



Case Report

# Microvascular decompression for abducens nerve palsy due to neurovascular compression from both the vertebral artery and anterior inferior cerebellar artery: A case report

Satoshi Miyamoto, Masahide Matsuda, Eiichi Ishikawa, Akira Matsumura

Department of Neurosurgery, University of Tsukuba, Tsukuba, Ibaraki, Japan.

E-mail: Satoshi Miyamoto - satomiya00@gmail.com; \*Masahide Matsuda - m-matsuda@md.tsukuba.ac.jp; Eiichi Ishikawa - e-ishikawa@md.tsukuba.ac.jp; Akira Matsumura - a-matsumur@md.tsukuba.ac.jp



**\*Corresponding author:**

Masahide Matsuda,  
Department of Neurosurgery,  
University of Tsukuba, 1-1-1  
Tennodai, Tsukuba-305-8575,  
Ibaraki, Japan.

[m-matsuda@md.tsukuba.ac.jp](mailto:m-matsuda@md.tsukuba.ac.jp)

Received : 10 March 2020

Accepted : 31 July 2020

Published : 15 August 2020

DOI

10.25259/SNI\_94\_2020

Quick Response Code:



## ABSTRACT

**Background:** Neurovascular compression is an extremely rare etiology of isolated abducens nerve palsy. We describe a successfully treated case of isolated abducens nerve palsy due to sandwich-type compression by the vertebral artery (VA) and anterior inferior cerebellar artery (AICA).

**Case Description:** A 30-year-old man presented with a 6-month history of horizontal diplopia without other symptoms. Magnetic resonance imaging (MRI) demonstrated pinching of the left abducens nerve between the elongated left VA and left AICA. MRI showed no abnormal findings in the brainstem, cavernous sinus, or orbit. Surgery was performed using a standard lateral suboccipital approach. The abducens nerve was found to be severely compressed from both sides by the VA and AICA, with marked indentation. First, the VA was transposed and fixed to the dura mater of the petrous bone using a Teflon sling with the dripping of fibrin glue. Next, because of limited mobilization due to penetration of the AICA into the nerve, the AICA transfixing the nerve was attached to the pons with Teflon felt and fibrin glue to move the AICA away from the main trunk of the abducens nerve. The abducens nerve palsy gradually improved and eventually resolved by 4 months after the operation.

**Conclusion:** When an elongated vertebrobasilar artery is identified as the offending vessel on high-resolution MRI, microvascular decompression can be carefully considered as a treatment option for patients with isolated abducens nerve palsy.

**Keywords:** Abducens nerve palsy, Anterior inferior cerebellar artery, Microvascular decompression, Neurovascular compression, Vertebral artery

## INTRODUCTION

Isolated abducens nerve palsy is the most common ocular motor cranial neuropathy.<sup>[3]</sup> The etiology of abducens nerve palsy includes brain tumor, head trauma, brainstem ischemia, intracranial hemorrhage, diabetes mellitus, and increased intracranial pressure.<sup>[3,6]</sup> Recent advances in imaging technology have shown neurovascular compression as an extremely rare etiology of isolated abducens nerve palsy.<sup>[1,2,6-8,12-17,19,20,22,24]</sup> In such cases, high-resolution magnetic resonance imaging

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.

©2020 Published by Scientific Scholar on behalf of Surgical Neurology International

(MRI) such as 3D MR cisternography demonstrated that the offending vessels were elongated vertebrobasilar arteries or the anterior inferior cerebellar artery (AICA).<sup>[1,2,8,13,15,17,19,20,22]</sup> Due to the rarity of this entity, the natural history, and adequate treatment strategy remain to be determined.

Here, we present a case of isolated abducens nerve palsy due to sandwich-type neurovascular compression by the vertebral artery (VA) and AICA, which was successfully treated with microvascular decompression (MVD). In this report, we discuss the surgical indication and strategy for abducens nerve palsy due to neurovascular compression.

