WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES
SJIF Impact Factor 7.421
Volume 8, Issue 2, 828-842 Research Article ISSN 2278 – 4357

CBCT GUIDED IMPLANT PLANNING – A RETROSPECTIVE STUDY

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Article Received on
04 Dec. 2018,

Revised on 25 Dec. 2018,
Accepted on 15 Jan. 2019

DOI: 10.20959/wjpps20192-13076

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ABSTRACT

Background: Cone beam computed tomography is the new technical development in the modern era which is a boon to the dentists for the planning of implant placement. **Aim:** The aim of our study is to prove that cone beam computed tomography will be the guiding tool for placement of implant in different clinical situations. **Materials and Methods:** In this study, cone beam computed tomography data of five patients with different clinical situations, scanned for implant placement were retrieved. The scan was performed using Planmeca Promax CBCT Scanner and Romexis Software was used for the assessment. Then planning was executed for implant placement in these situations. **Conclusion:** Cone beam computed tomography proves to be a valuable tool for the planning and placement of the implant.

KEYWORDS: CBCT, Implant planning, Romexis Software, Site specific recommendation, Radiography.

INTRODUCTION

The introduction of endosseous implant treatment has initiated a revolution in oral rehabilitation for both partially and fully edentulous patients. The clinical application of this concept of osseointegration was introduced in the mid sixties[1,2] soon revealed a predictable long term success.[3] Nowadays the use of implants is even more popular for the replacement of a single missing tooth.[4] Only an exhaustive and comprehensive radiological assessment

can provide the necessary information to select such optimal sites and the number and size of implants to be placed. The selection of the radiological technique should be based on weighing the required image quality against the radiation risks and costs involved.[5] In the perspective of implant surgery, a correct identification of some anatomic structures such us the mandibular canal is important to avoid nerve damage or other perioperative complications. In a position paper by the American Academy of Oral and Maxillofacial Radiology(AAOMR), Tyndall and Brooks[6] recommend that conventional cross-sectional tomography should be the method of choice for most implant patients. Nevertheless, the authors state that currently there is no scientific evidence for their recommendation. The ideal goal of the radiographic examination is to achieve as much information of the jaw bone as much as possible and at the same time to minimize the radiation burden to the patient.

Radiographic techniques, including intraoral, panoramic, and cephalometric imaging, are the conventional methods for implant treatment planning. However, these techniques limit proper evaluation, as they only provide a 2-dimensional image of the mesial-distal and occlusal-apical anatomy. Additionally, the most important criteria for implant selection and success is the availability of adequate occlusal-apical bone height and the buccal-lingual width and angulation. With traditional radiographs, neither buccal-lingual width nor angulation can be determined.

Panoramic radiographs have also been shown to over estimate implant length during treatment planning because of the inherent magnification in the imaging process. Overestimating implant depth can result in injury to adjacent anatomical structures (eg, floor of the maxillary sinus, inferior alveolar nerve) during implant placement. Additional complications from imaging distortion and superimposition can compromise the accuracy of treatment planning with conventional techniques.[7]

In the recent years, CBCT is a relatively new imaging modality, Cone-Beam CT with the use of sophisticated scanners are used for acquiring remarkable 3D images of dentomaxillofacial structures which has generated tremendous interest in dentistry and can be used for a variety of different clinical applications that include evaluation of dental implant receptor site; alveolar bone defect and bone reconstruction procedures; impacted teeth; orthodontic evaluation endodontics assessment temporomandibular joint (TMJ) diagnostics; sinus augmentation procedures; and orthognathic surgical interventions.[8,9]

In implantology, CBCT scanning has become a valuable imaging technique, for the diagnosis of intra bony defects and buccal/lingual bone destructions. CBCT can display the images in all its three dimensions by removing the disturbing anatomical structures and making it possible to evaluate each root and surrounding bone.[10] It expands the role of imaging from diagnosis to image guidance of operative and surgical procedures CBCT scans capture very critical informations essential to determine implant size, angle, height, width, morphology and density of the alveolar bone surrounding the implant site. It also helps to avoid complications such as inferior alveolar nerve injury because it allows for presurgical mapping of the inferior alveolar canal and its proximity to the lingual concavity in the mandibular posterior regions. Various research demonstrates that using CBCT for bone density assessment is significantly correlated with implant stability, improving predictability and efficiency of implant planning and placement. CBCT scanning has also proven helpful in confirming implant position after placement and osseointegration after surgery.

