Computerized Tomographic Localization of Inferior Alveolar Canal and Mental Foramen in the Mandible Among Implant Patients:An Imaging Study.

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ABSTRACT

PURPOSE: Assessment of location of vital anatomic structures is required while enterprising quality dental care. In this study, an assessment of the location of inferior alveolar canal(IAC) and mental foramen(MF) in the mandible was done by using computed tomography. An attempt was done to compare the variation in the location in various age groups.

MATERIAL & METHODS: The mean location of the IAC and MF from the alveolar crest was done on 30 patients by using cross-sectional computed tomography(CT). A comparison of the mean distance in the three age groups was done by using ANOVA.

RESULTS: The mean distance of the superior border of the IAC upto the alveolar crest of the mandibular 2nd premolar was at 12.56 on the right side and 12.65 on the left side. The mean distance of mandibular 1st molar was upto about 12.29mm on the right side and 12.71 on the left side. Mandibular 2nd molar showed the mean distance of 11.97mm on the right side and 11.94mm on the left side. The mean distance of the superior border of the MF upto the alveolar crest was at 11.99mm on the right side and 12.20mm on the left side. A comparison between the three age groups showed a statistical difference ($P<0.05$).

CONCLUSION: Assessment of vital anatomic structures for its presence and distribution is important in the pre-operative planning of dental implants so as to avoid bleeding due to damage of vessels within the jaw. The mean distance of the IAC with respect to the alveolar crest was decreasing as it was moving posteriorly.

Keywords: Inferior Alveolar Canal; Mental Foramen;Alveolar Crest; Computerized Tomography.

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INTRODUCTION

Dental implants are gaining immense popularity and wide acceptance because they not only replace lost teeth, but are also permanent restorations that do not interfere with oral function or speech or compromise the self-esteem of patients. Anatomic factors are considered by the clinician to determine the best implant placement sites. Appropriate replacement planning in which imaging plays a pivotal role helps to ensure a satisfactory outcome. Imaging can be used to determine status of the anatomy in the proposed implant site and how best to optimize the implant placement considering the prosthetic needs and anatomic constraints. The development of precise presurgical imaging techniques allows the dentist to place these implants with relative ease & predictability. Thus it is necessary to use imaging techniques that accurately determine the size and location of various anatomical structures at the proposed site for implant placement.

Assessment of location of various vital anatomic structures such as inferior alveolar canal (IAC) and mental foramen (MF) in the mandible are required while enterprising quality dental care, including simple extractions, impactions and dental implant surgery. IAC is one of the most important anatomical structures in mandible. Clinicians should be aware of the variation in course of the IAC as it runs through the jaw, because the IAC may present in different anatomical configurations in vertical plane. Other most challenged region for implantation in mandible is mental foramen region. This is because there are many variations with regards to the size, shape, location and direction of the opening of the MF. The shape of foramen can be round or oval; diameter ranges from 2.5 to 5.5 mm. The location of MF differs in the horizontal and vertical planes.

Computed Tomography(CT) can be considered perhaps the most effective diagnostic presurgical examination method, since it allows 3-dimensional visualization and has proved to be an excellent procedure for characterizing the anatomy. Dentascan is a software program that allows the mandible to be imaged in three planes: axial, panoramic and cross-sectional. It has been

widely used pre-operatively for implant surgery as it provides a comprehensive assessment of the morphology and measurement of dental implant site. This software thus helps the surgeon to identify suitable implant sites and to predict the primary stability before the implant insertion, thereby improving the surgical planning and, eventually, the success rates of the procedures.

Although many factors affect the outcome of treatment, precise presurgical evaluation of the bony support in the jaws and precise localization of important vital anatomic structures are among the most important factors for successful outcome. This study has been conducted keeping in view, broad aspects of variability of anatomic position of vital structures in the jaws of a given population of various ages, sexes, the minute variation of which can impede with the successful treatment outcome. So, here a comparative study was done to evaluate the location of inferior alveolar canal and mental foramen in the mandible of a given population of different age and gender by using Dentascan software program.

MATERIALS AND METHODS

The study was conducted among patients visiting the Department of Oral Medicine & Radiology, Yenepoya Dental College and Hospital, Mangalore. 30 patients with partially and completely edentulous areas consisting of equally divided males and females of different age groups who were selected for dental implant procedures were chosen for the study based on the inclusion and exclusion criteria. Among the sample, 15 patients were males and 15 were females. The age group of the patients was kept between 20 and 79 years. Patients with any orofacial infections, development disorders, any recent history of trauma and those with recent history of extraction were excluded from the study.The chosen samples were divided into 3 Groups: group A (20-39yrs), group B (40-59yrs) and group C (60-79yrs), 10 patients in each with equal number of male and female patients.