## CASE REPORT

A 30-year-old man presented with a 6-month history of horizontal diplopia without other symptoms. He was diagnosed with left-sided abducens nerve palsy by an ophthalmologist and referred to our hospital for further investigation. Other than bronchial asthma, his medical history was not significant. Neurological examination revealed left abducens nerve palsy without signs of impairment of any other cerebral nerves. His visual acuity was 1.2 on the right side and 1.0 on the left side. Laboratory test results, including HbA1c, C-reactive protein, and erythrocyte sedimentation rate, were normal. MRI with high-resolution T2-weighted imaging driven equilibrium radiofrequency reset pulse (T2WI-DRIVE) sequence showed pinching of the left abducens nerve between the elongated left VA and left AICA [Figure 1a–c]. MRI showed no abnormal findings in the brainstem, cavernous sinus, or orbit. Based on these MRI findings, sandwich-type neurovascular compression was thought to be the cause of the abducens nerve palsy.

Because his symptoms did not improve spontaneously in 6 months, we decided to perform MVD for this patient. Surgery was performed using a standard lateral suboccipital approach. After the dural incision, the cerebellomedullary cistern was

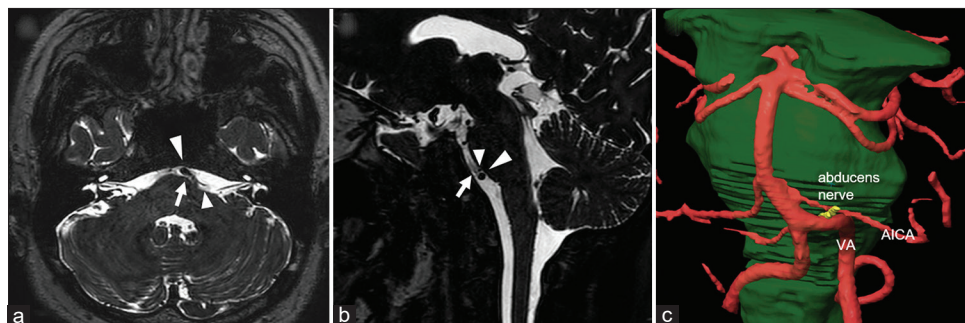
opened to release cerebrospinal fluid and allow sufficient cerebellar relaxation. The arachnoid membrane just above the lower cranial nerves was dissected. The lower cranial nerves were further dissected free from the choroid plexus to enable a clear view of the abducens nerve. The abducens nerve was found to be severely compressed from both sides by the VA and AICA [Figure 2a]. Severe indentation of the abducens nerve was observed after moving the VA away from the abducens nerve [Figure 2b]. The VA was first transposed and fixed to the dura mater of the petrous bone using a Teflon sling with the dripping of fibrin glue. Next, when we tried to mobilize the AICA toward the petrous bone, the AICA was found to penetrate the abducens nerve [Figure 2c]. Because this penetration limited mobilization of the AICA toward the petrous bone, the AICA was attached to the pons with Teflon felt and fibrin glue to move it away from the main trunk of the abducens nerve. The neurovascular compression of the abducens nerve was resolved after these procedures [Figure 2d].

Postoperatively, the patient presented transient dysphagia, presumably due to intraoperative retraction of the lower cranial nerves, which recovered after a few weeks. MRI demonstrated the disappearance of the neurovascular conflict of the abducens nerve with the VA and AICA [Figure 3]. The abducens nerve palsy gradually improved and eventually resolved 4 months after the operation.

