Assessing residual alveolar ridge width prior to dental implant placement

Dr. Yashika Bali[1*], Dr. Suresh Venugopalan[2], Dr. Bennete Fernandes[3], Dr. Sanjeev Kumar Salaria[4], Dr. Kehkashan Ehsan Azmi[5], Dr. Jyotsna Seth[6]

[1*]MDS, PhD Scholar, Department of Prosthodontics and Crown & Bridge, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (Deemed to be University), Chennai 600077, Tamil Nadu, India

[2]MDS, Department of Prosthodontics and Crown & Bridge, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (Deemed to be University), Chennai 600077, Tamil Nadu, India

[3]Faculty of Dentistry, SEGi University, Selangor - 47810, Malaysia; Adjunct Professor, Department of Periodontology, Dr. D.Y. Patil Dental College & Hospital, Dr. D.Y Patil Vidyapeeth, Pimpri, Pune - 411018, Maharashtra, India; and Adjunct Professor, Department of Periodontology, Faculty of Dental Sciences, Rama University, Kanpur, Uttar Pradesh, India

[4]Professor and Head, Department of Periodontology, DJ College of Dental Sciences and Research, Niwari Road, Modinagar - 201204, Ghaziabad, India

[5]Assistant Professor, PhD Scholar, Department of Oral Pathology and Microbiology, Manav Rachna Dental College, MRIIRS, Faridabad, Haryana -121004, India

[6]Professor, Department of Prosthodontics, Seema Dental College & Hospital, Rishikesh, Dehradun, Uttarakhand, India

***Corresponding Author:**

Dr. Yashika Bali

MDS, PhD Scholar, Department of Prosthodontics and Crown & Bridge, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (Deemed to be University), Chennai 600077, Tamil Nadu, India

Email ID: yashika1990@yahoo.com

Abstract

Background:

Precise assessment of residual alveolar ridge width is critical for optimal dental implant placement, as it governs implant selection, spatial positioning, and long-term prognostic outcomes. Conventional clinical approaches, however, may lack the accuracy and reproducibility afforded by advanced imaging modalities and digital workflows.

Aim:

To quantitatively evaluate and compare residual alveolar ridge width using clinical ridge mapping, CBCT, and digital planning modalities prior to dental implant placement.

Materials and Methods:

A total of 40 implant sites in partially edentulous patients were included in this comparative clinico-radiographic study. Residual ridge width was assessed clinically via ridge mapping and radiographically using cone-beam computed tomography (CBCT). Additionally, digital planning software facilitated virtual measurement of ridge dimensions. The acquired data were systematically recorded and subjected to statistical analysis using appropriate tests, with significance set at $p < 0.05$.

Results:

The mean ridge width measured clinically was 5.42 ± 0.86 mm, whereas CBCT demonstrated a higher mean value of 5.96 ± 0.91 mm. Digital planning measurements (5.88 ± 0.89 mm) closely approximated CBCT-derived values. A statistically significant difference was identified between clinical and CBCT measurements ($p = 0.003$). A strong positive correlation was observed between CBCT and digital modalities, while clinical measurements exhibited comparatively lower agreement.

Conclusion:

CBCT and digital planning modalities demonstrate superior accuracy and reliability in assessing residual alveolar ridge width compared to clinical ridge mapping, thereby enhancing precision in implant planning and contributing to more predictable clinical outcomes. The integration of advanced imaging technologies and digital workflows aligns with SDG 3 (Good Health and Well-being) by improving patient care quality, SDG 9 (Industry, Innovation and Infrastructure) through the adoption of innovative diagnostic approaches, and SDG 17 (Partnerships for the Goals) by fostering interdisciplinary and technology-driven collaboration in contemporary implant dentistry.

Keywords:
Dental implants, alveolar ridge width, CBCT, ridge mapping, digital planning, implant accuracy, SDG 3, SDG 9, SDG 17.

