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Clinical Study

Side predilections of offending arteries in hemifacial spasm

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ABSTRACT

The side predilections of various offending arteries in hemifacial spasm (HFS) have not been well studied. The relationship between clinical and radiological features of HFS and offending arteries were investigated in the present study. A retrospective analysis of 370 patients who underwent microvascular decompression for HFS was performed. The patients were divided into four groups based on the offending arteries, namely anterior inferior cerebellar artery (AICA), posterior inferior cerebellar artery (PICA), vertebral artery, and multiple offending arteries. Affected side, age at onset, presence of hypertension, and sigmoid sinus area and dominance were compared between groups. The mean age of patients with a left HFS was significantly greater than that of patients with a right HFS ($P = 0.009$). The AICA affected primarily the right side and PICA and multiple offending arteries the left side ($P < 0.001$). Side of sigmoid sinus dominance was significantly different among groups ($P < 0.001$). The offending arteries in HFS may be related to these differences. AICA was associated with right-sided symptoms, younger age at onset, and presence of left dominant sigmoid sinus, while PICA was associated with left-sided symptoms, older age at onset, and smaller right sigmoid sinus area.

1. Introduction

Hemifacial spasm (HFS) is characterized by involuntary unilateral facial muscle contraction [1–3] caused by nuclear hyperexcitability and ephaptic transmission between neighboring axons [4,5]. HFS typically affects middle-aged patients, and tends to involve the left side more frequently or affects the left and right sides equally, which varies between reports [6–11]. Generally, vessels form loops around the facial nerve at its exit zone resulting in neuro-vascular conflict and facial spasm. The vessels typically involved include those originating from the vertebral and basilar arteries or their branches [1,12–14]. HFS may be associated with arterial hypertension (HTN) as HTN may cause atherosclerosis, which can give rise to ectatic vasculature, and subsequent facial nerve compression [3,7,15–17].

In most cases an artery very close to the facial nerve, such as the anterior inferior cerebellar artery (AICA) or the posterior inferior cerebellar artery (PICA), is responsible for the compression. Over time, pulsatile blood flow in these arteries presses against the nerve, with damage to its outer surface. Although several factors have been suggested to cause HFS, predisposing conditions for these vascular changes are not yet fully understood [9,14,18–21]. Furthermore, to our knowledge, side predilection of the various offending arteries has not been well studied. Therefore, we investigated whether the affected side and other HFS characteristics are related to the offending artery. Additionally, a dominant sigmoid sinus, a well-known side predilection in human brain anatomy [22–25], was evaluated as a possible factor predisposing to a side predilection in HFS.

2. Methods

We retrospectively reviewed the medical records of 439 patients who underwent microvascular decompression for HFS between March 2003 and December 2013 at our institutions. Patients were included if they had a diagnosis of primary HFS according to their medical history and typical facial muscle contractions without other positive neurological signs. The exclusion criteria included secondary HFS caused by a tumor or venous compression, atypical HFS, and insufficient MRI or MR angiography data. Age of onset was calculated by subtracting disease duration from age at operation. The systolic and diastolic blood pressures were measured in every patient. HTN was defined as a systolic blood pressure of >140 mmHg, a diastolic pressure of >90 mmHg, or use of antihypertensive therapy at the time of the examination.

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Areas (in mm^2) of the right and left sigmoid sinuses were measured at the level of the internal auditory canal (Fig. 1) using MRI. The area ratio was calculated as area of right sigmoid sinus/area of left sigmoid sinus. Using this area ratio, the dominant sigmoid sinus was categorized as follows: the right sigmoid sinus was dominant if the area ratio was $\geqslant$1.5; the left sigmoid sinus was dominant if the area ratio was $\leqslant$0.67; and the sigmoid sinuses were symmetrical if the area ratio was between 1.5 and 0.67 (Fig. 2) [24].

2.1. Statistics

Statistical analyses were performed using Statistical Package for the Social Sciences (version 19.0.0, IBM, Armonk, NY, USA). Differences in baseline characteristics were compared between right-sided and left-sided HFS using independent sample *t*-test for age, disease duration and sigmoid sinus area, and chi-squared test for sex, HTN and dominant sinus. The patients were divided into four groups based on the offending artery, namely AICA, PICA, vertebral artery (VA) and multiple offending arteries. Baseline characteristics were compared among the groups. Analysis of variance was used for age, duration of disease, and area of both sigmoid sinuses. The chi-squared test was used to compare sigmoid sinus ratios, affected side and presence of HTN. The *post hoc* test was performed using the Fisher's least significant difference test. Furthermore, differences in sigmoid sinus area were compared between right-sided and left-sided HFS in each offending artery group using an independent *t*-test. Unless otherwise indicated, all tests were performed using a two-tailed test, and a P value <0.05 indicated statistical significance.