The CT scan machine used for this study was GE Medical System. This has multidetector (MDCT) technology (16 slices) with 16 detector array. CT slice was of 1.0 mm with reconstruction increment of 1.0 mm, along with effective mA of 200 and 120 kilo voltage. Image acquisition of 16 × 0.62 mm with rotation time of 1 s and slice collimation and width of 0.6 mm and 10 mm, respectively. The patient was placed supine in the gantry, using a head holder, chin strap and sponges on either side of the head to prevent motion. The patient head was oriented in the center of the scan field with the use of lateral laser light marker for positioning.

Images were analyzed using Dentascan software program. Measurement was done on personal computer from the compact disk with help of measuring icon in the software.

For the evaluation of position of inferior alveolar canal, measurements were taken by marking a line, with the measuring icon, from the center of alveolar crest with respect to second premolar, first molar and second molar up to the highest point on the superior border of inferior alveolar canal. Similarly for the evaluation of position of MF, measurements were taken by marking a line, with the measuring icon, from the alveolar crest to a point on the superior border of mental foramen on both sides.

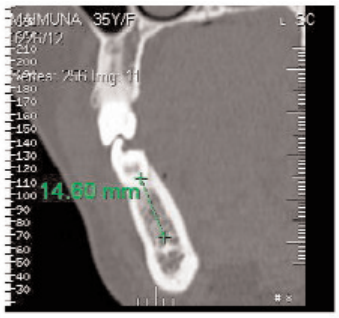


Fig 1: Location of Inferior Alveolar canal

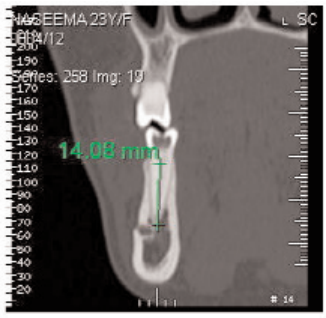


Fig 2: Location of Mental Foramen

DATA ANALYSIS

Analyses of associations between variables were conducted employing one-way ANOVA was used to test for differences among three age groups and unpaired t test carried to compare two genders. Level of statistical analysis was chosen at $P < 0.05$. the statistical processing was conducted employing SPSS statistics 17.0.

RESULTS

Age wise comparison among three groups (Table 1,Chart 1 and 2)with respect to inferior alveolar canal using one way ANOVA test shows that there was a significant difference between group A & group C and between groupB & group C in relation to all teeth. In case of right 1st molar, there was very highly significant difference with a p value of 0.008. On age wise comparison by ANOVA with respect to mental foramen(Table 2,Chart 3) (right & left) in 10 patients each in all the three age groups , there was a very highly significant difference between the three age groups with respect to right and left mental foramen with p values of 0.003 and 0.005 respectively

Table 1:Age Wise Comparison of Location of Inferior Alveolar Canal(Group A, group B and group C)

Site in relation to IAC	20-39 yrs MEAN (STDEV)	40-59 yrs MEAN (STDEV)	60-79 yrs MEAN (STDEV)	P value
2nd Premolar (right)	14.27 (3.08)	13.33 (2.60)	10.09 (3.76)	**0.017**
2nd Premolar (left)	13.58 (2.42)	13.83 (2.37)	10.53 (3.77)	**0.031**
1st Molar (right)	13.20 (3.31)	13.99 (2.25)	9.68 (3.36)	**0.008**
1st Molar (left)	13.81 (2.18)	13.69 (2.73)	10.63 (3.23)	**0.023**
2nd Molar (right)	12.06 (3.10)	13.78 (2.29)	10.00 (2.74)	**0.010**
2nd Molar (left)	12.92 (1.80)	12.41 (2.56)	10.49 (3.73)	**0.014**

Table 2: Age wise comparison of location of mental foramen

Site in relation to Mental foramen	20-39 yrs MEAN (STDEV)	40-59 yrs MEAN (STDEV)	60-79 yrs MEAN (STDEV)	P
Right	13.94 (3.37)	13.17 (1.98)	8.86 (4.10)	**0.003**
Left	13.14 (2.09)	14.61 (2.73)	8.84 (3.55)	**0.005**

Chart 1: Age wise comparison of location of inferior alveolar canal on right side

