Original article

http://dx.doi.org/10.4322/jms.108417

Topographic analysis of the mandibular canal in coronal section, in the region of molars

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Abstract

The studies about bone resorption contributed greatly to the advancement of rehabilitation with dental implants and Buccomaxillo facial Surgery and Traumatology. This phenomenon leads to a more superficial localization of the mandibular canal in relation to the alveolar ridge when teeth are lost, limiting and hindering the installation Bone tissue, of implants, as well as other surgical procedures. This anatomical study aimed to analyze and interpret the distances from the mandibular canal to the alveolar ridge, in groups of dentate individuals and toothless, comparing them statistically, so 20 adult male cadavers divided into two groups, namely group A, formed by 10 dentate and group B, consisting of 10 toothless individuals. All their teeth were dissected and then, were checked the measurements of the distances between the roof of the mandibular canal and the alveolar ridge. The averages found were enlightening to say that bone resorption has consequences for treatment and surgery for dental implants, due to the decreasing bone support for the implantation and other surgical procedures, increasing the risk of injury to the inferior alveolar neurovascular bundle.

Keywords: dental implant, bone resorption, bone tissue, dental alveolus.

1 Introduction

The society knew several attempts and scientific methods of dental implants (LOURENÇO, MORANO-JÚNIOR and DARUGE-JÚNIOR, 2007). The advent of osseo integration in dental implants enabled the creation of a new treatment, exceeding the results of conventional fixed and removable prostheses (BARBOZA, CARVALHO, FRANCISCO et al., 2007). In this sense, literature says that the implants represent a successful rehabilitation, with high success rates (TOLSTUNOV, 2007). However, the loss of teeth determines the reduction of the function and subsequent resorption of the alveolar process (MATIAS, ANDRADE and FERNANDES, 2004), which can determine a remaining atrophic bone that may be tapered and/or shallow. That is low, making the oral rehabilitation with dental implants more difficult (KAO, YEUNG, CHOU et al., 2002). In this sense, the proper reconstruction of the bone for implantation will be one of the goals of the implantodontist surgeon, aiming to restore the aesthetics and function, because even with the variety of implants, it is necessary to find an adequate bone (HOEXTER, 2002). In the molar region, i.e., in the posterior mandible, there is the mandibular canal which houses the inferior alveolar neurovascular bundle. It represents an increased risk of placement of the implants, because a violation of this canal can injure this bundle, causing a hemorrhage (FLANAGAN, 2003), or paresthesia, which may be temporary or permanent (VELASCO, DIAS, VELASCO et al., 2008). Thus, the location of this bundle, especially for patients who have severe bone resorption resulting in little height to install the implant, makes the procedure more complicated and limited (RIGATO, 2000). A study showed that injuries to the inferior alveolar neurovascular bundle can result in sensory changes in fractures of mandibular body, but also that there is a significant relationship of paresthesia in the postoperative period of rigid internal fixation, especially in edentulous mandibles, but the paresthesia of post-surgery was not related to the preoperative paresthesia (LIZUKA and LINDQVIST, 1991), demonstrating that this surgical procedure presents a risk of violation of the mandibular canal. According to Andrade, Araujo, Souza et al. (2015), study of the variations of the channel of the mandibula in panoramic radiographs, noted that there was no prevalence of the channels high in women compared to men. In order to analyze the reliability of panoramic radiographic signs of the relationship of the mandibular canal with the roots of the third molars (SILVEIRA, COSTA, BEZERRA et al., 2016), came to the conclusion that these panoramic radiographic signs showed high sensitivity, specificity and accuracy to predict near lower third molar with the mandibular canal. Aiming the health of patients, especially those with atrophic alveolar ridge and improve the anatomical knowledge in the areas of surgery and implantology, this study provides important information about the process of resorption and discusses its clinical implications from the analysis of comparative values between human cadavers dentate and edentulous, using the measurements from the roof of the mandibular canal and the alveolar ridge in the mandibular molar region and, thus, quantitatively investigate how the loss of teeth affects the anatomy of the mandibular alveolar process.

