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Original Research

Pre-surgical assessment of dental implant placement site using cone beam computed tomography

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ABSTRACT:
Background: Dental rehabilitation programmes for individuals with missing teeth now include the insertion of dental implants. The present study was conducted with the aim of pre- surgical assessment of dental implant placement site using cone beam computed tomography (CBCT). **Materials & Methods:** 200 patients requiring dental implant in either of the jawswere subjected to CBCT scan depending upon the edentulous site using Newtom Giano CBCT machine**.** Parameters such as bone height, bone width, maxillary sinus, inferior alveolar nerve canal and jaw pathologies etc. was recorded. **Results:** Out of 200 patients, males were 107 (53.5%) and females were 93 (46.5%).Out of 103 implant sites, subantral class (SAC) 1 was seen in 38, 2 in 28, 3 in 21 and 4 in 16sites. 18 patients showed sinus opacification. A non- significant difference was observed in subantral class (P> 0.05). Inferior alveolar nerve canal level was high in 15, intermediate in 19 and low in 39 implant sites. IAC pattern was straight in 53, perpendicular in 18 and anterior loop was seen in 3 sites. A significant difference was observed in level and pattern of inferior alveolar nerve canal (P< 0.05). Common pathologies observed was root pieces in 10 (5%) patients. **Conclusion:** CBCT are used to perform multidimensional, presurgical assessment of anatomy, thereby reducing the possibilities of incorrect implant placements, which can result in untoward sequelae, such as perforations of cortical borders and invasions of adjacent structures.
Keywords: Bone height, CBCT, Dental implants

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INTRODUCTION

Dental rehabilitation programmes for individuals with missing teeth now include the insertion of dental implants. The clinician chooses the optimum implant placement sites by taking into account anatomical and prosthetic aspects. Wherever there is the greatest probability of success, dental implants should be inserted in that site.[1] In addition to being placed in the space left by a lost tooth, an implant must also meet restorative, aesthetic, biomechanical, and functional requirements.[2]

Depending on the number of lost teeth, the patient may need one or several implants. Overdentures supported by implants are now the preferred treatment for patients who are totally edentulous.[3]Successful implant treatment depends on efficient planning which includes assessment of height, width, morphology, as well as identification and location of anatomical landmarks. Bone height is measured from alveolar crest to important anatomical structures. Most implant systems require bone widths of 5 to 7 mm.[4] Recommendations for successful results ideally require at least 1 mm of bone surrounding each implant. Careful evaluation of anatomical landmarks such as nasopalatine canal, nasal fossae, maxillary sinus, zygomatic bone, pterygoid process, inferior alveolar nerve canal (IANC), mental foramen, incisive canal and lingual foramen helps in treatment

planning.[5]The present study was conducted with the aim of pre- surgical assessment of dental implant placement site using cone beam computed tomography (CBCT).

MATERIALS & METHODS

The present study was conducted on 200 patients of both genders visiting the department of Oral Medicine & Radiology, Dasmesh Institute of Research & Dental Sciences, Faridkot (Punjab) requiring dental implant in either of the jaws. The study protocol was approved by the ethical committee. Patients were informed regarding the study and written consent was obtained.
Data such as name, age, gender etc. was recorded. A thorough oral examination was carried out. Patients were subjected to CBCT scan depending upon the edentulous site using Newtom Giano CBCT machine operating at 90 kVp and 1-10 mA with field of view (FOV) ranging from 5X5 cm to 11X8 cm and voxel size of 0.3 mm X 0.3 mm X 0.3 mm. NNT software and slice thickness of 0.3 mm was used. All three planes such as coronal plane, sagittal plane and axial plane were obtained.Parameters such as bone height, bone width (Fig- 1), maxillary sinus, inferior alveolar nerve canal (Fig- 2) and jaw pathologies etc. was recorded. Results thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

RESULTS

Table I Distribution of patients

Total- 200		
Gender	**Male**	**Female**
Number (%)	107 (53.5%)	93 (46.5%)

Out of 200 patients, males were 107 (53.5%) and females were 93 (46.5%).