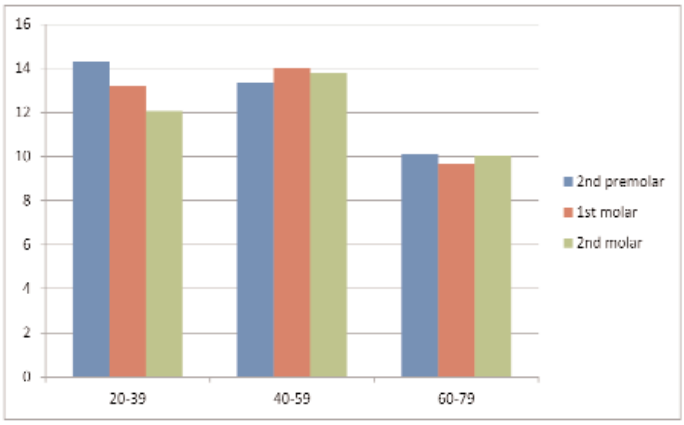


Chart 2: Age wise comparison of location of inferior alveolar canal on left side

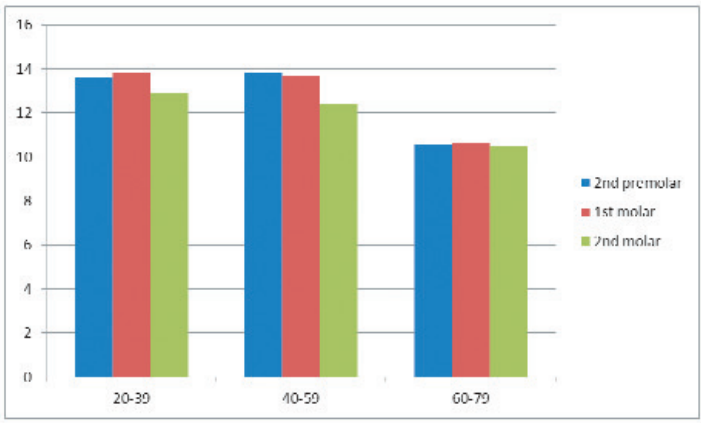
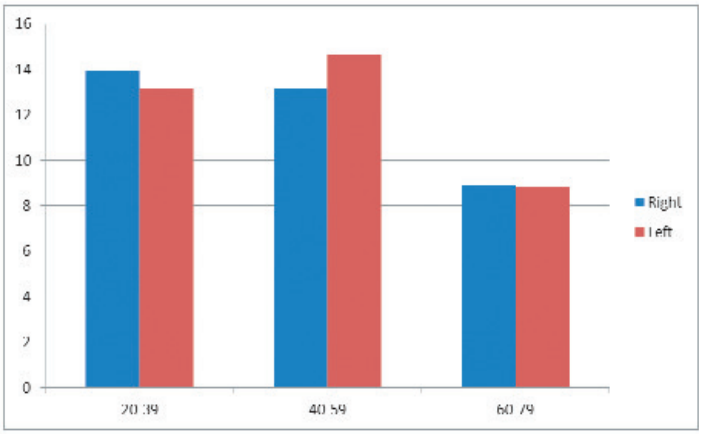


Chart 3: Age wise comparison of location of mental foramen



DISCUSSION

Precise, pre-surgical evaluation is one of the most important factors ensuring success in dental implant treatment. A major complication that comes across during implant placement is the damage or presence of anatomic structures such as inferior alveolar canal and mental foramen in the mandible. Conventional, two dimensional images do not adequately allow dentists to assess these anatomic structures. Advanced imaging modalities such as computed tomography has proved to be an excellent procedure for visualizing these anatomic structures and offers additional possibility of multiplanar reconstructions in high quality images. CT scan is particularly important for pre-operative planning in dental implantology as it aids in avoiding injury to critical structures such as inferior alveolar canal and mental foramen in the mandible.

In this study, cross sectional computed tomography was used to evaluate the location of these anatomical structures and an attempt was done to compare their proximity to alveolar crest in thirty patients of equally divided males and females in different age groups based in and around Mangalore locality.

INFERIOR ALVEOLAR CANAL

The overall mean distance of superior border of inferior alveolar canal from the alveolar crest of 2nd premolar was at 12.56mm on the right and 12.65mm on the left side, 1st molar was at 12.29mm on the right and 12.71mm on the left side, 2nd premolar was at 11.95mm on the right and 11.94mm on the left side.

Butterfield KJ et. al conducted a study on human fresh cadavers to evaluate the accuracy of conventional spiral tomography for the localization of the mandibular canal. It was found that the overestimations of the distance from alveolar crest to the mandibular canal (8/18) ranged from 1.05 to 0.10 mm and underestimations from 0.30 to 1.36 mm.[1]. Frei C et. al conducted a study in Berne population (Switzerland) and found that the average measured bone height from the mandibular canal to the alveolar crest in the panoramic radiograph was 13.9+/-2.66mm and the average bone height in linear tomography was 14.87+/-3.3mm[2].

