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Association between Facial Type and Mandibular Canal Morphology – Analysis in Digital Panoramic Radiographs

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In this study we investigate the association between facial type and mandibular canal course morphology analysing this in digital panoramic radiographs images. We used 603 digital images from panoramic radiographs. We selected only panoramic radiographs of fully dentate individuals, who had all lower molars bilaterally and with complete root formation. The sample distribution was determined by facial type and sex. The course of the mandibular canal, as seen in the panoramic radiographs, was classified into 3 types, bilaterally. The classification used was: type 1 if the mandibular canal is in contact or is positioned at most 2 mm from the root apex of the three permanent molars; type 2 if the mandibular canal is located halfway between the root apex of the three permanent molars and a half away from the mandibular basis; and type 3 if the mandibular canal is in contact with or approaches, a maximum of 2 mm from the cortical bone of the mandibular basis. For results, the data were analyzed by Chi-square test ($p<0.05$). Data analysis (Chi-square) showed there were more canals type 2 ($p=0.0012$) and fewer canals type 1 ($p=0.0336$) in females than in males, without association with the facial types. In conclusion, the facial type does not associated with the mandibular canal course analyzed.

Key Words: morphology, mandibular canal, injuries, dental surgery.

Introduction

The mandibular canal is an important anatomical structure that should be considered before any surgery in the posterior mandible as third molar extraction or implant installation (1-3). Frequent variations in the course of the mandibular canal have been found in studies (2,4). Certainly, the exact course of the mandibular canal can be prevent complications during any surgical procedures (5).

Determining possible changes in the anatomical course of the mandibular canal in relation to age and sex, using panoramic radiographs is important for clinical planning in implant surgical procedure in adulthood patients (6).

There is a lot of trauma to the inferior alveolar nerve during lower third molar extractions, but little is known about the factors that increase the injury rate (7). So it is extremely important that the dentist knows the location of the mandibular canal, performing radiographic examinations that allow their study, prior to any procedure such as anesthesia for inferior alveolar nerve block, preoperative planning for placement implants, third molars extractions, osteotomies and other maxillofacial surgery (8).

The shape, size and symmetry of craniofacial structures vary according to the facial type. In dentistry, the verification of different facial types is important for treatment planning in several clinical areas. The facial type is a main factor in the growth prediction and orthodontic planning. Three basic facial types are described: dolichofacial (vertical growth), mesofacial and brachyfacial (horizontal growth) (9). There is a positive correlation between the height and the average distance of the alveolar process to the superior wall of the mandibular canal. High individuals have longer face bones than those with lower height, which can contribute to this correlation (9).

Our aim was to investigate the association between facial type and mandibular canal course morphology analyzing this in digital panoramic radiographs images.

Material and Methods

This study was approved by the local Ethics Committee (protocol number: 008/2014).

Sample Distribution

We used 603 digital images from panoramic radiographs belonging to the Department of Morphology, Anatomy area, Piracicaba Dental School, University of Campinas (UNICAMP), Brazil.

For inclusion criteria, we selected only panoramic radiographs of fully dentate individuals, who had all lower molars bilaterally and with complete root formation. Moreover, the images had single mandibular canal and of the same type bilaterally (symmetry). Individuals belonged

to the age group 18-51 years. The exclusion criteria were panoramic radiographs with teeth absence, implants and/or fixed prostheses and/or orthodontic treatment.

All sample test to calculate Chi-squared performed in a sample indicated an average of 270 (test power: 0.80; alfa level: 0.05) panoramic radiographs for the independence test between the types of facial type/mandibular canal/sex. In our lab, we have 1,000 panoramic radiographs but only 603 with panoramic radiographs presented corresponding lateral cephalometric radiographs available. Thus, we evaluated the 603 panoramic radiographs once the calculation is according.

All radiographs were obtained in the radiographic apparatus P300 Kavo Kerr (Brazil Ind. Com. Ltda). The same technician in the same equipment performed the 603 radiographic exams. The parameters used in the radiographic device were set at 60 kV, 2.5 mA, and a 180° rotation (14.3 s scan).