Table II Assessment of bone height based on age group

Age group (Years)	Region	Mean	SD	P value
18-27	Maxillary incisors	16.6	2.3	0.001
	Maxillary canine	16.9	1.2	
	Maxillary Premolars	17.8	2.7	
	Maxillary molars	7.4	2.1	
	Mandibular incisors	28.4	7.6	
	Mandibular molars	14.9	1.1	
28-37	Maxillary incisors	14.1	4.3	0.52
	Maxillary Premolars	11.4	1.8	
	Maxillary molars	12.6	0.5	
	Mandibular incisors	29.2	1.0	
	Mandibular Premolars	13.6	1.3	
	Mandibular molars	14.7	1.9	
38-47	Maxillary incisors	17.5	4.4	0.01
	Maxillary Premolars	15.3	4.6	
	Maxillary molars	9.1	3.4	
	Mandibular incisors	24.4	11.3	
	Mandibular Premolars	10.5	0.7	
	Mandibular molars	11.9	3.1	
48-57	Maxillary incisors	13.1	3.5	0.05
	Maxillary Canine	15.6	3.8	
	Maxillary Premolars	12.0	2.2	
	Maxillary molars	6.0	3.3	
	Mandibular incisors	17.6	6.3	
	Mandibular Premolars	15.0	1.6	
	Mandibular molars	13.5	1.7	
58-67	Maxillary incisors	14.6	2.1	0.02
	Maxillary Premolars	15.7	1.4	
	Maxillary molars	6.8	3.2	
	Mandibular incisors	27.2	2.6	
	Mandibular Premolars	17.7	8.3	
	Mandibular molars	12.5	3.3	
68- 80	Maxillary incisors	12.1	3.9	0.04
	Maxillary Canine	15.3	3.3	

	Maxillary Premolars	12.1	4.9	
	Maxillary molars	8.6	2.5	
	Mandibular incisors	29.1	0.2	
	Mandibular canine	15.5	1.3	
	Mandibular molars	12.3	2.7	

In age group 18-27 years, mean bone height in maxillary incisors found to be 16.6 mm, in canines 16.9 mm, in premolars 17.8 mm, in molars was 7.4 mm, in mandibular incisors was 28.4 mm and in mandibular molars was 14.9 mm. A significant difference was observed (P< 0.05). In age group 28-37 years, mean bone height in maxillary incisors was 14.1 mm, in maxillary canine was 11.4 mm, in premolar was 11.4 mm, in in maxillary molar was 12.6 mm, in mandibular incisors was 29.2 mm, in premolars was 13.6 mm and in mandibular molars was 14.7 mm. A non- significant difference was observed (P> 0.05). In age group 38-47 years, mean bone height in maxillary incisors was 17.5 mm, in maxillary premolars was 15.3 mm, in maxillary molars was 9.1 mm, in mandibular incisors was 24.4 mm, in premolars was 10.5 mm and in molars was 11.9 mm. A significant difference was observed (P< 0.05). In age group 48-57 years, mean bone height in maxillary incisors was 13.1 mm, maxillary canine was 15.6 mm, in maxillary premolars was 112.0 mm and in maxillary molars was 6.0 mm, in mandibular incisors was 17.6 mm, in premolars was 15.0 mm and in molars was 13.5 mm. A significant difference was observed (P< 0.05). In age group 58-67 years, mean bone height in maxillary incisors was 14.6 mm, in maxillary premolars was 15.7 mm and in maxillary molars was 6.8 mm and in mandibular incisors was 27.2 mm, premolars was 17.7 mm and in molars was 12.5 mm. A significant difference was observed (P< 0.05). In age group 68-80 years, mean bone height in maxillary incisors was 12.1 mm, canine was 15.3 mm, premolars was 12.1 mm and in molars was 8.6 mm and in mandibular incisors was 29.1 mm, in canine was 15.5 mm and in mandibular molar was 12.3 mm. A significant difference was observed (P< 0.05).

