THE SURGICAL ANATOMY OF TRANSORAL APPROACH

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ABSTRACT

Objective: The aim of this study is to obtain summarized description of the surgical anatomy of Transoral Approach (TOA) and to show the relationship between the important bony and ligamentous anatomical structures.

Material and Methods: To demonstrate the TOA, ten cadaveric head specimens filled with microfil were dissected. Metric measurements between the important anatomical structures were performed in twenty head specimens. Extended indications of the approach were discussed.

Results: In all specimens the TOA was successfully demonstrated. The Transoral Transpalatal Approach (TOTPA) is performed as a modification of TOA with the resection of the hard palate to reach the skull base. Some of the important metric measurements were as follows: 8.2 ± 0.2 cm between teeth and odontoid process; height of odontoid process: 2.4 ± 0.1 cm; height of arcus of C1: 1.1 ± 0.1 cm; intercondylar distance: 2.2 ± 0.1 cm. The longest distance of the approach was with 11.2 ± 0.2 cm between the teeth and the vertebral arteries.

Conclusion: The TOA is a useful procedure for ventral and ventrolateral extradural and intradural lesions of craniovertebral junction. For a proper exposure the surgical anatomy of the region should be well known. For intradural approaches, specially designed instruments should be used.

Key Words: Craniovertebral junction, Surgical anatomy, Transoral approach

INTRODUCTION

The Transoral Approach (TOA) is chosen for lesions close to the midline of the lower third of the clivus, the craniocervical junction, and the upper two cervical vertebrae (1,2). This approach provides a direct extradural and intradural operative exposure to the ventral side of the lower clivus and the upper cervical spine (3). The working length from the incisor teeth to the foramen magnum is more than 10 cm. Therefere, the operative field for this procedure is very narrow and deep, requiring the use of long and specially designed instruments. Laterally extended lesions may need a combination of TOA with other cranial base approaches. Closure after the procedure should be performed meticulously (4,5). The stability after TOA is not rare and posterior stabilization may be required (6,7).

The normal anatomical structures of and around the clivus, and the upper cervical region should be well known before performing an extradural exposure via TOA. If the exposure of dura is necessary, neural and vascular structures must be identified.

MATERIALS AND METHODS

Ten cadaveric head specimens filled with microfil were used to perform TOA, and metric measurements of distances between important anatomical structures were taken from twenty specimens.

Surgical Anatomy and Technique

The position of the patient during the operation may be supine, lateral or semi-sitting. Before the procedure, evaluation of jaw opening is important. If the jaw does not open more than 25 mm, the mandibular split operation should be considered, permitting the tongue to be retracted downward into the hypopharynx and adequate surgical exposure to be achieved.

The transoral approach may be considered under three categories: the basic transoral approach, the transoral transpalatal approach, and the transoral transmandibular approach. A special retractor should be applied to the upper teeth and to the tongue with tongue blade. There are several types of transoral retractors such as Crockard, Dingman, Davis-Crowe, McGarwer etc. Care is taken to ensure that lip or tongue is not caught between the tongue blade and

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the teeth. A rubber catheter should be used sometimes to retract the uvula and soft palate.

The anterior tubercle of C1 should be identified by palpation before incising the pharyngeal mucosa. The pharyngeal mucosa is incised vertically in the midline. For lesions above the foramen magnum, the soft plate also needs to be incised. A midline incision is made in the soft palate extending from the posterior end of the hard palate to the base of the uvula, then circumscribing the uvula (Fig. 1). After the prevertebral fascia is opened, the median raphe between the longus colli muscles is seen and then the anterior longitudinal ligament will be exposed (Fig. 2). The longus colli muscles and anterior longitudinal ligament are inserted to the anterior tubercle of C1. The longus capitis muscles run lateral to the longus colli muscles and may sometimes be confused with them.