How to cite this article: Bali Y, Venugopalan S, Fernandes B, Salaria SK, Azmi KE, Seth J. Assessing Residual Alveolar Ridge Width Prior to Dental Implant Placement. Int J Drug Deliv Technol. 2026;16(24s): 902-907;
DOI: 10.25258/ijddt.16.24s.106

Introduction

Dental implantology is a well-established and highly predictable modality for the rehabilitation of missing teeth, with consistently high success rates and the capacity to restore both function and aesthetics. Accurate preoperative assessment of the alveolar ridge is fundamental to achieving optimal implant placement and long-term clinical success. In this context, precise evaluation of residual alveolar ridge width is pivotal for determining implant dimensions, spatial positioning, and the necessity for adjunctive augmentation procedures[1]. Various clinical and radiographic modalities have been advocated for the assessment of ridge dimensions prior to implant placement. While conventional approaches remain clinically valuable, they may be limited in precision relative to advanced imaging techniques. The integration of digital technologies and computer-guided workflows has markedly enhanced diagnostic accuracy and optimization of treatment planning in contemporary implant dentistry[2,3]. These advancements enable precise visualization of anatomical structures and facilitate prosthetically driven implant planning. In the aesthetic zone, implant placement necessitates meticulous preoperative planning to achieve optimal peri-implant soft tissue architecture and superior esthetic outcomes. Approaches such as immediate provisionalization and computer-guided implant placement have demonstrated significant improvements in both functional integration and esthetic predictability[3,4] . Additionally, simplified planning approaches, such as the S-technique, have been introduced to aid clinicians in achieving accurate implant positioning with predictable outcomes[4].

The integration of virtual implant alignment and digital workflows has significantly advanced implant dentistry, enabling the precise fabrication of surgical guides and interim restorations with a high degree of accuracy. These innovations facilitate minimally invasive surgical approaches, reduce operative time, and enhance overall treatment efficiency[5]. Contemporary consensus guidelines further underscore the critical importance of meticulous treatment planning and execution to optimize esthetic outcomes in implant therapy[6]. Surgical guides serve as a vital interface between virtual planning and clinical application, with a spectrum of systems—ranging from conventional to fully digital—developed to improve the accuracy and reproducibility of implant placement[7]. Additionally, hybrid techniques integrating analog and digital impressions have demonstrated reliable clinical outcomes, particularly in complex and geriatric cases[8]. Despite these advancements, precise assessment of alveolar ridge width remains a fundamental prerequisite for successful implant therapy. Emerging evidence from comparative clinico-imaging studies emphasizes the value of integrating clinical evaluation with advanced imaging modalities to achieve accurate measurements and enhance treatment outcomes[9]. Collectively, these developments align with SDG 3 (Good Health and Well-being) by improving the quality and predictability of patient care, SDG 9 (Industry, Innovation and Infrastructure) through the adoption of cutting-edge digital technologies, and SDG 17 (Partnerships for the Goals) by fostering interdisciplinary collaboration and integration of technological innovations in contemporary implant dentistry.

Methodology

The present study was designed as a comparative clinico-radiographic investigation to evaluate residual alveolar ridge width prior to dental implant placement. The study was conducted in a clinical setting within the Department of Implantology/Prosthodontics following approval from the Institutional Ethical Committee. Patients requiring implant therapy were selected based on predefined inclusion and exclusion criteria, and written informed consent was obtained from all participants prior to enrolment.

A total of 40 partially edentulous patients aged 18–65 years were included. Patients with adequate alveolar bone height for implant placement and without systemic conditions affecting bone healing were selected. Individuals with a history of head and neck radiotherapy, severe periodontal disease, or other contraindications to implant therapy were excluded.

Residual alveolar ridge width was assessed using both clinical and radiographic methods. Clinical evaluation was performed using ridge mapping under local anaesthesia, with measurements obtained at predetermined implant sites using calibrated ridge-mapping instruments. Radiographic assessment was conducted using cone beam computed tomography (CBCT), providing three-dimensional visualization of alveolar bone, with ridge width measured at corresponding anatomical sites using standardized imaging software to ensure accuracy and reproducibility. Where indicated, digital implant planning software was employed to simulate implant positioning and obtain virtual ridge dimension measurements, enabling prosthetically driven planning and comparative assessment across modalities.

