Isolated abducens nerve palsy following lumbar puncture: case report and review of the mechanism of action

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Isolated abducens nerve palsy following lumbar puncture is a very rare condition. In this case we discussed the probable causes of abducens nerve palsy and review the mechanism of action in anatomical relevant literature. A 53-year old hypertensive female patient with a saccular aneurysm on the left middle cerebral artery (MCA) bifurcation underwent emergency operation. Before the operation lumbar puncture (LP) was performed to the patient lying on the right lateral position to facilitate cerebral relaxation intraoperatively. The left MCA bifurcation aneurysm was clipped successfully with a left petroclival-transsylvian approach. Postoperatively, she complained of visual diplopia and postural headache. In her neurological examination, isolated abducens nerve palsy was found on the left eye. The patient was treated with intravenous hydration, bed rest and non-steroid antiinflammatory drugs (NSAID) for postural headache. Her postural headache was resolved in the postoperative fifth day, but her abducens nerve palsy was present in the postoperative sixth month follow-up. Many classic textbooks have attributed the vulnerability of the abducens nerve to its long intracranial course, but it is now known that abducens nerves angulation points are the vulnerable parts of the nerve. We hypothesize that the petroclival dural entrance point is the entrapment point and lateral type abducens nerve, if present may be a factor that facilitates the injury of the nerve by lumbar puncture (LP).

Key words: Abducens nerve diseases - Spinal puncture - Intracranial aneurysm.

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Abducens nerve palsy is the most common isolated ocular nerve palsy.1 The annual incidence was found 9.3-13.2/100 000.2 Idiopathic, congenital, trauma, tumor, aneurysm, subarachnoid hemorrhage, metabolic diseases such as diabetes mellitus, Wernicke Korsakoff, multiple sclerosis, acute hydrocephalus, lumbar puncture (LP) and post-infectious immunologically mediated mechanisms are the causes of isolated abducens nerve palsy.1, 3-17

Cranial nerve palsy is a rare complication of lumbar puncture.18, 19 It is known that cerebrospinal fluid (CSF) leakage after LP through the dural hole, causes descent and downward “sagging” of the brain, traction of the abducens nerve which leads to palsy.18, 19 The petrous apex and petrosphenoidal ligament entrapment were accused as the reason of abducens nerve palsy in trauma.20-24 Considering the abducens nerve palsy following LP as a mild injury, we explain the significance of dural entrance point in development of its palsy in this report.

Case report

A 53-year old hypertensive female suffered from sudden headache, nausea and vomiting one day before admission to the Emergency service. Computed tomography (CT) showed subarachnoid hemorrhage filling the left Sylvian cistern (Figure 1). Three dimensional computed tomography – angiog-
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a 14-Gauge spinal needle was performed to the patient lying on the right lateral position to facilitate cerebral relaxation intraoperatively. The left MCA bifurcation aneurysm was clipped successfully with a left pterional-transtubal approach. Postoperatively, she complained of visual diplopia and postural headache. In her neurological examination, isolated abducens nerve palsy was found on the left eye (Figure 3). The patient was treated with intravenous hydration, bed rest and non-steroid antiflammatory drugs (NSAID) for postural headache. Her postural headache was resolved in the postoperative fifth day, but her abducens nerve palsy was present in the postoperative sixth month follow-up.

Discussion

Anatomy of the nerve

Abducens nerve innervates the ipsilateral rectus muscle, which functions to abduct the ipsilateral eye. The nucleus is located in the pons, just ventral to the floor of the fourth ventricle and have a close relationship with the axons of the facial nerve.25-27 There are three parts in the course of the nerve: the subarachnoidal, intracavernous and intraorbital.28 The subarachnoidal part surrounded by a sheath which arise from the invagination of the petroclival dura mater and arachnoid membrane,29 is the main vulnerable part of the nerve (Figure 4A).

The abducens nerve has three angulation points, between the dural entrance point and its anastomosis with the petrosal sympathetic plexus. These three angulation points of the nerve have different angles in the horizontal and sagittal planes.

In the sagittal plane, the nerve makes a 15-20 degree angle to cranial in the petroclival dural entrance point, 60 degree caudally at the petrous apex.

Figure 1.—Computed tomography scan revealed a subarachnoid hemorrhage in the left Sylvian cistern.

Figure 2.—Three dimensional computed tomography-angiography demonstrated a saccular aneurysm on the left middle cerebral artery bifurcation on the AP view.

Figure 3.—Photographs of the patient shows abducens nerve palsy on the left lateral gaze.
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Figure 4.—A) The invagination of the petroclival dura mater and arachnoid mater forms the dural entrance point (DEP). This is the probable entrapment point of the nerve after lumbar puncture. B) Schema shows the angles of the abducens nerve at the petroclival region on the midsagittal plane. At petrous apex the nerve bends forward with an angle of 60 degree. In the previous literature, the forward bending angle of the nerve at the petrous apex is 120 degree.