The anterior longitudinal ligament and the longus colli muscles are detached from the anterior tubercle of the atlas with a blade. The anterior arch of the atlas is exposed subperiostally (Fig. 3). The odontoid process is posterior to the anterior arch (Fig. 4). The lateral exposure should be

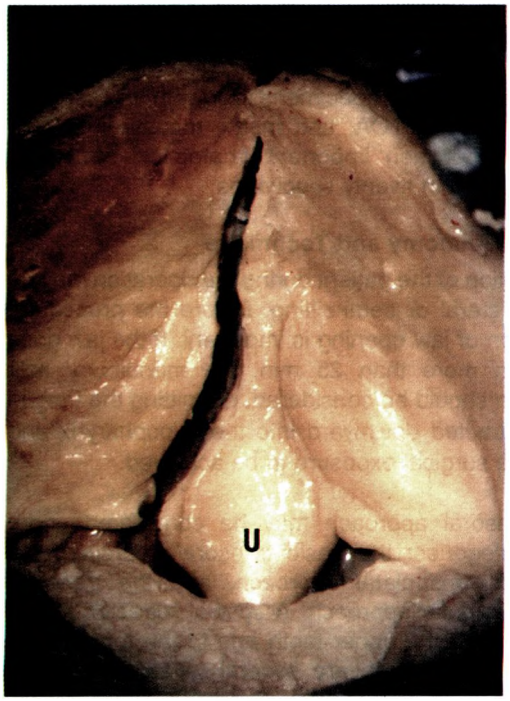

Fig.1: A midline incision is made in the soft palate extending from the posterior end of the hard palate to the base of the uvula, then circumscribing the uvula(U).

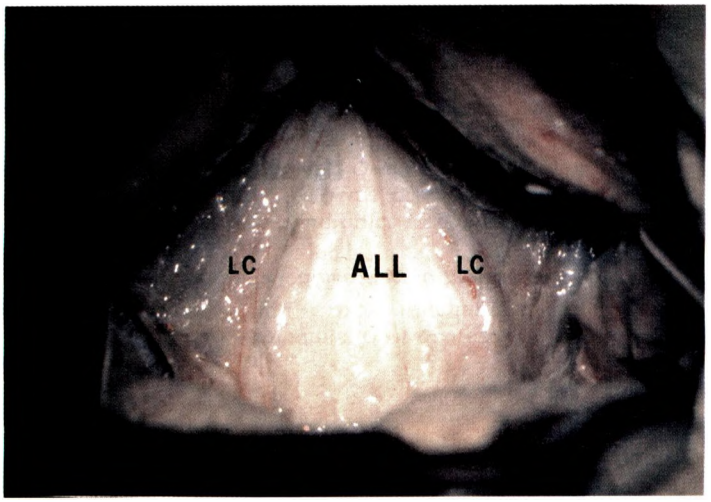

Fig.2: After the prevertebral fascia is opened, the median raphe between the longus colli muscles (LC) is seen and then the anterior longitudinal ligament (ALL) will be exposed.

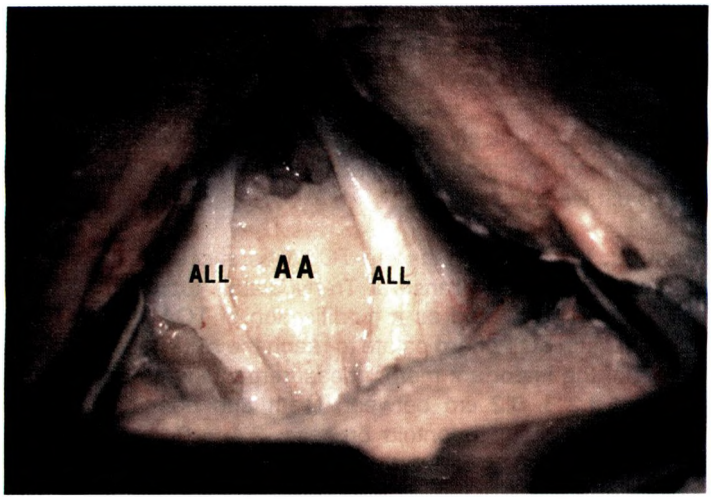

Fig.3: The anterior longitudinal ligament (ALL) and longus colli muscles are detached from the anterior tubercle of the atlas with blade. The anterior arch of the atlas (AA) is exposed subperiostally.

