,10). Torg Ratio is an indicator that can help diagnose patients at risk for cervical spine injury, obtained by dividing the diameter of the spinal canal in a vertebra by the corresponding vertebral body sagittal diameter (11).

Other formations that distinguish cervical vertebrae from other vertebrae are vertebral foramen and uncinate processes in their transverse processes (Figure 1.2). Vertebral arteries pass through the vertebral foramen, and it is vital to consider the vertebral artery neighborhoods in all procedures to be performed on the cervical spine. The uncinate processes, on the other hand, are located dorsilaterally, superior to the corpus of the cervical vertebrae, and form the uncovertebral joint with the caudodorsilateral of the corpus of the lower vertebrae. In cervical discectomy method, partial resection of the uncinate process has an important place in terms of decompressing the nerve root trace and it has been seen that it provides significant benefit in post-op intervertebral foramen enlargement. (7)

Between the two adjacent vertebrae are the intervertebral foramina, from which the nerve roots emerge. The shape of the foramen is considered ovoid. These foramina also contain segmental radicular arteries and sinuvertebral nerves (recurrent meningeal). Nerve endings innervating the annulus fibrosis from the sinuvertebral nerves branch and may be the source of chronic neck pain and discopathic pain (12). Intervertebral foramen borders the intervertebral disc anteriorly, uncinate processes in the trunk and cervical vertebrae, facet joint posteriorly, pedicles above and below (Figure 1.3). The dimensions of the intervertebral foramen in the cervical region, in the MRI measurements of Lantell et al. in 20 healthy people; On average, the height was 11.08 ± 1.88 mm, the width was 5.69 ± 1.91, and the area was 51.61 ± 1.83 mm2 (13). It was reported that the widest area was between C2-C3 and the narrowest area was C7-T1 (13). As the nerve roots leave the intervertebral foramen It exits by running close to the pedicle of the upper vertebra (2). The uncinate process located in front of the intervertebral foramen undergoes osteophytic changes as a result of degenerative processes and causes radiculopathic pain in the patient by compressing the nerve trace. (1) The basic mechanism of osteophytic changes is the deterioration of axial balance and the spine's efforts to develop compensation by hypertrophying the uncinate processes (3).

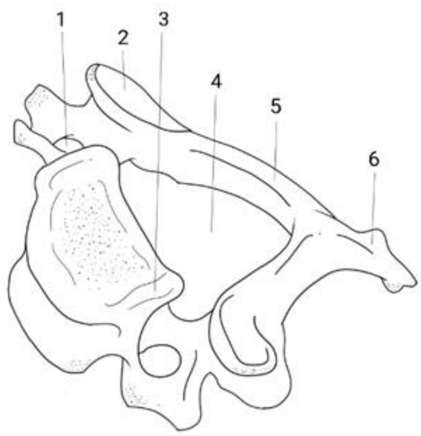

Figure 1.1. 1. Transvers Foramen 2. Superior Articular Facet 3.Uncus 4. Vertebral Foramen 5. Lamina 6. Spinous Process

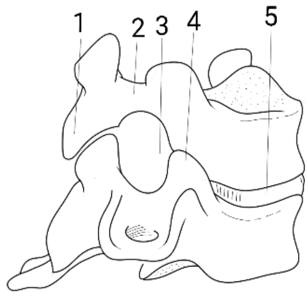

Figure 1.2. 1. Superior Facet Joint 2. Pedicle 3. Intervertebral foramen 4. Uncus 5. Intervertebral Disc

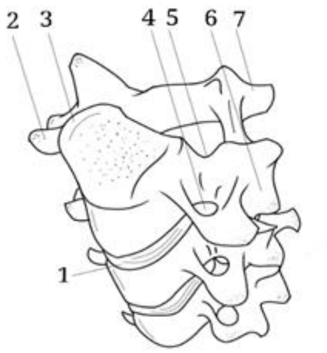

Figure 1.3. 1. Intervertebral Disc 2. Anterior Tubercle 3. Uncus 4. Transverse Foramen 5. Pedicle 6. Inferior Articular Process 7. Spinous Process

METHODS

Unlike the lumbar level, routine axial, coronal and sagittal reformat images are not sufficient in the evaluation of the cervical neural foramen (Figure 2.2). For this reason, oblique sagittal images were created for each level to reveal the neural foramen anatomy and existing pathologies. Information about patient imaging was collected from the picture archiving and communication system (PACS) of our institution. CT images were acquired on a 64-slice CT system (60–80 mAs, 120 kVp, FC86 reconstruction core and 2.0 mm slice thickness at 2.0 mm intervals). Oblique sagittal images were created with OsiriX Lite v.12.0.1 version and measurements were performed (Figure 2.1). In addition to the short and long axis length of the neural foramen, area measurements were made from pre-op and post-op oblique sagittsal images for each level (Figure 2.3).