Although CBCT imaging is helpful in treatment planning, selecting the appropriate implant can be challenging. Complications from poor implant placement includes inaccurate abutment seating, rotational engagement, poor bone-to-implant contact at the crestal zone, pressure on the cortical bone, time-consuming treatment, and poor stability. Using implants with internal hexagon connections provides a better fit between the implant and the abutment, minimizing micro-movements and reducing bone resorption. Micro-rings at the neck of the implant increase the bone-to-implant contact, avoiding bone resorption at the neck. With the ideal implant, surgical guide and CBCT technology, implantology can become an efficient and accurate treatment modality.[7]

METHODOLOGY

This retrospective study was carried out in the department of Oral Medicine and Radiology, Meenakshi Ammal Dental College and Hospital, Chennai, India. Cone beam computed tomography data of five patients acquired using PLANMECA MID PROMEX 3D machine was retrieved from archives and images were analyzed using romexis software.

- CASE 1 – FOR IMPLANT IN MAXILLARY ANTERIOR REGION (fig 1)
- CASE 2 - FOR IMPLANT IN MAXILLARY POSTERIOR REGION (fig 2)
- CASE 3- FOR IMPLANT IN MANDIBULAR ANTERIOR REGION (fig 3)
- CASE 4 – FOR IMPLANT IN MANDIBULAR POSTERIORREGION (fig 4)
- CASE 5 - FOR IMPLANT IN COMPLETELY EDENTULOUS (fig 5)

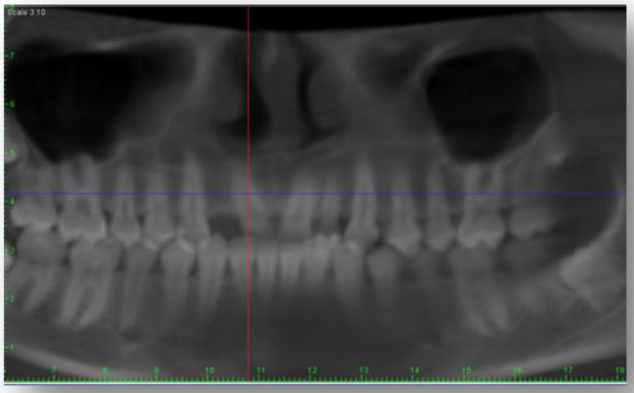


FIG 1: IMPLANT PLANNING IN MAXILARY ANTERIOR REGON.

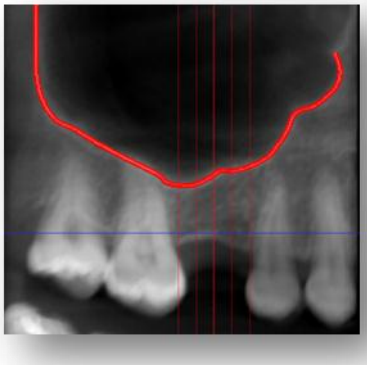


FIG 2: IMPLANT PLANNING IN MAXILLARY POSTERIOR REGION.

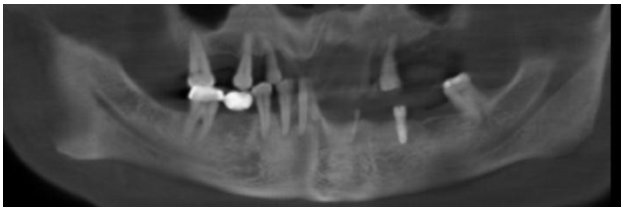


FIG 3: IMPLANT PLANNING IN MANDIBULAR ANTERIOR REGION.

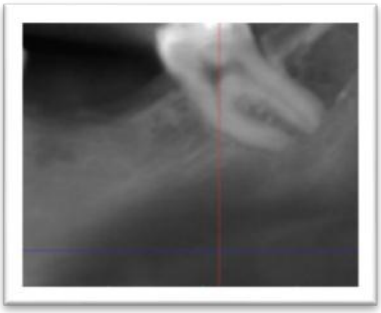


FIG 4: IMPLANT PLANNING IN MANDIBULAR POSTERIOR REGION.