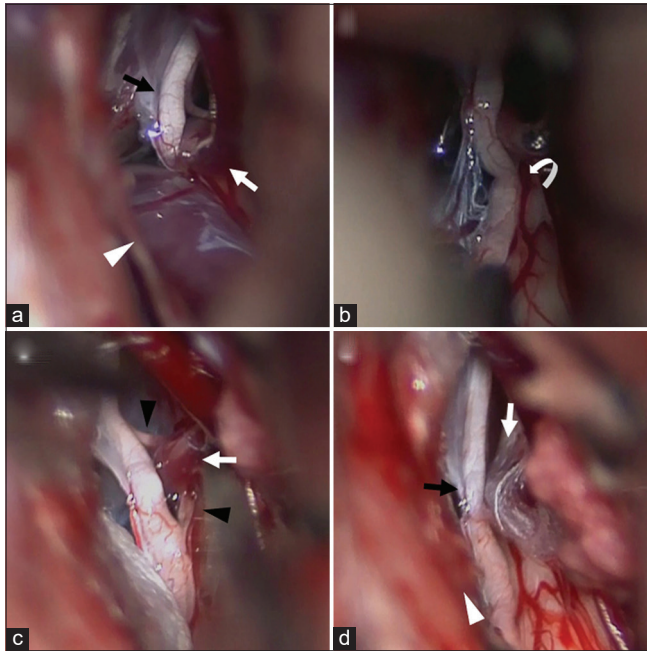
## DISCUSSION

### Offending arteries and outcome of treatments

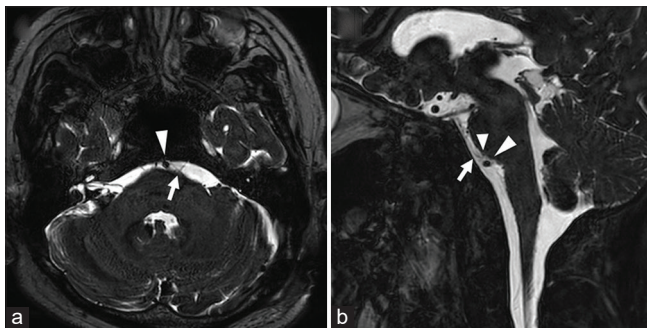
To the best of our knowledge, 15 reports (16 cases) of isolated abducens nerve palsy due to neurovascular compression have been described in the literature [Table 1].<sup>[1,2,6-8,12-17,19,20,22,24]</sup> In these previous reports as well as our report, the offending vessels were identified to be the basilar artery (BA) in seven patients (41.2%), VA in six patients (35.3%), AICA in two patients (11.8%), both the BA and AICA in one patient



**Figure 1:** Preoperative magnetic resonance imaging. Preoperative axial T2-weighted imaging driven equilibrium radiofrequency reset pulse (T2WI-DRIVE) (a) and sagittal T2WI-DRIVE (b) demonstrate sandwich-type neurovascular compression of the abducens nerve by the vertebral artery (VA) and anterior inferior cerebellar artery (AICA). A three-dimensional (3D) MR fusion image (c) shows pinching of the abducens nerve between the elongated VA and AICA. Arrows indicate the abducens nerve. Large arrowheads indicate the VA. Small arrowheads indicate the AICA.



**Figure 2:** Intraoperative photograph. (a) An intraoperative photograph reveals that the abducens nerve was pinched between the VA and AICA. (b) An intraoperative photograph shows a severe indentation of the abducens nerve. (c) An intraoperative photograph demonstrates penetration of the abducens nerve by the AICA. (d) An intraoperative photograph shows that the abducens nerve was released from neurovascular compression by the VA and AICA. Black arrows indicate the main trunk of the abducens nerve. White arrowheads indicate the VA. White arrows indicate the AICA. The white curved arrow indicates the indentation of the abducens nerve. Black arrowheads indicate the small nerve fiber of the abducens nerve.



**Figure 3:** Postoperative magnetic resonance imaging. Postoperative axial T2-weighted imaging driven equilibrium radiofrequency reset pulse (T2WI-DRIVE) (a) and sagittal T2WI-DRIVE (b) show disappearance of neurovascular compression of the abducens nerve by the VA and AICA. Arrows indicate the abducens nerve. Large arrowheads indicate the VA. Small arrowhead indicates the AICA.

