A New Segment of the Trochlear Nerve: Cadaveric Study with Application to Skull Base Surgery

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Introduction

The anatomy of the cranial nerves is, in general, well understood and lacking controversy.1 For example, anatomical knowledge of the trochlear nerve has not changed in hundreds of years. Because the trochlear nerve travels through multiple regions of the intracranial compartment, knowledge of its detailed surgical anatomy is necessary for the neurosurgeon, as this nerve may be encountered in many areas such as the supracerebellar, middle cranial fossa, parasellar, and orbital regions.

The trochlear nerve originates from the trochlear nuclei in the caudal midbrain at the inferior collicular level and carries...
primarily motor fibers destined for the superior oblique muscle. The fibers emerge from the dorsal surface of the brain stem, with the rootlets combining to form the cisternal segment of the nerve. These emerge from below the inferior colliculus.\textsuperscript{2,3} The initial portion of the cisternal segment travels in the quadrigeminal plate cistern but continues laterally and inferiorly through the ambient cistern. There is some variation as to where the cisternal segment travels, with the nerve passing laterally from the inferior colliculus to the free edge of the tentorium, then travelling perpendicularly to the anterior direction. In 60\%, the nerve travels more obliquely, taking a more direct route. In either case, the cisternal segment follows the same path as the superior cerebellar artery, the posterior cerebral artery, and the basal vein of Rosenthal.\textsuperscript{2} The nerve then pierces the dura at the level of the rostrolateral free edge of the tentorium cerebelli. The cavernous segment is classically described as beginning at this point, taking an anterior path in the lateral wall of the cavernous sinus with the oculomotor nerve superior and the ophthalmic division of the trigeminal nerve inferior to it. The trochlear nerve then leaves the skull through the superior orbital fissure superior to the common tendinous ring. Once in the orbit, the nerve then travels to its only innervation, the superior oblique muscle, where it usually innervates it from the orbital surface of the muscle.\textsuperscript{4}

\section*{Materials and Methods}
Twenty latex-injected adult cadaveric sides (blue into the venous system) (10 adult cadavers; 5 males and 5 females with an average age at death of 78.5 years) were dissected with the aid of an operating microscope (Zeiss, Oberkochen, Germany). Standard microdissection techniques were employed to examine the course of the distal cisternal segment of the trochlear nerve. Measurements were made using a microcaliper (Mituoyo, Kanagawa, Japan). Digital images were made of the dissections (Nikon, Tokyo, Japan).

\section*{Results}
In all specimens, we identified an additional segment of the trochlear nerve (\textit{Figs. 1–5}). This part of the nerve coursed between the entrance of the trochlear nerve into the posterior corner of the oculomotor trigone to the posterior wall of the cavernous sinus.\textsuperscript{5} This segment of trochlear nerve was, on average, 4 mm in length (range 2.2 to 6 mm). No venous or arterial structures traveled with the trochlear nerve in this segment. On average, the trochlear nerve entered the oculomotor trigone 1 cm posterior to the entrance of the oculomotor nerve into the same trigone (range 0.6 to 1.4 cm).

\section*{Discussion}
Based on our study, the trochlear nerve can be exposed more distally without entering the cavernous sinus. This knowledge may be useful to the neurosurgeon during approaches near the posterior clinoid process. Retracting the trochlear nerve outside the cavernous sinus can be increased by opening the dura covering it prior to its entering the cavernous sinus.

Recently, Iaconetta et al\textsuperscript{6} performed a cadaveric study using microdissection and endoscopic techniques.\textsuperscript{6} The authors used median supracerebellar infratentorial,
subtemporal, fronto-temporo-orbito-zygomatic, and endo-
soscopic endonasal transsphenoidal approaches to expose the
trochlear nerve. The authors concluded that there are five
segments of the trochlear nerve: cisternal, tentorial, cavern-
ous, fissural, and orbital. Based on our findings, an additional
segment should be included, a trigonal segment, located
between the tentorial and cavernous segments.

In describing a combined petrosal approach, Terasaka
et al.\(^7\) included transection of the tentorium cerebelli medially
toward the incisura to a point posterior to the trochlear
nerve’s entrance into the posterior corner of the oculomotor
trigone. Stopping at the trochlear nerve’s entrance into the
oculomotor trigone was based on the misconception that the
nerve enters the cavernous sinus at this point.

Conclusions

We have identified a new segment of the trochlear nerve not
previously described. We propose that this be referred to as the
trigonal segment. Knowledge of the microanatomy of the
trichlear nerve may be useful to the skull base surgeon.
Additionally, in future publications and texts, the trigonal
segment of the trochlear nerve should be mentioned as a part
of the trochlear nerve.

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