Clinical Radiology 70 (2015) 943–947

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

Superior semicircular canal dehiscence in relation to the superior petrosal sinus: a potential cause of pulsatile tinnitus

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ARTICLE INFORMATION

Article history:
Received 29 November 2014
Received in revised form
8 April 2015
Accepted 28 April 2015

AIM: To examine the association between superior semicircular canal dehiscence (SSCD) and pulsatile tinnitus (PT).

MATERIALS AND METHODS: Two SSCD groups included 408 unilateral persistent PT patients, and 511 controls undergoing head and neck dual-phase contrast-enhanced computed tomography (DP-CECT) for reasons other than PT. The prevalence of type I (no the superior petrosal sinus running through the dehiscence) and type II (superior semicircular canal dehiscence in relation to the superior petrosal sinus) SSCD was analysed using chi-square test.

RESULTS: SSCD was identified in 5.1% (21/408) of PT ears, significantly different from 2% (8/408) of non-PT ears and 0.7% (7/1022) of controls. There was no significant difference in SSCD prevalence between non-PT ears in the PT group and controls. In the PT group, 15/21 ears were type II SSCD; 6/21 ears were type I. Fifteen combined non-PT and control ears with SSCD included two type II and 13 type I SSCD. The prevalence of type II SSCD in PT ears was significantly higher than that of non-PT ears in both groups, and the prevalence of type I SSCD in PT ears was similar to that of non-PT ears in both groups.

CONCLUSION: Compared with type I SSCD, there may be a causal relationship between type II SSCD and PT.

Introduction

Pulsatile tinnitus (PT), a subtype of tinnitus, is the perception of a rhythmical noise that is synchronous with the patient's heartbeat. It is a serious public health problem and frequently induces anxiety and depression, and sometimes suicide. Most of these distressed patients are willing to accept the risks of surgery for their disorder. Because management is ideally directed at treating the cause of PT, accurate diagnosis is imperative.

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http://dx.doi.org/10.1016/j.crad.2015.04.017
0009-9260/

PT has numerous causes including arterial, venous, and non-vascular.[1–6] Superior semicircular canal dehiscence (SSCD) has been reported as one cause of PT[1,7–15]; however, most SSCD patients do not present with PT symptoms and instead, present only with vertiginous symptoms, oscillopsia, and rotatory and vertical nystagmus following loud noises (SSCD syndrome).[16–26] It remains unclear whether there are differences in SSCD patients with and without PT. Various imaging strategies have been proposed and continue to evolve to investigate the causes of PT. Compared with promising results from dual-phase contrast-enhanced computed tomography (DP-CECT), which has the advantage of demonstrating artery, venous, soft tissue, and temporal bone in a single study,[27] high-resolution CT (HRCT) and magnetic resonance imaging (MRI) used in previous studies have limitations.

The aim of the present study was to investigate the relationship between SSCD and PT, and to determine the characteristics of SSCD patients with PT based on DP-CECT image analysis in a large patient population. Similar to previous studies, it was hypothesised that SSCD is a cause of PT.

Materials and methods

Patients

The Institutional Review Board for Human Subjects Research of Capital Medical University, Beijing Tongren Hospital, Beijing Friendship Hospital, and Shandong Medical Imaging Research Institute approved this study and informed consent was obtained from all patients. Two groups were evaluated for radiographic evidence of SSCD and the relationship between the dehiscence and superior petrosal sinus. The PT group included all patients with persistent unilateral PT between May 2008 and Jan 2013. Four hundred and eight patients were identified, 336 were female and 72 were male with a mean age of 45±13 years (range 17–79 years). One hundred and seventy-two patients had left-sided PT and 236 had right-sided PT. The median PT duration was 19 months (range 10 days to 36 years). After follow-up, the PT remained unchanged in 302 patients, gradually aggravated in 103 patients, and decreased slightly in the remaining three patients.

Among 937 consecutive patients with sinonasal or orbital tumours, or orbital trauma who did not present with a history of tinnitus and underwent DP-CECT between May 2008 and January 2013, 511 patients were identified as controls, after excluding patients with low-quality images, brain or temporal bone surgery, and temporal bone fracture. The controls comprised 336 men and 175 women, with a mean age of 48 years (range 10–86 years).

CT technique

DP-CECT imaging was performed on a 64-section multidetector CT system (Brilliance 64; Philips, Best, The Netherlands). CT data acquisition spanned the vertex to the sixth cervical level. The imaging parameters were as follows: 100 kV and 250 mAs/section; 0.891 pitch; 512×512 matrix; 22×22 cm to 24×24 cm field of view; 0.75 s rotation time; and 64×0.625 mm collimation. A bolus-tracking program (Trigger Bolus software; region of interest area, 200 mm^2; trigger point, ascending aorta; trigger threshold, 120 HU) was used. Iodinated non-ionic contrast material (iopamidol, 370 mg iodine/ml; BRACCO, Shanghai, China) was administered intravenously using an injection syringe at a rate of 5 ml/s, at a dose of 60 ml/kg, based on the patient's weight. The arterial phase was performed in a cephalocaudal direction and venous phase was performed in the opposite direction after 8 s. Axial, coronal, and oblique sagittal planes paralleling to the superior semicircular canal were reconstructed in a workstation to evaluate the arterial and venous systems with narrower settings (width, 700 HU; level, 200 HU), and the temporal bone with bone window settings (width, 4000 HU; level, 700 HU). The section thickness was 1 mm without a gap.

Image interpretation

The CT images were reviewed by two radiologists with 13 and 11 years' experience, respectively, and the findings were reached by consensus. These radiologists were blinded to the clinical history and radiological impressions at the time of study. During the analysis of the bony labyrinth of the superior semicircular canal, three radiological patterns were distinguished. A complete roof of the superior semicircular canal was considered as the normal pattern. SSCD was classified into two types: type I was characterised by bony dehiscence of the superior semicircular canal without the superior petrosal sinus running through, and type II was characterised by the superior petrosal sinus running through the dehiscence in the superior semicircular canal.

Statistical analysis

Chi-square tests and SPSS for Windows (version 11.0; SPSS, Chicago, IL, USA) were used to analyse the data. Fisher's exact test was used when the sample size was deemed too small. First, the SSCD radiological frequency distribution was compared between sides or genders of the controls and between the PT group and controls. Second, the radiological frequency distribution of type I and type II SSCD in PT ears was compared with that in non-PT ears in the PT group and controls. All hypothesis tests were two-sided using a 0.05 significance level.

Results

Within the controls, SSCD was identified in 0.4% of left ears (2/511 sides) and 1% of right ears (5/511 sides). Five of 336 male patients and one of 175 female patients presented with SSCD, with one male patient having bilateral SSCD. No significant difference was found in SSCD prevalence between sides or genders (p=0.452 and p=0.669, respectively).

Of the 408 PT patients, SSCD was identified in 5.1% of PT ears (21/408) and 2% of non-PT ears (8/408) with a