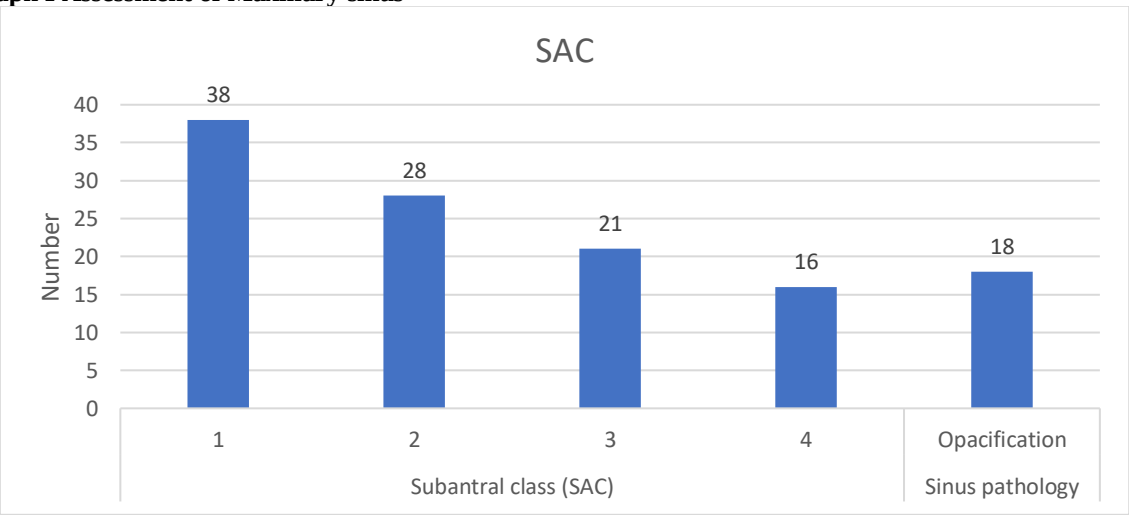
Table III Assessment of bone width based on age group

Age group (Years)	Region	3 mm		6 mm	
		Mean	SD	Mean	SD
18-27	Maxillary incisors	4.8	1.5	6.0	1.3
	Maxillary canine	3.5	1.4	4.3	1.3
	Maxillary Premolars	7.7	2.2	9.2	2.5
	Maxillary molars	8.0	0.7	9.5	1.4
	Mandibular incisors	5.4	1.4	6.5	0.5
	Mandibular molars	4.6	2.4	6.1	2.6
	P value	0.001		0.002	
28-37	Maxillary incisors	4.7	1.3	5.2	1.1
	Maxillary Premolars	6.0	2.1	7.8	2.7
	Maxillary molars	6.1	0.2	8.4	0.1
	Mandibular incisors	4.1	0.1	5.3	0.2
	Mandibular Premolars	5.1	0.3	7.7	0.1
	Mandibular molars	8	2.1	10.0	3.3
	P value	0.001		0.001	
38-47	Maxillary incisors	4.3	1.8	5.4	1.5
	Maxillary Premolars	5.7	1.3	7.1	1.2
	Maxillary molars	8.5	2.6	9.6	1.9
	Mandibular incisors	3.7	0.6	5.3	1.5
	Mandibular Premolars	4.5	0.2	5.8	0.5
	Mandibular molars	7.0	2.8	8.7	2.2
	P value	0.02		0.04	
48-57	Maxillary incisors	5.5	1.5	6.2	1.3
	Maxillary canine	3.4	0.1	4.6	0.2
	Maxillary Premolars	6.4	2.0	7.8	2.2
	Maxillary molars	7.1	2.1	10.3	2.4
	Mandibular incisors	3.0	0.8	4.5	1.6
	Mandibular Premolars	7.5	0.6	9.0	1.1
	Mandibular molars	7.2	2.4	9.2	2.5
	P value	0.01		0.03	
58-67	Maxillary incisors	3.6	1.1	4.7	1.2

