RSBO

ISSN:
Electronic version: 1984-5685
RSBO. 2021 Jul-Dez;18(2):221-5

Original Article

Prevalence of foramen of Huschke and petrotympanic fissure in the Brazilian population: CBCT study

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Received for publication: May 11, 2020. Accepted for publication: February 9, 2021.

Keywords:
temporomandibular joint; cone-beam computed tomography; arthroscopy.

Abstract

Introduction and Objective: The aim of the present study was to analyze cone-beam computed tomography (CBCT) images to study the prevalence of foramen of Huschke (FH) and petrotympanic fissure (PF) in a sample of the Brazilian population. **Material and Methods:** A total of 146 CBCT exams were studied (292 ears), being 100 women (68.5%) and 46 men (31.5%). The images were evaluated by a maxillofacial radiology specialist, who noted the presence of FH and stated if the PF could be clearly observed. Frequency and descriptive analyses were performed on dedicated software (SPSS 10.0; SPSS Inc., Chicago, IL). **Results:** FH was observed in 10 ears (6.8%) of nine patients (13.14%), eight patients (11.68%) presenting it unilaterally, and one patient (1.46%) bilaterally. PF was observed in 113 patients (77.39%), 35 (23.97%) of those presenting it unilaterally and 78 (53.42%) bilaterally, being observed in 192 ears (65.75%). **Conclusion:** FH is an anatomical anomaly with prevalence of 6.8% of the studied ears, while PF is an anatomical feature that was observed on 65.75% of the ears.

Introduction

The opening of the developing tympanic ring, known as the foramen of Huschke (FH), was first described by Emil Huschke in 1889 as a structure present during the embryological development of the tympanic portion of the temporal bone, which is normally closed around 5 years of age [12]. The FH is located on the anterior wall of the external acoustic canal (EAC), in the tympanic portion of the

temporal bone, creating a communication between the EAC and the temporomandibular fossa [5].

The persistence of this foramen in adults is considered an anatomical anomaly and may be related to temporomandibular joint (TMJ) herniations and otological problems in the EAC [1, 4]. Its presence may also be associated with saliva discharge in the EAC during joint movements, and it has been reported that infections located on the infra-temporal fossa can reach the EAC through the FH, and vice versa [1, 7]. During maneuvers such as arthroscopy and arthrography, the FH may result in otologic complications [1]. Clinicians, therefore, should be aware of the prevalence and variability of the FH, evaluating radiographically the TMJ and adjacent structures before performing surgeries on that region, in order to avoid trans-surgical complications [7].

The petrotympanic fissure (PF) is a narrow space that joins the articular disc of the TMJ and the malleus in the tympanic cavity, through which the discomallear ligament runs [9]. In some cases, the PF might be presented as a wide structure, and it has been suggested that it can cause TMJ pain and dysfunction via the same mechanisms that happen when the FH is present, also being associated with an increased risk of tinnitus in patients with TMJ dysfunction [2, 9].

Anatomical variations as the FH can be detected in radiographs, but it is well known that they carry a series of limitations such as positioning errors, distortions, ampliations and superposition of anatomical structures, making it more challenging to interpret the images and identify small structures [1]. Lacout *et al.* [4] used high-resolution spiral computed tomography (HRCT) to define FH prevalence, location, and size, concluding that HRCT is sensitive for detection of the FH because of its thin sections, high-spatial resolution, and multiplanar capabilities.

Cone-beam computed tomography (CBCT) is a relatively new method that uses a conical beam to acquire images. CBCT exposes the patient to lower doses of radiation when compared to conventional computed tomography (CT) and can be used for the oral and maxillofacial region and the head and neck region [9-11]. Several authors have published studies detecting FH using conventional CT and cadaver samples [4-6], but only two studies have been conducted on CBCT images [1, 11]. Regarding the observation of PF on CBCT images, Cakur and Yasa [2] performed a study that analyzed PF subtypes on CBCT images, stating that the radiologic interpretation of this bony and narrow structure is challenging.

The objective of the present study was to analyze CBCT images to study the prevalence of FH and PF in the Brazilian population, using a maxillofacial radiologist experienced on CBCT image analysis.

