Preoperative three-dimensional multifusion imaging aiding successful microvascular decompression of a cerebellopontine angle lipoma: associated hemifacial spasm. Illustrative case

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BACKGROUND Cerebellopontine angle (CPA) lipoma–associated hemifacial spasm (HFS) is rare. As the removal of CPA lipomas has a high risk of worsening the neurological symptoms, surgical exploration is warranted only in selected patients. Preoperative identification of the lipoma affected site of the facial nerve, and offending artery are crucial for patient selection and successful microvascular decompression (MVD).

OBSERVATIONS Presurgical simulation using three-dimensional (3D) multifusion imaging showed a tiny CPA lipoma wedged between the facial and auditory nerves, as well as an affected facial nerve by the anterior inferior cerebellar artery (AICA) at the cisternal segment. Although a recurrent perforating artery from the AICA anchored the AICA to the lipoma, successful MVD was achieved without lipoma removal.

LESSONS The presurgical simulation using 3D multifusion imaging could identify the CPA lipoma, affected site of the facial nerve, and offending artery. It was helpful for patient selection and successful MVD.

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KEYWORDS cerebellopontine angle lipoma; hemifacial spasm; microvascular decompression; 3D multifusion imaging; chemical shift

Hemifacial spasm (HFS) is mostly caused by vascular compression of the facial nerve at the root exit zone (REZ), and microvascular decompression (MVD) is a well-established treatment.1 Lipomas occurring in the cerebellopontine angle (CPA) are rare, with an incidence of 0.14–0.15% among CPA tumors,2 and have rarely been reported to cause HFS.3,4 Surgery for HFS caused by CPA lipoma has a high risk of worsening the neurological symptoms on removal of the lipoma, with an inherently strong affinity for the nerves and blood vessels to form a hamartomatous lesion. A current literature review supports conservative management of CPA lipomas. Surgical exploration is warranted only in selected patients for whom clinical symptoms have become intractable despite medical or rehabilitative treatment. In these cases, MVD is proposed without lipoma resection.4 We report a rare case of HFS associated with a tiny CPA lipoma. The culprit artery was the AICA, and the vascular compression site of the facial nerve was the cisternal segment, which was not in the lipoma. These could be identified and explored preoperatively on recently introduced presurgical simulation using three-dimensional (3D) multifusion imaging.

Illustrative Case

A 77-year-old woman presented with a history of left HFS that had worsened over 6 years. Fine involuntary muscle contractions were observed in the left orbicularis oculi muscle. Electrophysiology showed an abnormal muscle response (AMR) in the left orbicularis oculi and orbicularis oris muscles. Magnetic resonance imaging (MRI) showed no obvious vessel compression in the REZ of the facial nerve, and the AICA ran between the left facial and auditory

ABBREVIATIONS 3D = three-dimensional; AICA = anterior inferior cerebellar artery; AMR = abnormal muscle response; CISS = constructive interference in steady state; CPA = cerebellopontine angle; CT = computed tomography; HFS = hemifacial spasm; MRA = magnetic resonance angiography; MRI = magnetic resonance imaging; MVD = microvascular decompression; REZ = root exit zone; RPA = recurrent perforating artery; TOF = time of flight.

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nerves. A 2.5-mm mass with hypoattenuation on computed tomography (CT) and hyperintensity on T1-weighted MRI was found wedged between the left facial and auditory nerves (Fig. 1A and B). Constructive interference in steady state (CISS) images and a time-of-flight magnetic resonance angiography (TOF-MRA) source image revealed a hypointense rim of the mass (Fig. 1C and D). Based on these findings, the small mass was diagnosed as a lipoma. Preoperative simulation was performed with 3D multifusion imaging using the commercially available software Geomagic Freeform 2021 (3D Systems Corporation), as previously described elsewhere, and showed no vascular compression or distortion of the facial nerve by the tumor at the REZ of the left facial nerve and the left AICA running between the facial and auditory nerves (Fig. 2A). The AICA was anchored by its small RPA involved in the lipoma that tightly adhered to the proximal facial nerve. Although standard MVD could not be performed, the AMR disappeared after moving the AICA from the facial nerve. In patients with HFS caused by a CPA lipoma, the offending artery and/or the affected facial nerve are involved in the lipoma. In our case, however, there was no offending blood vessel at the REZ, and the facial nerve was not distorted in the CPA lipoma. Such a case of CPA lipoma–related HFS could not be found in the literature.