	Maxillary Premolars	6.2	1.8	7.6	1.7
	Mandibular incisors	6.0	1.4	6.9	1.8
	Mandibular Premolars	4.3	0.6	6.5	1.0
	Mandibular molars	5.9	1.8	8.8	2.0
	P value	0.00		0.02	
68- 80	Maxillary incisors	4.0	1.1	5.3	0.9
	Maxillary Canine	4.3	1.6	5.2	1.3
	Maxillary Premolars	6.5	2.0	7.6	2.3
	Maxillary molars	6.3	2.8	11.4	2.3
	Mandibular incisors	5.5	0.5	7.0	0.8
	Mandibular canine	6.4	1.6	7.3	1.5
	Mandibular Premolars	6.6	0.2	7.6	0.4
	Mandibular molars	5.8	0.8	9.0	2.5
	P value	0.02		0.01	

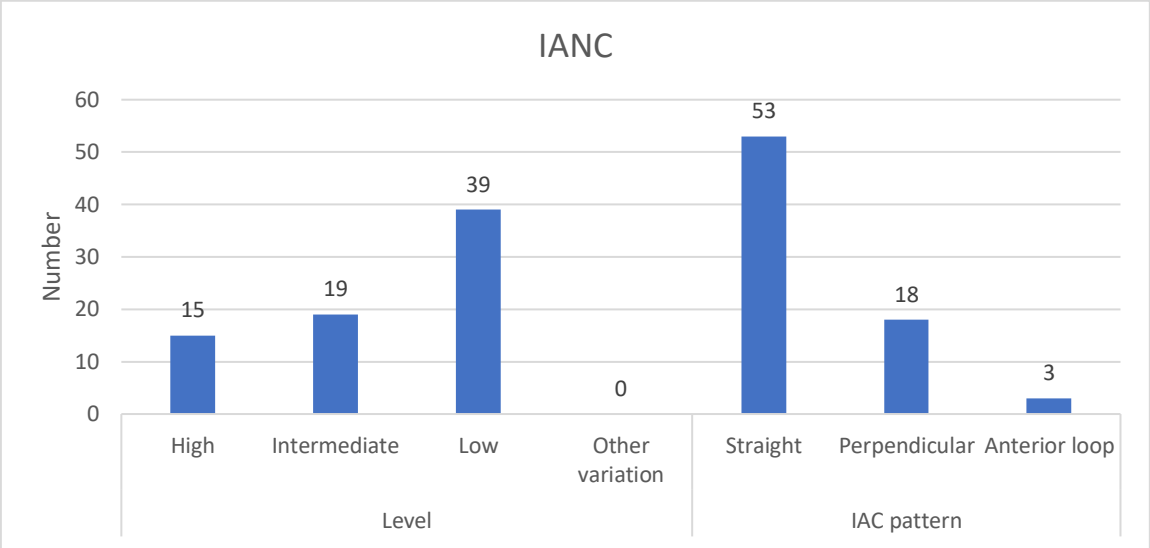
In age group 18-27 years, mean bone width at 3 mm and 6 mm in maxillary incisors found to be 4.8 mm and 6.0 mm, in canines was 3.5 mm and 4.3 mm, in premolars was 7.7 mm and 9.2 mm, in molars was 8.0 mm and 9.5 mm, in mandibular incisors was 5.4 mm and 6.5 mm, and in mandibular molars was 4.6 mm and 6.1 mm respectively. A significant difference was observed (P< 0.05).In age group 28-37 years, mean bone width at 3 mm and 6 mm in maxillary incisors was 4.7 mm and 5.2 mm, in maxillary premolars was 6.0 mm and 7.8 mm, in maxillary molars was 6.1 mm and 8.4 mm, in mandibular incisors was 4.1 mm and 5.3 mm, in mandibular premolar was 5.1 mm and 7.7 mm and in mandibular molars was 8.0 mm and 10.0 mm. A significant difference was observed (P< 0.05).In age group 38-47 years, mean bone width at 3 mm and 6 mm in maxillary incisors was 4.3 mm and 5.4 mm, in maxillary premolars was 5.7 mm and 7.1 mm, in maxillary molars was 8.5 mm and 9.6 mm, in mandibular incisor was 3.7 mm and 5.3 mm, in premolars was 4.5 mm and 5.8 mm and in molars was 7.0 mm and 8.7 mm respectively. A significant difference was observed (P< 0.05).In age group 48-57 years, mean bone width at 3 mm and 6 mm in maxillary incisors was 5.5 mm and 6.2 mm, maxillary canine was 3.4 mm and 4.6 mm, in maxillary premolars was 6.4 mm and 7.8 mm, in molars was 7.4 mm and 10.3 mm, in mandibular incisors was 3.0 mm and 4.5 mm, in premolars was 7.5 mm and 9.0 mm and in molars was 7.2 mm and 9.2 mm respectively. A significant difference was observed (P< 0.05).In age group 58-67 years, mean bone width at 3 mm and 6 mm in mandibular incisors was 3.6 mm and 4.7 mm, premolars was 6.2 mm and 7.6 mm and in mandibular incisors was 6.0 mm and 6.9 mm, in premolars was 4.3 mm and 6.5 mm and in mandibular molars was 5.9 mm and 8.8 mm respectively. A significant difference was observed (P< 0.05).In age group 68-80 years, mean bone width at 3 mm and 6 mm in maxillary incisors was 4.0 mm and 5.3 mm, canine was 4.3 mm and 5.2 mm, premolars was 6.5 mm and 7.6 mm, in maxillary molars was 7.3 mm and 10.4 mm, in mandibular incisors was 5.5 mm and 7.0 mm and in canine was 6.4 mm and 7.3 mm, in mandibular premolar was 6.6 mm and 7.6 mm and in mandibular molars was 5.8 mm and 9.0 mm respectively. A significant difference was observed (P< 0.05).