The sample distribution was determined by facial type and sex. Facial type (dolichofacial, mesofacial and brachyfacial) was determined by the VERT index as calculated by Ricketts (9) in cephalometric analysis performed in a lateral radiograph. In our archives, each individual had a panoramic (used for mandibular canal evaluation) and a lateral radiograph (used for facial type evaluation). For each individual we had a panoramic and a lateral cephalometric radiograph. Therefore, we obtained the facial type in a lateral cephalometric radiograph and the mandibular type canal in a panoramic radiograph, both in the same individual. For the facial type, we used the Ricketts method (9), that we verified the facial high by an angle established by the intersection of the extension of the Xi-Pm plane with the Ba-Na line. We interpret evaluating the mandibular body behavior with the total cranial basis (Average: 60°±3°).

Analysis of Mandibular Canal Course

The course of the mandibular canal, as seen in the panoramic radiographs, was classified into 3 types, bilaterally, according Nortjé et al. (10) classification: 1: The mandibular canal is in contact or is positioned at most 2 mm from the root apex of the first, second and third permanent molars (Fig. 1). 2: The mandibular canal is located halfway between the root apex of the first, second and third permanent molars and a half away from the mandibular basis (Fig. 2). 3: The mandibular canal is in contact with or approaches, a maximum of 2 mm from the cortical bone of the mandibular basis (Fig. 3). Measurements were performed using ImageLab2000® software (Bio Diracon Informatics. Ltda., Vargem Grande do Sul, SP, Brazil).

Statistical Analysis

For results, the data were analyzed by chi-square test ($p<0.05$). The data were analyzed using GraphPad Prism 6, Inc (GraphPad Inc., La Jolla, CA, USA).

Results

Figure 4 shows the absolute distribution of the type of mandibular canal and facial type (brachyfacial, mesofacial and dolichofacial) and sex.

There was perfect symmetry between the right and left sides, considering the type of mandibular canal, both for

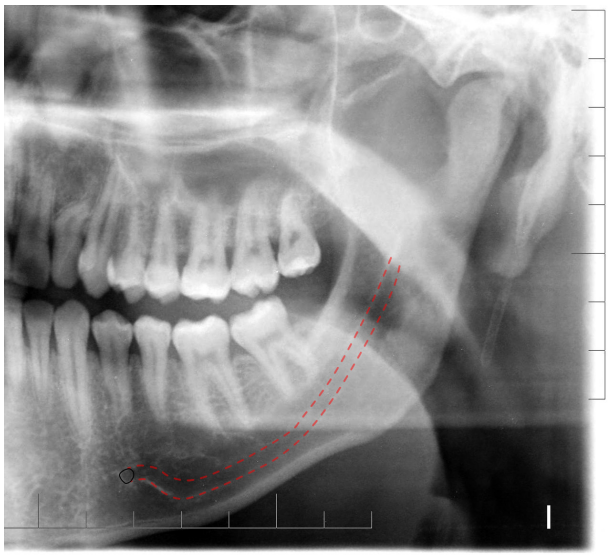

Figure 1. Radiographic image of the mandibular canal type 1 (red traces) in relation to the lower molars apexes according Nortjé et al. (10) classification.

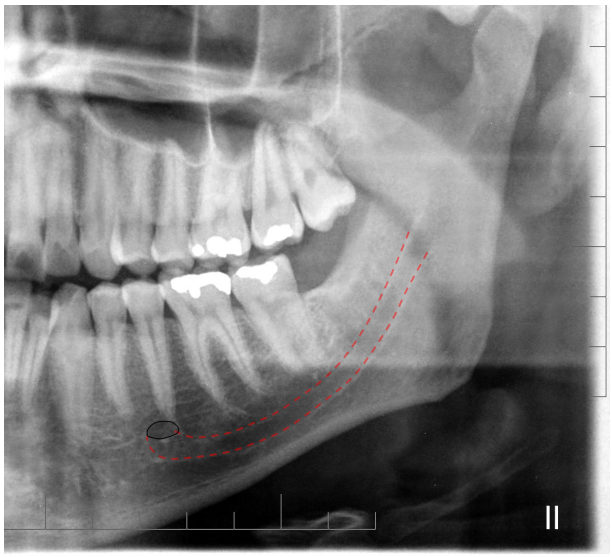

Figure 2. Radiographic image of the mandibular canal type 2 (red traces) in relation to the lower molars apexes according Nortjé et al. (10) classification.

males as for females.