Material and methods

This project was approved by the research ethics committee of Universidade de São Paulo, School of Dentistry, under the number 3.141.301.

Sample selection

A total of 146 CBCT exams (292 ears) were used. They were part of the Laboratório para Análise e Processamento de Imagens of School of Dentistry, Universidade de São Paulo database, and were acquired on i-CAT Next Generation (Imaging Sciences International, Hatfield, PA, United States of America). All images were acquired at 120 kV and 5 mA, using a 23-cm × 17-cm-field of view and total exposure time of 26,9 seconds.

Image analysis

The images were evaluated on XoranCAT® (Xoran Technologies, United States of America) software. For both sides of every patient, one observer with two years of experience on CBCT images noted the presence of FH and if the PF could be clearly observed. FH and PF were identified on axial images, and their existence was confirmed on coronal and sagittal images (Figures 1-3).

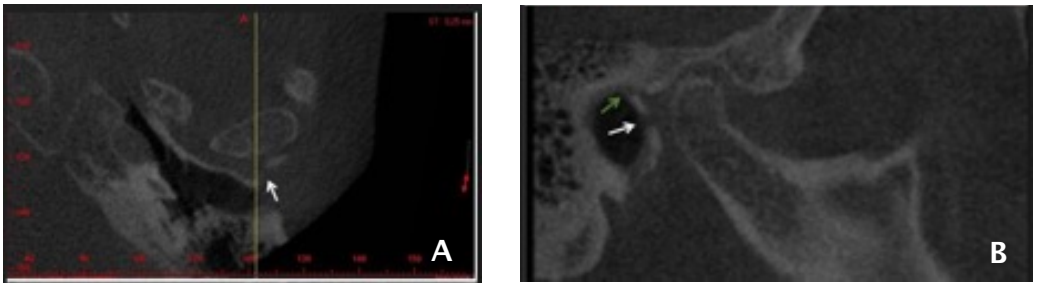

Figure 1 – XoranCAT® interface showing the presence of foramen of Huschke (white arrows) and petrotympanic fissure (green arrow) on (A) axial and (B) sagittal planes

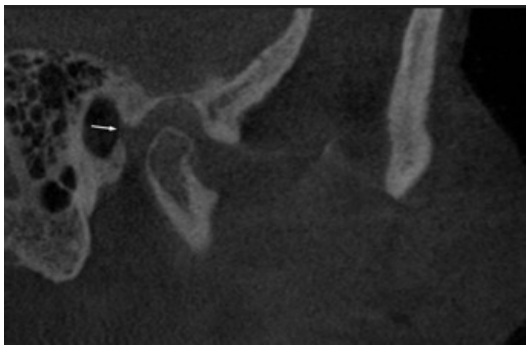

Figure 2 – Foramen of Huschke observed on sagittal plane (white arrow)

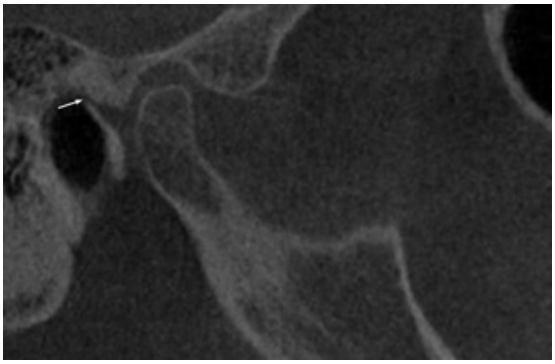

Figure 3 – Petrotympanic fissure observed on sagittal plane (white arrow)

Statistical analysis

The results were tabulated on Microsoft Excel 2013 (Microsoft Corporation, United States of America), and data evaluation was performed on dedicated software Statistical Package for the Social Sciences (SPSS) (version 10.0; SPSS Inc., Chicago, IL, United States of America). To assess the prevalence of FH and PF, frequency and descriptive analyses were performed.

Results

Our sample was selected from the Brazilian population and consisted of 100 women (68,5%) and 46 men (31,5%). The FH was found in 10 (6,80%) of the 292 ears. Table I shows the FH prevalence on this sample, pointing out the differences found between the left and right ears. The FH was found on nine (13.14%) patients, eight (11.68%) presenting it unilaterally, and one (1.46%) bilaterally.