DEP: dural entrance point; AM: arachnoid membrane; CDM: cerebral dura mater; PDM: periosteal dura mater; PA: petrous apex; PSP: periarterial sympathetic plexus

Mechanisms causing to abducens nerve palsy

TRAUMA

The mechanism of traumatic abducens nerve palsy might fall into two categories: Direct mechanical injury and ischemic changes due to vessel compression and courses parallel to the ICA at the level where the nerve makes anastomosis with the periarterial sympathetic plexus. Though it is formerly stated in the literature that abducens nerve makes a 120 degrees angle at the petrous apex, in our opinion it is more appropriate that it should be accepted abducens nerve heads towards caudally with an angulation of approximately 60 degrees from its ongoing direction because the angulation in the linear course of the nerve must be taken into consideration (Figure 4B).

In the horizontal plane, the first angulation point is in the dural entrance point. At the petrous apex, the nerve courses laterally to reach the lateral wall of the internal carotid artery (ICA), forming the second angulation point. The third angulation point is at the junction of the nerve with the sympathetic plexus branches on the lateral wall of the ICA (Figure 5A). Two different positions of the dural sleeve of the abducens nerve below the petrosphenoidal ligament has been described. Lateral type courses below the lateral one-third of the petrosphenoidal ligament. The medial type occupied the middle one-third of the petrosphenoidal ligament. The first and second angulation points are larger in the lateral type than the medial type (Figure 5B). These points are vulnerable and are the most common causes of abducens nerve palsy which are debated in the literature mostly.

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or vasospasm which is called indirect injury. By a linear accelerated force on a midsagittal plane the petrous apex acts as a fulcrum so that both abducens nerves could be compressed, contused and stretched against the petrous apex. In a cervical spine injury a vector of midfrontal force transmitted upward and posteriorly that produced contusion or avulsion of the nerve by the petroscopic ligament. It has been thought that the ligament behaved as a fulcrum of the abducens nerve in case of upward and posterior displacement of the brain in cervical spine fracture. But histological studies revealed that the amount of injury of the nerve segment beneath the petrosphenoidal ligament was not as significant as those at dural entrance point and petrous apex. The anastomosis site of the abducens nerve with the sympathetic plexus forms another tethering point for the abducens nerve. Involvement of abducens nerve together with the sympathetic plexus can result with ipsilateral partial Horner’s Syndrome. In severe head trauma, the abducens nerve can be injured at the sites of dural entrance point, petrous apex and lateral wall of the ICA directly proportional with the amount of the trauma.

Nerve has been fixed by both dura at the petrous apex and by ICA at the level where the nerve makes anastomosis with the periarterial sympathetic plexus quite tightly. Nevertheless nerve is much more free in the petroclival dural entrance point. That is why damage may happen for the nerve in the occasion of mild trauma in the dural entrance point. Likewise, it is possible to be influenced for the other points in severe trauma.

Lumbar Puncture

Many classic textbooks have attributed the vulnerability of the abducens nerve to its long intracranial course, however several other cranial nerves have intracranial courses longer than the VI. nerve, such as the trochlear nerve being the longest. Cranial nerves except 1, 9 and 10 have potential risk to be involved after LP. Onset of post-dural puncture headache most commonly occurs within 12-24 hours after puncture. Signs of cranial nerve palsy after LP are rare before the fourth day. In our case, there has been a difference occurred because abducens nevre palsy has arised less than the time that is defined in the literature, in the postoperative 12th hour. The mean presentation time is 10 days after LP. In our case, we used a 14 Gauge spinal needle which supports these findings. Brain weighs only 50g as it floats in the cerebrospinal fluid. Decreasing of LP affiliated BOS increases the relative weight of the brain. Petroclival dural entrance point is the most common entrapment point where the nerve can be faced to compression.

In addition to CSF leakage through the dural hole, two consecutive reasons are the facilitating factors in the occurrence of abducens nerve palsy because first; the angulations are larger in the lateral type abducens nerve and second; crossside abducens nerve is tightened to lower parts by hanging loosely before dural entrance point especially in the lateral type which is seen more frequently. Further tightening of VI. nerve located at the side on which the patient lied, may be prevented through being held by petrous bone and tentorium cerebelli. Abducens nerve palsy after LP which is generally occurred at the opposite side on where the patient lied is a characteristic which encourages our opinion.

Treatment and prognosis

Conservative management of post-dural puncture headache includes avoidance of the upright position, NSAIDs, restoring CSF volume with i.v./oral hydration and bed rest. Furthermore, theophiline, sumatriptan, desmopressin and steroids have been reported to be of some benefits; autologous blood infusion into the epidural space which is called epidural blood patch is another choice of treatment. Treatment of nerve abducens palsy includes prism control, patching, injection of botulinum toxin into the medial rectus muscle. Surgery should be considered when the deviation has been stable for at least 6 months. Approximately half of all abducens nerve palsies recover spontaneously. In our case abducens nerve palsy, continuous in the sixth month follow up after LP.

Conclusions

Many classic textbooks have attributed the vulnerability of the abducens nerve to its long intracranial course, but it is now known that abducens nerves angulation points; petroclival dural...
entrance point, petrous apex and lateral wall of the ICA where the nerve anastomoses the sympathetic plexus are the vulnerable parts of the nerve. We hypothesize that the petroclival dural entrance point is the entrapment point and lateral type abducens nerve, if present may be a factor that facilitate the injury of the nerve by LP.

References