Data analysis showed no significant differences between facial types both for females (p=0.8776) and for males (p=0.1514).

Proportionally, there were more canals type 2 (p=0.0012) and fewer canals type 1 (p=0.0336) in females than in males, without considering the facial types.

There was a higher overall ratio (p<0.05) for the type 1 of mandibular canal on all facial types for both the male and the female, except for male in mesofacial type, in which there were no statistically significant differences (p=0.0564) between type 1 and 2 of mandibular canal. Similarly, there were no statistically significant differences (p>0.05) between types 2 and 3 canals in male and female, but there were more 2 type than 3 type in brachyfacial and mesofacial males (Fig. 4).

Discussion

The knowledge of the location of mandibular canal variations are important in dental procedures involving the mandible. Stella and Tharanon (8) reported that the anatomy of the mandibular canal, when considering the morphological type, could vary according to several factors such as age, sex, race and development of the alveolar bone. In a previous study from our research group (1), we evaluated the type of mandibular canal using as variation factor the occlusal pattern of individuals in panoramic radiographs. Studies have not been elucidation about the association of the topography of the mandibular canal for each facial type.

The inferior alveolar nerve, descending in an anterior direction, presents intraosseous relationships with the roots of the lower molars. There are types of relationships may be established that should be identified before surgical intervention by means of diagnostic imaging (11). The mandibular canal morphology importance has been studied (1,3-5,10-12) because the pre-operative radiological investigation can provide the exact intraosseous location of the mandibular canal (5) and prevent complications during surgical procedures such as extraction of an impacted third molar, dental implant treatment and sagittal split ramus osteotomy (5,11,13).

Digital images from panoramic radiographs are frequently used for preoperative planning before extraction of impacted mandibular third molars. The advantages of panoramic radiographs include low cost and wide availability (5). The third molar extraction is one of the main causes of injury in the inferior alveolar nerve.

Thus, the panoramic radiographic evaluation of mandibular canal course helps preventing the inferior alveolar nerve damage (7). In relation to the accuracy of the digital panoramic radiography, Schulze et al. (14) studied the precision and accuracy of measurements on digital panoramic radiography. They did the measurements with a single software program and concluded that high image magnification (2:1) lowered the measurement accuracy. In our study, panoramic radiographs were used; as they allow the evaluator define the mandibular canal exactly, as a radiolucent area, bordered by two radiopaque edges, one upper and one lower (5). Furthermore, Díaz-Torrez et al. (11) and Schulze et al. (14) reported that reproducibility studies are likely to be held in panoramic radiographs because there is the possibility of minimizing mistakes, eliminate distortions of the image during radiography, and verify the relationship between the lower molar and the mandibular canal.

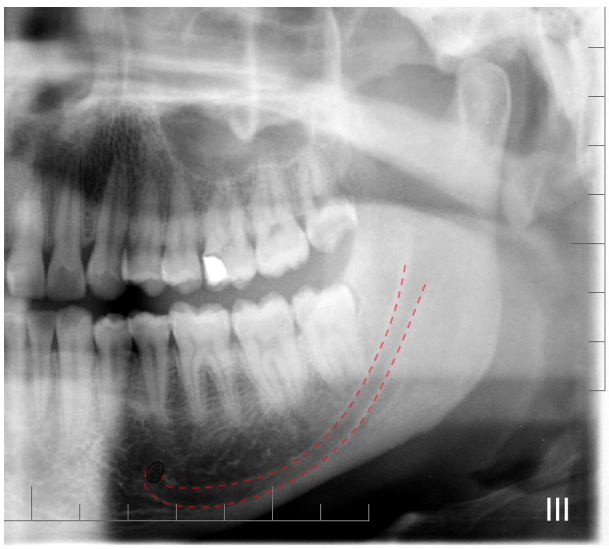

Figure 3. Radiographic image of the mandibular canal type 3 (red traces) in relation to the lower molars apexes according Nortjé et al. (10) classification.