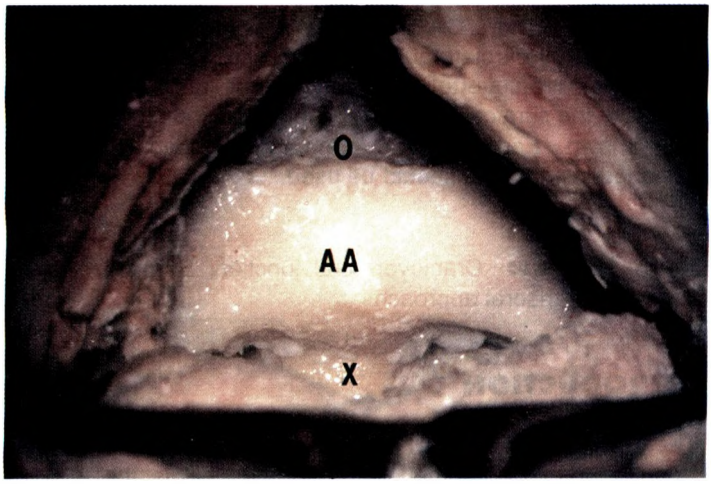

Fig.4: The odontoid process (O:tip, X:base) is posterior to the anterior arch of the atlas (AA). Two ligaments are attached to the odontoid process. The apical ligament is attached to the apex of the odontoid process and the alar ligaments are attached laterally on either side of odontoid process, and then to the occipital condyles.

limited with 15 mm because of the injury risk to both vertebral arteries. Using a high speed drill, the anterior arch of the atlas is removed. The odontoid process is located posterior to the anterior arch of C1. Two ligaments are attached to the odontoid process. The apical ligament is attached to the apex of the odontoid process and the alar ligaments are attached laterally on either side of it, and then to the occipital condyles. The transverse ligament is a main component of the cruciate ligament. This thick ligament surrounds the odontoid process posteriorly. To expose this ligament, odontoid process should be thinned and hollowed with a high speed drill. The alar ligaments on both sides and the apical ligament are resected. There is an interface between the alar and transverse ligament. The direction of the alar ligaments is oblique and they are located anterior to the transverse ligament. The transverse ligament is attached to the posterior surface of the anterior arch of the atlas (Fig. 5).

The upper portion of the body of C2 must be drilled away to remove the transverse ligament. Then transverse ligament is removed, the tectorial membrane will be seen. The color of the tectorial ligament is slightly dark yellow to light brown. The tectorial membrane must be removed very carefully, and then the dura will be seen, whitish in color and much thinner than the tectorial membrane. For more extensive exposure (Transoral-Transpalatal), the clivus should be drilled (Fig. 6). After opening the dura vertically, the intradural structures are observed (Fig. 7).

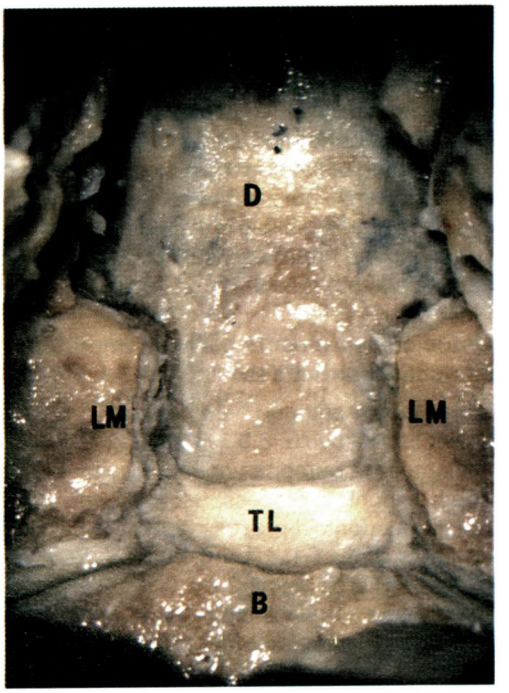

Fig.6: The extensive anatomical drilling of the foramen magnum and the clivus is performed. The cranio-cervical junction dura (D) is exposed (Abb: B: Body of C2, LM: Lateral Masses of C1, TL: Transverse Ligament).