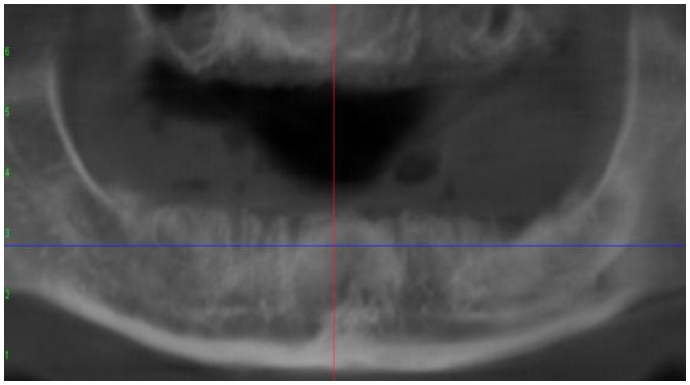


FIG 5: IMPLANT PLANNING IN COMPLETELY EDENTULOUS RIDGE.

RESULTS

Factors considered for implant placement in the maxillary anterior region

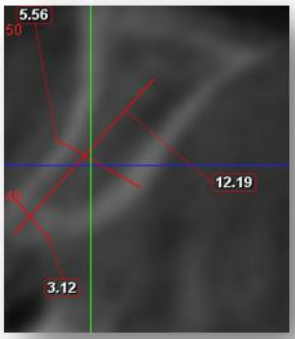
Implant placement in Maxillary anterior region requires the most rigorous pre-operative assessment, because the alveolar dimension and morphology will have a direct influence on aesthetic outcome and stability of implant placement.[11] The adequate alveolar height is not the only prerequisite for a successful implant placement. Deficiency of transversal ridge width would lead to length reduction or even impossible implant insertion.[12]

CASE 1

In CASE 1 Maxillary right lateral incisor was missing for which implant planning was carried out and various parameters were assessed. Alveolar height was measured in the sagittal section as a line was drawn from alveolar crest paralleling with the long axis of alveolar ridge (Fig 6). The distance from alveolar crest to the floor of nasal fossa was defined as the alveolar height.

The distance between buccal and palatal cortical plate was defined as the alveolar width (fig 6).

Evaluation of labial undercut in the maxillary anterior region is also important since the lateral incisor region usually has the thinnest alveolar ridge compared with the central incisor and canine, probably due to the presence of a lateral fossa which creates the buccal concavity adjacent to lateral incisor which determines the angle of the implant placed. Labial undercut location value demonstrated how close the buccal undercut was to the alveolar crest.



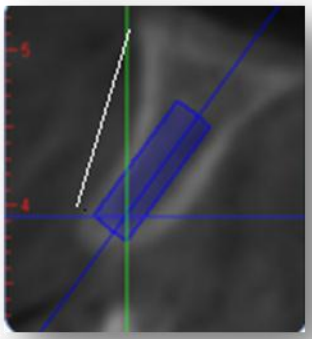


FIG 6- MEASURMENT OF HEIGHT AND WIDTH. **FIG 7- EVALUATION OF LABIAL UNDERCUT.**

To measure a labial undercut, a line was extended from alveolar crest which was perpendicular to the long axis of the alveolar ridge(Fig 7). The distance from where the labial cortical plate started dipping to the a forementioned line was defined as labial undercut., a line tangent to labial cortical plate and parallel to the long axis of alveolar ridge was drawn. The distance from the deepest point of the buccal undercut to the aforementioned line was measured.

Subsequent to tooth loss, decrease in the height and/or width of the alveolar process and the development of a labial concavity often necessitate bone augmentation. The morphology and dimension of the nasopalatine (incisive canal) and the location of the floor of the nasal fossae may also compromise the available bone volume and these are the important anatomical structure to be considered.

CASE 2

Factors considered for implant placement in the maxillary posterior region

In CASE 2 Maxillary right first molar was missing for which implant planning was carried out and various parameters were assessed. Alveolar height was measured in the sagittal section as a line was drawn from alveolar crest paralleling with the long axis of alveolar ridge. The distance from alveolar crest to the floor of maxillary sinus was defined as alveolar height. The alveolar height has to be evaluated to determine the requirement for sinus lift surgeries.

The distance between buccal and palatal cortical plate was defined as alveolar width (fig 8).

