Quantitative Study of Posterior Fossa Crowdedness in Hemifacial Spasm

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■ OBJECTIVE: **To quantitatively study the degree of posterior fossa crowdedness (PFC) in patients with hemifacial spasm (HFS) and to further investigate whether overcrowding in posterior fossa affects the efficacy and safety of microvascular decompression.**

■ METHODS: **We conducted a prospective case-control study of patients diagnosed with HFS and sex- and age-matched healthy control patients. All subjects underwent high-resolution, 3-dimensional magnetic resonance imaging, and posterior fossa crowdedness index (PFCI) and cerebrospinal fluid volume (CSFV) were measured. Patients with HFS underwent primary microvascular decompression and long-term follow-up. Associations of PFCI and other factors with operative outcomes and complications were analyzed.**

■ RESULTS: **The study enrolled 153 subjects: 102 patients and 51 control subjects. Compared with control subjects, patients had a more PFC (PFCI: 83.2% vs. 80.2%; $P = 0.005$) and smaller posterior fossa CSFV (16,248.0 mm^3 vs. 20,054.0 mm^3; $P = 0.001$). The mean effective space of posterior fossa cerebrospinal fluid in patients with HFS was 11.8% smaller than in control subjects ($P = 0.004$). Compared with men, women showed larger PFCI (83.6% vs. 82.2%; $P = 0.012$) and smaller PF CSFV (16,027.5 mm^3 vs. 17,299.5 mm^3; $P = 0.009$). Sixty-one patients (59.8%) were spasm-free immediately postoperatively, and 95 (93.1%) were spasm-free at follow-up. Complication rates were 9.8% in the short term, and 2.9% at follow-up. Lower PFCI (odds ratio [OR] 0.63; $P = 0.019$) and severe indention (OR 1.41; $P = 0.027$) were significantly associated with better short-term outcomes. Greater PFCI (OR 2.05, $P = 0.008$) was associated with greater early complication incidence.**

■ CONCLUSION: **Patients with HFS had more PFC. PFC potentially leads to cranial nerve and vascular structure crowding, which may increase HFS risk. PFC was significantly associated with poor short-term outcomes and greater incidence of early complications but not long-term outcomes and complications.**

INTRODUCTION

Hemifacial spasm (HFS) generally is believed to be caused by vascular compression of the facial nerve root exit zone (REZ). Microvascular decompression (MVD) leads to the elimination of neurovascular conflict (NVC) and successful relief of spasms, strongly supporting this theory (3, 20, 26, 28, 29). NVC, however, also has been demonstrated in healthy subjects (1, 26), and it is also puzzling why there is a dominance in women (prevalence of 14.5/100,000 among women and 7.4/100,000 among men) (16), whereas women reportedly have more posterior fossa crowdedness (PFC) than men (13).

Although epidemiologic studies performed in Asia remain scarce, most neurologists have observed that HFS seems more common among Asian patients (26); however, structural differences of the posterior fossa and temporal bone between Asian and white populations have been reported (14).

Key words
- Hemifacial spasm
- Microvascular decompression
- Neurovascular conflict
- Pathogenesis
- Posterior fossa crowdedness
- Prognosis

Abbreviations and Acronyms
AMR: Abnormal muscle response
CSF: Cerebrospinal fluid
CSFV: Cerebrospinal fluid volume
HBV: Hindbrain volume
HFS: Hemifacial spasm
MRI: Magnetic resonance imaging
MVD: Microvascular decompression
NVC: Neurovascular conflict
OR: Odds ratio
PFC: Posterior fossa crowdedness
PFCI: Posterior fossa crowdedness index
PFV: Posterior fossa volume
REZ: Root exit zone

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Furthermore, several cases of HFS have been associated with cerebellar hematoma (8), cerebellar gangliocytoma (15), Paget disease (6), and hydrocephalus (31), suggesting that narrowing of the posterior fossa caused by these abnormalities may increase the chance of vascular compression of the facial nerve.

These observations led us to hypothesize that PFC may be a risk factor for HFS. Here, we designed a prospective, case-control study to test this hypothesis by measuring and comparing the posterior fossa crowdedness index (PFCI) and posterior fossa cerebrospinal fluid volume (CSFV) in patients with HFS and healthy control subjects. Additionally, in clinical practice, sometimes we find that an PFC increases the difficulty of the procedure and prolongs operative time. However, the literature contains little information on whether the PFC objectively influences operative efficacy and safety. Thus, we further analyzed the relationship between the degree of PFC and operative efficacy and complications by long-term follow-up.