(5.9%), and both the VA and AICA in one patient (5.9%). Vertebrobasilar arteries are the offending arteries in 88.2% of all cases, if cases in which two arteries were involved are included. Among the reports in which the outcome was

described, the conservative observation was chosen in five patients, antihypertensive drug therapy was prescribed in one patient, medial rectus recession was performed in one patient, and MVD was performed in only three patients. As for the outcome following treatment, all MVD cases resulted in full recovery (3/3, 100%).<sup>[2,22]</sup> On the other hand, only one of the observed cases showed slight improvement (1/5, 20%), and no improvement was reported in the other four cases.<sup>[1,6,7,14,17]</sup>

### Surgical indication

Due to the small number of reported cases of isolated abducens nerve palsy, particularly in surgically treated cases, determining the surgical indication is difficult. For isolated abducens nerve palsy of unknown origin, the spontaneous recovery rate was about 74% by 6 months.<sup>[9]</sup> Spontaneous recovery rates over 6 months for isolated abducens nerve palsy due to various etiologies were 88% from trauma, 62% from vasculopathy, and 40% from neoplastic causes.<sup>[3]</sup> On the other hand, as described above, the spontaneous recovery rate for isolated abducens nerve palsy due to neurovascular compression is presumably quite low. Therefore, treatment intervention is worth considering for cases of isolated abducens nerve palsy due to neurovascular compression. Furthermore, based on the fact that the average time until recovery was 2.4 months and 94% of cured patients had recovered in 6 months, treatment intervention should be considered for patients whose symptoms past over 6 months.

Neurovascular compression observed on MRI does not always cause symptoms. A previous study using detailed MRI revealed that the abducens nerve contacts the AICA in 76.6% of asymptomatic people.<sup>[23]</sup> This suggests that some cases with isolated abducens nerve palsy presumably due to AICA compression possibly include idiopathic cases that are not good candidates for treatment with MVD. On the other hand, a previous study disclosed that the contact rate of the BA or VA with the abducens nerve is much less than that of the AICA.<sup>[23]</sup> In the previous two cases of isolated abducens nerve palsy that were successfully treated with MVD, the offending vessels were the dolichoectatic BA or elongated VA.<sup>[2,22]</sup> In the present case, the abducens nerve was compressed from both sides by an elongated VA and AICA. Notably, multiple offending vessels, including those that create sandwich-type compression, are related to severe compression and severe symptoms in cases of hemifacial spasm, suggesting a close relationship between multiple offending vessels and pathogenesis.<sup>[11]</sup> Taken together with the characteristics of the offending vessels in these three successfully treated cases, MVD is the preferred treatment option for cases of isolated abducens nerve palsy with severe compression by the dolichoectatic BA or elongated VA, particularly in cases with sandwich-type compression including the BA or VA. On the other hand, whether to

**Table 1:** Summary of reported cases of abducens nerve palsy due to neurovascular compression

Author	Year	Age (years)	Sex	Offending artery	Treatment	Outcome	Time elapsed until the outcome
Smoker et al.	1986	59	M	VA	ND	ND	-
Ohtsuka et al.	1996	46	M	VA	Observation	Unchanged	1 year
Narai et al.	2000	47	M	VA	ND	ND	-
Ohhashi et al.	2001	71	F	BA	Antihypertensive drug	Mostly resolved	1 week
Goldenberg-Cohen et al.	2004	65	M	BA	Observation	Unchanged	4 years
Giray et al.	2005	53	M	VA	Observation	Unchanged	6 months
Zhu et al.	2005	68	M	VA	Medial rectus recession	Orthophoria, free of diplopia	-
Ridder et al.	2007	56	M	BA	MVD	Completely resolved	a few days
Sandvand et al.	2008	38	M	AICA	Prism glasses	ND	-
Kato et al.	2010	50	M	BA and AICA	Observation	ND	-
Taniguchi et al.	2011	75	M	bilateral AICA	Observation	Slightly improved	4 months
Tsai et al.	2011	11	M	BA	ND	ND	-
Tsai et al.	2011	52	M	BA	ND	ND	-
Tuzcu et al.	2013	9	F	BA	ND	ND	-
Yamazaki et al.	2015	46	M	VA	MVD	Completely resolved	3 months
Arishima et al.	2017	74	M	BA	Observation	Recurrence after slight improvement	ND
Present case		30	M	VA and AICA	MVD	Completely resolved	4 months

VA: vertebral artery, BA: basilar artery, AICA: anterior inferior cerebellar artery, MVD: microvascular decompression, ND: not determined

recommend MVD in cases in which the AICA is suspected to be the offending vessel, that is, still a matter of debate.