Determination of buccal concavity determines not only the angle of the implant placed but also aids in deciding the need for bone augmentation procedures. To measure a buccal

undercut, a line was extended from alveolar crest which was perpendicular to the long axis of the alveolar ridge. The distance from where the buccal cortical plate started dipping to the a fore mentioned line was defined as buccal undercut., a line tangent to buccal cortical plate and parallel to the long axis of alveolar ridge was drawn. The distance from the deepest point of the buccal undercut to the aforementioned line was measured.

Post-operative challenges encountered while placing the implant in the maxillary posterior region. As it has the lowest bone density and the highest implant failure rate.

FIG 8- MEASURMENT OF HEIGHT AND WIDTH.

Factors considered for implant placement in mandibular anterior region

During implant placement in anterior mandible, lingual foramina are often ignored and it appears to have a low clinical risk associated with them.[13] Lingual foramen in the midline of the mandible may be of varying sizes. Alveolar bone between mental foramina area are considered as relatively safe areas for surgical implants. Damage to the arteries that pass through the lingual Foramen can lead to edema. In such cases, pressure is applied to the lingual mandible to stop bleeding and when the bleeding stops, antibiotics and steroids should be prescribed.[13,14] Thus, if bleeding is observed in this area during implant surgery, clinicians should consider the possibility of damage to the sublingual artery branches. When lingual foramen have diameter more than 1 mm in CBCT images before implant surgery, clinicians should be aware of this impending vascular damage.

CASE 3

Mandibular anterior teeth are missing(31 and 32) for which implant planning was carried out and various parameters were assessed . The vertical height of the bone was measured in the sagittal section from the crest of the alveolar ridge to the inferior border of the

mandible.Alveolar width is calculated using the Alveolar height measured at coronal, middle, and apical third. In the middle of each third, a line was drawn perpendicular to the long axis of alveolar ridge. The distance between buccal and palatal cortical plate was defined as alveolar width (fig 9).

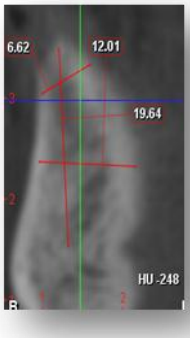


FIG 9- MEASURMENT OF HEIGHT AND WIDTH.

Factors considered for implant placement in mandibular posterior region

In the posterior mandibular region the height and width of the alveolar bone the lingual concavity (submandibular gland fossa, submandibular fossa) below the mylohyoid ridge and the inferior alveolar (mandibular) canal which might have variations in its course can restrict implant placement.

CASE 4

Missing teeth are the mandibular posteriors(36,37) region (fig 11) for which implant planning was carried out and various parameters were assessed. The vertical height of the bone was measured in the sagittal section from the crest of the alveolar ridge to the inferior border of the mandible. In the middle of each third, a line was drawn perpendicular to the long axis of alveolar ridge. The distance between buccal and palatal cortical plate was defined as alveolar width (fig 10).

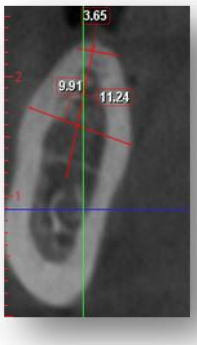


FIG 10- MEASURMENT OF HEIGHT AND WIDTH.

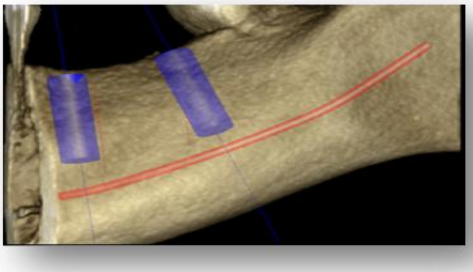


FIG 11- REFORMATED IMAGE OF MANDIBULAR.

CASE 5

Factors considered for implant planning in completely edentulous ridges

In completely edentulous patient all the important anatomical parameters discussed in case 1,2,3 and 4 should be considered prior to implant placement (fig12). The number of implants to be placed depends on the type of prosthesis and the choice of prosthetic design. Conversely, the number of implants that can be placed with respect to anatomic-morphologic conditions will determine to a certain degree of the type and design of prosthesis. Additionally, the size, curvature and shape of the ridges determine the distribution of the implants over the arch.