3. Results

During the study period, 439 patients underwent microvascular decompression. Sixty-nine patients were excluded (25 trigeminal neuralgias, two glossopharyngeal neuralgias, two atypical HFS, two bilateral HFS, 15 non-arterial offenders, 19 imaging studies not adequate, and four reoperations). The surgical outcomes and complications of our patients have been published previously [6,26,27]. Patient characteristics are summarized in Table 1. Notably, the mean age of onset in patients with a left HFS was significantly greater than in patients with a right HFS (P = 0.009). Disease duration and incidence of HTN were not significantly different between right-sided and left-sided HFS patients. Although the right sigmoid sinus area tended to be larger in left-sided HFS than right-sided HFS, this was not statistically significant (P = 0.065). The left sigmoid sinus area was not significantly different between right-sided and left-sided HFS. The dominant sinus proportions were not significantly different between right-sided and left-sided HFS.

The characteristics of the offending artery groups are shown in Table 2. In general, AICA (44.6%) constituted the largest proportion of offending arteries in this study. The affected sides of HFS were significantly different between the groups; AICA affected the right side more than left side and PICA and multiple offending arteries affected the left side more than the right side (P < 0.001). The mean age was significantly different between groups (P = 0.014); mean age of patients with an offending AICA was significantly younger than of patients with offending PICA and VA. Analysis of the dominant sigmoid sinus showed significant differences between the groups (P < 0.001). Twenty-three patients with left dominant sigmoid sinus were found in the AICA group, however, no patient had left dominant sigmoid sinus in the other groups. Disease duration, HTN, and sigmoid sinus area were not significantly different among the groups.

The sigmoid sinus area differences between right-sided and left-sided HFS are shown in Table 3. No significant differences were observed in the AICA and multiple offending arteries groups. However, in the PICA group, the right sigmoid sinuses of patients with left-side HFS were significantly larger than those with right-sided HFS (P = 0.001). This relationship tended to be reversed in the VA group although this did not achieve statistical significance (P = 0.07).

4. Discussion

In the present study, we found several predilections of HFS that varied based on the different offending arteries. Offending AICA tended to cause right-sided symptoms while the other offending arteries caused left-sided symptoms. Age at disease onset was significantly younger in patients with an offending AICA than patients with an offending PICA. Moreover, the proportion of dominant sigmoid sinuses was different between AICA and the other groups; left dominant sigmoid sinuses were found only in patients with an offending AICA and not in patients with other offending arteries. Furthermore, when the PICA was an offending artery in HFS patients, left-sided HFS was associated with a larger right sigmoid sinus area than with right-sided HFS (reciprocal relationship).

The PICA, which arises from the VA, is the most important and largest cerebellar artery [28]. Comparably, the AICA, which arises from the basilar artery rather than the VA, is the smallest cerebellar artery [28]. Accordingly, hemodynamic forces in the VA may differently affect the PICA than the AICA. Continuous hemodynamic stress appears to be a predisposing factor for arterial deformation [16,20], and increased arterial blood flow in the VA may precede new onset of HFS [29]. Therefore, the deformative force produced by background hemodynamic conditions may be different among the offending arteries.

Several conditions may be associated with the development of deformational loops or elongation of these cerebellar arteries. One well-known factor is arterial HTN [7,14–16] especially in elderly people [7,14,20]. Arterial HTN could cause arteries in the cerebellopontine angle to elongate and develop ectasias [16,20,30]. A familial history of HFS is another predisposing factor for HFS [3,9,17,20]. Patients with familial HFS present with similar clinical features to those with sporadic HFS showing left-side dominance [9], a low penetrative autosomal dominant trait [9,20], and the VA is implicated more frequently as the offending artery [17]. Additionally, possible anatomic determinants include the anatomic differences in the posterior fossa of Asian subjects [14], a small infratentorial cisternal volume [18], and occipitovertebral abnormal anatomy [11,12,21].

Several reports have addressed the non-equivalence of clinical characteristics between right-sided and left-sided HFS. Three decades ago, Jannetta et al. [8] proposed neurogenic HTN was caused by vascular compression in the left ventrolateral medulla with the PICA being the dominant offending vessel [8,18,30–32]. Additionally, the right ventrolateral medulla may be a possible location of arterial conflict for neurogenic HTN, but these cases are rarely reported, and the reason for its rarity is unclear [30]. Furthermore, Defazio et al. [15] reported that left-sided HFS was associated with HTN but that right-sided HFS was not. Additionally, in HFS patients with a younger age at onset (under 25 years of age), there was a higher occurrence of right-sided HFS than in older patients [33]. Because arterial deformation generated by long-standing hemodynamic stress is time-dependent [16,20], these studies support the assumption that an occurrence of left-sided HFS is related more to hemodynamic conditions than right-sided HFS. The present