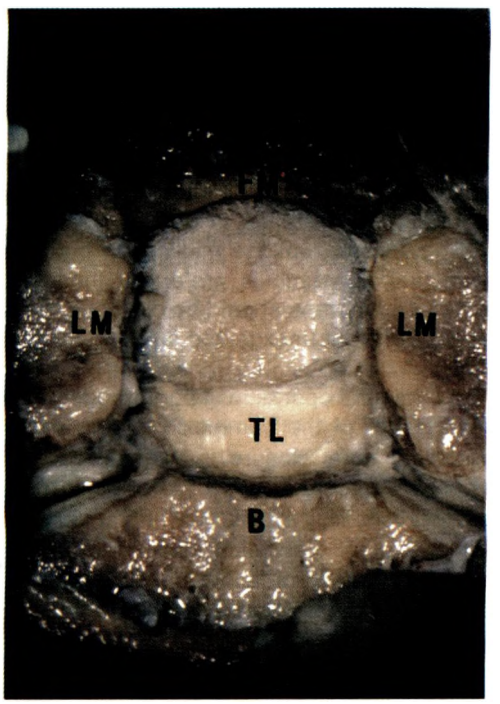

Fig.5: Using a high speed drill the anterior arch of the atlas is removed. The odontoid process is also removed anatomically. The transverse ligament (TL) is a main component of the cruciate ligament. This thick ligament surrounds the odontoid process posteriorly. The tectorial membrane is under the transverse ligament (Abb: B: Body of C2, FM: Foramen Magnum, LM: Lateral Masses of C1).

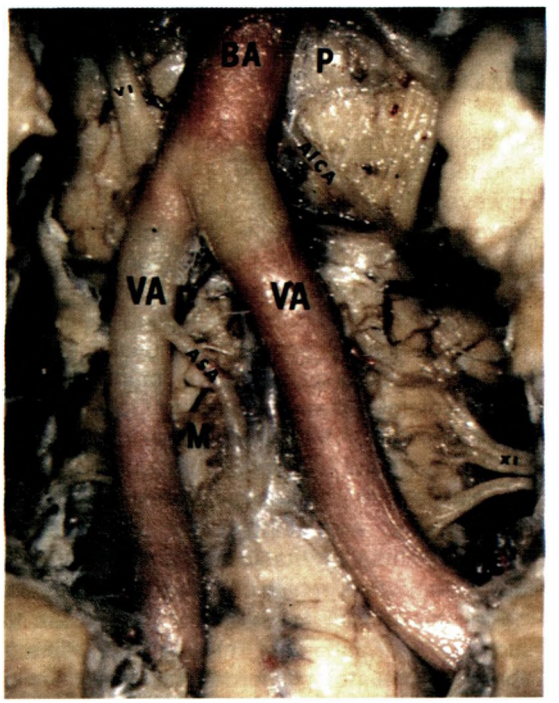

Fig.7: The dura is opened vertically to expose intradural neural and vascular structures (Abb: AICA: Anterior Inferior Cerebellar Artery, ASA: Anterior Spinal Artery, BA: Basilar Artery M: Medulla, P: Pons, VA: Vertebral Artery: VI: n. abducens, XI: n. accessorius).

RESULTS

In all specimens the TOA was successfully demonstrated. The Transoral Transpalatal Approach (TOTPA) is performed as a modification of TOA with the resection of the hard palate. The division of the soft palate and resection of the hard palate provide wider exposure than the basic transoral approach. The entire clivus and the upper cervical spine can be reached by transpalatal approach.

Metric measurements between important anatomical structures:

Lower teeth - soft and hard palate: 5.3 ± 0.2 cm
Lower teeth - uvula: 6.9 ± 0.3 cm
Lower teeth - retropharyngeal mucosa: 7.9 ± 0.3 cm
Teeth - odontoid process: 8.2 ± 0.2 cm
Height of odontoid process: 2.4 ± 0.1 cm
Height of arcus C1: 1.1 ± 0.1 cm
Intercondylar distance: 2.2 ± 0.1 cm
Upper teeth-anterior longitudinal ligament: 9.3 ± 0.3 cm
Upper teeth-anterior border of foramen magnum: 9.7 ± 0.3 cm
Anterior border of foramen magnum - odontoid process: 0.9 ± 0.1 cm
Teeth-dura: 10.8 ± 0.4 cm
Teeth - vertebral artery: 11.2 ± 0.2 cm
Vertebrobasilar junction - condyl: 2.4 ± 0.5 cm
Basilar artery - clivus: 3.1 ± 0.9 cm

