# A comparison of cone beam computed tomography and ridge mapping in treatment planning of dental implants

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**ABSTRACT**

**Objectives:** To compare cone beam computed tomography and ridge mapping in measuring alveolar ridge bone width prior to dental implant placement.

**Study Design:** An observational comparative study.

**Place and Duration:** Prosthodontics Department, Armed Forces Institute of Dentistry, Rawalpindi from 1st Aug 2016 to 31st July 2017.

**Methodology:** For this study, partially dentate patients that required dental implant supported prosthesis for the replacement of their missing teeth were selected. Vacuum formed radiographic templates with reference points were used for the evaluation of alveolar ridge bone width measurements at specific points (Crestal, Buccal and Lingual side) with Ridge mapping and Cone Beam Computed Tomography. Alveolar ridge bone width's measurement acquired from both the methods was then compared.

**Results:** Out of the total 100 participants, 51% were females and 49% were males with mean age 33.86±7.857. No statistically significant differences were found in measurements of the alveolar ridge width obtained with Ridge mapping and Cone Beam Computed Tomography; p value of 0.924 and 0.967 respectively were found to be non-significant.

**Conclusion:** Both techniques showed convincing and similar measurements so either of the technique can be used to measure pre surgical alveolar ridge dimension.

**Keywords**: Alveolar ridge width, Cone beam computed Tomography, Ridge mapping, Dental Implants, Treatment

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## INTRODUCTION

In this era of Osseo integration, dental implants have shown breakthrough results in the treatment of missing teeth and full mouth rehabilitations, restoring facial aesthetics and functions[1,2]. For the success of implants, proper diagnosis and treatment planning is required, so a thorough presurgical clinical and radiographic assessment is done to provide information regarding prosthesis design, patient force factors, bone density in the edentulous site, height and width of ridge, surrounding critical and non-critical structures, presence of any pathology, occlusal patterns/loads, number and size of implants required and key implant position. Evaluation of the alveolar ridge dimensions is an important prerequisite for implant treatment planning. In routine practice bone is usually assessed with two-dimensional radiographs such as panoramic and/or periapical though they should only be used for initial evaluation as they lack cross-sectional information and with them it is necessary to perform corrections related to the magnifications produced by the machinery. Therefore, for accurate evaluation of implant sites advanced digital radiographs such as computed tomography (CT) or Cone Beam Computed tomography (CBCT) should be advised as they provides three-dimensional information but these imaging technologies may not be widely available[2-4].

CBCT is a medical imaging technique in which cone shaped X-ray beam is used. The scanner rotates around the patient producing various 2D images. The scanning software collects the data and reconstructs it in three-dimensional (3D) data set. CBCT provides better visualization, more detailed and accurate view of anatomical structures and reflect true osseous morphology, resulting in better clinical outcomes[5]. However, because of certain disadvantages such as rare availability, cost, technique sensitive and patient being subjected to radiations, most of the implant placement procedures are still conducted without 3D imaging[4].

The alveolar ridge dimensions can also be measured using an alternative and conventional clinical method like Ridge mapping (RM)[3]. Ridge mapping is a reliable and convenient approach performed chair side under local anesthesia[3,4]. A caliper (e.g., Vernier) can be used to map the ridge width (combined soft tissue and bone thickness) at the crest and then every 2-3 mm upto the vestibule. Bone thickness can also be evaluated using an instrument called a ridge mapper. (Salvin Dental Specialties)[6,7]. Few studies have been done in which measurement of alveolar ridge bone width is assessed using direct caliper after reflection of the flap, ridge mapping method, CT and CBCT. In a study it was found that there is no significant difference in the measurement obtained from CBCT and direct surgical exposure measurements, which support that CBCT method, can solely be used for the evaluation of alveolar ridge width[3].

In this study, the mean alveolar ridge bone width prior to dental implant placement will be evaluated using CBCT and Ridge mapping. By keeping the CBCT as a gold standard, the mean difference in measurements of ridge mapping and CBCT will be compared. If significant difference is found between the values of the two then it will be an essential to evaluate the ridge dimensions on CBCT or other 3d imaging technique to avoid any chances of error. If no significant difference is observed, then ridge mapping along with panoramic will be sufficient to evaluate the ridge width and advanced imaging technique like CT and CBCT can be avoided as they are costly and not widely accessible. Hence the aim of this study is to compare Cone Beam Computed Tomography and Ridge mapping in measuring alveolar ridge bone width prior to dental implant placement. This study was planned with an objective to compare Cone Beam Computed Tomography and Ridge mapping in measuring alveolar ridge bone width prior to dental implant placement.

