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Original Article

Imaging of carotid artery-cochlear dehiscence. A cause of pulsatile tinnitus

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ABSTRACT

The petrous bone is a strategic area within the skull base. The cochlea and the carotid artery canal are extremely close to each other within that area. Pulsatile tinnitus requires intact hearing and usually source of sound. It can be arterial or venous in origin, or originating in-between. The aim of this study was to use the MDCT in measurement of the thickness of the bony plate between the internal carotid artery and cochlea within the skull base in patients with pulsatile tinnitus showing no other detectable etiology on MDCT basis as well as for detection of any bony dehiscence involving this bony plate.

Results: This study was conducted on 8 adult patients. The dehiscences ranged between 0.7 and 1.7 mm (average 1.04 mm). Two male patients showed bilateral dehiscences together with excessive pneumatization of both petrous apices. Six female patients showed only unilateral dehiscences. In the controls, the internal carotid artery to cochlea (ICA/Ch) distance ranged from 0.59 mm to 3.1 mm and was 1.618 mm in average. The dehiscences were more common in female. However when they occur in males, they tend to be bilateral and seems to be predisposed by excessive pneumatization of both petrous apices.

1. Introduction

The anatomic knowledge is the corner stone in medical imaging. The petrous bone is a strategic area within the skull base. The cochlea, the carotid artery canal and other crucial anatomic structures are extremely close to each others within that area.

The internal carotid artery could be divided into four portions namely cervical, petrous, cavernous and cerebral. The petrous portion is the portion passing through the skull base to gain intracranial access. It is passing within its dedicated bone canal inside the petrous portion of the temporal bone and showing two segments. The short vertical segment is ranging from 5.0 to 12.5 mm long and 4.0–7.5 mm in diameter. This segment is passing between the jugular fossa posteriorly, the Eustachian tube anteriorly, the tympanic cavity antero-laterally as well as the very close to the cochlear turns in the anterior-inferior location. Then the artery shows sharp turn starting its long horizontal segment that is directed anterior-medially by a path of 14.5–24 mm long and 4.5–7.0 mm in diameter [1].

Tinnitus is the conscious and usually unwanted perception of sound that arises or seems to arise involuntarily in the affected ear. In most of the cases, it is non-pulsatile tinnitus and there is no apparent genuine physical source of sound. The non-pulsatile tinnitus is caused by a hearing malfunction [2]. Less than 10% of the tinnitus patients suffer from pulsatile tinnitus [3]. Pulsatile tinnitus requires intact hearing and usually a genuine physical source of sound [4].

It is often possible to identify the cause of the pulsatile tinnitus. Both patient's medical history, clinical examination, imaging procedures play an important role in such diagnosis. However, no cause is found in up to 30% of patients [5].

Pulsatile tinnitus can be arterial or venous in origin, or originating in-between arteries and veins, i.e. in capillaries or the arteriovenous transition. The differential diagnosis is a long list including and the cause of vascular stenoses as arteriosclerotic plaques and fibromuscular dysplasia. Multiple anatomical variants and vascular abnormalities could be the cause of pulsatile tinnitus. With the use of Multi-detector computed tomography (MDCT), the ectopic internal carotid artery, persistent stapedial artery and carotid-cochlear dehiscence could be diagnosed [6–8].

The frequency of vascular loops in the inner ear is higher in individuals with pulsatile tinnitus [9]. The transfer of flow sound to the inner ear through the bone conduction may be a cause of pulsatile tinnitus [10]. Microscopic vascular abnormalities in the inner ear should be mentioned for the sake of completeness [11].

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In this study, we used the MDCT to evaluate the presence of dehiscence of the bony plate separating the internal carotid artery and cochlea in patients with pulsatile tinnitus showing no other detectable etiology on imaging basis.

2. Aim of the work

The aim of this study was to use the MDCT in measurement of the thickness of the bony plate between the internal carotid artery and cochlea within the skull base in patients with pulsatile tinnitus showing no other detectable etiology on MDCT basis as well as for detection of any bony dehiscence involving this bony plate.

3. Patients and methods

The study design and methodology were reviewed and accepted by our local institutional medical ethics committee.

3.1. Inclusion criteria

This study was conducted on 8 patients. All of these patients were adults (above 18 years old). They all suffered from pulsatile pattern of tinnitus as referred to our MDCT imaging unit. They showed no other detectable etiology on clinical and MDCT basis.