2 Materials and Methods

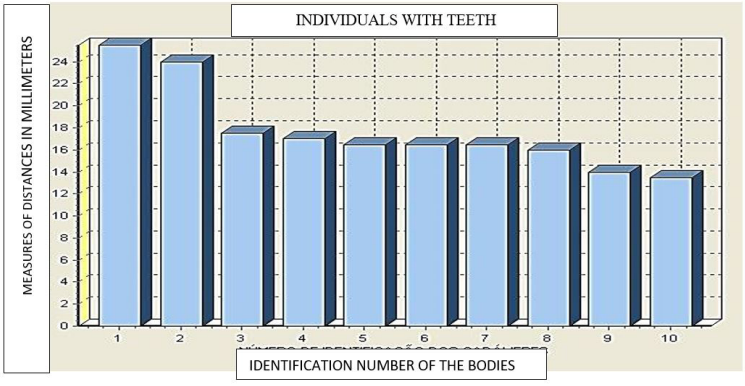
This study was approved by the Ethics Committee and was conducted at the Department of Human Morphology, at the Federal University of Piauí from the data collection and statistical comparative analysis through dissection in the dental arches of adult male cadavers. The size of the sample was chosen for convenience because of the difficulty of obtaining anatomical parts. The sample was divided into two groups, namely group A, consisting of 10 dentate subjects and group B, consisting of 10 edentulous subjects, obtained from the Laboratory of Human Anatomy, at the Federal University of Piauí. The corpses were identified separately and photographed for documentation. To select the sample, there were excluded those corpses in poor conservation that could difficult the adoption of measures for structural uncertainties.

In group A (dentate) was performed a perpendicular coronal section to the median plane between the first and second molars, and in group B (toothless), this cut was performed in the posterior mandible corresponding to the same area of molars. Then It was measured the distances between the roof of the mandibular canal to the alveolar ridge with the help of an endodontic ruler. After this step the data were recorded on a file card. The data collected were analyzed descriptive and statistically. All values were analyzed using SPSS software (version 10.0). For the statistical data were applied position measurements and dispersal in order to determine the average measure of the distance between the roof of the mandibular canal and the alveolar ridge in the dentate and edentulous groups as well as to check the differences between them and determine the standard deviation and variance, investigating quantitatively how tooth loss influences the resorption of the alveolar process of the mandible.

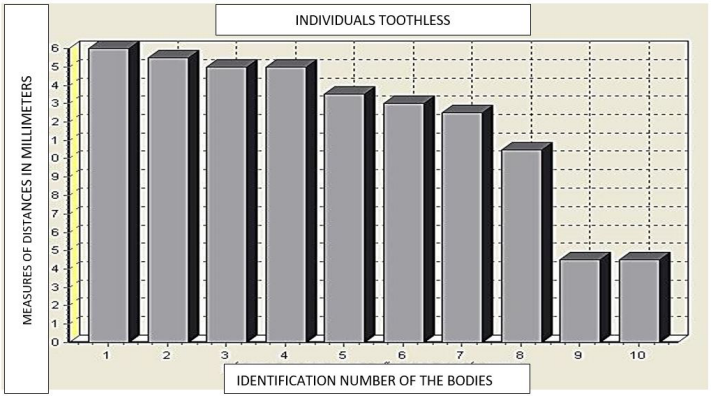
3 Results

The analysis of the measurements of the distance between the mandibular canal and the alveolar edge, shows the distances between the roof of the mandibular canal to the alveolar ridge in millimeters in dentate subjects (Graphic 1). The shortest distance was of 13.5 mm and the greatest was of 24.5 mm, and the difference between them was of 11.5 mm. It is seen also by the provision of data, that there is a little variation between the intermediate values.

