Focus on the Lateral Incisural Space: Where is the Trochlear Nerve?

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Abstract

Objective To define the entrance point of the trochlear nerve in the free edge of the tentorium, giving a topographical description in relation to supratentorial and infratentorial reference points.

Method The study was performed on seven formaldehyde-fixed specimens (14 sides). The distance from supratentorial and infratentorial reference points to the entrance point of the trochlear nerve into the free tentorial edge was measured.

Results The cisternal segment of the trochlear nerve, the tentorial entry point, and the reference points could be clearly identified in all specimens. The assessed distances measured from the tentorial entry point of the trochlear nerve to the anterior clinoid process was 14 to 28 mm, to the posterior clinoid process was 9 to 19 mm, to the posterior lip of the inner auditory canal was 25 to 29 mm, to the posterior border of the Meckel cave was 9 to 14 mm, and to the oculomotor triangle was 5 to 16 mm.

Conclusions The cisternal length of the trochlear nerve shows a marked variability and may be further distorted by tumors, whereas the entry point into the tentorium is a stable landmark. Therefore, it might be an important reference point for identifying the nerve before cutting the tentorium.

Keywords

- trochlear nerve
- cranial nerve IV
- tentorial notch
- lateral incisural space

Introduction

The trochlear nerve shows the longest intracranial course of all cranial nerves (CNs).^{1,2} Further, it is the only CN arising from the dorsal aspect of the brainstem and the only one whose fibers decussate. The trochlear nerve is thin (0.75 to 1 mm) and along its incisural course it is hidden by the tentorium. Whenever the tentorial edge has to be cut to extend a supratentorial approach to the infratentorial space or vice versa, the nerve is in danger.

Thus, accurate knowledge of CN IV topography is essential.³ Mass lesions growing around the incisural space, however, displace the nerve from its natural course. Points of reference remain in every case the exit from the brainstem and the entrance into the tentorium/posterior cavernous sinus.

The aim of this study was to topographically define the entrance point of the trochlear nerve in the free edge of the tentorium/posterior margin of the cavernous sinus in relation to both supratentorial and infratentorial reference points.

Material and Methods

The anatomic measurements were accomplished on seven formaldehyde-fixed specimens (14 sides) donated for education and research to the Institute of Clinical Anatomy, Eberhard-Karls-University Tübingen. We performed a transversal anatomical transection of the skulls and removed the cerebrum, leaving the mesencephalon and connected structures in place. The entrance point of the trochlear nerve into the

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free tentorial edge was identified. The anterior and posterior clinoid process, posterior lip of the inner auditory canal, posterior limit of the Meckel cave, and the entrance of the oculomotor nerve into the roof of the cavernous sinus (oculomotor triangle) were defined as reference points (►Fig. 1). We chose several points in different anatomical areas, because according to pathology and approach only a limited number of structures will be examinable during a microsurgical intervention. We measured with a caliper rule the distances from these reference points to the entrance of the trochlear nerve into the tentorium. The entrance was defined as the point where the nerve is completely enclosed by dura and thus clearly discerned from the nerve's dural groove on the lower surface of the tentorium (►Fig. 2).

Results

The cisternal segment of the trochlear nerve, the tentorial entry point, and the reference points could be clearly identified in all specimens. All nerves entrenched themselves progressively in a groove on the lower surface of the free tentorial edge. Because it is a smooth transition from the free cisternal segment to the definitive dural entry point, an accurate assessment of the effective length of the groove is not feasible.

The assessed distances measured from the tentorial entry point of the trochlear nerve to the anterior clinoid process was 1.4 to 2.8 (mean 2.2) mm, to the posterior clinoid process was 0.9 to 1.9 (mean 1.4) mm, to the posterior lip of the inner auditory canal was 2.5 to 2.9 (mean 2.7) mm, to the posterior border of the Meckel cave was 0.9 to 1.4 (mean 1.1) mm, and to the oculomotor triangle was 0.5 to 1.6 (mean 1.1) mm (►Table 1).

Fig. 1 Picture of a skull base with overlay of dura and cranial nerves (CNs) on the right side illustrating the reference points related to the entrance of CN IV into the tentorium/posterior cavernous sinus. AC, anterior clinoid process; CA, carotid artery; CN, cranial nerve; IAC, inner auditory canal; MC, Meckel cave; ON, optic nerve.

Fig. 2 View from above on the left incisural space after partial resection of the tentorium. The white arrow indicates the entrance point of the trochlear nerve (cranial nerve IV) into the free tentorial edge. CN, cranial nerve; MC, Meckel cave; PC, cerebral peduncle; MB, midbrain.

Discussion

The cisternal course of the trochlear nerve may be divided into quadrigeminal, ambient, and tentorial segments.³ The entire cisternal length measures 25 to 45 (mean 35.6) mm.⁴ The length of the quadrigeminal and ambient segment (exit from the dorsal midbrain to the free tentorial edge) is very variable and ranges between 1.0 to 14.0 (mean 7.5) mm.⁵ Within the quadrigeminal and ambient cisternal segments, the nerve may be distorted in the presence of tumors like meningiomas or epidermoids growing from the infratentorial to the supratentorial space. Thus, the nerve is at an elevated risk during incision of the tentorium for approaches to the incisural space.³ Indeed, the most frequent complication following meningioma surgery in the region of the tentorial notch is trochlear palsy.⁶

In the tentorial segment CN IV runs within an unequally formed groove on the inferior aspect of the free tentorial edge. Therefore, we consider the entrance of the nerve into the free edge of the tentorium a crucial landmark. Once located, the nerve may be dissected and followed in its cisternal, infratentorial course. CN IV is very fragile and special attention has to be paid during manipulation. Localizing the trochlear nerve in the lateral incisural space may be difficult particularly from a supratentorial approach. The nerve is hidden by the free tentorial notch, and tumors may displace it from its normal anatomic course. A constant landmark is the trochlear nerve's entry point into the distal tentorium/posterior margin of the cavernous sinus. Our measurements show a relatively stable distance from intraoperatively well-identifiable reference points to that landmark. Regarding the anterior and posterior clinoid process, our data matches that of Tubbs and Oakes,⁴ who assessed the relationships of the cisternal segment of CN IV in 12 cadavers.

Table 1 Descriptive statistics of distances (in mm) measured from the tentorial entrance point of the trochlear nerve to the respective reference points

Reference points to tentorial entrance CN IV	n	Minimum	Maximum	Mean	Std. Dev.
Anterior clinoid process	14	14	28	22.1	3.89
Posterior clinoid process	14	9	19	14.1	3.22
Posterior lip IAC	14	25	29	26.5	1.22
Posterior border MC	14	9	14	11.1	1.28
Oculomotor triangle	14	5	16	10.6	2.76

Abbreviations: CN, cranial nerve; IAC, inner auditory canal; MC, Meckel cave; Std. Dev., standard deviation.

Because the nerve is more intimately related with the notch in the distal tentorial segment, the tentorium should be cut more dorsally.⁶ Accurate knowledge about the trochlear nerve's topography renders tentorial opening much safer. Additionally, the entry point of the trochlear nerve is an important landmark for opening the cavernous sinus via the retrosigmoid suprameatal approach.⁷

Conclusion

Identifying the trochlear nerve in the intraoperative situation with a tumor distorting local anatomy is often difficult. Although the cisternal length of the trochlear nerve shows a marked variability in physiologic conditions and may be further distorted in the presence of an extra-axial tumor, its entry point into the tentorium/posterior cavernous sinus is a stable landmark. Depending on the surgical approach chosen and the exposed area, it might be an important reference point for identifying the nerve before cutting the tentorium.

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