Abducens Nerve Palsy in a Patient With a Parasagittal Meningioma

—Case Report—

Ibrahim M. ZİYAL, Gökhan BOZKURT, Burçak BILGINER,
Salih GÜLSEN, and Osman E. ÖZCAN

Department of Neurosurgery, Faculty of Medicine, Hacettepe University, Ankara, Turkey

Abstract

A 67-year-old female presented with isolated unilateral abducens nerve palsy progressing in 10 days. There were no signs of elevated intracranial pressure. Magnetic resonance imaging revealed a right parasagittal meningioma. The tumor was grossly totally removed and the patient's nerve palsy gradually improved within 3 weeks. The mechanism of the isolated abducens nerve palsy in this case is attributed to compression of the abducens nerve by entrapment of the cerebrospinal fluid just before entering Dorello's canal under the petrolingual ligament. Linear forces in the midsagittal plane due to the mass effect of the tumor may have temporarily increased the local cerebrospinal fluid pressure and caused 'pseudoentrapment' of the abducens nerve.

Key words: abducens nerve, parasagittal meningioma, petrolingual ligament, pseudoentrapment

Introduction

The abducens nerve has a long intracranial course along the vascular, neural, ligamentous, and bony structures, and is very vulnerable to direct and indirect injury.^{1,2,4-6,8,11,14)} Abducens nerve palsy may be caused by trauma, tumor, increased intracranial pressure, intracranial aneurysm and subarachnoid hemorrhage,¹⁴⁾ infection, demyelinating disease, and other diseases. Tumors that are located close to the nerve, such as tumors in the cavernous sinus, are quite common causes of abducens nerve palsy. In such cases, the tumor compresses the nerve directly. Supratentorial tumors may cause abducens nerve palsy indirectly through nerve compression due to peritumoral edema with other signs of elevated intracranial pressure.^{5,7)}

Here we describe a case of parasagittal tumor manifesting as isolated unilateral abducens nerve palsy.

Case Report

A 64-year-old female was admitted to our neurosurgery clinic with diplopia progressing over 10 days.

Received March 7, 2005; Accepted September 22, 2005

Fig. 1 Photographs of the patient admitted with progressive diplopia (A). Preoperative coronal and sagittal T₁-weighted magnetic resonance images with contrast enhancement demonstrating a right parasagittal meningioma (B).

Neurological examination revealed isolated right abducens nerve palsy (Fig. 1A) with no other symptom or abnormal neurological finding. Cranial magnetic resonance imaging demonstrated a right

Fig. 2 Early postoperative coronal and sagittal T₁-weighted magnetic resonance images with contrast enhancement revealing gross total removal of the tumor (A). The patient's abducens nerve palsy totally improved within 3 weeks (B).

frontal parasagittal mass lesion resembling a meningioma (Fig. 1B). Right parasagittal craniotomy was performed and the tumor was grossly totally removed with Simpson grade II (Fig. 2A). The histological diagnosis was meningioma. The abducens nerve palsy totally recovered within 3 weeks (Fig. 2B).

Discussion

The abducens nerve has five segments between the brain stem and the lateral rectus muscle: brain stem, subarachnoid, petrosal, cavernous, and orbital.⁴⁾ The nerve is believed to be affected by indirect compression in the extradural space extending to the cavernous sinus. Extradurally, the nerve ascends vertically from the dorsum sellae over the posterior surface of the petrous bone, bends forward by 120 degrees at the petrous apex, and passes beneath Gruber's ligament (petro-sphenoidal ligament). However, the nerve or fascicles may also pass above Gruber's ligament.^{3,7)} The nerve then courses in Dorello's canal, bounded by Gruber's ligament, the petrous apex, and the posterior clinoid process. Gruber's ligament is rigid and the nerve may be stretched under this ligament.^{2,4,8,9)}