METHODS

Patients and Control Subjects

The study included patients clinically diagnosed with HFS who underwent primary MVD in the neurosurgery department of West China Hospital from April 2011 to April 2012. Patients with symptomatic HFS secondary to schwannoma, aneurysm, Chiari malformation, hydrocephalus, etc, were excluded. The following subject characteristics were recorded: age; sex; symptom duration; operation date; surgical findings, including the compressing vessels, REZ indentation, and abnormal muscle response (AMR) resolution (i.e., AMR disappeared completely or amplitude reduced greater than 90%); underlying diseases (e.g., hypertension, diabetes, renal insufficiency, etc); follow-up duration; operative efficacy; and complications. Control subjects were healthy age- and sex-matched volunteers who provided written informed consent. The study design was approved by the West China Hospital Ethics Committee.

Magnetic Resonance Imaging

All subjects underwent a standard magnetic resonance imaging (MRI) protocol (Philips Achieva, 3.0 T; Philips Health, Andover, Massachusetts, USA), including conventional axial T1-weighted imaging, axial T2-weighted imaging, and a special 3-dimensional sequence focused over the posterior fossa: 3D-T2-DRIVE (TR, 2000 ms; TE, 200 ms; matrix, 256 × 168; acquisition voxel measurement phase slice, 0.59/0.89/1.60 mm; reconstruction voxel measurement phase slice, 0.29/0.29/0.80 mm; thickness, 0.5 mm; 75 slices). The image was jointly interpreted by neurosurgeons and neuroradiologists. Subjects with structural abnormalities were excluded.

Measurements

Posterior fossa volume (PFV) was defined as the space encircled by tentorium cerebelli, occipital bone, clivus, and foramen magnum. Hindbrain volume (HBV) was defined by encircling the cerebellar tissue inside the posterior fossa area, including the fourth ventricle. Posterior fossa CSFV was defined as the space between the posterior fossa endocranium and the hindbrain outline. The cerebrospinal fluid (CSF) space included cranial nerves and vasculature. The measurement was sampled on 40 slices over a total range of 20 mm, with the slab midpoint centered over the pontomedullary sulcus. MRI dates were transferred to a personal computer, and 3D-Slicer software (3.6.3 version; www.slicer.org.) was used for segmentation and measurement (Figure 1). All work was performed by a radiologist blinded to group and experienced with the software to avoid interobserver variability. PFCI was calculated as the volume ratio of HBV to PFV.

Surgical Techniques

MVD was performed using an infratentorial lateral supracerebellar approach. With the patient in a lateral position, a 6- to 8-cm retroauricular straight incision was made. Next, a small bone window craniotomy was performed to expose the transverse and sigmoid sinus edges. The dura is incised in a curvilinear manner, 3–5 mm from the 2 sinuses, and the dural edges are then secured with tenting sutures to widen the exposure. The cisterna magna is opened to drain CSF to provide enough space for gentle cerebellar

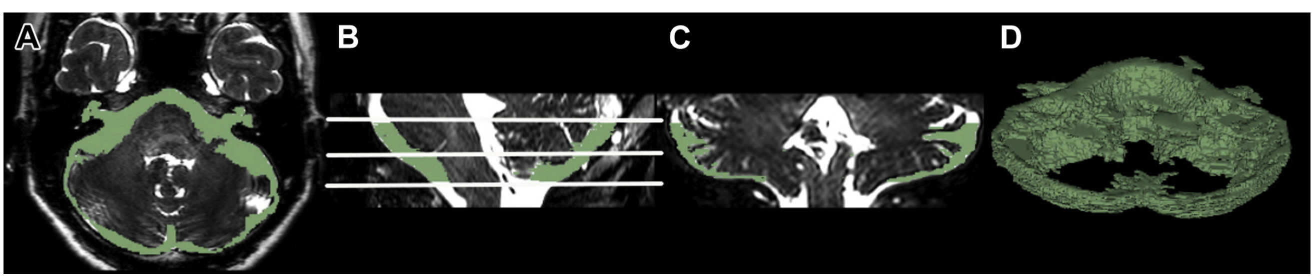

Figure 1. Segmentation and synthesis of posterior fossa cerebrospinal fluid (CSF). Demarcation of the posterior fossa CSF in the axial (**A**), sagittal (**B**), and coronal (**C**) slices (*green areas*). The measurement was sampled on 40 slices over a total range of 20 mm (between the upper and lower two *white lines* in **B**), with the slab midpoint centered over the pontomedullary sulcus (the median line) (**B**). The volume of the posterior fossa CSF was calculated by summation of the volume of each voxel within the manually created mask on each axial section. A 3-dimensional volumetric rendering of the posterior fossa CSF mask was generated (**D**).