## METHODOLOGY

This observational comparative study was conducted at Prosthodontics Department, Armed forces Institute of Dentistry, Rawalpindi, from 1st Aug 2016 to 31st July 2017. A total of 100 partially dentate patients with missing 1 to 2 teeth between age group of 20 to 50 years requiring Dental implant supported prosthesis for the replacement of their missing teeth were recruited. Patients were excluded if they had unhealed sockets and multiple restorations or prostheses present that might cause radiographic artifacts on CT images. General Exclusion criteria also included Patients needing immediate implant placement, long span edentulous area i.e. missing three or more teeth, untreated periodontal diseases, poor oral hygiene, pregnancy, smoking habits, debilitating diseases, immunocompromised patients, patients with severe class-I ridge defects and class II or III ridge defects in the surgical area. As a protocol all patients presenting to the institute were examined in dental OPD and then again in the Prosthodontics department.

History, complete oral examination and informed consent were sought out for each participant. Irreversible hydrocolloid impressions were made of the subject arches (Cavex CA-37) and study casts were poured with Bego hard plaster. Vacuum formed radiographic templates with reference points were used for RM and CBCT scanning. RM measurements were recorded on specific points (Crestal, Buccal and Lingual points, Standard periodontal probe was used) and later was translated onto dental casts. Patients were referred for CBCT, and measurements were recorded of the same points. (Newtom VGI, NNT application). Measurement acquired from both the techniques was compared. The scores calculated were filled in the Performa for further analysis.

**Data Analysis:** The IBM SPSS version 21.0 was used for statistical analysis. Descriptive statistics were calculated for both qualitative and quantitative variables. For qualitative variables, like gender, frequency and percentages were calculated. For Quantitative, variables like age, measurement of alveolar ridge dimension obtained by Ridge mapping and CBCT means ± SD were calculated. Paired samples t-test was used to compare quantitative variables i.e. alveolar ridge dimensions between ridge mapping and CBCT. P values of <0.05 was considered significant.

## RESULTS

A total of 100 patients were selected of mean age 33.86±7.857. Out of these 51 (51%) were females and 49 (49%) were males. The mean alveolar ridge dimensions obtained from both the methods i.e. Ridge mapping and CBCT procedure were 4.5810mm and 4.5840mm respectively for point 1 and 7.5900mm and 7.5920 mm respectively for point 2 as shown in Table-I. Paired sample t-test was applied to compare the difference between two methods at point 1 and point 2 and a p value of 0.924 and 0.967 respectively were found to be non-significant.

**Table-I: Alveolar ridge width characteristics using ridge mapping and cone beam computerized tomography, (N=100)**

| | Number | Mean | Standard deviation |
|---|---|---|---|
| **RM Point 1** | 100 | 4.58 | 1.02 |
| **CBCT Point 1** | 100 | 4.58 | 1.08 |
| **RM Point 2** | 100 | 7.59 | 1.23 |
| **CBCT Point 2** | 100 | 7.59 | 1.11 |

## DISCUSSION

In all stages of clinical dentistry, proper diagnosis and

treatment planning is essential as it results in a more predictable outcome. The two important factors both esthetically and functionally, responsible for implant-supported single tooth restoration are morphology of the ridge and implant orientation. In order to assure ideal implant position, the contour of the residual ridge must be evaluated prior to implant placement[8].

Preoperative radiographic evaluation plays an essential role in treatment planning for implant-supported prostheses. The diagnostic methods like panoramic and periapical radiographs, being two-dimensional reveals no information on the sagittal bony morphology and on the proper orientation of implant[9-11], so there is always a requirement for a more advanced and extensive radiographic examination than the ones used for other types of oral rehabilitation, for example cephalometric, tomographic radiography, CT, interactive CT, and magnetic resonance imaging[11,12]. In a nutshell for better visualization of the sagittal topography of the bone a pre-surgical bone assessment using a Scan (with a radiopaque indicator) or a technique for probing the surface of the bone is necessary[13,14].

In this study, the mean alveolar ridge bone width prior to dental implant placement was determined using CBCT and Ridge mapping and then the 2 techniques were compared. To minimize any potential confounding variables, only one type of CBCT machine and one type of software were used. Cone beam CT was used in this study because it reduces radiation exposure versus traditional CT[15,16]. In addition, studies have shown that CBCT is an accurate method for measuring the alveolar ridge[17, 18]. All measurements in the present study were performed by one examiner using the built-in software of the cone beam CT machine to minimize inter examiner error and variations between software programs.