DISCUSSION

An approach through the mouth for platybasia was reported by Scoville and Sherman in 1951 (8). However, the first clinical report of a transoral approach to the base of the skull appeared earlier, by Kanaval in 1919 (9). After these reports, the value of the anterior surgical approach to ventral spinal canal pathology has been defined in several disorders (10 - 17). The transoral approach is ideal for extradural lesions (18), but is also preferred for intradural lesions situted ventral and ventrolateral to the neuroaxis. The indications of TOA for extradural lesions are congenital malformations of craniovertebral junction such as rheumatoid arthritis, basilar impression, dystotic os odontoideum and tumors such as chordomas, osteoblastomas, metastasis, abscesses, several malignant tumors which need decompression. The indications of TOA for intradural lesions are tumors such as schwannomas, meningiomas, dermoid or epidermoid tumors, chordomas, glomus jugulare tumors, metastasis cysts of anterior spino-medullary junction (1, 2, 19), and vascular lesions such as vertebral artery and vertebrobasiler junction aneurysms, cavernomas (4, 20). In this study, the distance between the teeth and the clivus dura was measured and found to be from 10.4 to 11.2 cm. This distance is pretty long and may not permit enough control of surgical manipulation. Specially designed instruments such as modified clip appliers, dissectors, bipolars etc. should be used (20).

The indications of TOTPA, a modification of TOA, are tumors of nasopharynx, posterior pharynx, choanae, and sphenoid sinus and sella with nasopharyngeal extention. Other indications are lesions which need repair such as choanal atresia, choanal stenosis, meningocele, and vidian neurectomy. The Transoral Transmandibular Approach (TOTMA) is preferred to reach the skull base and cervical spine by splitting the mandible and the tongue. Glossotomy provides a more inferior exposure, down to the level of C4, if necessary. The indications of TOTMA are extensive benign neoplasms in nasopharynx, parapharyngeal space, and the upper cervical spine; tumors of the tongue, epiglottis, and posterior pharyngeal wall.

Since posterolateral approaches to the ventral and ventrolateral craniovertebral junction require cerebral and brain stem manipulation, known to produce worsening of neurological function, the TOA is preferred by several authors (3, 21-28). However, in different stages of TOA several pitfalls may occur. If the incision of the pharyngeal mucosa is not made in the midline, the surgeon may lose his way between the longus colli and the longus capitis muscles. The far lateral dissection of the anterior arch may result in injury of the vertebral arteries. The transverse ligament is so thick and tough that it may sometimes be hard to remove it with a knife. In such cases, the drill should be used to cut the ligament. The far lateral drilling of the clivus may damage the hypoglossal nerves. As measured in this study, it should be remembered that intercondylar distance is between 2.1 and 2.3 cm, 1.05 -1.15 cm from the midline on both sides. If an extradural approach is preferred, the dura and the tectorial membrane should be distinguished from each other to prevent unexpected dural opening.

If an intradural operation is performed, the dura will be determinant of the complexity of the closure. Since watertight dural closure is very difficult, fascia lata, fascia harvested from the external oblique aponeurosis, fat pad, Surgicel, fibrin glue are used for reinforcement. Sandwich technique might be very useful. One layer of fascia is inserted inside the dura into the subdural space and a layer of fat and fascia are placed outside the dura in the epidural space. Compelete postoperative closure of the nasopharyngeal mucosa should be essential (4,5). Continuous lumbar drainage is important to prevent an increase in CSF pressure during the first few days.

The functional anatomy of the craniovertebral junction is such that a wide excision of the ventral

osteoligamentous components is bound to produce instability after TOA and this requires stabilization (6,7). The preferred stabilization methods are posterior occipitocervical or atlantoaxial fusion, with contoured loop or interlaminar wiring; and sterno-occipitomandibular brace or halo brace. Genarally, a posterior fusion is preferred (6).

In conclusion, the surgical anatomy of transoral approach for ventral and ventrolateral extradural and intradural lesions of craniovertebral junction should be well known for proper exposure and better surgical results.