In edentulous group results showed that the distances between the roof of the mandible canal to the alveolar ridge in millimeters in toothless individuals, corresponding to the vertical bone height for implantation (Graphic 2), on which the shortest distance was of 4.5 mm and largest was of 16.0 mm, and the difference between them of 11.5 mm, curiously, the



Graphic 1. Distances from the mandibular canal to the alveolar ridge in millimeters and in descending order for dentate subjects (group A).



Graphic 2. Distances from the mandibular canal to the alveolar ridge in millimeters and in descending order in edentulous subjects (group B).

same as for dentate subjects, however the average vertical bone availability for deployment has been reduced. It is seen also by the provision of data, that the variation between the intermediate values is greater when compared to dentate subjects.

Through analysis of the position measurements in Table 1, it could be noticed that the average was 17.70 mm for dentate and 12.00 mm for edentulous,, the difference between the two groups of subjects was of 5.27 mm. The median was of 16.50 mm and 13.25 mm for dentate and edentulous mandibles, respectively, suggesting a vertical reduction of the bone in edentulous mandibles

The dispersion measures indicate how much the values vary around the average. Through their analysis from the table 01, it can be seen that the height of the bone of the dentate group varies less than in the toothless one. That is, the variance and standard deviation was of 3.94 mm and 15.51 mm^2, respectively, for dentate, and 4.28 mm and 18.28 mm^2, respectively, for toothless. This becomes clearer in terms of percentage which is the coefficient of variation, that was 22.25% for dentate and 35.66% for edentulous.

4 Discussion

These results show that the average distance between the roof of the mandibular canal to the alveolar ridge in edentulous subjects was of 12 mm, and in dentate was of 17.7 mm. This difference occurs by the resorption occurred due to the absence of teeth. The present study showed a great variation in bone heights within the group of edentulous subjects, revealed from the measurements of dispersion such as variance, standard deviation and coefficient of variation that usually means how much the measures varied around the average and also that the averages were statistically lower when compared to dentate individuals. This work brings together some information from the literature emphasizing the importance of anatomical knowledge of the mandibular canal for surgical procedures associated with it, considering the risk of accidents and complications.

It is considered that the ideal height of the remaining bone for placement of implants is from 11 to 12 mm (HOEXTER, 2002), and as a safety measure the implants must be installed at least 5 mm from the mental foramen and 2 mm from the mandibular canal (PELAYO, DIAGO, BOWEN et al., 2008), the greater the length of the implant and surface is, the greater is the area of osseointegration (CHI WU and WAH YUNG, 2005).

In general, society has experienced an improvement in oral health care, but even so, elderly sick patients still suffer from the loss of teeth, with a high frequency of edentulous mandibles, especially in this part of the population (MATIAS, ANDRADE and FERNANDES, 2004). But it has also increased the search for rehabilitation with implant prostheses (HOEXTER, 2002).

But the loss of teeth and consequently the associated periodontal tissues, influence of various ways in the organism and the quality of life of individuals, because due to this phenomenon, it might occur a dental movement, difficulty in speaking and chewing, imbalance in the orofacial muscles and esthetic and dental care, and negatively affect the self-esteem (SOARES, KNOP, JESUS et al., 2007). That is, the vertical and horizontal bone deficiency can result in stability problems with prosthesis, speech and chewing problems, pain, mucous membrane intolerant to chewing, loss of soft tissue support and altered facial appearance, as well (PEREIRA-FILHO, HOCHULI-VIEIRA, GABRIELLI et al., 2007).

