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INTERVENTIONAI DIAGNOSIS AND TREATMENT OF VASCULOGENEIC PULSATILE TINNITUS

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Abstract

Objective To retrospectively study clinical features and diagnostic imaging of vasculogeneic pulsatile tinnitus, and the feasibility and efficacy of transvascular interventional treatment for this condition. **Methods** Data from 82 cases of arterial or venous pulsatile tinnitus were reviewed. DSA characteristics and possible pathophysiological mechanisms of pulsatile tinnitus in these cases were studied. Diagnoses in this group included intracranial arterovenous fistula (AVF) (n=3), spontaneous skull base dural AVF (n=16), traumatic carotid-cavernous sinus fistula (n=5), subclavian artery stenosis (n=2), internal carotid artery stenosis (n=3), intracranial arterial stenosis (n=1), kinked and/or elongated vertebrobasilar artery (n=2), venous sinus diverticulum (n=2), venous sinus stenosis on the dominant drainage side (n=46) and occipital sinus stenosis (n=2). Treatments included embolization and stenting using coils, NBCA glue, Balt balloons, self-expansion stents and intracranial micro-stents via either the femoral artery or femoral vein. **Results** Procedures were successful in all cases with no surgery-related complications. Tinnitus disappeared within 2 days after the procedure in all cases. Follow up duration was 5-36 months. Recurrence occurred in 4 cases of arterial tinnitus within 3 months following the initial procedure, which improved after revision embolization or symptom management. There was no recurrence in venous tinnitus cases following stent plastic or stent-coiling embolization treatments. **Conclusions** Endovascular intervention provides a new approach to the diagnosis and treatment of intractable pulsatile tinnitus. It is also effective in differentiating and studying other types of tinnitus.

Key words: Pulsatile tinnitus; AVF; cerebral artery; Venous sinus; Stenosis; Embolization; Stent vasculoplasty

Introduction

Epidemiology studies indicate that prevalence of tinnitus is 14.5% among those under 40 years of age and 17.5 - 35% among those over 40 [1,2], most of it being sensorineural in nature. Although prevalence of pulsatile tinnitus is merely 4% [3], considering the size of the population, it carries a considerable negative impact on the wellbeing and quality of life among people. Pulsatile tinnitus that is synchronized to heart beat can be further characterized as "objective" and "subjective". Objective pulsatile tinnitus is often seen in atherosclerotic stenosis of skull base carotid artery and vertebrobasilar artery (VBA), carotid-cavernous sinus arterovenous fistula (AVF), meningeal AVF, skull base aneurysms and arteries of aberrant courses. Due to lack of specific physical signs, subjective pulsatile tinnitus is sometimes mistaken as depression or other forms of "psychological disorders". Patients with severe pulsatile tinnitus can suffer greatly when appropriate medical care is not available. With recent advances in cerebral vascular imaging, it has been recognized that some arterial stenosis, dural venous sinus stenosis, high rising jugular bulb and venous sinus diverticulum in the skull base area can be the cause of subjective pulsatile tinnitus [4-6].

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The current study is a review of 82 cases of pulsatile tinnitus treated by the authors between January 2003 and January 2013, reporting their diagnoses, etiologies, interventions and treatment outcomes.

Clinical data

Patients

The series included 53 females and 29 males,aged13 - 61 years (mean = 37.3 years).Symptom duration ranged 1 - 24 months. Auscultation revealed bruits synchronized to heart beat over the ipsilateral subclavian artery or near the mandibular angle in some cases. In most patients with skull base meningeal AVF, bruits were audible behind the ear, above the orbit or in the temporal area.Auscultation was usually negative in patients with intracranial arterial stenosis, kinking or elongation, or in those with venous sinus stenosis or diverticulum. Otological consultation ruled out diseases of the outer or middle ear.

Diagnostic imaging

Magnetic resonance imaging (MRI) and digital subtractive angiography (DSA) were performed in all 82 cases. T1 and T2 weighted MRI clearly revealed intracranial or skull base AVF draining into intracranial vessels in 15 cases, and kinked and elongated VBA compressing on the VIIIth cranial ver（vevestibulocochlear nerve）near the superior olivary fossa and other neural structures close to the brainstem in 1 case.Computed tomography (CT) scan showed internal lamina erosion next to a sigmoid sinus diverticulum in 2 cases.DSA was performed to visualize the morphology and course of cervical and intracranial arterial and venous systems, and to determine blood flow distribution and circulation time, as well as the location and degree of arterial stenosis. DSA also provided information on the location of AVF and its supplying and draining vessels, the extent of kinking and elongation of VBA, characteristics of venous drainage and presence of stenosis, and the location, size and morphology of venous sinus diverticula.Diagnoses based on DSA in this group included intracranial AVF (n=3), spontaneous skull base dural AVF (n=16), traumatic carotid-cavernous sinus fistula (TCCF) (n=5), subclavian artery stenosis (n=2), internal carotid artery stenosis (n=3), intracranial arterial stenosis (n=1), VBA kink and/or elongation (n=2), venous sinus diverticulum (n=2), venous sinus stenosis on the dominant drainage side (n=46) and occipital sinus stenosis (n=2).

Treatments

Three techniques were used to restore anatomical normalcy of cervical and cerebral vascular and neural structures via transvascular interventional approach under general anesthesia with endotracheal intubation. 1) In the 56 cases of arterial or venous stenosis, balloon dilation and stent were used to restore vascular structural normalcy, changing turbulent into laminar flows and thus eliminating tinnitus. 2) For the 24 patients with various AVF and venous diverticula,balloons, coils, NBCA glue and stents were used in various combinations for embolization and elimination of abnormal arterovenous communications to restore normal vascular anatomy.3) To treat VBA kinking and abnormal elongation, micro-stents were used to reshape kinked vessels, creating a separation from the brainstem or nerve roots for a decompressing effect [7,8] (see example cases).

Treatment outcomes and follow up

Procedures were successful in all 82 cases. There were no surgery-related complications.Pulsatile tinnitus was reported to have disappeared within the first 2 days following the procedure by all patients in this series. During the 5-36 months follow up, pulsatile tinnitus recurred in 3 cases of skull base spontaneous AVF, which disappeared again after revision embolization. In a case of intracranial arterial stenosis, mild tinnitus of different pitches from the original tinnitus appeared 3 months after stent treatment, which improved following treatment with vasodilating agents. There was no recurrence in cases of pulsatile tinnitus from venous system abnormalities following treatments with stents or coils.

Discussion

Clinical features and classification of tinnitus

Various types of tinnitus exist, with dozens of etiologies and variable loudness and pitch features. However, tinnitus is probably originated from within the auditory system including the tympanic membrane, cochlea, auditory nerve, auditory nuclei in the brainstem, thalamus and auditory cortex. Pathological changes involving any of these structures have the potential to generate abnormal auditory perceptions, or tinnitus. Due to the difficulties in determining the mechanisms and locations of tinnitus generation, clinical research on and treatment of tinnitus have been challenging for a long time, leading to dissatisfaction in both clinicians and patients. From our experiences in treating vascular disorders and reports in the literature, the authors classify tinnitus into the following four categories based upon its anatomical location and clinical features.

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