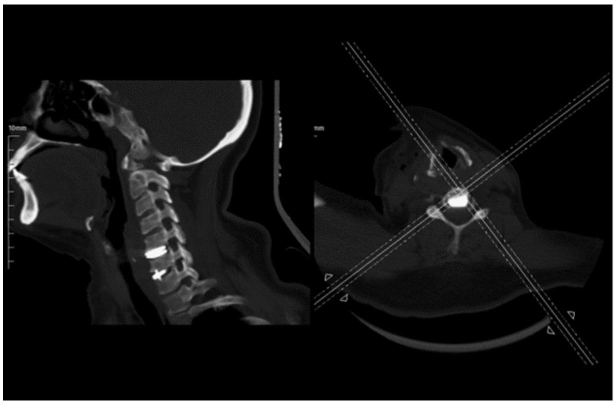

Figure 2.1. Sagittal foramen view in oblique reconstruction

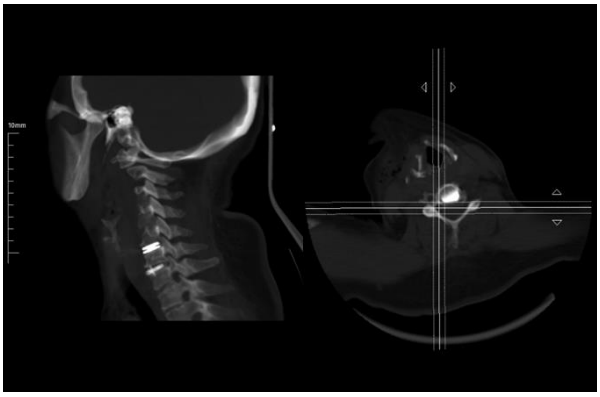

Figure 2.2. Sagittal foramen view in conventional CT

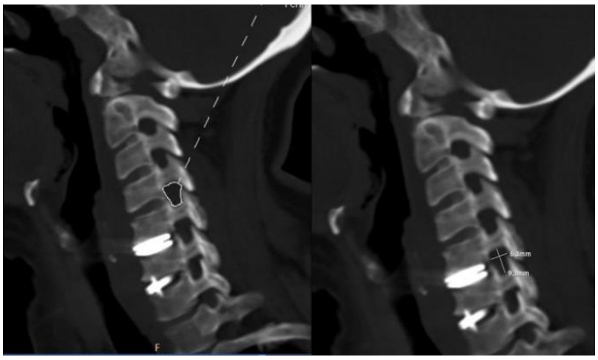

Figure 2.3. Foramen area measurement in oblique sagitt

Statistical analysis

Statistical data IBM SPSS 20.0 software was used. Numerical data were evaluated with histogram and Kolmogorov-Smirnov test. All parameters fit the normal distribution. Sampled sample t-test was used to compare the data. These data were shown with numbers and numerical data were determined as mean + - standard deviation or median. P < 0.005% was found to be statistically significant

RESULTS

In our study, between 16/01/2019 and 03/02/2020, 43 patients were single-level, 3 patients were two-level anterior cervical discectomy + interbody cage, 98 cervical intervertebral foramen oblique CT performed preop-postop; long axis, short axis and area measurements were evaluated. 21 of the patients were female and 22 were male. Laminoplasty was not added to the operation. Schematic drawings and CT images of the cervical intervertebral foramen are shown below. In the calculations made accordingly; right side long axis preop 8.1204mm (±1.11766mm) postop 9.2061mm (±1.36830mm) (p<0.001), short axis preop 4.5959mm (±1.14782mm) postop 4.8714mm (±1, 24197mm) (p<0.001) and area preop 35.9735mm² (±11.55679mm²) postop 42.0429mm² (±12.89079mm²) (p<0.001). Left side long axis preop 8.1939mm (±1.16412mm) postop 9.3633mm (±1.32251mm) (p<0.001) short axis preop 4.4204mm (±1.14909mm) postop 4.7347mm (±1.20460mm)) (p<0.001) and area preop 34.6732mm² (± 10.97012mm²) postop 42.7203 (±12.66639 mm²) (p<0.001) Right side, long axis, short axis and area, respectively; There was an increase of 13.37%, 5.99%, 16.87%. Left side, long axis, short axis, and area respectively; There was an increase of 14.27%, 7.11%, 23.20%. (Table 1) As a result of this surgical procedure, a statistically significant increase was found in spinal foramen measurements (p<0.005%).

