6-1-2019

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Case Report
https://doi.org/10.5115/acb.2019.52.2.211
pISSN 2093-3665 eISSN 2093-3673
Anatomy & Cell Biology acb

Ossification of the roof of the porus trigeminus with duplicated abducens nerve

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Abstract: Ossification of parts of the intracranial dura mater is common and is generally accepted as an age-related finding. Additionally, duplication of the abducens nerve along its course to the lateral rectus muscle is a known, although uncommon anatomical variant. During routine cadaveric dissection, an ossified portion of dura mater traveling over the trigeminal nerve's entrance (porus trigeminus) into the middle cranial fossa was observed unilaterally. Ipsilaterally, a duplicated abducens nerve was also observed, with a unique foramen superolateral to the entrance of Dorello's canal. To our knowledge, there has been no existing report of a simultaneous ossified roof of the porus trigeminus with an ipsilateral duplicated abducens nerve. Herein, we discuss this case and the potential clinical and surgical applications. We believe this case report will be informative for the skull base surgeon in the diagnosis of neuralgic pain in the frontomaxillary, mandibular, orbital, and external and middle ear regions.

Key words: Meckel's cave ossification, Trigeminal neuralgia, Abducens nerve variation, Microneurosurgery

Received January 9, 2019; Revised February 7, 2019; Accepted February 8, 2019

Introduction

Eponymously known as Meckel's cave, the trigeminal cave (cavum trigeminale) described as a "space between two layers of the dura mater at the tip of the petrous portion of the temporal bone" houses the proximal trigeminal nerve (CN V) and trigeminal (Gasserian) ganglion [1]. The expansion of medical imaging technology and microneurosurgical anatomy has allowed surgeons to traverse this area and establish key anatomical landmarks within this space as well as its relations to other structures within the posterior and middle cranial fossae. Meckel's cave acts as a doorway to several important regions of the skull base (e.g., anterior, middle, and posterior cranial fossae, petrous apex, the petroclival zone) once the tentorium cerebelli are surrounding dura mater are opened [2]. This depression is a main conduit and placeholder for the rootlets of the trigeminal nerve, trigeminal ganglion, proximal segments of the ophthalmic (V_1), maxillary (V_2), and mandibular (V_3) nerves [2]. Immediately proximal to the porus trigeminus is the abducens nerve (CN VI)—known for its long course and potential for anatomical variations [3]. The porus trigeminus acts as an entry point for the root of the trigeminal nerve to traverse along Meckel's cave.

The roof of the porus trigeminus may present with ossification resulting in the formation of a bony aperture that may restrict the mobility of or compress the trigeminal nerve [4]. Herein, we report an interesting case of unilateral ossification of the roof of the porus trigeminus with a duplicated abducens nerve found during routine dissection of the skull base. This occurrence necessitates that the skull base surgeon be aware of the variations of the course and aberrant multiplicities of the abducens nerve and that they consider the ossification of the porus trigeminus in the diagnosis of the trigeminal

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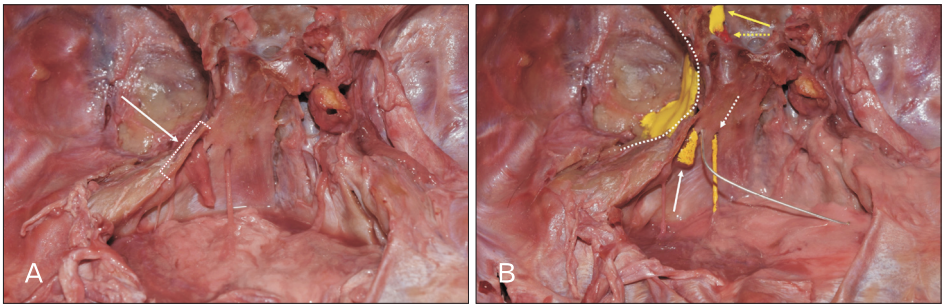

Fig. 1. (A) Ossified roof of the porus trigeminus (arrow), covering the trigeminal nerve as it enters the middle cranial fossa. The boundary of the ossification is indicated by the dashed bracket. (B) A duplicated abducens nerve dural foramen is indicated by the dissector, with one part of the nerve traveling inferomedial (dashed white arrow). The trigeminal root (solid white arrow) traverses the ossified porus trigeminus into Meckel's cave (curved dashed line). More anteriorly, the optic nerve (yellow solid arrow) and internal carotid artery (yellow dashed arrow) are colored for reference.

neuralgia and neuropathy due to the compression of the nerve.