The petro-lingual ligament (PLL) is the continuation of the periosteum of the carotid canal extending between the petrous apex and the lingula of the sphenoid bone.¹⁵⁾ The abducens nerve leaves Dorello's canal and enters the cavernous sinus

Fig. 3 Photograph of an anatomical dissection demonstrating the triangle (black borders) where the abducens nerve (VI) leaves Dorello's canal and enters the cavernous sinus. This triangle is formed laterally by the petro-lingual ligament (PLL), medially by the cavernous internal carotid artery (ICA), and posteriorly by the petrous apex (PA), the dorsum sellae, and the petro-sphenoidal ligament (Gruber's ligament). The abducens nerve is very close to the PLL and may be compressed or stretched by this ligament in special circumstances. In this specimen, the trigeminal nerve complex and Gruber's ligament attached to the petrous apex (white dotted area) have been removed.

through a triangle formed laterally by the PLL, medially by the internal carotid artery (ICA), and posteriorly by the petrous apex, the dorsum sellae, and the petro-sphenoidal ligament (Gruber's ligament) (Fig. 3).¹⁵⁾ The abducens nerve is very close and sometimes attached to the PLL, so may be stretched or compressed by the PLL in special circumstances.

The abducens nerve has three classical angulations. The most severe is located at the petrous apex.¹²⁾ Here, the nerve passes along the lateral wall of the cavernous ICA but is attached by connective tissue. The nerve is also fixed to the dura at the entrance and exit of the so-called extradural space^{8,9)} which corresponds to the petrous apex.²⁾ Just before entering the Dorello's canal, the nerve courses close to the petrous ridge, the lateral type, or the basilar plexus, the medial type.⁸⁾ The distance between the dural entrance and the petrous ridge is shorter in the lateral type,⁸⁾ which is thus more prone to stretching. Therefore, the lateral type carries more risk of compression.

Intracranial pathologies may affect the abducens nerve by direct or indirect mechanisms. An orbital tumor may compress the nerve directly in the orbit

and a cavernous sinus tumor may stretch the nerve close to the petrous apex. Increased intracranial pressure stretches extra-axial part of the nerve at the bony or ligamentous structures around the petrous apex or the brain stem.¹⁾ Therefore, the tumor may compress the nerve directly, or the peritumoral edema may compress the nerve indirectly. Even intracisternal accumulation of blood due to bleeding of a ruptured aneurysm may compress the nerve.¹⁴⁾ Intracranial hypotension secondary to myelography or shunting may cause stretching of the abducens nerve at the petrous apex due to downward migration of the brain.^{5,6)} Stretching of the medial wall of the Meckel's cave may also cause abducens nerve palsy.¹⁶⁾

On the other hand, linear accelerated forces in the midsagittal plane may stretch the abducens nerve towards the petrous apex.^{4,10,11)} Cervical spine fracture was associated with bilateral abducens nerve palsy, suggesting that the midfrontal force was transmitted upward and posteriorly, and caused injury to the abducens nerve against the rigid Gruber's ligament.¹⁰⁾ However, such injury of the abducens nerve at Gruber's ligament may be impossible because the nerve is fixed under the ligament by the dura and petrous apex. Therefore, linear forces in the midsagittal plane may act with the petrous apex as a fulcrum.^{2,4,11)}

The petroclival part of the abducens nerve is now known to be intradural,^{9,13)} but was previously suggested to be partly extradural.^{2,4)} Reflection of the meningeal dural layer forms a dural pouch around the nerve which extends to the interdural space. This dural pouch contains cerebrospinal fluid and the abducens nerve. We suggest that a parasagittal tumor in the midsagittal plane may cause local entrapment of the cerebrospinal fluid and so compress the nerve towards the petrous apex at the point where the nerve enters the Dorello's canal. This location is the point where the abducens nerve courses under the PLL. Our present case had an unusual presentation of compression or stretching of the abducens nerve without other increased intracranial pressure signs. This event may be called 'pseudoentrapment' of the abducens nerve, and may occur temporarily and repeatedly.

