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

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INTRODUCTION

Isolated abducens nerve palsy is the most common ocular motor cranial neuropathy.[3] The etiology of abducens nerve palsy includes brain tumor, head trauma, brainstem ischemia, intracranial hemorrhage, diabetes mellitus, and increased intracranial pressure.[3,6] Recent advances in imaging technology have shown neurovascular compression as an extremely rare etiology of isolated abducens nerve palsy.[1,2,6,8,12-17,19,20,22,24] In such cases, high-resolution magnetic resonance imaging
(MRI) such as 3D MR cisternography demonstrated that the offending vessels were elongated vertebrobasilar arteries or the anterior inferior cerebellar artery (AICA).\[^{1,2,8,13,17,19,20,22}\] 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].\[^{1,2,6-8,12-17,19,20,22,24}\] 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
As 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%). 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.

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. 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. 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 persist 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. 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. 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. 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. 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

![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.](image1)

![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.](image2)
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[21]. 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.[7,8,15] 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.[4,10] 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.[5,18] 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.

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**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   | VA and AICA      | Observation       | Recurrence after slight improvement | ND                           |
| Present case         | 2019 | 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.
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Conflicts of interest

There are no conflicts of interest.

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