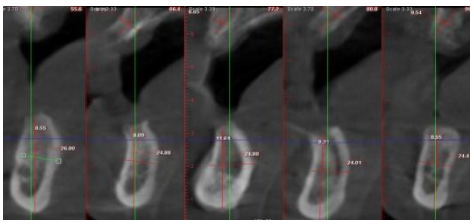


FIG 12: ASSESSMENT OF VARIOUS PARAMETERS.

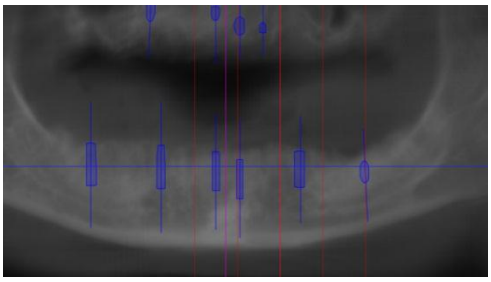


FIG-13: IMPLANT PLANNING IN COMPLETELY EDENTULOUS RIDGE.

DISCUSSION

CBCT is a important an advanced imaging modality which is used for various diagnosis of various maxillofacial pathologies and also in pre- treatment in impant surgery. AAOMR has given a recommendation to take CBCT fo implant surgery.

The basic principles of imaging as far as implant evaluations is concerned which includes, images should have appropriate diagnostic quality and not contain artifacts that compromise anatomic-structure assessments. Images should extend beyond the immediate area of interest to include areas that could be affected by implant placements. Practitioners should have appropriate training in operating radiographic equipment and competence in interpreting images from the modality used.

The following selection criteria recommendations provide literature based, consensus-derived, clinical guidance for practitioners on the appropriate imaging (with particular relevance to CBCT) at each phase of dental-implant therapy.

1. INITIAL EXAMINATION

Maxillofacial imaging interfaces with patient history, clinical examination, definitive diagnosis, treatment planning, and implant therapy. The purpose of the initial radiographic examination is to assess the overall status of the remaining dentition, to identify and characterize the location and nature of the edentulous regions, and to detect regional anatomic abnormalities and pathologies. Any of these may have important ramifications in the overall timing and sequencing of treatment phases, such as implant loading protocols and post prosthetic occlusal protection.

Recommendation 1.

Panoramic radiography should be used as the imaging modality of choice in the initial evaluation of the dental implant patient.

Recommendation 2.

Use intraoral periapical radiography to supplement the preliminary information from panoramic radiography.

Recommendation 3.

Do not use cross-sectional imaging, including CBCT, as an initial diagnostic imaging examination.

2. Preoperative site specific imaging

Imaging for presurgical, dental-implant planning must provide information supportive of the following goals.

1. The morphologic characteristics of the residual alveolar ridge (RAR) includes bone volume and quality. Vertical bone height, horizontal width, and edentulous saddle length determines the amount of bone volume available which is necessary to match the available bone dimensions with the number and physical dimensions of the implants. Moderate and severe deficiencies in horizontal and vertical bone may be corrected by augmentation procedures . Similarly excessive or irregular vertical alveolar bone may require preprosthetic or simultaneous alveoloplasty.

2. The orientation and residual topography of the alveolar-basal bone complex must be assessed to determine whether or not there are variations that could compromise the alignment of the implant fixture with the planned prosthetic restoration. This is particularly

important in the mandible (e.g., submandibular gland fossa) and anterior maxilla (e.g., labial cortical bone concavity).

3. Identification of local anatomic or pathologic conditions restricting implant placement should be evaluated in the maxilla, these include the incisor region (nasopalatine fossa and canal, nasal fossa), the canine region (canine fossa, nasal fossa), and the premolar/molar region (floor of the maxillary sinus). In the mandible, these include the incisor region (lingual foramen), canine/premolar region (mental foramen), and molar region (submandibular gland fossa, inferior alveolar [mandibular] canal containing the neurovascular bundle).

4. Radiographic images are not only used for with aid in prosthetic planning, but are also used to construct templates to guide surgical procedures and implant placements.

Recommendation 4.

The radiographic examination of any potential implant site should include crosssectional imaging orthogonal to the site of interest. This reaffirms the previously stated position of the AAOMR.

Recommendation 5.

CBCT should be considered as the imaging modality of choice for preoperative crosssectional imaging of potential implant sites. As with any type of imaging, a patient should be exposed to the least amount of ionizing radiation that is needed to produce CBCT images of acceptable diagnostic quality. This is achieved by careful selection of exposure parameters and FOV. CBCT is best for the evaluation of volumetric and topographic changes of the restored residual alveolar ridge.