Case Report

During routine dissection of the skull base of a 71-year-old Caucasian male cadaver, the roof of the porus trigeminus was found to be ossified on the left side (Fig. 1A) and forming a bony bar resulting in an oval shaped aperture by which the trigeminal nerve entered. This aperture measured 3.93 mm×7.11 mm and the bony bar measured 1.85 mm (width)×14.95 mm (length) and was discovered after removal of the dura and tentorium cerebelli. There were no observed variations in the course or variation of the V1–3 branches of the trigeminal nerve in the middle cranial fossa (Meckel's cave). Additionally, immediately anteroinferior to the left porus trigeminus, a duplicated abducens nerve was observed with two separate dural foraminal entrance sites (Fig. 1B).

Discussion

Ossification of the roof of the porus trigeminus

Though trigeminal neuralgia is often a result of pathological vascular enlargement due to embolism (blood or gas) or fistula within neighboring vessels of the skull base and or dura mater that compress the cisternal segment (root) of the trigeminal nerve, it may also be a result of the ossification of the roof of the porus trigeminus [4, 5]. The roof of the porus trigeminus may also be referred to as the posterior petroclinoid dural fold, and has several important neighboring structures crucial to the knowledge of the skull base surgeon [6]. Based on a cadaveric study by Ciołkowski et al. [7], the mean width of the porus trigeminus was 7.3±1.0 mm, with the mean height 2.2±0.4 mm. Of significant interest to the surgeon are the immediate relations to the porus trigeminus: the internal acoustic porus (6.6±1.7 mm), jugular foramen (16.2±1.8 mm), jugular tubercle (18.9±1.8 mm), abducens nerve (5.9±1.2 mm), trochlear nerve (8.4±1.9 mm), and oculomotor nerve (8.4±1.9 mm) [7]. Trigeminal nerve compression may be due to the superior cerebellar or basilar artery or neurovascular conflicts between the trigeminal nerve and petrosal vein [8]. These etiologies may manifest as symptomatically identical (i.e., excruciating neuropathic pain during stimulation of the face or oral cavity, and external and middle ear); therefore, magnetic resonance imaging and computed tomography (CT) angiography should be employed for preoperative neurodiagnostics. Notably, the tentorium cerebelli is susceptible to age-related ossification and have been observed throughout the tentorium cerebelli and other dura mater with no discrete zones predisposed to ossification [9, 10]. Kıroğlu et al. [9] reports that tentorial, falcian, and dural ossifications occur in 10% of elderly individuals. In differential diagnosis of neurological symptoms, CT is widely used to discern intracranial ossifications that may contribute to alterations in sensations or pain in the facial region by compression neuropathy, easily observable as a hyperintense stretch highlighting the area of ossification. Due to itsproximity to the proximal trigeminal nerve, well-circumscribed ossifications of the tentorium cerebelli may also result in trigeminal neuralgic symptoms [11]. Treatment of idiopathic trigeminal neuralgia involves accessing the petroclival zone and posterior fossa and dividing the ossified dural slip compressing the trigeminal root [6].

Duplication of the abducens nerve

We also observed duplication of the abducens nerve, with well-defined dural openings for the duplicated nerve, superolateral and slightly posterior to the entrance of the Dorello's canal. While relatively constant in course intradurally and extradurally, the abducens nerve is known to have remarkable variations involving double and triplications observed from its origin at the pontomedullary junction of the brain stem, as well as along its course into the orbit [3]. The reported incidence of a duplicated abducens nerve ranges from 8% to 18% [12].

The petroclinoid ligament (Gruber's ligament) that forms the roof of the pathway for the abducens nerve (Dorello's canal) is also prone to ossification, and may result in dysfunction of the lateral rectus muscle if the abducens nerve is compressed [9]. The abducens nerve is secured tightly within Dorello's canal via a secondary tube as it travels to the cavernous sinus [13]. Head trauma with movement of the brain stem, has been posited to injure the abducens nerve due to its tethering within Dorello's canal [13]. Such an injury would denervate the abducens nerve. If an accessory abducens nerve not bound in Dorello's canal continued to innervate the lateral rectus muscle, some abduction of the eye may be preserved.

Surgeons of the skull base must be aware of common and uncommon anatomical variations. Therefore, knowledge of the two anatomical variations as noted in the case herein is important during operations of the middle and posterior cranial fossae [14, 15].

Conclusion

This case demonstrates, to our knowledge, the first report of the simultaneous occurrence of a duplicated abducens nerve and ossification of the roof of the porus trigeminus. We believe this report will be helpful for the skull base surgeon who might encounter such anatomy and for archival purposes.

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