ENDOSCOPIC TRANSNASAL REMOVAL OF THE PATHOLOGICALLY AFFECTED AREAS OF THE C2 ODONTOID PROCESS

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Objective. To assess capabilities and advantages of endoscopic transnasal removal of pathological foci in the region of the C2 odontoid process.
Material and Methods. The study included 3 patients who underwent endoscopic transnasal removal of the invaginated odontoid process accompanied by simultaneously (2 cases) or previously performed (1 case) occipitospondylodesis.
Results. The pathological focus was totally removed in all cases. Postoperative complication occurred in one case — wound liquorrhea with subsequent development of meningitis which required performing plastic surgery of the CSF fistula. At follow-up examination, all patients presented with complete regression of symptoms.
Conclusion. Endoscopic transnasal access allows for radical removal of pathological foci of the craniovertebral junction. Endoscopic transnasal approach will not be able to completely replace a transoral one, but it is a reasonable alternative in experienced hands.
Key Words: invaginated odontoid process, endoscopic transnasal approach. transoral approach.
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Lesions of the craniovertebral junction area are challenging for both diagnosis and surgical treatment. First of all, this is due to the topographic and anatomical features of this area and close proximity of the vital brainstem structures and main cerebral vessels. Destruction of the bony structures of the craniovertebral junction area and compression of the upper spinal cord segments and brainstem structures are most often caused by the following lesions: tumors (chordoma, giant cell tumor, osteoblastoma, metastases), inflammatory processes (rheumatism), and developmental anomalies (platybasia and basilar impression).

Various approaches are used for treatment of these lesions [1–4]. The most common surgical procedures are as follows:

– posterior occipitospondylodesis with simultaneous decompression of the spinal cord, followed by removal of the lesion through the transoral approach; the stages of surgical treatment can be performed in a reverse order [5–8];

– transoral removal of the lesion and anterior stabilization using screws [9], a Harms plate [10], and a customized stabilization system [11].

The transoral approach is associated with serious problems (baseline stiffness of the mandibular joint, which reduces the size of the surgical field and decreases the area and angle of the operative action) and possible complications, such as failure of sutures in the oral cavity and a significant wound surface in the oropharyngeal area [12, 13].

Expansion of indications for application of the endoscopic transnasal approach enabled its use in the surgical treatment of various lesions in the C1–C2 region, which has been confirmed by a number of anatomical studies [14–16].

We present our experience in the surgical treatment of three patients with pathology of the C1–C2 region. The aim of this study was to analyze the capabilities and advantages of endoscopic transnasal removal of lesions in the odontoid process region.

Material and Methods

The study included three patients (Table) who underwent a standard clinical diagnostic examination, including CT, MRI, and assessment of the neurological status before surgery, immediately after surgery, and at a follow-up examination (3 months after surgery). Motor functions were assessed using a 5-point scale. All cases were characterized by severe compression of the lower brainstem structures and upper cervical spinal cord segments by an invaginated odontoid process; in one case, a giant syrinx formed. All patients underwent total resection of the lesion; occipitospondylodesis was used for stabilization.

The surgical stages included the endoscopic endonasal approach to the lower clivus and anterior C1 arch, resection of the lower clivus and anterior C1 arch, and resection of the odontoid process (Fig. 1).

The key point of surgery was trepanation of the anterior C1 arch and

Table
Characterization of operated patients

Patient (gender; age)	Diagnosis	Clinical presentation before surgery	Complications	Clinical presentation after surgery	Follow-up
1 (female; 58 years)	Post-rheumatoid invagination of the odontoid process	Tetraparesis (1 point)	No	Partial regression of tetraparesis (3 points)	No changes after 8 years
2 (male; 27 years)	Basilar impression, invagination of the odontoid process, a C3—T7 syringomyelia cyst	Tetraparesis (4 points), bulbar disorders	CSF leak, meningitis*	Regression of tetraparesis, bulbar disorders remained	At 3 months. complete regression of symptoms, regression of the syringomyelia cyst
3 (female; 22 years)	Platibasia, invagination of the odontoid process	Cranialgia, periodic respiratory distress, numbness of the fingers	No	Mild bulbar disorders	At 6 months, complete regression of symptoms

*Repeated surgery, repair of a CSF fistula, was performed on the 10th day.

the changed odontoid process. Step-by-step, the odontoid process was trephined, and a high-speed drill with a fine diamond burr was used for drilling from the inside to the posterior cortical plate that was thinned to the egg shell thickness and could be fragmented by a Kerrison punch or detached en bloc from the underlying dura mater.