However these studies were confined only to limited region, whereas our study showed the mean distance at multiple areas, that is, 2nd premolar, 1st molar and 2nd molar of mandibular arch on both right and left sides.

The location of the anatomical structures in different age groups such as group A (20-39 years), group B (40-59 years) and group C (60-79 yearsl) was also compared in this study.

Mean distance of the mandibular 2nd premolar in group A was 14.27mm on the right and 13.58mm on the left side, group B was 13.33mm on the right and 13.83 on the left side and group C was

10.09mm on the right and 10.55mm on the left side. Mean distance of mandibular 1st molar in group A was 13.20mm on the right and 13.81mm on the left side, group B was 13.99mm on the right and 13.69 on the left side and group C was 9.68mm on the right and 10.63mm on the left side. Mean distance of mandibular 2nd molar in group A was 12.06mm on the right and 12.92mm on the left side, group B was 13.78mm on the right and 12.41 on the left side and in group C was 10.06mm on the right and 10.49mm on the left side.

The studies available in literature most of which are done on edentulous jaws have been mostly used for implant planning. Therefore in our study, with reference to implant placement planning it is important to determine the amount of bone resorption taking place in an extraction wound.

MENTAL FORAMEN

The overall mean distance of superior border of mental foramen from the alveolar crest was 11.99mm on the right and 12.20mm on the left side.

BouSerhal C assessed the accuracy of panoramic radiography and computed tomography for the localization of the mental foramen. The distance from the alveolar crest to the mental foramen was measured from panoramic radiographs, spiral tomograms and CT scans. Panoramic radiography showed more deviation (+0.6 mm) from the perioperative measurements than either spiral or computed tomography (+0.4 and 70.3 mm respectively). Cross-sectional imaging techniques are recommended for the pre-operative planning of implants in the posterior mandible[3].

In a study by Ngeow WC et. al determined the visibility of anterior loop on panoramic radiographs in dentate subjects of various age groups. The anterior loop is defined as where the mental neurovascular bundle crosses anterior to the mental foramen then doubles back to exit the mental foramen. This anatomical structure is important in determining the placement position of endosseous implants in the mandibular premolar region. They found out that one or more anterior loops were visible in radiographs and were mostly observed bilaterally. The visibility of anterior loops reduced as the age of the subject increased. They concluded that panoramic radiography is not sufficient for presurgical implant planning in the mental region and may need to be supplemented with other modalities such as CT for better visualization of the area[4].

Ngeow et. al in his study indicated the most common position for the MF was in line with the longitudinal axis of the second premolar (69.2%) followed by a location between the first and second premolar (19.6%). The right and left foramina were bilaterally symmetrical in three of six recorded positions in 67.7% patients. The MF was most often in line with the second premolar.

In the present study, the exact location of MF was measured from the alveolar crest to the superior border which was in proximity with 2nd premolar region in both partially and completely edentulous patients. Also attempt was made to evaluate the height of mental foramen on both right and left sides. It was found that the average location of mental foramen is more on left side when compared to right side. With age wise comparison, the height of MF from its superior border to the alveolar crest level decreases as age advances.

Another important finding in our study showed that the location of the anatomical structures becomes closer with the alveolar crest as it runs posteriorly or the alveolar crest was receding as it moved posteriorly.

The location of IAC and MF in relation to the alveolar crest of all the posterior teeth considered in this study population was also evaluated separately for equally divided males and females in mandibular jaws from this study population. Age wise comparison was done between the three groups (group A, group B, group C), results were statistically significant. In case of right 1st molar in relation to IAC, there was very highly significant difference with a p value of 0.008. Whereas in comparing right and left mental foramen, results showed a very high significance with p values of 0.003 and 0.005 on right and left sides respectively.

In addition, CT plays a crucial role in pre-implantation assessment of the mandible to detect various anatomic structures such as IAC and MF[5,6]. In the present study with CT scan, evaluation of position of these structures were done. Thus computed tomographic examination helps the clinician for the surgical treatment planning of dental implant treatment. Thus implant planning is one of the most important step prior to implant surgery and should be undertaken by means advanced imaging such as a computed tomography inorder to address the surgical complications which are the major cause of hemorrhage[7].

CONCLUSION

The knowledge of the location of the anatomical structures is important while proceeding with the dental implant treatment in the vicinity of the area to prevent any severe complications. In this study we have made an attempt to locate the anatomical structures like IAC and MF in 30 patients with the use of computerized tomography. This information can be used as a guideline while delivering implant treatment to the patients in the vicinity of these anatomical structures.

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