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Using of Model Casts Supported By Imaging Technique for Detection of Vital Structure for Optimal Canine Implant Placement

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Abstract

Introduction:*The mental foramen is an important landmark when considering placing implants in the foraminal region of the mandibular arch. Differences in its location, the number of foramina, and the possibility that an anterior loop of the mental nerve may be present mesial to the mental foramen need to be considered prior to preparing an osteotomy in this region. This article review, methods to provide the measurements with respect to the mental foramen and makes clinical suggestions to reduce inadvertent damage to the mental nerve during osteotomy development.*

Aim of the Work:*The purpose of the present study was to provide available clinical techniques to recommend the most appropriate imaging modalities for the identification of mandibular vital structures especially the mental foramen when planning for oral implants surgery, how to detect and avoid the damage of these vital structures during implant therapy.*

Materials and Methods:*The clinicians should carefully identify these anatomical landmarks, by analyzing all influencing factors, prior to their implant surgical operation.*

The mental foramen is an important landmark, and its location needs to be considered prior to implant placement in the foraminal region. The foramen's position can vary, and radiographs may be misleading with regard to its precise location and the presence of an anterior loop of the mental nerve. Nevertheless, injuries to this nerve during implant placement can be avoided if the mental foramen is located and evaluated, and this information is used to help guide surgical procedures by using Panoramic and computerized tomography (CT).

Results:*Measuring the distance between the inclined implant line at 15° and the mental foramen of all patients by different method showed that no difference & no change between the Rt&Lt sides both were stable. In the two methods no injury to the mental foramen or any vital structure were done.*

Conclusions:*The clinicians should carefully identify these anatomical landmarks, by analyzing all influencing factors, prior to their implant surgical operation. To avoid nerve injury during surgery in the foraminal area, guidelines were developed with respect to verifying the position of the mental foramen and the implant is positioning to be precisely executed, and when safe positioning of implants with optimal use of available bone and save time for surgical work.*

Key Word*:Mental foramen, Imaging technique,canine implant placement,*

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I. Introduction

The mental foramen is an important landmark when considering placing implants in the foraminal region of the mandibular arch. Differences in its location, the number of foramina, and the possibility that an anterior loop of the mental nerve may be present mesial to the mental foramen need to be considered prior to preparing an osteotomy in this region. This article reviews the literature with respect to the mental foramen and makes clinical suggestions to reduce inadvertent damage to the mental nerve during osteotomy development.

Normally, three nerve branches come out of the mental foramen[1]. One innervates the skin of the mental area, and the other two proceed to the skin of the lower lip, mucous membranes, and the gingiva as far posteriorly as the second premolar. The mental nerve may provide innervation to tissues adjacent to the canine and incisor areas[2]. Medial to the mental foramen, studies confirmed the existence of a true incisive canal, which is a continuation of the mandibular canal[1,3-5]. The incisive canal may also appear to be ill-defined, and neurovascular bundles may run through a labyrinth of intertrabecular spaces[6].

In about 1% of patients, the mandibular canal bifurcates in the inferior superior or medial lateral plane[7,8]. Thus, a bifurcated mandibular canal will manifest more than one mental foramen. This may or may not be seen on panoramic or periapical films[7]. Accordingly, Dario[7] suggested that clinicians should consider obtaining a preoperative tomogram to avoid nerve injury prior to implant placement above the inferior alveolar canal.

Mbajiorguet al.[9] found different shapes of the mental foramen in the mandibles of Zimbabwean subjects: round in 14 of 32 (43.8%) mandibles and oval in 18 of 32 (56.3%) jaws. Others reported it was round in 34.5% of mandibles and oval in 65.5% (N = 575)[10].

Morphometric skull analyses revealed the mean height of the mental foramen was 3.47 mm (range: 2.5 to 5.5 mm) and the average width was 3.59 mm (range: 2 to 5.5 mm)[11]. Other investigators noted that the mean diameter of the foramen was 3.5[12] and 5 mm wide.

Anatomical variations occur concerning the mental foramen's location[13,14]. It is usually found more coronal than the mandibular canal[15,16]. Agthong et al. indicated the foramen was 28 mm from the midline of the mandible and 14 to 15 mm from the inferior border of the mandible. Similarly, Neiva et al.[11] reported the foramen was 27.6 mm (range: 22 to 31 mm) from the midline and 12 mm(range: 9 to 15 mm) from the most apical portion of the lower cortex of the mandible. Other authors[5] commented the foramen was usually found halfway between the crest of bone and the inferior border of the mandible. However, this finding could be influenced by the amount of crestal bone loss.