The literature has cited that the reduction of the alveolar process can occur due to loss of teeth (SEGUNDO, 2000; TECIMER and BEHR, 2001; MATIAS, ANDRADE and FERNANDES, 2004; JUODZBALYS and RAUSTIA, 2004; KLASSMANN, CORÓ, THOMÉ et al., 2006; PEÑARROCHA-DIAGO, GÓMEZ-ADRIÁN, GARCÍA-GARCÍA et al., 2006; SIDDIQUI and SOSOVICKA, 2006), to the trauma (SEGUNDO, 2000; PEÑARROCHA-DIAGO, GÓMEZ-ADRIÁN, GARCÍA-GARCÍA et al., 2006; SIDDIQUI and SOSOVICKA, 2006), aplasia, infections, poorly fitted dentures (SEGUNDO, 2000) and periodontal disease (PEÑARROCHA-DIAGO, GÓMEZ-ADRIÁN, GARCÍA-GARCÍA et al., 2006).

In this sense, it is not uncommon implantodontists face with inadequate bone for implant placement (LEY and CRANIN, 2004), however, it is crucial to the success of treatment with dental implants that the condition of the bone that will receive the implant be adequate (MAURETTE, MAZZONETTO, O'BRIEN et al., 2005; PEREIRA-FILHO, HOCHULI-VIEIRA, GABRIELLI et al., 2007), since both the quantity and quality of the site that will receive the implant will influence the bio-mechanical-esthetic results, the prosthetic stability and health of the remaining teeth (MAURETTE, MAZZONETTO, O'BRIEN et al., 2005).

Thus, the dental implant placement is often limited, since there is a reduction of the alveolar ridge, resulting in decreased bone volume that will receive the implant (KLASSMANN, CORÓ, THOMÉ et al., 2006; FUKUDA, LINO, OHNUKI et al., 2003) both in height and width (SEGUNDO, 2000; PEÑARROCHA-DIAGO, GÓMEZ-ADRIÁN, GARCÍA-GARCÍA et al., 2006; JUODZBALYS and RAUSTIA, 2004), but besides the quantity, quality of bone also influences (TECIMER and BEHR, 2001), even in the success of treatment (FREITAS and MONTEBELLO FILHO, 2004).

Therefore, for surgical planning in implant therapy, besides the health of the patient, the anatomical characteristics of the jaw, such as height, width and length of the bone must be

Table 1. Comparative analysis of the measure of the distances between the roof of the mandibular canal to the alveolar ridge in the molar region in dentate and edentulous.

MEASURES	INDIVIDUALS		
	Toothed	Toothless	Diference
AVERAGE **(mm)**	**17.70**	**12.00**	**5.70**
MEDIAN **(mm)**	**16.50**	**13.25**	**3.25**
STANDARD DEVIATION **(mm)**	**3.94**	**4.28**	**0.34**
VARIANCE **(mm²)**	**15.51**	**18.28**	**2.77**
COEFFICIENT OF VARIATION (%)	**22.25**	**35.66**	**13.41**

evaluated, since the choice of location of the implant, in fact, is anatomically and, from this evaluation, important information can be raised, as the presence of the mandibular canal in the vertical direction, that is, bone height (JUODZBALYS and RAUSTIA, 2004) which sets a challenge (PROUSSAEFS, 2005).

Thus, in pursuit for accuracy in the diagnosis and treatment, surgeons have resorted to increasingly advanced technologies for analysis and planning of case, especially in imaging exams (MOYA, VERA, IRANZO et al., 2006; ANDRADE, ARAUJO, SOUZA et al., 2015; SILVEIRA, COSTA, BEZERRA et al., 2016). Nowadays, there are several types of imaging studies to evaluate mandibles before and after the installation of implants, such as intraoral, the panoramic, conventional and computed tomography images, but none of them can provide an ideal image, as they are under the risk of false positive or negative results, requiring the association of information and the anatomy of the region (MORAES, CASTILHO, DOTTO et al., 2004).

Thus, the success of dental implants in the mandible is definitely associated with the anatomy of this region, making the computed tomography the most accurate method for image analysis of important structures for the installation of dental implants, in particular the height of the alveolar ridge and the course of the mandibular canal, the most important anatomical structure of the jaw, since a more severe atrophy that occurs in the back of the jaw reduces the bone height of the rim above the neurovascular bundle which is contained in the canal (METZGER, BORMANN, SCHOEN et al., 2006).