REFERENCES

1. *Miller E, Crockard HA. Transoral transclival removal of anteriorly placed meningiomas at the foramen magnum. Neurosurgery 1987;20:966-968.*
2. *Crockard HA, Sen CN. The transoral approach for the management of intradural lesions of the craniovertebral junction: a review of 7 cases. Neurosurgery 1991;28:88-98.*
3. *Crockard HA. Transoral approach to intradural/extradural tumors. In: Sekhar LN, Janecka IP, eds. Surgery of cranial base tumors. New York: Raven Press, Ltd., 1993:225-234.*
4. *Hayakawa T, Kamikawa K, Ohnishi T, Yoshimine T. Prevention of postoperative complications after a transoral transclival approach to basilar aneurysms. J Neurosurg 1981;54:699-703.*
5. *Yamaura A, Makino H, Isobe K, Takashima, T, Nakamura T, Takemiya S. Repair of cerebrospinal fluid fistula following transoral transclival approach to a basilar aneurysm. J Neurosurg 1979;50:834-836.*
6. *Crockard HA, Calder I, Ransford AO. One stage transoral decompression and posterior fixation in rheumatoid atlanto-axial subluxation: a technical note. J Bone Joint Surg (Br) 1990;72B:682-685.*
7. *Subin B, Liu JF, Marshall GJ, Huang HY, Ou JH, Xu GZ. Transoral anterior decompression and fusion of chronic irreducible atlantoaxial dislocation with spinal cord compression. Spine 1995;20:1233-1240.*
8. *Scoville WB, Sherman IJ. Platybasia. Report of ten cases with comments on familial tendency, a special diagnostic sign, and the end results of operation. Ann Surg 1951;133:496,502.*
9. *Kanaval AB. Bullet located between the atlas and the base of the skull: Technique of removal through the mouth. Surg Clin Chicago 1919;1:361-366.*
10. *Apuzzo MLJ, Weiss MH, Heiden JS. Transoral exposure of the atlantoaxial region. Neurosurgery 1978;3:201-207.*
11. *Crockard HA. The transoral approach to the base of the brain and upper cervical cord. Ann R Coll Surg Eng 1985;67:321-325.*
12. *Crockard HA, Bradford R. Transoral, transclival removal of a schwannoma anterior to the cranio-cervical junction. J Neurosurg 1985;62:293-295.*
13. *Crockard HA, Essigman WK, Stevens JM. Surgical treatment of cervical cord compression in rheumatoid arthritis. Ann Rheum Dis 1985;44:809-816.*
14. *Greenberg AD, Scoville WB, Davey LM. Transoral decompression of the atlanto-axial dislocation due to odontoid hypoplasia. Report of two cases. J Neurosurg 1968;28:266-269.*
15. *Menezes AH, Graf CJ, Hibri N. Abnormalities of the cranio-vertebral junction with cervico-medullary compression. Childs Brain 1980;7:15-30.*
16. *Mullan S, Naunton R, Hekmatpanah J, Vailati G. The use of an anterior approach to ventral placed tumors in the foramen magnum. J Neurosurg 1966;24:536-543.*
17. *Pasztor E, Vajda J, Piffko P, Horvath M, Gador I. Transoral surgery for craniocervical space-occupying processes. J Neurosurg 1984;60:276-281.*
18. *Lorenzo ND. Transoral approach to extradural lesions of the lower clivus and upper cervical spine: An experience of 19 cases. Neurosurgery 1989;24:37-42.*
19. *Pasztor E. Transoral approach to anterior brain stem compression. Acta Neurochir (Wien) 1992;118:7-19.*
20. *Crockard HA, Koksel T, Watkin N. Transoral transclival clipping of anterior inferior cerebellar artery aneurysm using new rotating applier. Technical note. J Neurosurg 1991;75:483-485.*
21. *Crumley RL, Gutin PH. Surgical access for clivus chordoma. Arch Otolaryngol Head Neck Surg 1989;115:295-300.*
22. *Kikuchi H, Hakuba A, Baba M. Transoral approach for atlanto-axial dislocation. In illustrated techniques in microneuro surgery. Tokyo: Igaku-Shoin Medical Publishers. Inc. 1990:227-236.*
23. *Kingdom TT, Nockels RP, Kaplan MJ. Transoral-transpharyngeal approach to the craniocervical junction. Otolaryngol Head Neck Surg 1995;113:393-400.*
24. *Klockner C, Kern O, Zierski J, Weber U. Microsurgical transoral decompression in disease of and injuries to the cranio-cervical junction. Orthopedics 1998;27:477-481.*
25. *Menezes A, VanGilder JC. Transoral-transpharyngeal approach to the anterior craniocervical junction. Ten-year experience with 72 patients. J Neurosurg 1988;69:895-903.*
26. *Miller E, Crockard A. Transoral transclival removal of anteriorly placed meningiomas at the foramen magnum. Neurosurgery 1987;20:966-968.*
27. *Seifert V, Laszig R. Transoral transpalatal removal of a giant premesencephalic clivus chordoma. Acta Neurochir (Wien) 1991;112:141-146.*
28. *Berkman MZ, İplikçioglu AC. Transoral-transpharyngeal approach to extradural lesions of the craniovertebral junction. An experience of 22 cases. Marmara Med J 1998;11:137-142.*