After extraction of teeth and resorption of alveolar bone, the mental foramen is closer to the alveolar crest[10,17]. In extreme situations, the mental foramen and mandibular canal can be adjacent to the crest of the alveolar ridge[18]. Radiographs indicating close proximity of the foramen to the alveolar crest dictate that the foramen should be surgically located to avoid nerve damage prior to osteotomy development. Furthermore, if there is insufficient roomto place implants, the nerve can be transposed to create adequate space. Some investigators[19,20] found this procedure to be very successful. However, other researchers noted a high rate of sensory dysfunction post operatively [21-23].

More than one mental foramen may be present. Sawyer et al[14] assessed the frequency of accessory mental foramina in skulls in four population groups[13,14]. It can be surmised that a variety of patterns occurs, and it should not be assumed that there is only one mental foramen on each side.

Radiographic assessment of the mental foramen must be interpreted cautiously. Jacobs et al.[24] reported the foramen was detected on 94% (N = 545) of panoramic radiographs, but clear visibility was only attained 49% of the time. Similarly, Yosue and Brooks[12] noticed the foramen on 87.5% (N = 297) of panoramic radiographs, and it was distinct 64% of the time. In another investigation in which four skulls were radiographed, Yosue and Brooks[25] concluded that panoramic and periapical films reflected the actual position of the foramen in the skulls <50% the time. They also classified the foramen's appearance on panoramic radiographs into four categories (separated from the mandibular canal, continuous with the mandibular canal, diffuse with indistinct borders, and unidentified) and recorded the occurrence of each type[25].

With respect to periapical films, the mental foramen was found on 75% (N = 75) in one investigation and on 46.8% (N = 1,000) in another study. To enhance foramen detection, it was suggested that a vertical bitewing and a panoramic film be taken in conjunction with a horizontal periapical film[26].

Measurement discrepancies when using different radiographic methods must be considered when computing the amount of bone coronal to the mental foramen.

CT scans are more accurate than conventional radiographs[24,27-30]. Nevertheless, conventional radiographs can usually be used if potential radiographic distortions are taken into account. However, if it is difficult to locate the inferior alveolar canal or the mental foramen, consideration should be given to obtaining a CT scan.

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. CT 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 the 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 CT software program[31].

To improve visualization of the mandibular canal when taking a panoramic radiograph, Dharmar suggested that the patient's head should be tilted ~5° downward with reference to the Frankfort horizontal reference bar of the orthopantomogram machine. Changing the angulation improved seeing structures because it reduced the chance of superimposition of the contralateral side. In addition, to compensate for radiographic distortions caused by the panoramic method, it is prudent during film taking to include a 5-mm ball bearing (held in position with wax), which can be used to calculate the percentage of radiographic error[32].

The purpose of the present study was to provide available clinical techniques to recommend the most appropriate imaging modalities for the identification of mandibular vital structures especially the mental foramen when planning for oral implants surgery, how to detect and avoid the damage of these vital structures during implant therapy.

II. Materials and Methods

Nine complete edentulous patients were selected from the department of removable prosthodontics, faculty for dentistry. Alexandria University. Mandibular complete over denture supported by two inclined implants with the help of a fabricated guide stent, was constructed and evaluated by clinical and radiographic analysis. Measuring the distance between the inclined implant line at 15° and the mental foramen were recorded for every patient.

Methods

Preparation of the stent: The radiographic stent was fabricated to evaluate the implant sites: A Vacuum thermoplastic base plate material was adapted to the mandibululer stone casts. At the desired implant locations – the mandibuler cast was marked by a pencil on the crest of the edentulous ridge.

Then again, the locations are marked on the lingual surface of the clear acrylic thermoplastic base plate material using an indelible pencil – corresponding to locations on the mandibuler cast.

The locations roughly at canine and first premolar area (each implant were 5 mm anterior to the mental foramen) and the two implants were equidistance to each other.

Two small openings 5 mm length and 2.7 mm diameter were drilled in the specified locations on the lingual surface of the stent. Two small metal tubes 5 mm length and 2.7 mm diameter were fixed to the concavities using a clear cyanoacrylate adhesive.

The patient wore the thermoplastic stent and the surgen was taken to confirm that the location of the tubes did not interfere with the important mandibular structures. A line was drawn using indelible pencil on the labial surface of the canines of the stent extending from the tip of the canines to the lower surfaces of the cast.

According to the natural inclination of the canines which are directed misially toward the mild line. Then a protractor was used to drawn another line which is inclined by15°. A straight hand piece was fixed by special metallic part to be parall to the vertical arm of the survivor then the cast with the surgical stent is placed on it and the table is tilted to the right and to the left to drill the point of placement of the metallic tubes for the Accurate inclined positional of the implants.

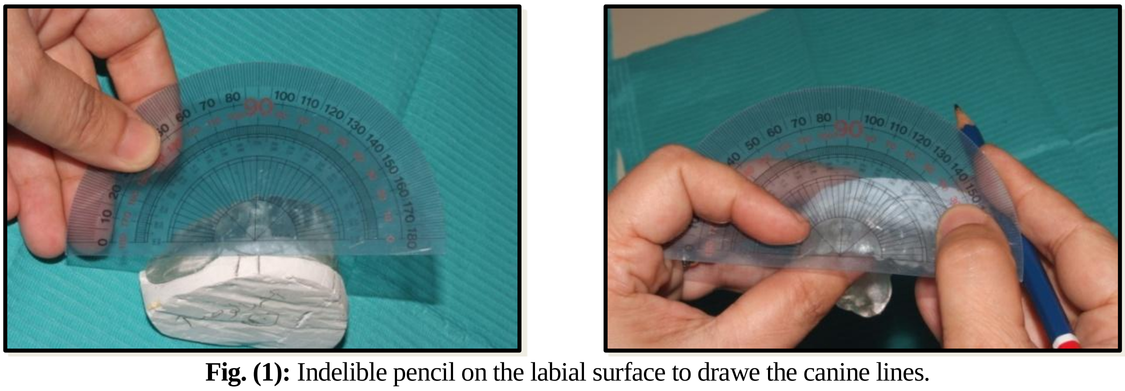


Fig. (1): Indelible pencil on the labial surface to drawe the canine lines.

Fig. (2): Specially designed cupper plate with 2 holes and 2 screws attached to the dental surveyor mandrill.

Fig. (3): Simple tool to measure the angle on the model.

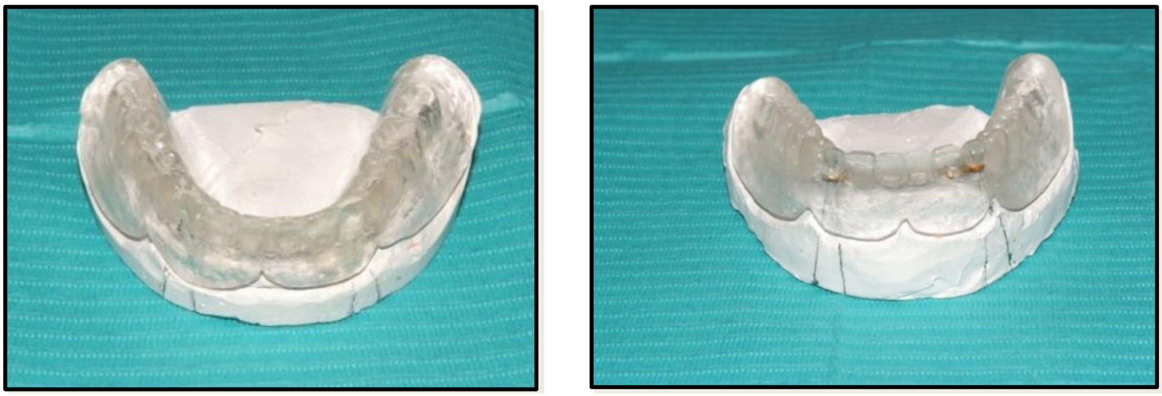


Fig. (4): The surgical stent with two drilled holes for receiving a guiding ring of (2.6mm diameter, 5 mm length which act as a guiding channel).

Computerized tomography (CT) scans are more accurate for detecting the mental foramen than conventional radiographs. There are discrepancies between studies regarding the prevalence and length of the loop of the mental nerve mesial to the mental foramen. Furthermore, investigations that compared radiographic and cadaveric dissection data with respect to identifying the anterior loop reported that radiographic assessments result in a high percentage of false-positive and -negatives findings. Sensory dysfunction due to nerve damage in the foraminal area can occur if the inferior alveolar or mental nerve is damaged during preparation of an osteotomy[33].

To detect the marginal bone height around each implant before surgery: On the CT around each implant a line was drawn from the crest of the alveolar ridge to the lower border of the mandible with the long axis of the natural canine and another line inclined by 15° to it and the distance between the inclined line and the mental foramen were measured and recorded for both sides.

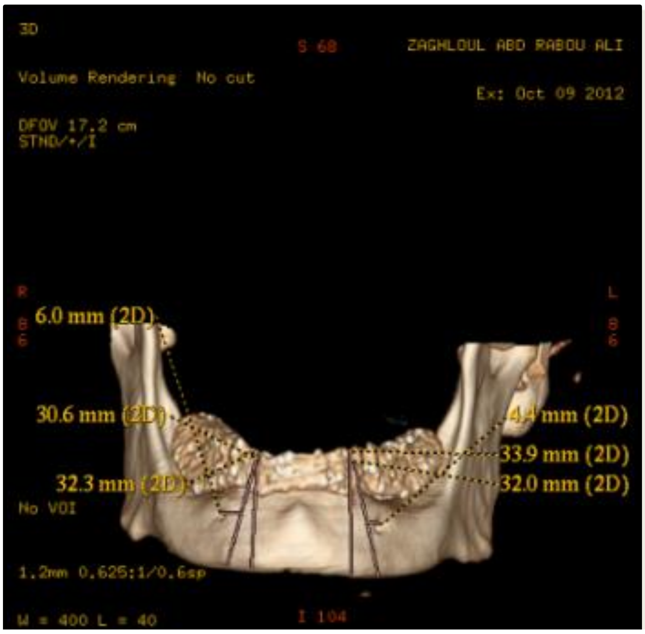


Fig. (5):CT scan (5mm axial cuts) to detect the marginal bone height around each implant after surgery.

III. Results

Measuring the distance between the inclined implant line at 15° and the mental foramen

Measuring the distance between the inclined implant line at 15° and the mental foramen of all patients of both sides were presented in (Table I and Graph I).

At the right side the mean 1 year stage was (7.19) which is lower than the left side mean which was (8.48) and that observed difference was statistically insignificant (p = 0.092).

On the initial examination after prosthesis insertion the mean of the distance between the inclined implant line and the mental foramen measurement scores of all patients for the right side was (7.99 - 7.99 - 8.03 -7.19) which was stable at most stages. It was observed that no difference & no change between the RT & LT sides both were stable.

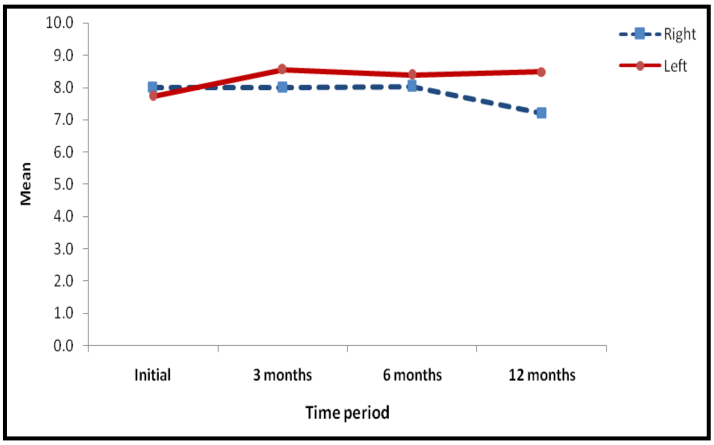
For left side the mean at 1, 3, 6 months and 1 year was (7.73 - 8.55 - 8.39 - 8.48) which nearly stable at all stages.

Table no I: Mean and standard deviation of the distance between the inclined implant line at 15° and the mental foramen of all patients of both sides.

M.F Side	Initial					3 months					6 months					After 1 year					P^+
	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	Minimum	Maximum	Mean	SD	Median	
Right	5.00	13.00	7.99	3.04	7.05	5.00	10.90	7.99	2.03	7.90	5.00	12.00	8.03	2.11	7.90	3.50	12.20	7.19	2.89	6.15	0.652
Left	4.90	11.00	7.73	2.43	7.10	5.80	13.40	8.55	2.53	8.00	4.40	12.60	8.39	2.42	8.00	5.20	11.90	8.48	2.23	8.40	0.785
P	**0.944**					**0.161**					**0.484**					**0.092**					

p: p value based on Wilcoxon test for two related samples

P +: P value based on Friedman test for several related samples



IV. Discussion

In a previous study done by Nagarajan et al.,[34] to evaluate a method of diagnostic imaging for dental implant therapy, it was concluded that the development of pre-surgical imaging techniques and surgical templates helps the dentist place the implants with relative ease which focuses on various types of imaging modalities that have a pivotal role in implant therapy which agree with our result.

In another overview studied by Moslehifard[35] showed different techniques of pre-surgical diagnosis and treatmentplanning with emphasis on computer assisted methods was given which reveals that computerassisted methods enhance the capability of prosthodontists to diagnose and choose aconvenient and easy to apply methods for implant placement and also this study agree with our result.

V. Conclusions

To avoid nerve injury during surgery in the foraminal area, guidelines were developed with respect to verifying the position of the mental foramen.

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 and predictability. Thus it is necessary to use the model casts supported by a Guide Stent and Computerized Tomgraphic (CT) that accurately determine the size and location of various anatomical structures at the proposed site for implant placement.

The implant is positioning to be precisely executed, and when safe positioning of implants with optimal use of available bone and save time for surgical work.

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