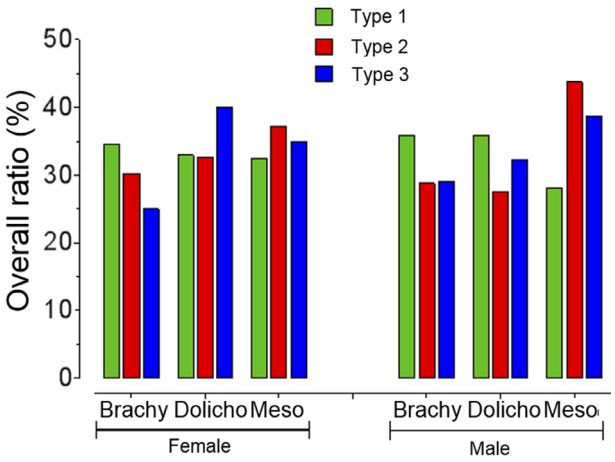

Figure 4. Overall ratio (%) of the types of mandibular canals distributed by facial types and sexes.

In general, our results showed that there was a greater proportion of the mandibular canal type 1 in all facial biotypes in both the male and the female sex, with no statistically significant difference between the overall ratio of a type of mandibular canal for a specific facial biotype, i.e. morphological type of mandibular canal was not associated with the facial type. Although Shahin (6) has reported that the height of face influences the height of the alveolar bone and, therefore, the facial type can influence the amount of alveolar bone. We suggested that the differences in the types of the mandibular canal could be more associated with changes in the positioning of the teeth in the molar region (1,7,10,15) than with differences in height of the alveolar bone. In the present study, the mandibular canal type 1 was the most frequent in all facial types, by definition; it has almost no interposition of cancellous bone between the apexes of the three molars and the upper edge of the mandibular canal (10).

Here when we not considered the facial type, we observed that there were more mandibular canal of the type 2 and less mandibular canal of the type 1 in female than in male sex. Angel et al. (16) conducted a study on CT scans, and explained that variations in the positioning of the mandibular canal between the sexes are possible due to existing sexual dimorphism in locating the mandibular foramen caused by differences in height of the mandible branch between the sexes, previously confirmed by Afsar et al. (17).

In conclusion, the facial type does not associated with the mandibular canal course analyzed by the Nortjé et al. (10) classification. The mandibular canal type 1 was the most common, distributed in all facial types studied. We suggested that future studies should be conducted to prevent the neurovascular bundle injuries during surgical procedures in the posterior region of the human mandible.

Resumo

Neste estudo investigamos a associação entre o tipo facial e o trajeto do canal mandibular por meio de análises em imagens de radiografia panorâmica digital. Foram utilizadas 603 imagens de radiografias panorâmicas digitais. Foram selecionadas apenas radiografias panorâmicas de indivíduos totalmente dentados, que apresentaram todos os dentes molares inferiores bilateralmente e com completa formação das raízes. A amostra foi determinada pelo tipo facial e pelo sexo. O trajeto do canal mandibular, avaliado nas radiografias panorâmicas, foi classificado em 3 tipos bilateralmente. A classificação usada foi: tipo 1 se o canal mandibular estiver em contato ou posicionado a no máximo 2 mm do ápice radicular dos 3 molares permanentes; tipo 2 se o canal mandibular estiver a meia distância do ápice radicular dos 3 molares permanentes e da base da mandíbula; e tipo 3 se o canal mandibular estiver em contato com ou posicionado a no máximo 2 mm do osso cortical da base da mandíbula. Para os resultados, os dados foram analisados pelo teste qui-quadrado ($p<0,05$). Os dados analisados (qui-quadrado) mostraram que existem mais canais do tipo 2 ($p=0,0012$) e menos canais tipo 1 ($p=0,0336$) em indivíduos femininos do que em masculinos, sem associação com os tipos faciais. Conclui-se que o tipo facial não está associado ao trajeto do canal mandibular.

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