### Operation

The abducens nerve emerges near the midline at the pontomedullary junction. The nerve then ascends in a rostral and lateral direction toward the clivus through the most caudomedial part of the cerebellopontine cistern<sup>[21]</sup>. Based on the anatomical location of the abducens nerve, which courses deeper than the trigeminal nerve or facial nerve, surgical manipulation around the abducens nerve is considered to be difficult compared to surgery for trigeminal neuralgia or hemifacial spasm. In the previous reports, surgery was less frequently proposed for isolated abducens nerve palsy due to neurovascular compression because of this technical complexity and because the risks are thought to outweigh the benefits.<sup>[7,8,15]</sup> However, a thorough dissection of the arachnoid tissue around the lower cranial nerves and the choroid plexus provides an adequate surgical space to perform transposition of the VA and AICA from the abducens nerve through a standard lateral suboccipital approach. The standard microvascular decompression technique plus further dissection of the deep-seated arachnoid tissue will enable simple and less invasive surgery for neurovascular compression of the abducens nerve.

In the present case, the AICA penetrated the abducens nerve, which made mobilization of the AICA away from the abducens

nerve difficult. The previous anatomical studies have revealed that the AICA or its main branches pierce the abducens nerve in 11.4–25.0% of cases.<sup>[4,10]</sup> Several surgical techniques for transposition of the transfixing artery from the nerve have been reported such as partial rhizotomy longitudinal to the axis of the nerve to move the artery toward the periphery, partial rhizotomy lateral to a rather small portion of the nerve to free the artery, and wrapping of the artery using a Teflon sponge.<sup>[5,18]</sup> In the present case, the AICA coursed through a loop formed between the main trunk of the nerve and the small nerve fiber, allowing only limited mobilization of the AICA toward the petrous bone. To diminish compression of the main trunk of the abducens nerve, we moved the AICA away from the main trunk of the nerve and attached it to the pons with Teflon felt and fibrin glue.

### CONCLUSION

Neurovascular compression, although rare, should be considered a possible underlying cause of isolated abducens nerve palsy. When an elongated vertebrobasilar artery is identified as the offending vessel on high-resolution MRI in a patient whose isolated abducens nerve palsy does not spontaneously recover, MVD can be carefully considered as one of the treatment options.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