Removal of the invaginated odontoid process was performed very tenderly due to pronounced thinning of the underlying dura mater in order to avoid perforation of the dura, which might cause cerebrospinal fluid leak and require repair of the defect.

Clinical case. A 22-year-old female patient S. was admitted (18.06.2018) to the Burdenko National Scientific and Practical Center for Neurosurgery with a diagnosis of platybasia, invagination of the odontoid process, and compression of the medulla oblongata. She underwent occipitopondylodesis as the first stage of treatment in March 2018. She clinically presented with periodic respiratory distress, numbness of the fingers, and severe cranialgia. The patient underwent transnasal endoscopic removal of the invaginated odontoid process and decompression of the brainstem structures (Fig. 2).

After surgery, the patient developed mild transient bulbar disorders. She was discharged in satisfactory condition on the 12th day after surgery without tracheostomy. A follow-up examination at 6 months revealed complete regression of symptoms.

Results and Discussion

Two patients underwent single-stage surgery: occipitospondylodesis and endoscopic endonasal removal of the odontoid process with decompression of the medulla oblongata and upper cervical spinal cord segments. In the third case, surgical treatment was divided into two stages; the first stage included occipitospondylodesis, and the second stage included transnasal removal of the lesion. We used 4 mm 0° and 30° rigid endoscopes. In all three cases, total removal of the lesion was accompanied by complete regression of clinical symptoms in the postoperative period.

In one case, there was a postoperative complication –cerebrospinal fluid wound leak followed by the development of meningitis, which required repair of a CSF fistula.

Until recently, patients with these diseases were considered completely inoperable; they underwent exclusively palliative surgery (posterior decompression or posterior decompression with posterior stabilization). Given location of the lesion above the horizontal line of the hard palate in the presented clinical cases, the transoral approach would not provide complete removal of the lesion.

Transoral microsurgical removal of craniovertebral lesions is a traditional, proven by many years of experience, reliable, and widely used in neurosurgical practice procedure; however, it is more traumatic compared to endoscopic endonasal removal because the transoral approach is associated with a more extensive dissection of the oropharyngeal area and soft palate [17]. In addition, stiffness of the mandibular joint due to anatomical features or concomitant diseases decreases the size of the surgical field as well as the angle and area of the operative action, which limits application of the transoral approach. In the postoperative period, there may be failure of sutures in the oral cavity and soft palate as well as inflammatory complications of the oral cavity. In addition, the transoral approach is associated with gastric tube or parenteral feeding within 1–3 postoperative days [13, 18]. The transoral approach enables using all three types of intubation (tracheostomy, orotracheal and nasotracheal intubation), but, in our opinion, the most optimal intubation is tracheostomy that is not always required for the endoscopic transnasal approach [19].