According to the survey of the literature done by Devito and Tamburus (2001), his anatomical knowledge is also important in other procedures such as the inferior alveolar anesthetic block, extraction of lower third molars, osteotomies and maxillofacial surgery, endodontic procedures, the choice of the point of support for dentures and orthodontic procedures, fractures and traumas involving the inferior alveolar plexus. In this sense, didactically, this canal can be classified into three segments: the posterior, which descends obliquely to the anterior part from the lingula to the mandibular second molar, the middle segment, which is more horizontal, vestibular and basilar and goes from the second molar to the second premolar, and the anterior segment, which gives rise to the mental and the incisive canal, the constitution of the mandibular canal is of a compact bone and, when sectioned coronally, has a circular or oval aspect (GALDAMES, HERRERA, LOPEZ et al., 2007). This canal houses the vein, artery and the inferior alveolar nerve (DEVITO and TAMBURUS, 2001).

Its location represents a risk to the installation process, because a violation of this canal may injure the neurovascular bundle, causing a hemorrhage (FLANAGAN, 2003), or sensitive changes, such as anesthesia, hypoesthesia, paresthesia or dysesthesia (PELAYO, DIAGO, BOWEN et al., 2008). Thus, the presence of this beam, especially for patients who have severe bone resorption resulting in little height to install the implant, makes the procedure more complicated and limited (RIGATO, 2000). Thus, the mandibular canal must be accurately located (ROCKENBACH, SAMPAIO, COSTA et al., 2003). In this sense, the literature meant that we can choose the following techniques to circumvent this anatomical difficulty: the use of short implants and in greater numbers, the use of tilted implants (GARCIA-JUNIOR, MAGRO-FILHO, CARDOSO et al., 2006), the performance of bone grafts for height gain and the lateralization of the inferior alveolar neurovascular bundle, and the osteogenesis distraction (GARCIA-JUNIOR, MAGRO-FILHO, CARDOSO et al., 2006; DEL-CASTILLO-PARDO-DE-VERA, CHAMORRO-PONS and CEBRIÁN-CARRETERO, 2008).

The use of rigid internal fixation in surgical interventions in complex fractures of mandibular body must be done by following a few principles to achieve a minimally traumatic procedure. Thus, important structures such as the mandibular canal and the tooth roots, if possible, should be avoided with the installation of monocortical screws or even by passing them (WILFRIED, 1997). However, the bones undergo a involutive and physiological process during some time, however, in the mandible, this phenomenon becomes more significant when related to the loss of teeth, inclusively reducing the distance from the mandibular canal in relation to the alveolar ridge, as there is an overall reduction of bone mass, which leads to approximate the tension and compression zones (MATIAS, ANDRADE and FERNANDES, 2004), which makes this type of treatment more difficult, since monocortical screws are used in the zone of tension and bicortical in the zone of compression, through the technique of rigid internal fixation with plates and screws.

One study showed that there is a significant relationship of paresthesia in the postoperative period of rigid internal fixation, especially in edentulous mandibles, but this was not correlated with the preoperative paresthesia (LIZUKA and LINDQVIST, 1991), demonstrating that this surgical procedure presents a risk of violation of the mandibular canal.

Considering the implications of the alveolar process bone resorption due to the loss of teeth, it is proved the clinical importance of anatomical knowledge of the mandibular canal, especially for surgical procedures involving structures associated with it. It was concluded that the loss of teeth leads to resorption of the alveolar process, highlighting the importance of preservation of the teeth, since given the conditions of study, there was a significant difference in the height of the ridge between the dentate and edentulous. Proving that there is bone resorption when the physiological demands of the alveolar process is reduced by loss of teeth. Furthermore, it should be borne in mind that the loss of teeth leads to a continuous process of resorption, which assumes the individual characteristics that vary from a person to another and at different locations in the same individual.

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Received November 2, 2016
Accepted November 5, 2017