Recommendation 6.

CBCT should be considered when clinical conditions indicate a need for augmentation procedures or site development before placement of dental implants: (1) sinus augmentation, (2) block or particulate bone grafting, (3) ramus or symphysis grafting, (4) assessment of impacted teeth in the field of interest, and (5) evaluation of prior traumatic injury.

Recommendation 7.

CBCT imaging should be considered if bone reconstruction and augmentation procedures (e.g., ridge preservation or bone grafting) have been performed to treat bone volume deficiencies before implant placement.

3. Postoperative imaging

The purpose of postoperative imaging after dentalimplant placement is to confirm the location of the fixture at implant insertion. From 3 to 5 years and beyond, imaging is used to assess the bone-implant interface and marginal peri-implant bone height. Titanium implant fixtures inherently produce artifacts such as beam-hardening and streak artifacts obscuring subtle changes in marginal and peri-implant bone. In addition, the resolution of CBCT images for the detection of these findings is inferior to intraoral radiography.

Recommendation 8.

In the absence of clinical signs or symptoms, use intraoral periapical radiography for the postoperative assessment of implants. Panoramic radiographs may be indicated for more extensive implant therapy cases.

Recommendation 9.

Use cross-sectional imaging (particularly CBCT) immediately postoperatively only if the patient presents with implant mobility or altered sensation, especially if the fixture is in the posterior mandible.[15]

According to the study done by Ashok Balasundaram, Laurence W Seluk, Erika Benavides (2012) implied that CBCT scans of the anterior maxilla are recommended prior to surgical placement of implant fixtures in the anterior maxilla, as reinforced in our study would help to avoid injury to the nasopalatine canal. Accuracy during implant placement leads, in turn, to an ideal restoration of the implant fixture to produce excellent functional and esthetic results.[16]

According to the study done by Yaser Safi et al, Zahra Vasegh et al,(2016) proposed that in the pre implants surgical designing of mandibular edentulous patients the existing bone quality is determined by recording the height and width of alveolar bone and morphology as done in our study . By measuring current height, the biggest fixture that can suitably provide maximum support and distribution of masticatory forces is selected. Most of morphological views such as bone undercuts that are not directly visible in clinical examinations become visible with cross-sectional imaging.[17]

According to the study done by Meltem Koray et al (2017) suggested that alveolar ridge width is an important criteria in implant palnning which is in relevance to our study. In there

study they evaluated patients who presented with partial or total edentulous space in maxilla and mandibule, having a ridge width of 2.5 mm to 6.0 mm, measured pre- and post-operatively, using CBCT. However, in their study they also stated that inadequate amount of bone for implant placement at functionally and esthetically most appropriate position is a common problem. Hence placement of implants in atrophic ridges is often accompanied by various challenges. If inadequate bone exists, several surgical techniques may be used to reconstruct the deficient ridge for implant placement. Investigators have adopted several techniques to overcome these consequences by employing procedures like guided bone regeneration (GBR), onlay grafts, distraction osteogenesis, ridge expansion, and revascularized flaps.[18]

CONCLUSION

Cone beam computed tomography proves to be a valuable tool for the planning implant placement.The use of CBCT imaging allows for 3D evaluation, increasing the visualization of critical anatomic structures and providing a paramount information.[19-22] The radio graphic visualization of the alveolar ridge, adjacent teeth position, and the restorative plan are necessary steps in assessment of a potential implant site, treatment sequence and planning of implant. The three dimensional cross sectional visualization of bone contour and configuration allows for more precise treatment planning and presurgical preparation.

REFERENCES

1. Maria Eugenia Guerrero, Reinhilde Jacobs, MietLoubele, FilipSchutyser, Paul Suetens and Daniel van Steenberghe. State-of-the-art on cone beam CT imaging for preoperative planning of implant placemen t .Clin Oral Invest, 2006; 10: 1–7.
2. Brånemark P-I, Breine U, Adell R, Hanson Bo, Lindström J, Ohlsson A., Intraosseous anchorage of dental prostheses. Scand J PlastReconstrSurg, 1969; 3: 81–100.
3. Lindquist LW, Carlsson GE, Jemt T, A prospective 15year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implants Res, 1996; 7: 329–336.
4. Belser U, Schmit B, Higginbottom F, Buser D., Outcome analysis of implant restorations located in the anterior maxilla: A review of the literature. Int J Oral Maxillofac Implants, 2004; 19: 30–42 (Suppl).
5. Jacobs R, Gijbels F., Oral Imaging 2000. KULeuven, Dept Periodontology, Leuven, 2000; 4–8.