Graph I Assessment of Maxillary sinus



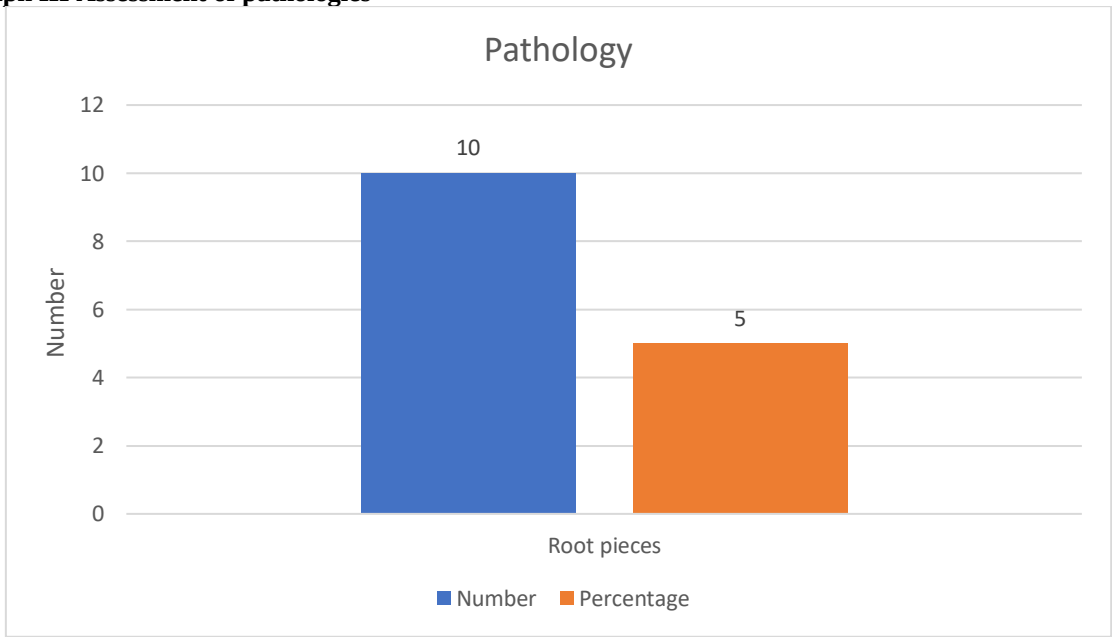
Out of 103 implant sites, subantral class (SAC) 1 was seen in 38, 2 in 28, 3 in 21 and 4 in 16sites. 18 patients showed sinus opacification. A non- significant difference was observed in subantral class (P> 0.05).

Graph II Assessment of inferior alveolar nerve canal



Inferior alveolar nerve canal level was high in 15, intermediate in 19 and low in 39 implant sites. IAC pattern was straight in 53, perpendicular in 18 and anterior loop was seen in 3 sites. A significant difference was observed in level and pattern of inferior alveolar nerve canal (P< 0.05).

Graph III Assessment of pathologies



Common pathologies observed was root pieces in 10 (5%) patients.

Fig 1- CBCT image shows bone height & Bone width

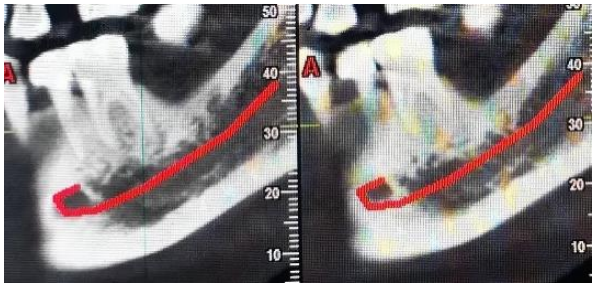


Fig 2- CBCT image shows anterior loop

DISCUSSION

Implant dentistry has emerged as a major component of dental practice in response to a large number of people who have some or all of their teeth missing. Today, dental implants are an acceptable alternative, capable of providing bone-anchored prostheses for improved quality of life and self-esteem for many of the patients. It has frequently been noted that during implant surgery, doctors positioned implants in areas with the most bone volume without completely accounting for the final location of the crown. In preoperative, surgical, and post-prosthetic implant imaging, radiographs are crucial.[6] Because the pictures produced by conventional radiography techniques only show one (facial) aspect of the maxilla and mandible and have unpredictable magnification, they cannot accurately assess the quality and quantity of accessible bone. To obtain as much information as possible regarding the implant site, computed tomography (CT) and cone beam computed tomography (CBCT) have so taken their position. Despite their ideality, these methods nevertheless have a number of drawbacks, including high radiation doses, metal artifacts, expensive costs, and limited access to precise software.[7] The present study was conducted with the aim of pre- surgical assessment of dental implant placement site using cone beam computed tomography (CBCT).

We found that out of 200 patients, males were 107 (53.5%) and females were 93 (46.5%). In our study, out of 103 implant sites, subantral class (SAC) 1 was seen in 38, 2 in 28, 3 in 21 and 4 in 16sites. 18 patients showed sinus opacification. Nunes et al[8] confirmed a high percentage of edentulous sites in the posterior maxilla require sinus floor elevation to allow placement of dental implants. It has been observed that sinus volume increases following tooth extraction. Moreover, prolong edentulism and old age leads to pneumatization of sinus therefore the bone height between the floor of the maxillary sinus and alveolar bone needs careful evaluation prior to implant insertion. There should be 1.5-2mm distance between floor of maxillary sinus and dental implant for success of treatment.

We observed that inferior alveolar nerve canal level was high in 15, intermediate in 19 and low in 39 implant sites. IAC pattern was straight in 53, perpendicular in 18 and anterior loop was seen in 3 sites (Fig- 2). Nortje et al[9] classified mandibular canal into type A = a high MC (within 2 mm of the apices of the first and second molars); B = an intermediate MC; C = a low MC and D = other variations (duplication or division of the MC, apparent partial or complete absence of the canal or lack of symmetry). Nortje et al[9] found an occurrence of 0.9% of bifid IAN canal.

We found that common pathologies observed was root pieces in 10 (5%) patients. Jaw pathology in the proposed implant site or within the maxillofacial regions is important to detect, diagnose, treatment plan and treatment sequence. Abnormalities involving the alveolar ridge include retained root tips, inflammatory processes, cyst and tumors etc.[10]

The American Academy of Oral and Maxillofacial Radiology (AAOMR) recently recommended CBCT as the best option. AAOMR recommended that CBCT should be considered as the imaging modality of choice for preoperative cross- sectional imaging of potential implant sites.[11]Cone beam computed tomography (CBCT) systems have become available for 3D visualization of the craniofacial complex. CBCT produces views and volumetric reconstructions of craniofacial structures similar to multi-slice conventional computed tomography (CT); however, it does so with reduced acquisition times, lower effective radiation doses, and a decreased financial burden compared with CT.[12]

CONCLUSION

CBCT are used to perform multidimensional, presurgical assessment of anatomy, thereby reducing the possibilities of incorrect implant placements, which can result in untoward sequelae, such as perforations of cortical borders and invasions of adjacent structures.

REFERENCES

1. Juodzbalys, G. and Kubilius, M., 2013. Clinical and radiological classification of the jawbone anatomy in endosseous dental implant treatment. Journal of oral & maxillofacial research 2013;4(2):1-17.
2. Choquet, V., Hermans, M., Adriaenssens, P., Daelemans, P., Tarnow, D.P. and Malevez, C. Clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants. A retrospective study in the maxillary anterior region. Journal of periodontology 2001;72(10);.1364-1371.
3. Lekholm U, Zarb GA. In: Patient selection and preparation. Tissue integrated prostheses:

osseointegration in clinical dentistry. Branemark PI, Zarb GA, Albrektsson T, editor. Chicago: Quintessence Publishing Company 1985;199–209.
4. Misch CE. Bone character. Second vital implant criterion, Dent today 1988;7:39-40.
5. Kircos LT, Misch CE. Diagnostic imaging and techniques in Misch CE, Editor: Contemporary implant dentistry, Ed 2. St Louis, Mosby. 1999.
6. Angelopoulos, C., Thomas, S., Hechler, S., Parissis, N. and Hlavacek, M. Comparison between digital panoramic radiography and cone-beam computed tomography for the identification of the mandibular canal as part of presurgical dental implant assessment. Journal of Oral and Maxillofacial Surgery 2008;66(10):2130-2135.
7. Nasseh, I., Aoun, G. and Sokhn, S. Assessment of the nasopalatine canal: An anatomical study. Acta Informatica Medica2017; 25(1):34- 38.
8. De Souza Nunes, L.S., Bornstein, M.M., Sendi, P. and Buser, D. Anatomical characteristics and dimensions of edentulous sites in the posterior maxillae of patients referred for implant therapy. International journal of periodontics & restorative dentistry 2013;33(3).
9. Nortje, C.J., Farman, A.G. and Grotepass, F.W. Variations in the normal anatomy of the inferior dental (mandibular) canal: A retrospective study of panoramic radiographs from 3612 routine dental patients. British Journal of Oral Surgery 1977;15(1):55-63.
10. Zygogiannis K, Aartman IHA, Parsa A, van der Stelt PF, Wismeijer D. Implant Size Selection and Location of Anatomical Structures Prior to Implant Placement to Retain Mandibular Overdentures: Panoramic Radiographs vs Cone Beam Computed Tomography. JSM Dent 2017;5(1):1081.
11. Tyndall, D.A., Price, J.B., Tetradis, S., Ganz, S.D., Hildebolt, C. and Scarfe, W.C.Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. Oral surgery, oral medicine, oral pathology and oral radiology 2012; 113(6):817-826.
12. Chau, A.C. and Fung, K. Comparison of radiation dose for implant imaging using conventional spiral tomography, computed tomography, and cone-beam computed tomography. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology 2009;107(4): 559-565.