

Case Report

A Case of Aberrant Abducens Nerve in a Cadaver and Review of Its Clinical Significance

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The abducens nerve usually travels from the brainstem to the lateral rectus muscle as a single trunk. However, it has been reported that this nerve could split into branches occasionally. We attempted to show the aberrant course of abducens nerve in a specimen with unilateral duplicated abducens nerve and review relevant literatures. The micro-dissections were performed in a head specimen injected with colored latex under the microscope. The abducens nerve was duplicated unilaterally. This nerve emerged from the pontomedullary sulcus as a single trunk and splitted into two branches in the prepontine cistern. These two separate branches were piercing the cerebral dura of the petroclival region respectively. The slender lower branch passed between the petroclinoid and petrosphenoid ligaments and the thick lower one passed under the petrosphenoid ligament. These two branches united just lateral to the ascending segment of internal carotid artery in the cavernous sinus. The fact that there are several types of aberrant abducens nerve is helpful to perform numerous neurosurgical procedures in the petroclival region and cavernous sinus without inadvertent neurovascular injuries.

KEY WORDS : Aberrant abducens nerve · Petroclival region.

INTRODUCTION

The abducens nerve usually emerges from the pontomedullary sulcus of the brain stem as a single trunk. It travels in the subarachnoid cisterns of the posterior fossa and passes through the cavernous sinus lying lateral to the intra-cavernous carotid artery after piercing the dura on the petroclival region. And then, it enters the orbit through the superior orbital fissure to innervate the lateral rectus muscle. However, it has been reported that the abducens nerve does not always follow above classic anatomical descriptions^{4-6,8,13}. Therefore, it may be important to know these aberrations of the abducens nerve for endovascular interventions and skull base surgery being performed in the petroclival and cavernous sinus regions. We attempted to show the course of abducens nerve between the brain stem and cavernous sinus through a specimen with unilateral duplicated abducens

nerve and review relevant literatures.

CASE REPORT

A human head specimen injected with colored latex was used. A unilateral duplicated abducens nerve was found in the specimen incidentally. The micro-dissections were performed to observe the course of aberrant abducens nerve in the posterior fossa, petroclival region, and cavernous sinus under the microscope. In the posterior fossa (Fig. 1), the abducens nerve emerged from the brain stem as a single trunk and split into two branches in the prepontine cistern immediately after leaving the brain stem. One with small diameter was coursing parallel and superior to the other with large diameter. Of two separate branches, the slender upper branch pierced the dura on the upper petroclival region, several millimeters above the point where the thick lower branch pierced. The superior and lateral walls of the cavernous sinus were removed to observe the neurovascular structures in the cavernous sinus (Fig. 2). The dorsal meningeal artery and the tentorial artery arising from the meningohypophyseal trunk ran toward the posterior and lateral walls of the cavernous sinus respectively. The infer-

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olateral trunk called the artery of inferior cavernous sinus arising from the horizontal segment of the intra-cavernous carotid artery ran toward the anterior portion of the cavernous sinus. The inferior hypophyseal artery arising from the meningohypophyseal trunk ran toward the medial wall of the cavernous sinus to supply the pituitary gland. The calcified posterior petroclinoid ligament and petrosphenoid ligament were identified in the upper petroclival region.