Table I – Prevalence of foramen of Huschke on the 292 ears analyzed

Foramen of Huschke	Frequency	Percentage
Right ear	4	2.70
Left ear	6	4.10
Total	10	6.80

Table II shows the PF prevalence on our sample, considering each ear and the differences found between them. The PF was found on 113 (77.39%) patients, 35 (23.97%) presenting it unilaterally, and 78 (53.42%) bilaterally.

Table II – Prevalence of PF on the 292 ears analyzed

Petrotympanic fissure	Frequency	Percentage
Right ear	103	35.25
Left ear	89	30.5
Total	192	65.75

Discussion

The FH consists of a developmental defect in the antero-inferior aspect of the bony external auditory meatus. In a portion of the population, ranging from 5 to 46%, the FH may persist through life [8]. The FH is a variant of ossification that transmits no neural or vascular structures, being in fact an osseous defect closed by a membranous structure. The term foramen is defined by a structure traversing it. Therefore, the FH is not a true foramen and, according to Lacout *et al.* [4], might be more appropriately termed a bony or osseous defect or dehiscence.

The literature shows various studies stating that FH is a rare structure, such as Wang *et al.* [12], that examined 377 skulls, finding a rate of persistent FH of 7.2%, with some differences between the populations studied: rates were 6.7% in the skulls from China and 9.1% in skulls from Toronto, Canada. Lacout *et al.* [4] used high-resolution spiral CT images to evaluate 130 ears, stating that FH was found in six of those ones (4.6%). The present study also shows low prevalence of FH: 10 ears (6.8%) of nine (13.14%) individuals, eight of those presenting it unilaterally and one bilaterally. Regarding the difference between right and left ears, even though no statistical analysis was performed,

our results show that the findings were similar, since four FH were found on right ears, and six on left ears. Tozoglu *et al.* [11] performed statistical analysis to compare the presence of FH on each side, concluding that the right side was statistically significantly different than the left side.

Moreno *et al.* [5] diagnosed FH using contrast material associated with panoramic radiograph, submental vertex radiograph and corrected sagittal linear TMJ tomograms, concluding that linear tomography was the technique that showed the best results regarding the visualization of FH. On the other hand, Tozoglu *et al.* [11] were the first authors to use flat panel detector-based CBCT images to study FH prevalence and location, concluding that it is an uncommon structure and, even though tomography provides good visualization of the FH, CBCT can produce images with high diagnostic quality, high resolution, short scanning time and radiation dose lower than those of conventional CT scans.

The present study shows prevalence of PF on 77.39% of patients, being 65.75% of the ears studied, which is less than expected, since it is an anatomical structure that should be observed in all individuals. Our difficulty of observation may be explained due to the fact that the observer presented only a few years of experience dealing with CBCT images, which is an important limitation of this study, combined with the intra-observer agreement assessment was not performed. Another hypothesis regards the difficulty of observing the PF lies on the poor soft tissue contrast of CBCT images, associated to the fact that, as the age increases, the morphometric measurements related to PF decrease significantly, which can be interpreted as progressive degenerative changes associated with aging [3]. Since the data used to perform this research did not disclose the age of each patient selected for the sample, the fact that the progressive degenerative changes associated with aging might have affected the observation of the PF remains only a possibility. Further studies regarding this matter must be performed in order to affirm such correlation.

The presence of FH is an obstacle when it comes to surgical approach in the TMJ region, invasive or by arthroscopy, once it presents a communication with the middle ear, increasing the chance of complications during the procedure. Clinicians should be aware of the presence of this developmental defect since it may affect diagnosis, treatment, and prognosis [11].

The main contribution of the present study was to demonstrate that FH is an anatomical anomaly that can be found in the Brazilian population and might be observed on TMJ surgical patients, being essential that surgeons and radiologists are prepared to diagnose it.

Conclusion

FH is an anatomical anomaly that presented prevalence of 6.8% of the studied ears, while PF is an anatomical feature that was observed on 65.75% of the ears.

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