3.2. Exclusion criteria

Patients under 18 years old or suffers from non-pulsatile tinnitus. Patient with other clinical or MDCT diagnosed etiology explaining their tinnitus also were excluded from the study.

3.3. Control group

The measurements were also taken in 30 normal adult individuals. 15 were male and 15 were females. They have no complaint or pathological changes related to this area within the skull base. Their studies were performed for other reasons within the head and neck.

Eight slices multi-detector CT machine (Bright speed S, GE, USA) was used in assessment of all patients. Before imaging, the patient was informed about the investigation and instructed not to move during scanning. Patients were positioned in supine position and their heads were positioned as symmetrically as possible. A lateral scout view was taken and used for planning the axial images. Axial images were taken without any angulations (Tilt 0). The protocol was 120 mA, 120 kV, 1.2 mm slice thickness, large field of view (FOV) and 1.35 pitch.

All images were reconstructed at 0.625 mm thickness; using both soft tissue and high-resolution bone filter (70s sharp). Then the reconstructed axial images were transferred to Advantage 4.4 GE, USA workstation for manipulation of data. Then multi-planar reformation (MPR) was generated in different planes.

Using MPR capabilities, oblique sagittal plane parallel to basal turn of cochlea and the long horizontal portion of the internal carotid artery within the skull base was obtained. Mild medial inclination of the caudal aspect of this plane was required to obtain a full demonstration of both horizontal, vertical portions and genu in-between in one double oblique reformat plane. Excellent and accurate visualization of the bony plate separating the bony canal of the internal carotid artery and the basal turn of the cochlea was obtained in that double oblique view (Fig. 1).

The carotid artery-cochlear interval or distance was considered as the minimal thickness of the bony plate separating the basal turn of the cochlea from the bony cortex of the carotid artery canal in that double oblique view. Maximum dimensions of any dehiscences in that bony plate was measured. All measurements were performed by using electronic calipers on an Advantage 4.4 GE, USA workstation.

4. Results

This study was conducted on 8 patients. All of the patients were adults (above 18 years old). Six patients (75%) were female and two

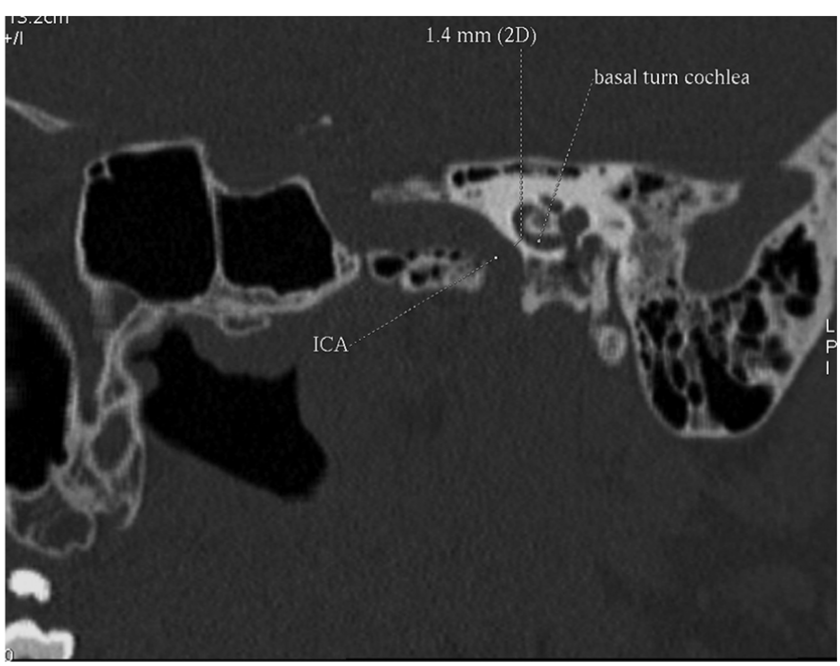

Fig. 1. Showing the double oblique view with excellent demonstration of the carotid artery canal within the skull base. Both the short vertical portion and long horizontal portion are well seen. The carotid artery-cochlear interval or distance was considered as the minimal thickness of the bony plate separating the basal turn of the cochlea from the bony cortex of the carotid artery canal in that double oblique view.

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