6. Tyndall AA, Brooks SL, Selection criteria for dental implant site imaging: a position paper of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2000; 89: 630–637.
7. C Chitralekha, P Arun Kumar Prasad, H Esther Nalini, R Renuka Devi, Cone-beam computed tomography: Three-dimensional imaging in periodontal diagnosis, Journal of Indian Academy of Dental Specialist Researchers.
8. Ganz SD. Cone beam computed tomography-assisted treatment planning concepts. Dent Clin North Am, 2011; 55: 515-36.
9. Mohan R, Singh A, Gundappa M. Three-dimensional imaging in periodontal diagnosis – Utilization of cone beam computed tomography. J Indian SocPeriodontol, 2011; 15: 11-7.
10. Harris D, Buser D, Dula K, et al. E.A.O. guidelines for the use of diagnostic imaging in implant dentistry. A consensus workshop organized by the European Association for Osseointegration in Trinity College Dublin. *Clin Oral Implants Res*, 2002; 13(5): 566-570.
11. Wakimoto M, Matsumura T, Ueno T, Mizukawa N, Yanagi Y, Iida S. Bonequality and quantity of the anterior maxillary trabecular bone in dentalimplant sites. Clinical oral implants research, 2012; 23(11): 1314–9.
12. Eufinger H, Konig S, Eufinger A. The role of alveolar ridge width in dentalimplantology. Clin Oral Investig, 1997; 1(4): 169–77.
13. Shotwell JL, Billy EJ, Wang HL, Oh TJ. Implant surgical guide fabrication for partially edentulous patients. *J Prosthet Dent*, 2005; 93(3): 294-297.
14. Mello LA, Garcia RR, Leles JL, et al. Impact of cone-beam computed tomography on implant planning and on prediction of implant size. *Braz Oral Res*, 2014; 28(1): 46-53.
15. Donald A. Tyndall, DDS, MSPH, PhD, a Jeffery B. Price, DDS, MS, b SotiriosTetradis, DDS, PhD, 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, June 2012; 113(6).
16. Ashok Balasundaram[1], Laurence W Seluk[2], Erika Benavides[3], Ravichandra Juluri[4], Jon B Suzuki[5], Dincer Gurun . Significance of cone beam computed tomography based implant treatment planning and fabrication of stereolithographic surgical guides for implant therapy in the nasopalatine canal region journal of ICDRO, 2012; 4(1): 29-36.
17. Yaser Safi, Zahra Vasegh, Mahdi Kadkhodazadeh, Hoora Hadian, Nika Bahemmat. Different methods to evaluate mandibular alveolar ridge in Cone Beam Computed

Tomography images in pre-implant surgery assessments. International Journal of Medical Research & Health Sciences, 2016; 5(11): 134-142.

18. Meltem Koray, Neslihan Senel, Aysegul Senemtası, Ilknur Özcan, Mehmet .Changes in Alveolar Bone Width Following Bone Expansion Open Journal of Stomatology, 2017; 7: 305-313.
19. Presurgical Implant-SiteAssessment andRestoratively Driven Digital Planning Michael D. Scherer, Dent Clin N Am, 2014; 58: 561–595.
20. Benavides E, Rios HF, Ganz SD, et al. Use of cone beam computed tomography in implant dentistry: the International Congress of Oral Implantologists consensusreport. Implant Dent, 2012; 21: 78–86.
21. White SC, Heslop EW, Hollender LG, et al. Parameters of radiologic care: an officialreport of the American Academy of Oral and Maxillofacial Radiology. OralSurg Oral Med Oral Pathol Oral Radiol Endod, 2001; 91: 498–511.
22. Dreiseidler T, Mischkowski RA, Neugebauer J, et al. Comparison of cone-beam imaging with orthopantomography and computerized tomography for assessmentin presurgical implant dentistry. Int J Oral Maxillofac Implants, 2009; 24: 216–25.