Various authors have explained Ridge mapping technique to assess the alveolar ridge width using various mapping calipers. The method can be performed chair side under local anesthesia; the calipers designed for this purpose were penetrated in the lingual and buccal mucosa down to the bone. A series of measurements of the proposed implant site can be made[13,19]. Along with the advantage of avoidance of radiation exposure to the patient; this technique is also reliable, less technique sensitive and less costly[19].

In this study, no significant differences were found between ridge-mapping and CBCT techniques at all sites, (p value of 0.924 and 0.967 respectively were found to be non-significant), nevertheless, the data of this study are in agreement with a comparison study done by Chugh et al in which no significant differences were found in measurements obtained from direct surgical exposure and CBCT (p=0.83) and direct surgical exposure with ridge-mapping measurements, (p=0.97), which advocates the use of any of these methods for assessing of alveolar ridge width for partially edentulous ridges. They also concluded that the bony ridge widths predicted pre surgically, proved to be reasonably accurate at the time of surgery for the maximum number of cases. They suggested the use of CBCT method for assessing the alveolar ridge width measurements in areas where the ridges are resorbed, there are maxillary anterior ridge concavities, high lingual frenum areas, and vestibular depth is less[3].

Our results are also in accordance with Gupta et al, who found insignificant differences between soft tissue depth on comparing ridge mapping and CBCT data (p value of >0.05). For soft tissue depth, significant differences were found only at one-point B3, which could be due to the presence of loose and highly compressible soft tissue near the vestibular area, making the ridge mapping readings aberrant[20].

The results of this study differ to some extent with those obtained by Chen et al. who found statistically significant equivalences between RM and gold standard measurements, but not with those from CBCT and the gold standard[21]. Though other researches contradict it and concluded that CBCT is an accurate method for bone evaluation for dental implant[17,18] However, Availability of CBCT is still a question. The technology is only available in a few places in Pakistan. Ridge mapping on the other hand provides instant information at chair side, avoiding the need for tomographic imaging. In addition, the improved ridge-mapping technique using a template can provide more clinical information, including the topography of the residual ridge, when compared with earlier methods[17].

Furthermore, our results also differ from those obtained by Luk et al. who concluded that bone ridge measurements obtained on CBCT and the RM were significantly different (average discrepancy of 0.3–0.5 mm)[4]. In-addition Sutaria F B also found that average mean measurements significantly differs between surgical open method and bone mapping though CBCT measurement is almost the same as surgical open method as a mean difference of 0.06 mm in between CBCT and surgical open method and 0.18 mm in between bone mapping and surgical open method was found[17].

Moreover, the results of our study are in agreement with a recent study conducted by Castro-Ruiz CT et al. in which they compare the validity of alveolar ridge measurements obtained with ridge mapping (RM) technique against CBCT measurements[14]. No statistically significant differences were obtained with CBCT and RM measurements (P = 0.207). For detecting proper buccal‑lingual ridge, the sensitivity and specificity were 92% and 94% for CBCT while RM obtained 59% of sensitivity and 91% of specificity. Data obtained in this study reaffirm the usefulness and accuracy of CBCT for presurgical planning of DIs, and likewise, give validity to the use of RM technique as a useful tool for buccolingual width measurements in ideal cases. Within the limitations of this study, it was observed that there was no statistically significant difference in the measurements obtained by RM and CBCT techniques. Use of ridge mapping technique along with panoramic and intraoral radiograph is adequate in cases where even mucosal thickness along with regular pattern of resorption is present. CBCT is advised in situations with resorbed ridges, presence of maxillary anterior ridge concavities, high lingual frenum areas, inadequate vestibular depth, and where ever ridge mapping is not feasible.

## CONCLUSION

Both techniques showed convincing and similar measurements so either of the technique can be used to measure pre surgical alveolar ridge dimension.

## AUTHOR'S CONTRIBUTION

**Shakoor M:** Conceived idea, Designed research methodology, Literature review, Manuscript writing
**Rahim S:** Manuscript writing, Data collection
**Qureshi AW:** Data Collection, Data analysis
**Sharif M:** Critical Review, Final review
**Shah R:** Literature review, Manuscript writing
**Minallah S:** Data analysis, Data interpretation, Final review

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