Lessons

CPA lipomas account for approximately 10% of intracranial lipomas. There are no characteristic symptoms of CPA lipomas; however, they might be present in patients with cochlear and/or vestibular symptoms. Facial neurological symptoms are present in 9% of cases, with only a few case reports on HFS. CPA lipomas develop with abnormal differentiation of primary meninges and have a strong affinity for nerves and blood vessels congenitally. Unlike neoplastic lesions, CPA lipomas rarely enlarge, and removal of lipomas has a high risk of worsening neurological symptoms. Therefore, it is important to differentiate them from other CPA tumors. Reflecting lipid, imaging findings of lipomas are characterized by hypointensity on CT, hyperintensity on T1-weighted imaging, and decreased signal intensity with fat suppression. Thin-slice CISS and TOF-MRA source images are useful for depicting the facial nerve and culprit artery in HFS. These imaging techniques with gradient-echo sequence show chemical shift artifacts around the lipoma as a characteristic dark rim caused by fat–water phase cancellation in out-of-phase at the lipid–water interface. Both imaging methods are useful for differentiating lipomas from other CPA tumors on MRI. A tiny lipoma, such as in our case, might be easily overlooked on CT, although the characteristic dark rim indicates a lipoma preoperatively.

HFS is generally thought to be caused by pulsatile vascular compression at the partially demyelinated facial nerve, and its degeneration. The central myelin sheath is considered more vulnerable to external force than the peripheral myelin sheath. A typical compression site is, therefore, the REZ of the facial nerve, where the central myelin sheath transits to the peripheral myelin sheath. However, the pathomechanism of HFS has not been fully elucidated. There are a few reports of HFS caused by vascular compression at the distal portion of the facial nerve.

In patients with HFS caused by a CPA lipoma, the offending artery and/or the affected facial nerve are involved in the lipoma, and removal of CPA lipomas has a high risk of aggravating the neurological symptoms on removal of the lipoma. In our case, however, there was no offending blood vessel at the REZ, and the facial nerve was not distorted in the CPA lipoma, whereas the AICA compressed the facial nerve at its cisternal segment apart from the lipoma. Therefore, the suggested cause of the HFS was the vascular compression of the facial nerve at the cisternal segment by the AICA, not the lipoma itself. These findings could be demonstrated on the presurgical simulation and identified in the MVD. The cause of the HFS was confirmed electrophysiologically because the AMR disappeared just after moving the AICA from the cisternal segment.
Finally, HFS could be resolved with successful MVD, although standard MVD could not be performed, as the culprit AICA anchored by its small RPA was involved in the CPA lipoma tightly adhering to the facial nerve. In our case, the tiny CPA lipoma was not the direct cause, but it did play a role in the pathomechanism of HFS. We could not find a similar CPA lipoma–associated HFS in the literature.

Identifying the culprit artery and evaluating 3D anatomical structures in the microsurgical field are helpful for successful MVD surgery. The 3D multifusion imaging obtained from MRI and CT data provides detailed and variable microsurgical anatomy and intraoperative microscopic views. Presurgical simulation in patients with a CPA lipoma using 3D multifusion imaging could demonstrate the culprit artery path, the affected site of the facial nerve, and the lipoma itself, allowing appropriate patient selection and suitable decompression procedures to be performed during surgery for HFS.

The quality of the 3D multifusion imaging depends on the resolution of source images and thickness of the structures themselves. The perforating arteries and the small branches may not be visible.

**FIG. 2.** Presurgical simulation on 3D multifusion imaging (A, B, and E) and intraoperative findings (C, D, and F). A tiny lipoma and surrounding structures are observed clearly on 3D multifusion imaging (A). The lipoma exists between the facial and auditory nerves (B). The AICA and its recurrent perforating branch run (arrowhead) between the facial and auditory nerves (C and D). The AICA compresses the facial nerve at its bend (asterisk) in the cisternal segment toward the brainstem (B–E). The AICA is lifted and straightened toward the cerebellum (white arrow) to decompress the facial nerve (E and F). Black squares indicate the same point (E and F). cbll = cerebellum; L = lipoma; V = cranial nerve V (trigeminal nerve); VI = cranial nerve VI (abducens nerve); VII = cranial nerve VII (facial nerve); VIII = cranial nerve VIII (acoustic nerve).

**FIG. 3.** Intraoperative AMR from the mentalis muscle. The AMR disappeared after MVD.
In our case, the tiny lipoma, the AICA passing between the facial and auditory nerves, and the compressed site of the facial nerve by the AICA could be identified on presurgical simulation using 3D multifusion imaging, but the small RPA could not be visualized. It is necessary to be mindful that CPA lipomas have a strong affinity for the nerves and blood vessels as a hamartomatous lesion. The small blood vessels anchoring to the offending vessel and lipoma that tightly adhered to the nerve could not be visualized during preoperative simulation, and careful manipulation during MVD is necessary.

CPA lipomas are characterized by a dark rim on CISS and TOF-MRA source images. Although CPA lipomas are rarely associated with HFS, even small lipomas can interfere with culprit artery decompression because they adhere to the nerve tightly and involve a small branch from the culprit artery as an anchor to the lipoma. Thus, 3D multifusion imaging would be helpful for demonstrating the culprit artery path and compression site on the facial nerve in patients with lipoma. Presurgical simulation could aid patient selection and suggest the appropriate direction for safer MVD in patients with CPA lipoma–associated HFS.

References

Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions