Research Article

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A Clinical Guide to Locate Mandibular Anterior Safe Zone for Implant Placement in Gujarati Edentulous Patients: CBCT Study

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ABSTRACT

Background: This clinical study was aimed to measure the safe zone between the right and left mental foramina by locating genial tubercle and mental foramen from the CBCT in Gujarati edentulous population.

Methods and Material: A total of 50 DICOM files from the CBCTs of Gujarati edentulous patients irrespective of gender were selected for the study. Genial tubercle, the anterior loop of inferior alveolar nerve and anterior border of the mental foramen were located and the distance between them was measured from crest of the ridge for both the side. To measure the safe zone, 2mm was deducted from the measurement obtained. Statistical analysis used: To analyze sex and side-related variations mixed 2-way analysis of variance (ANOVA) test was performed.

Results: The mean value for safe zone 15.28 mm on the right side was and 18.12 mm on the left side. The safe zone in women on the right side was 15 mm and in men was 15.08 mm. The safe zone in women on the right side was 17 mm and in men was 19.03 mm.

Conclusions: Sex-related difference was not significant but the difference between the right and left side safe zone within the same individuals was substantial.

Keywords: Implant-supported overdenture, Genial tubercle, Anterior border of mental foramen, Anterior loop of inferior alveolar nerve, CBCT, Interforaminal area.

INTRODUCTION

Preventive prosthodontics focuses on the significance of any treatment or procedure that can delay or eliminate the need for future prosthodontic problems. The ultimate objective of prosthodontics service is to return the patient to as nearly normal function as possible for that much attention should be on preservation of the residual ridge. Overdenture is one of the critical treatment modality in preventive prosthodontics. It is of two types, one is tooth supported overdenture and another is implant-supported overdenture.

An overdenture is defined as any removable prosthesis that covers and rests on one or more remaining natural teeth, the roots of natural teeth, and/or dental implants; a dental prosthesis that includes and is partially supported by natural teeth, natural tooth roots and/or dental implants. (GPT-9) When few firm teeth are present in an otherwise compromised dentition, they can be retained and used as abutments for tooth-supported overdenture fabrication. This will helps to improve final prosthesis retention and stability. The most

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important benefits of tooth-supported overdentures are the preservation of the residual alveolar supporting bone, increase in retention and stability of the prosthesis and maintenance of vertical dimension of occlusion. The patient also gets psychological advantages due to proprioceptive guidance obtained from remaining natural teeth. Over a period of time tooth supported overdenture may get converted to complete denture due to loss of abutment teeth because of caries or periodontal problems.

So when the patient becomes completely edentulous or patient has been presented with a completely edentulous state, implant-supported overdenture has to be planned. The implant-supported prosthesis will prevent anterior bone loss and improves aesthetics, stability, retention, support, speech, occlusion, chewing efficiency and force, occlusal ability, and decreases soft tissue abrasion. However, the financial concerns by the patient, implant-retained overdentures more frequently opt over fixed implant-supported prostheses. Apart from this, implant-supported overdentures enhances the phonetic presentation, eases oral hygiene which may not be convenient with a fixed implant-supported prosthesis. Further, implant-supported overdenture is indicated over fixed implant-supported prosthesis in case of atrophied ridges, poor quality of bone, excessive interarch distance and the wherein esthetic result can not be achieved satisfactorily.

For implant-supported overdenture, implants are placed between interforaminal region (OD-1 to OD-5, acc to Misch). The interforaminal region is an area between right and left sides of the mental foramen. It is a part of the anterior body of the mandible and from there the inferior alveolar nerve exits as the mental nerve.

In planning for implant-supported overdenture, to ascertain the exact location of implant site radiopaque markers are needed to be placed but frequently, to obtain the intended location of implant placement the position of the radiopaque marker needs to be changed. So the patient will need to go for another CBCT with a changed situation of radiopaque markers, and this will also cause more exposure of radiation to the patient. This can be avoided if we know the distance between interforaminal region and we place the radiopaque markers in the known distance only. To accomplish this we need clinically palpable landmarks from which measurements can be made.

The genial tubercle is one such static landmark which can be palpated clinically and also easily distinguishable in the radiograph. Measurements can be made intraorally by taking genial tubercle as a reference point from which location of radiopaque markers can be ascertained.

The mandibular anterior region is considered “surgical safe zone” as there is no superficial nerves and vessels are present. In edentulous patients surgeries in this region have become more frequent as of advances in the field of orthognathic surgeries, dental implant placement, bone grafting, and lowering genial spines procedures. However, recent data regarding sudden bleeding and sublingual hematoma after a surgical procedure like genioplasty and implant placement have encouraged research into the matter and the vascularity of the anterior mandibular area.

During endosseous dental implant osteotomy, inferior alveolar nerve (IAN) and the mental nerve can be injured and also an anterior loop of the inferior alveolar nerve may affect the site of an implant osteotomy as it is a most uncertain anatomic landmark in the mandibular premolar region. To plan implant osteotomy sites more effectively, further information is needed regarding the location, frequency and dimension of anterior nerve loop length of inferior alveolar nerve. This enlightenment can help us in determining the exact location of radiopaque markers and also can direct dental practitioners in the absence of cone-beam computed tomography (CBCT) for determining implant osteotomy site. No information is currently available for the safe zone between the interforaminal region in the Gujarati edentulous population. The purpose of this study was to ascertain the distance between right and left mental foramina from genial tubercle, and to check for equality between the right and left side measurements and also between male and female safe zone measurements, measured from genial tubercle to the anterior-most border of the loop of the IAN in a Gujarati edentulous population.

MATERIAL AND METHODS

Ethical clearance for the study was obtained from the institutional ethical committee. In this present CBCT study, 50 Gujarati edentulous patients CBCT-

Digital Imaging and Communications in Medicine (DICOM) files were identified and selected from the total available data. According to the below-mentioned inclusion and exclusion criteria, the CBCT-DICOM files were excerpted.

Inclusion criteria: CBCT-DICOM files showing edentulous mandibular ridge without any congenital or developmental deformities.

Exclusion criteria: Presence of any rarefaction area, a disorder affecting mandible, traumatic fracture, cystic lesion, a benign or malignant tumour affecting the mandible or distorted or blurred CBCT images.

Excerpted files were then uploaded on the software (OnDemand 3D) to assess the anatomy of the mandible. The software provided visualisation of horizontal sectional view, coronal cross-sectional view and panoramic view on the same screen. The anatomy of mandible was first evaluated in each view that is horizontal sectional view, coronal cross-sectional view and panoramic view. The inferior alveolar nerve was then traced and then genial tubercle, anterior most border of mental foramina, and anterior border of the loop of the mandibular nerve image were located and marked in all the above-mentioned views. After identification of these key landmarks, the corresponding landmark was transferred over the crestal area of the ridge as we will measure the distance intraorally from the crestal level. Figure 1 shows the schematic representation of the reference point to be marked at the crestal level to facilitate the following measurements.

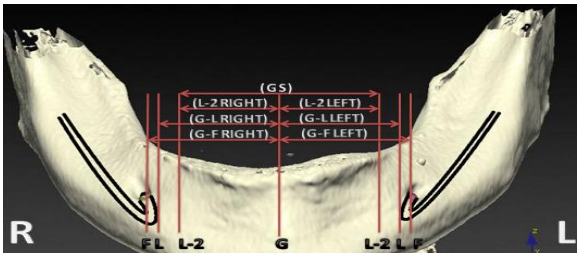


Fig 1: Schematic representation of CBCT image showing measurements to be made for finding the safe zone

1) F-F (F-right to F- left):- Denotes the distance between the right and left mental foramen measured from its most anterior border at crest of the ridge.

2) L-L (L- right to L- left):- Denotes the distance between the right and left anterior loop of inferior alveolar nerve measured from its most anterior border at the crest of the ridge.

3) G to F (F- right to F- left):- Denotes the distance measured from midpoint of genial tubercle to the right and left anterior-most border of mental foramen respectively at the crest of the ridge

4) G to L (L- right to L- left):- Denotes the distance measured from midpoint of genial tubercle to the right and left anterior-most border of anterior loop of inferior alveolar nerve respectively at the crest of the ridge.

5) GS:- Denotes the safe zone measured between right and left mental foramen region after reduction of 2 mm from both the sides. It can be calculated as follows: [S= 2 mm – L right (L-2 right + 2 mm - L left (L-2 left)][1].

6) GS right and GS left:- Denotes the safe zone for right and left side separately.

It can be calculated as follows: GS=GS right + GS left

GS right denotes the measurement made between G and L-2 on the right side and GS left denotes the measurement made between G and L-2 on the left side.

Screenshots were taken from the on-demand 3D software for the stepwise measurements to be made in measuring the safe zone (Figures 2A-4B).

Slide number with a prominent projection of genial tubercle is located and verified in horizontal, panoramic and cross-sectional view (Figures 2A-2C).

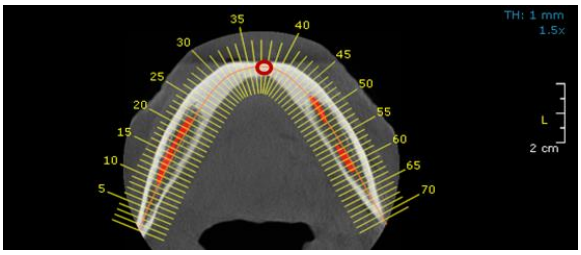


Fig 2A: Horizontal view showing the genial tubercle was located and marked at 37 slide number.

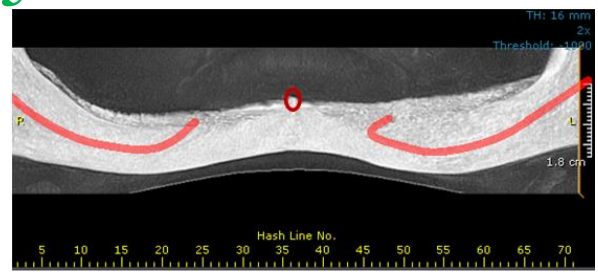


Fig 2B: Panoramic view showing the genial tubercle was located and marked at 37 slide number.

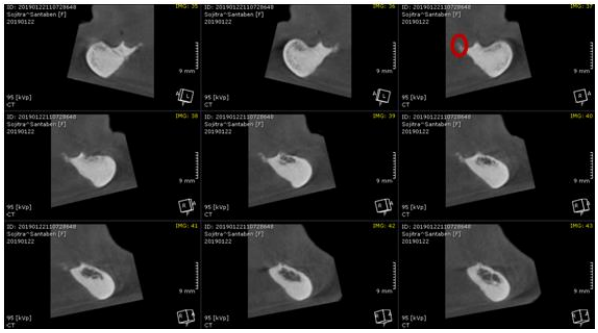


Fig 2C: Coronal cross-section view showing the genial tubercle was located and marked at 37 slide number.

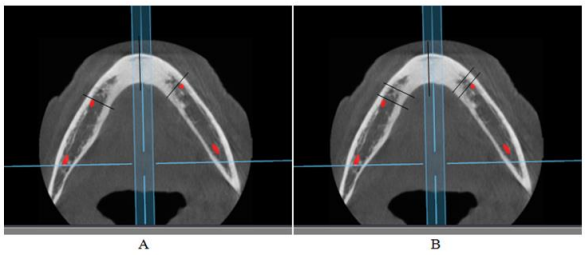


Fig 3A: Horizontal view showing markings at the anterior-most border of mental foramen on the right and left side.

Fig 3B: Horizontal view showing the anterior-most border of the anterior loop of inferior alveolar nerve marked in on the right and left side.

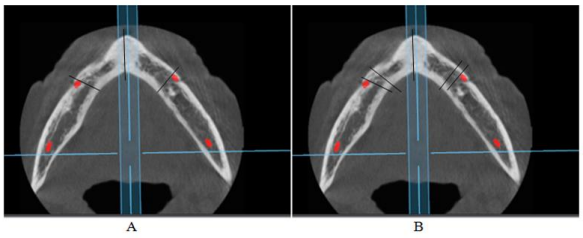


Fig 4: Markings of genial tubercle, anterior most border of mental foramen and an anterior-most border of the anterior loop of inferior alveolar nerve were transferred over the crest of the ridge to measure the safe zone.

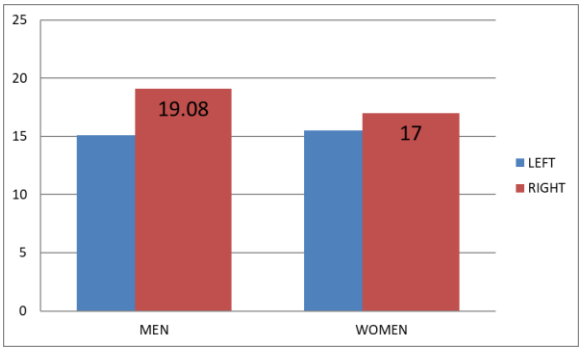
Fig 3A: Horizontal view showing markings at the anterior-most border of mental foramen on the right and left side at the crest of the ridge.

Fig 3B: Horizontal view showing the anterior-most border of the anterior loop of inferior alveolar nerve marked in on the right and left side at the crest of the ridge.

For selected 50 CBCT-DICOM files distance was measured from genial tubercle (G) to the 2 mm minus of anterior most border of anterior loop of the inferior alveolar nerve (L-2) on the right and left side to measure the safe zone at crestal level. Then, data obtained from 50 CBCT were calculated for mean values and they were subjected for statistical evaluation. Mean, median, minimum and maximum values were evaluated. The median value will help in computing difference with the mean values and avoid the influence of extreme values for right and left side. To compute the variation of the safe zone between male and female and between right and left side a mixed 2-way analysis of variance (ANOVA) test were carried out using statistical software (IBM SPSS Statistics v24; IBM Corp).

RESULTS

Graph 1: Statistically significant difference was present between the safe zone of right and left side ($P<0.04$) but there was no statistically significant difference present between the safe zone of the right side in male and female and on the left side in male and female($P=0.455$)



For men, on the left side, the safe zone distance measured as a mean of 50 CBCT-DICOM files was 19.03 mm and on the right side was 15.08 mm. From the genial tubercle to the left side safe zone the

maximum value observed was 30.0 mm and on right side was 26.0 mm.

For women, on the left side, the safe zone distance measured as a mean of 50 CBCT-DICOM files was 17.0 mm and on the left side was 15.0 mm. From the genial tubercle to the left side safe zone, the maximum value observed was 24.0 mm and on the right side was 24.0 mm. The mean value distance for safe zone considering 50 CBCT-DICOM files measured from the genial tubercle to the left side was 18.12 mm and 15.28 mm to the right side.

Table 1: Shows the values of distance(mm) measured from genial tubercle to anterior most border of mental foramina, anterior most border of anterior loop of inferior alveolar, and there related safe zone for right and left side in Gujarati edentulous CBCT-DICOM files.

	MEN(N=24)				WOMEN(N=26)				TOTAL(N=50)			
ANATOMICAL LOCATION	MEAN	MEDIUM	MAX	MIN	MEAN	MEDIUM	MAX	MIN	MEAN	MEDIUM	MAX	MIN
FORAMEN LEVEL												
G-left foramen	21.1	22	26	16	20.8	22	28	10	21.02	22	31	10
G-right foramen	19.1	20	26	12	18.3	18	28	10	18.9	18	28	10
ANTERIOR LOOP LEVEL												
G-left loop	19.1	20	24	12	18.6	20	26	8	18.88	20	26	8
G-right loop	17	18	24	10	16.3	16	26	8	16.9	16	26	8
SAFE ZONE												
G-left loop 2mm	19.03	20	30	12	17	18	24	6	18.12	18	30	6
G-right loop 2mm	15.08	16	26	4	15	16	24	6	15.28	16	26	4

Table 2: safe zone measurements on right and left side for men and women in Gujarati population

SIDE	PARTICIPANTS	N	MEAN +/- STANDARD DEVIATION
LEFT	MEN	24	19.03 +/- 5.2
	WOMEN	26	17 +/- 4.3
	OVERALL	50	18.12 +/- 4.8
RIGHT	MEN	24	15.08 +/- 4.1
	WOMEN	26	15 +/- 4.3
	OVERALL	50	15.28 +/- 4.4

DISCUSSION

Nowadays, as the life expectancy of people has increased so does the period of edentulism also increases, people usually now select for fixed or long term treatment options. Implant-supported overdenture is preventive and also most frequently planned treatment option for such patients. Bone is a dynamic tissue that continues to response under function, so when the teeth are lost it will lead to bone resorption, it will also decrease patient's neuromuscular function and proprioceptive response due to loss of receptor in PDL. Objectives of complete denture fabrication are retention, support, stability, esthetics and preservation of remaining structures. Frequently in the mandibular complete denture, retention is usually a problem especially when we compared the retention obtained from its maxillary counterpart. This is because of the increase in surface area in maxillary denture when compared with a mandibular complete denture.

Overdenture is one of preventive prosthodontic treatment option for such patient. To enhance retention and stability of conventional dentures, the concept of overdentures were introduced by fixing mechanical attachments to teeth roots. Whenever

the tooth is present, and it can be retained than we must opt for tooth-supported overdenture option, but once the patient gets completely edentulous in that case, implant-supported overdenture can be planned if patient financially can't afford for fixed prosthesis.

Implant placement procedure should pose no risk of damage to the adjacent anatomic structure, be a safe treatment option while also satisfying the esthetic and functional demands of the patient. To prevent injury during implant placement selection of an appropriate site is essential. Results derived from this study can help us in the initial treatment planning of dental implant locations in between the right and left mental foraminal region of the mandible.

In this present study, I have used genial tubercle and mental foramen to calculate safe zone. These reference points can be located easily correlated both intraorally as well as radiographically. For both right and left side, the safe zone calculated was distance measured from genial tubercle to 2mm minus anterior-most border of anterior loop of the inferior alveolar nerve(L-2). Lu et al[2] in his study identified that in 85.2% of patients the length of anterior loop of the mental nerve was 1.46 ±1.25 mm, without any statistically significant side (right and left) and sex-related differences. Juan et al. also has conducted a similar study in Mexican population and had concluded that the length of the anterior mental nerve loop is between 0 and 6.68mm, with a mean value of 2.19 mm.

From the present study, the mean distance of the safe zone in Gujarati edentulous population was 18.12 mm for the left side and 15.28 mm for the right side (table 1). Similar results were obtained by the study done by Yik Sze Voon in 2017 in Chinese-Malaysian population[1]. This difference in the right and left side of the mandibular anatomical landmark is to be due to normal developmental procedure[8]. So when the clinician is aware of the mean safe zone for the specific population between interforaminal region, then they can easily mark the safe zone distance on the right and left side from the genial tubercle by utilizing the data obtained from this study. This will enable the clinician in initial treatment planning regarding a number of implants that can be placed and the determination of the location of implant placement can quickly be done. Then this location can be easily transferred to the diagnostic stent and then the patient is sent for radiographic evaluation. So this will eliminate the need for second CBCT data which otherwise, might well be required if we intend to change the location of the implant osteotomy site.

These results can also be helpful in comparing the safe zone in different ethnic groups or population. In peripheral areas and also in dental clinics, CBCT scans are usually not available so this data can be helpful to them in implant placement within the safe zone without the requirement of CBCT. Genial tubercle and mental foramina are the static landmarks and their position doesn't change with the resorption of bone in a horizontal direction.

Limitation of this study is that the location of genial tubercle and anterior loop of the mental nerve might differ at crestal level in a horizontal plane. However, these differences don't cause significant differences in measurements of the safe zone as it is very minimal. More numbers of samples can be used to predict a better result. In a clinical situation, the measurement will be made from mucosal level but here I had used bony crestal level which might can cause alteration but this difference is also minimal.

CONCLUSIONS

The following conclusions were drawn based on this present study :

1. The genial tubercle which is a static landmark is used to measure safe zone between right and left mental foramen as it can be palpated easily intraorally as well as its position can be easily located on CBCT-DICOM image.

2. Within the same individual, there is a significant difference in the right and left side safe zone.

3. The mean value distance for safe zone considering 50 CBCT-DICOM files measured from the genial tubercle to the left side was 18.12 mm and 15.28 mm to the right side without any sex-related difference.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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