References

- 1) Antoniadis K, Karakasis D, Taskos N: Abducent nerve palsy following transverse fracture of the middle cranial fossa. *J Craniomaxillofac Surg* 21: 172-175, 1993
- 2) Arias MJ: Bilateral traumatic abducens nerve palsy without skull fracture and cervical spine fracture.

- Case report and review of the literature. *Neurosurgery* 16: 232-234, 1985
- 3) Destrieux C, Velut S, Kakou MK, Lefrancq T, Arbeille B, Santini JJ: A new concept in Dorello's canal microanatomy. *J Neurosurg* 87: 67-72, 1997
- 4) Lazow SK, Izzo SR, Feinberg ME, Berger JR: Bilateral abducens nerve palsy secondary to maxillofacial trauma: Report of case with proposed mechanism of injury. *J Oral Maxillofac Surg* 53: 1197-1199, 1995
- 5) Limnaios EE, Papageorgiou CT: Bilateral abducens nerve palsy. *Ophthalmologica* 181: 326-329, 1980
- 6) Miller EA, Savino PJ, Schatz NJ: Bilateral sixth-nerve palsy. *Arch Ophthalmol* 100: 603-604, 1982
- 7) Nathan H, Ouaknine G, Kosary IZ: The abducens nerve. *J Neurosurg* 41: 561-566, 1974
- 8) Ozveren MF, Sam B, Akdemir I, Aklan A, Tekdemir I, Deda H: Duplication of the abducens nerve at the petroclival region. An anatomic study. *Neurosurgery* 52: 645-652, 2003
- 9) Ozveren MF, Uchida K, Aiso S, Kawase T: Meningovenous structures of the petroclival region: Clinical importance for surgery and intravascular surgery. *Neurosurgery* 50: 829-837, 2002
- 10) Schneider RC, Johnson FD: Bilateral traumatic abducens palsy: A mechanism of injury suggested by the study of associated cervical spine fracture. *J Neurosurg* 34: 33-37, 1971
- 11) Takagi H, Miyasaka Y, Kuramae T, Ohwada T, Tsunoda M: [Bilateral traumatic abducens nerve palsy without skull fracture or intracranial hematoma — a report of 3 cases and consideration of the mechanism of injury]. *No Shinkei Geka* 4: 963-969, 1976 (Jpn, with Eng abstract)
- 12) Umansky F, Valarezo A, Elidan J: The microsurgical anatomy of the abducens nerve in its intracranial course. *Laryngoscope* 102: 1285-1292, 1992
- 13) Yousry I, Camello S, Wiesman M, Schmid UD, Moriggl B, Bruckman H, Yousry AT: Detailed magnetic resonance imaging anatomy of the cisternal segment of the abducens nerve. *J Neurosurg* 91: 276-283, 1999
- 14) Ziyal IM, Özcan OE, Deniz E, Bozkurt G, Ismailoğlu O: Early improvement of bilateral abducens nerve palsies following surgery of an anterior communicating artery aneurysm. *Acta Neurochir (Wien)* 145: 159-161, 2003
- 15) Ziyal IM, Salas E, Wright DC, Sekhar LN: The petrolingual ligament: The anatomy and surgical exposure of the posterolateral landmark of the cavernous sinus. *Acta Neurochir (Wien)* 140: 201-205, 1998
- 16) Ziyal IM, Sekhar LN, Özgen T, Söylemezoğlu F, Alper M, Beşer M: The trigeminal nerve and ganglion: An anatomical, histological and radiological study addressing the transtrigeminal approach. *Surg Neurol* 61: 564-574, 2004

Address reprint requests to: I. M. Ziyal, M.D., Susam Sokak, Yuvam Apt, 20/4, Cihangir, İstanbul, Turkey.
e-mail: ibrahimziyal@yahoo.com