Table 1. Increase rates of long axis, short axis and area of cervical foramen after preoperative and postoperative measurements.

	Long Axle	Short Axle	Area
Right-Side	% 13,37	% 5,99	% 16,87
Left-Side	% 14,27	% 7,11	% 23,20

DISCUSSION

Cervical disc herniation is a disease that is seen frequently in the community and is frequently applied to the outpatient clinic with neck pain, myelopathy and radiculopathy. In the surgical treatment, providing neural foramen (NF) decompression in the control of pain caused by radiculopathy is the main purpose of surgery.

The anatomy of the cervical neural foramen has been described in several studies. Ebrahiem et al. (14) have divided the neural foramen groove into 3 as medial middle and lateral. The medial region is thought to be associated with the intervertebral disc (Picture 1.4). Nobuhiro and colleagues (15) divided the neural foramen into a narrow entrance zone and a large cone-shaped zone where it separates from the dural sac. He stated that the interveretbral disc hernia is associated with the narrow zone.

MR foramen compression is very valuable in the evaluation of cervical disc herniation. However, MRI does not show bone tissue pathologies as well as soft tissue pathologies. Therefore, CT imaging is helpful in surgical planning and in the evaluation of post-operative bone decompression. There are publications that indicate that the source of cervical foramen stenosis is osteophytes rather than soft tissue (16).

In our study, we compared the preoperative and postoperative images of 46 patients who underwent

ACDF in oblique CT. The surgeon did not know that such a study would be done while performing the operations. Therefore, the surgeon did not aim to increase the long axis of the foramen during the operation. He used the anterior cervical discectomy technique, which he used in daily practice. He performed bilateral uncinate process decompression and used the cage material of the maximum size he could distance. With oblique CT, the intervertebral foramen could be evaluated optimally (figure 2.1-2.3). As a result of our measurements and statistical study, the long axis of the neural foramen increased due to the cage we could place. Due to the decompression of the uncinate process, the short axis increased, and the area of the neuronal foramen increased, and the compression due to the bone spur was decompressed.

There are few studies similar to ours in the literature. In their study, Wu et al. showed that the height and area of the intervertebral foramen increased in the measurements they made with conventional CT after the application of intervertebral cage (17). Again, Liu et al. compared the heights of the interforamen in cervical MRI after traction for conservative treatment and showed that the height of the foramen increased as the load placed on the traction increased (15).

Oshina et al. (16) measured interforaninal heights in preoperative and postoperative conventional CT and MR in patients scheduled for cervical disc surgery. Then, they evaluated oblique CT and 3D CT measurements as preop and postop in the same patients and compared these two different measurement techniques. While preoperative CTs did not change the surgical indication, they found differences with conventional imaging techniques in postoperative comparison. However, as seen in these studies, while conventional CT provides information about the long axis, it cannot provide clear information about the short axis and, accordingly, the change in the interforamen area

CONCLUSION

In conclusion, decompression of the long axis of the foramen cannot be performed surgically in anterior cervical disc surgery. Due to the difficulty of reaching this region and its close proximity to important vascular and neural structures, adequate decompression cannot be achieved. However, increasing the long axis of the cage foramen placed at the intervertebral level will help to increase the area of the foramen and decompress the nerve. For this reason, the material with the highest height that can be placed at the level of the intervertebral disc during surgery should be placed.

Ethics Committee Approval: Ethics committee approval for this study Ordu Received from the University Clinical Research Ethics Committee (ethics committee date and no:2021-216)

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Author Contributions:
Concept –V. A Design M.T. K Audit O.F.Ş Data Collection and / or Processing - M.S.Ç Analysis and / or Interpretation -O.F.S; Letter - Ö.F.Ş; Critical Review -V.A

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