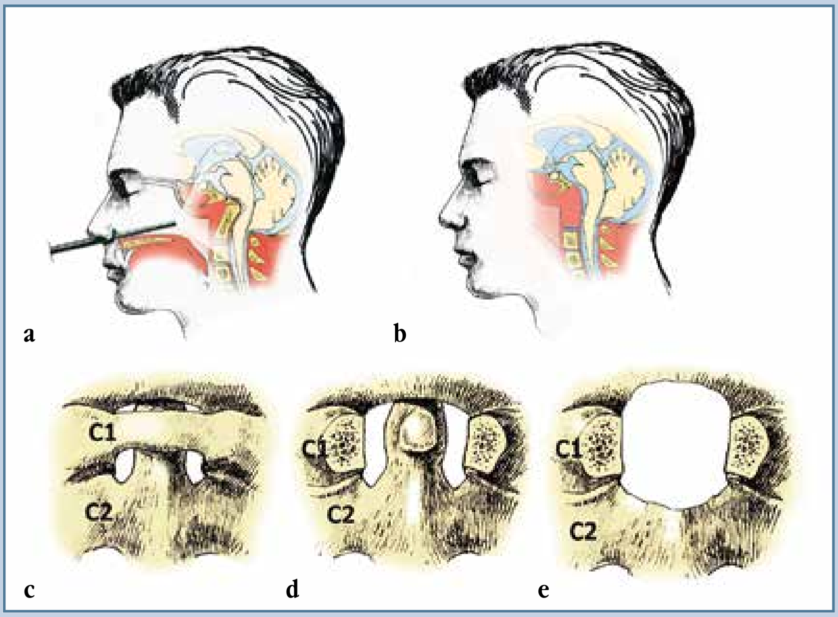

Fig. 1
Surgery diagram: **a**– endoscopic endonasal approach to the craniovertebral junction area with an invaginated odontoid process that compresses the brainstem structures; **b** – condition after endoscopic transnasal resection of the invaginated odontoid process and decompression of the brainstem structures; **c** – bone structures of the craniovertebral junction area; **d** – resection of the anterior C1 arch; **e** – resection of the odontoid process, part of the C2 vertebral body, and inferior clivus (drawing by D.N. Andreev)

The pioneer in application of the endoscopic transnasal approach in surgery of C2 lesions is an American neurosurgeon Kassam who first in the world performed this surgery in 2005 [18]. In Russia, a similar operation was first performed by a neurosurgeon A.N. Shkarubo in 2010 [19]. The largest series of 34 such operations was reported by Zwagerman et al. in 2018 [20]. Most publications in the literature include 1–3 clinical cases, and the total number of cases is about 170 [21–40].

The use of the endoscopic transnasal approach in surgery of C1–C2 lesions has been consistently growing since 2005 [27], which is confirmed by a meta-analysis performed by Aldahak et al. [41] and is due to a smaller number of complications in the postoperative period. This is due to the fact that the endoscopic endonasal approach, in comparison with the standard transoral one, has certain advantages: the amount of soft tissue injury is significantly reduced. In the case of the endonasal approach, the surgeon is limited by the hard palate and avoids damage to the nerve plexus in the oropharyngeal wall, and the oropharyngeal muscles are less damaged, which may explain a reduced rate of postoperative dysphagia [42]. However, in some cases, trepanation of the posterior hard palate is reasonable for increasing the angle of operative action. Also, in some cases, trepanation of the clivus is advisable for achieving the same goals [18].

A study by Ponce-Gomez et al. [43] showed that extubation of patients in the case of the endonasal approach occurs much earlier, which enables early oral feeding (except for cases of bulbar disorders). Also, hospital stay is reduced, and rehabilitation can start earlier [44], which prompts surgeons to choose the transnasal approach. However, there is a significant increase in the surgery time when using the endoscopic transnasal technology (endoscopic endonasal surgery takes 238 min, on average, and microscopic transoral surgery takes 141 min, on average) [43].

Currently, the addressed approach is used much rarely than the classic transoral one. This is due to a high labor intensity of the operation and the need in neurosurgeon's experience in endoscopic transnasal surgery. However, an analysis of the literature shows that the number of these operations has been consistently increasing.

Conclusion

Endoscopic endonasal removal of C1–C2 lesions enables performing radical surgery with a simultaneous decrease in invasiveness of the surgical intervention compared to the traditional transoral approachas, as well as starting earlier rehabilitation, which is important in severe and debilitated patients. This is also confirmed by our clinical experience.

Of course, the endoscopic transnasal approach cannot completely replace the transoral one, but may become, in experienced hands, the only possible technique for radical cure of patients with odontoid lesions.

For this surgery, the use of a 3D endoscope may be useful; it is also important to improve tools for resection of the bone structures of the craniovertebral junction area.