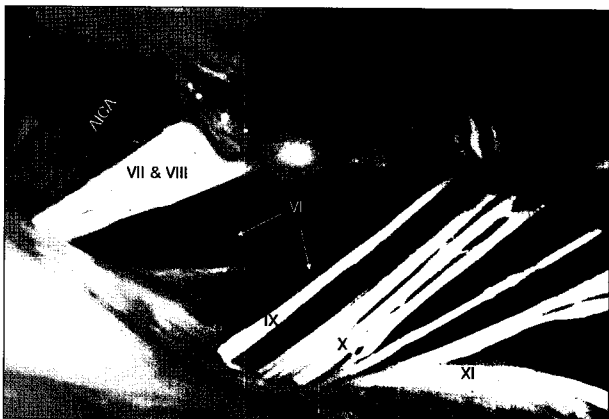


Fig. 1. The abducens nerve (white arrows) splitting into two branches in the prepontine cistern after emerging from the brain stem as a single trunk. Of two branches, the slender upper branch pierces the dura on the upper petroclival region several mm above the point where the thick lower branch pierces. V : trigeminal nerve, VI : abducens nerve, VII and VIII : facial and vestibulocochlear nerve complex, IX : glossopharyngeal nerve, X : vagus nerve, XI : accessory nerve. AICA : antero-inferior cerebellar artery, PICA : postero-inferior cerebellar artery, VA : vertebral artery.

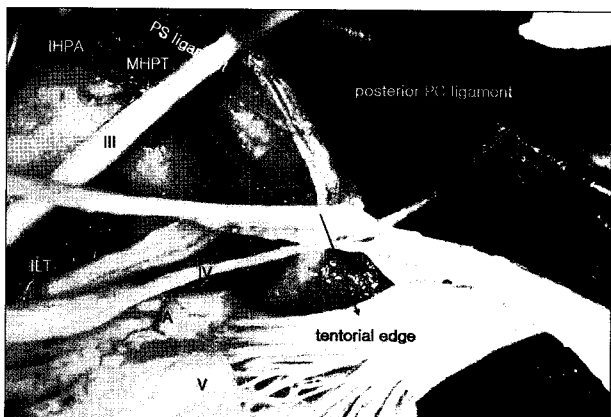


Fig. 2. The superior and lateral walls of the cavernous sinus are being removed. The dorsal meningeal artery, the tentorial artery, and inferior hypophyseal artery are arising from the meningohypophyseal trunk and tentorial artery was cut. The inferolateral trunk is arising from the horizontal segment of the intra-cavernous carotid artery. The calcified posterior petroclinoid ligament and petrosphenoid ligament are identified. These two separate branches unite just lateral to the ascending segment of the internal carotid artery in the cavernous sinus after piercing the dura of the petroclival region. The united abducens nerve run toward the superior orbital fissure as a single trunk to innervate the lateral rectus muscle in the orbit. III : oculomotor nerve, IV : trochlear nerve, V : trigeminal nerve, VI : abducens nerve. DMA : dorsal meningeal artery, IHPA : inferior hypophyseal artery, ILT : inferolateral trunk, MHPT : meningohypophyseal trunk, PC : petroclinoid, PS : petrosphenoidal, TA : tentorial artery.

These two nerve branches pierced the posterior wall of the cavernous sinus separately. The slender upper branch was situated lateral to the thick lower branch for a short length in the cavernous sinus and then the thick upper branch united with the slender lower branch just lateral to the ascending segment of the intra-cavernous carotid artery. The united abducens nerve ran toward the superior orbital fissure as a single trunk to innervate the lateral rectus muscle in the orbit. After the dura of the inferomedial paraclival triangle and posterior petroclinoid ligament were removed to observe the course of the aberrant abducens nerve in the petroclival region, basilar sinus and inferior petrosal sinus were opened (Fig. 3). The slender upper branch passed between the petrosphenoid ligament, called Gruber's ligament and the posterior petroclinoid ligament. However, the thick lower branch passed under the petrosphenoid ligament. Both were enveloped with dura and arachnoid for a short length in the cavernous sinus and separated from the venous blood such as the oculomotor and trochlear cisterns.