## REFERENCES

- Arishima H, Kikuta KI. Magnetic resonance imaging findings of isolated abducent nerve palsy induced by vascular compression of vertebrobasilar dolichoectasia. *J Neurosci Rural Pract* 2017;8:124-7.
- De Ridder D, Menovsky T. Neurovascular compression of the abducent nerve causing abducent palsy treated by microvascular decompression. Case report. *J Neurosurg* 2007;107:1231-4.
- Elder C, Hainline C, Galetta SL, Balcer LJ, Rucker JC. Isolated abducens nerve palsy: Update on evaluation and diagnosis. *Curr Neurol Neurosci Rep* 2016;16:69.
- Esmer AF, Sen T, Bilecenoglu B, Tuccar E, Uz A, Karahan ST. Neurovascular relationship between abducens nerve and anterior inferior cerebellar artery. *Folia Morphol (Warsz)* 2010;69:201-3.
- Feng BH, Zheng XS, Wang XH, Ying TT, Yang M, Tang YD, *et al.* Management of vessels passing through the facial nerve in the treatment of hemifacial spasm. *Acta Neurochir (Wien)* 2015;157:1935-40; discussion 1940.
- Giray S, Pelit A, Kizilkilic O, Karatas M. Isolated abducens nerve palsy caused by contralateral vertebral artery dolichoectasia. *Neurol India* 2005;53:246-7.
- Goldenberg-Cohen N, Miller NR. Noninvasive neuroimaging of basilar artery dolichoectasia in a patient with an isolated abducens nerve paresis. *Am J Ophthalmol* 2004;137:365-7.
- Kato H, Nakajima M, Ohnaka Y, Ishihara K, Kawamura M. Recurrent abducens nerve palsy associated with neurovascular compression. *J Neurol Sci* 2010;295:135-6.
- King AJ, Stacey E, Stephenson G, Trimble RB. Spontaneous recovery rates for unilateral sixth nerve palsies. *Eye (Lond)* 1995;9:476-8.
- Marinkovic SV, Gibo H, Stimec B. The neurovascular relationships and the blood supply of the abducent nerve: Surgical anatomy of its cisternal segment. *Neurosurgery* 1994;34:1017-26; discussion 1026.
- Na BS, Cho JW, Park K, Kwon S, Kim YS, Kim JS, *et al.* Severe hemifacial spasm is a predictor of severe indentation and facial palsy after microdecompression surgery. *J Clin Neurol* 2018;14:303-9.
- Narai H, Manabe Y, Deguchi K, Iwatsuki K, Sakai K, Abe K. Isolated abducens nerve palsy caused by vascular compression. *Neurology* 2000;55:453-4.
- Ohhashi G, Irie K, Tani S, Ogawa T, Abe T, Hata Y. Isolated abducens nerve palsy caused by the compression of the basilar artery: A case report. *No To Shinkei* 2001;53:69-72.
- Ohtsuka K, Sone A, Igarashi Y, Akiba H, Sakata M. Vascular compressive abducens nerve palsy disclosed by magnetic resonance imaging. *Am J Ophthalmol* 1996;122:416-9.
- Sandvand KA, Ringstad G, Kerty E. Periodic abducens nerve palsy in adults caused by neurovascular compression. *J Neurol Neurosurg Psychiatry* 2008;79:100-2.
- Smoker WR, Corbett JJ, Gentry LR, Keyes WD, Price MJ, McKusker S. High-resolution computed tomography of the basilar artery: 2. Vertebrobasilar dolichoectasia: Clinical-pathologic correlation and review. *AJNR Am J Neuroradiol* 1986;7:61-72.
- Taniguchi A, Ii Y, Kobayashi H, Maeda M, Tomimoto H. Bilateral abducens nerve palsy by compression from bilateral anterior inferior cerebellar artery. *J Neurol* 2011;258:2271-3.
- Tashiro H, Kondo A, Aoyama I, Nin K, Shimotake K, Nishioka T, *et al.* Trigeminal neuralgia caused by compression from arteries transfixing the nerve. Report of three cases. *J Neurosurg* 1991;75:783-6.
- Tsai TH, Demer JL. Nonaneurysmal cranial nerve compression as cause of neuropathic strabismus: Evidence from high-resolution magnetic resonance imaging. *Am J Ophthalmol* 2011;152:1067-73.e2.
- Tuzcu EA, Bayarogullari H, Coskun M, Yilmaz C, Ilhan N, Daglioglu MC, *et al.* Bilateral abducens paralysis secondary to compression of abducens nerve roots by vertebrobasilar dolichoectasia. *Neuroophthalmology* 2013;37:254-6.
- Umansky F, Valarezo A, Elidan J. The microsurgical anatomy of the abducens nerve in its intracranial course. *Laryngoscope* 1992;102:1285-92.
- Yamazaki T, Yamamoto T, Hatayama T, Zaboronok A, Ishikawa E, Akutsu H, *et al.* Abducent nerve palsy treated by microvascular decompression: A case report and review of the literature. *Acta Neurochir (Wien)* 2015;157:1801-5.
- Yousry I, Camelio S, Wiesmann M, Schmid UD, Moriggl B, Bruckmann H, *et al.* Detailed magnetic resonance imaging anatomy of the cisternal segment of the abducent nerve: Dorello's canal and neurovascular relationships and landmarks. *J Neurosurg* 1999;91:276-83.
- Zhu Y, Thulborn K, Curnyn K, Goodwin J. Sixth cranial nerve palsy caused by compression from a dolichoectatic vertebral artery. *J Neuroophthalmol* 2005;25:134-5.

**How to cite this article:** Miyamoto S, Matsuda M, Ishikawa E, Matsumura A. Microvascular decompression for abducens nerve palsy due to neurovascular compression from both the vertebral artery and anterior inferior cerebellar artery: A case report. *Surg Neurol Int* 2020;11:242.