Endoscopic endonasal operations should be performed by experienced surgeons at highly specialized medical institutions.

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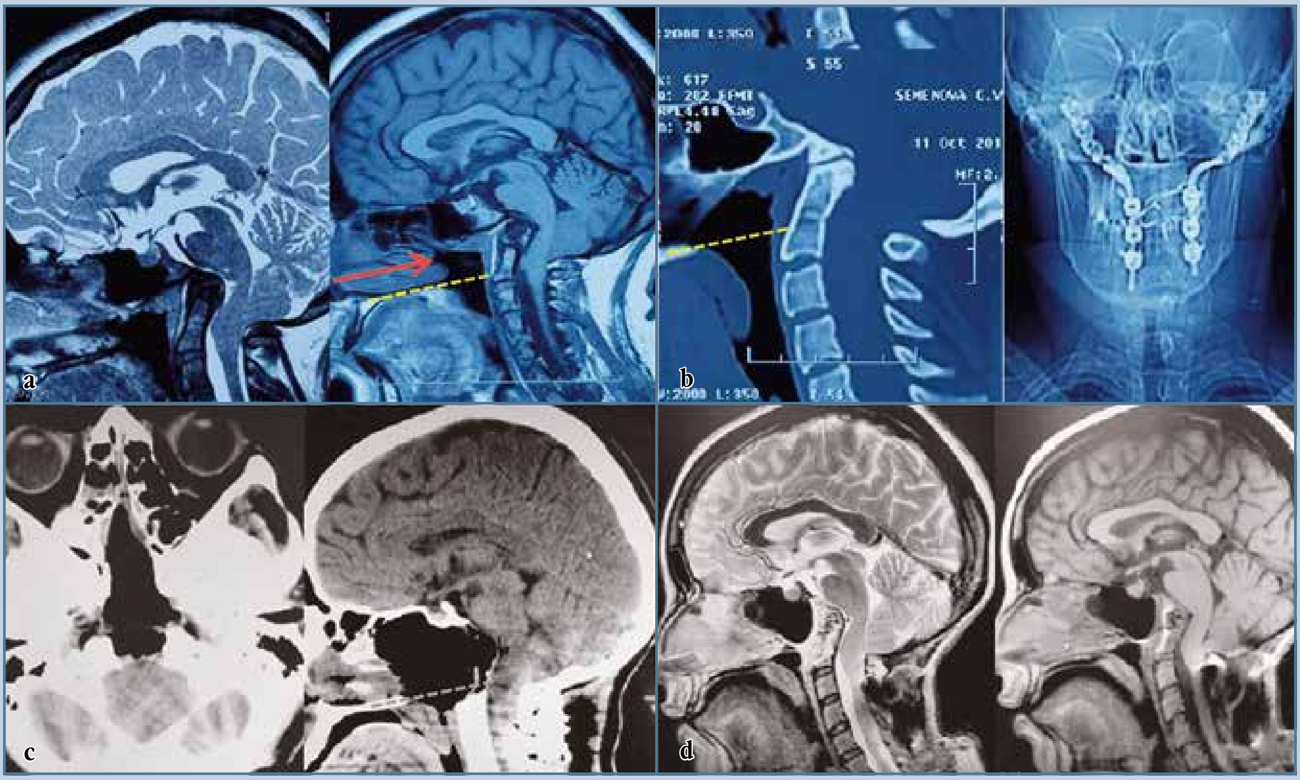

Fig. 2
Data of the 22-year-old female patient S.: **a** – MRI scans before surgery: platibasia, invagination of the odontoid process, and compression of the medulla oblongata; the red arrow indicates the approach direction; the yellow dotted line denotes the horizontal line of the hard palate; **b** – CT and radiography before surgery: occipitospondylodesis is performed; the yellow dotted line denotes the horizontal line of the hard palate; **c** – CT scan after surgery: complete decompression of the brainstem; the yellow dotted line denotes the horizontal line of the hard palate; **d** –T2- and T1-weighted MRI scans on the 9th day after surgery

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