DISCUSSION

Generally speaking of the course of the abducens nerve, it emerges from the pontomedullary sulcus of the brain stem, travels in the subarachnoid spaces of the posterior fossa, and passes through the cavernous sinus as a single trunk. However, the aberrations of the abducens nerve have been reported to range between 8 and 18%^{4-6,8,9)} and also the relevant literatures have shown the incidence of the bilateral duplication to range between 0 and 8%^{6,8,9)}. According to



Fig. 3. The dura of the inferomedial paraclival triangle and posterior petroclinoid ligament were removed to open the basilar sinus and inferior petrosal sinus. The slender upper branch passes between the petrosphenoid ligament and the posterior petroclinoid ligament. However, the thick lower branch passes under the petrosphenoid ligament. Both are enveloped with dura and arachnoid and separated from the venous blood such as the oculomotor and trochlear cisterns in the cavernous sinus. III : oculomotor nerve, IV : trochlear nerve, V : trigeminal nerve, VI : abducens nerve. BS : basilar sinus, DMA : dorsal meningeal artery, IPS : inferior petrosal sinus, PS : petrosphenoidal.

the above reports, the aberration of the abducens nerve is not very rare although it is not common. So, the authors think that it is required to take the possibility of the aberration of the abducens nerve into consideration while one performs the neurosurgical procedures in the petroclival region to avoid inadvertent injury. Ozveren et al.⁹⁾ defined six types of aberrant abducens nerve on the base of work of Nathan et al.⁸⁾. According to their classifications, Type I represents the most common whereby the nerve emerges from the brain stem as a single trunk and enters the cavernous sinus and then the orbit as such. In Type II, the abducens nerve leave the brain stem as a single trunk, but splits into two branches before piercing the dura on the petroclival region. It unites to form a single trunk in the cavernous sinus and then enters the orbit. In Type III, the nerve exits from the brain stem as two separate branches and travels in the cisterns of the posterior fossa. These two branches unite in the cavernous sinus and then enter the orbit as a single trunk. In Type IV, it emerges from the brain stem and then enters the cavernous sinus and orbit as separate two branches. Type V represents a case reported by Tillack and Winer¹³⁾ in which, the abducens nerve joins with oculomotor nerve in the brain stem and orbit and can not be seen within the subarachnoid space of posterior fossa and cavernous sinus. A case reported by Nathan et al.⁸⁾ represented type VI, in which the nerve splitted into three branches in the petroclival region. Our case was pertinent to type II of the above descriptions. Type I was the most common and followed the classic anatomical descriptions. Type II and III accounted for less than 10% of the cases respectively^{6,8,9)}. These aberrations of the abducens nerve can be explained by the fact that the oculomotor, trochlear, abducens, and hypoglossal nerves constitute the somatic efferent group developed from the ventral lamina of the midbrain during embryological development and the abducens nerve is in the form of two aberrant branches and so, variations can occur if these branches are not absorbed^{5,18)}. Dorello's canal is bounded by the petrosphenoid ligament, the petrous apex, and the superolateral part of the clivus and the abducens nerve, the inferior petrosal sinus, and the clival artery is known to pass through this canal^{15,16,19)}. However, it may be incorrect that the abducens nerve always passes under the petrosphenoidal ligament. In the case of aberration of the abducens nerve, one of branches could pass above the petrosphenoid ligament^{6,8)}. In our case, the slender lower branch passed above the petrosphenoid ligament, roof of Dorell's canal. So, someone insist that the term of petroclival venous confluens is appropriate instead of Dorello's canal¹⁾. The abducens nerve is enveloped by cerebral dura of petroclival region, separated from the venous

blood and the subarachnoid space also extends toward the cavernous sinus along the nerve^{1,2,9-12,14,17)}. We also found the both branches to be enveloped by cerebral dural layer and separated from venous blood. It is known that the main function of the petrosphenoid ligament is to fix the sheath of the abducens nerve within the petroclival venous confluence¹⁾. It has been reported that direct pressure or disturbance of blood supply in the endovascular procedure to treat the intra cavernous sinus lesions³⁾ and trauma or dissipated heat in the skull base surgery⁷⁾ may occur abducens nerve injury. We speculate that the risk of nerve injury may increase due to abnormal position or slenderness in the presence of aberrations of abducens nerve.

CONCLUSION

The fact that there are several types of aberrant abducens nerve and images of its aberrant course will be helpful to perform numerous neurosurgical procedures in the petroclival region and cavernous sinus without inadvertent neurovascular injuries.

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