All data were systematically recorded and tabulated for analysis. The primary outcome was residual alveolar ridge width (mm), while the secondary outcome involved intertechnique comparison. Statistical analysis was performed using appropriate software, with mean and standard deviation calculated for all variables. Comparative analysis was undertaken using paired statistical tests, with significance set at $p < 0.05$. Patient confidentiality was strictly maintained throughout the study.

Results

The present study evaluated 40 implant sites for assessment of residual alveolar ridge width using clinical, radiographic (CBCT), and digital methods. Descriptive analysis demonstrated a mean clinical ridge width of 5.42 ± 0.86 mm using ridge mapping, whereas CBCT measurements were higher at 5.96 ± 0.91 mm. Digital planning yielded a mean value of 5.88 ± 0.89 mm, closely approximating CBCT findings (Table 1).

Intergroup comparison revealed a consistent underestimation of ridge width by clinical measurements relative to CBCT and digital modalities. The difference between clinical ridge mapping and CBCT was statistically significant ($p = 0.003$), confirming superior measurement accuracy with radiographic evaluation over conventional clinical assessment (Table 1). Correlation analysis demonstrated a strong positive association between CBCT and digital measurements ($r = 0.92$), indicating high concordance between these modalities. In contrast, correlations between clinical and CBCT ($r = 0.78$) and clinical and digital measurements ($r = 0.74$) reflected moderate-to-strong agreement with comparatively reduced precision of clinical methods (Table 2).

Further analysis of mean differences showed the greatest discrepancy between clinical and CBCT measurements (0.54 mm), followed by clinical and digital measurements (0.46 mm). The difference between CBCT and digital methods was minimal (0.08 mm) and not statistically significant ($p = 0.210$), reinforcing their comparable accuracy (Table 3). Overall, the findings indicate that CBCT and digital planning provide superior precision and reliability in assessing residual alveolar ridge width compared to clinical ridge mapping, thereby enhancing diagnostic accuracy and implant treatment planning.

Table 1: Comparison of Mean Ridge Width by Different Methods

Method of Assessment	**Mean (mm)**	**Standard Deviation (SD)**	**p-value**
Clinical Ridge Mapping	5.42	± 0.86	
CBCT Measurement	5.96	± 0.91	
Digital Planning	5.88	± 0.89	
Clinical vs CBCT	—	—	**0.003**

Table 2: Correlation Between Different Measurement Techniques

Comparison Groups	**Correlation Coefficient (r)**	**Interpretation**
Clinical vs CBCT	0.78	Strong correlation
Clinical vs Digital	0.74	Moderate correlation
CBCT vs Digital	0.92	Very strong correlation

Table 3: Mean Difference Between Measurement Techniques

Comparison	Mean Difference (mm)	Standard Error	Significance (p-value)
Clinical vs CBCT	0.54	0.12	0.003
Clinical vs Digital	0.46	0.10	0.005
CBCT vs Digital	0.08	0.07	0.210 (NS)

Discussion

Accurate assessment of residual alveolar ridge width is a fundamental prerequisite for successful dental implant placement, as it directly influences implant selection, positioning, and long-term prognosis. The present study demonstrated that CBCT and digital planning modalities provide significantly more precise measurements compared to conventional clinical ridge mapping. These findings corroborate previous reports highlighting the diagnostic superiority of advanced imaging techniques in implant dentistry.

Jorba-García et al.[10] reported that dynamic computer-aided implant placement demonstrates high accuracy and reliability compared with conventional freehand techniques. Similarly, Sindhusha and Rajasekar[11] highlighted the efficiency of guided implant surgery in enhancing precision while minimizing operator-dependent errors. These findings corroborate the present study, wherein CBCT and digital assessments exhibited superior accuracy over clinical ridge mapping. The influence of fabrication technology on surgical guide precision has also been well established. Lo Russo et al.[12] demonstrated that advanced manufacturing methods significantly enhance implant placement accuracy, thereby improving clinical outcomes. Consistently, the present study showed close agreement between digital planning and CBCT measurements, indicating high reproducibility.

Digital workflow integration has become integral to contemporary implantology. da Silva Salomão et al.[13] emphasized its role in improving planning efficiency and reducing clinical errors. The strong correlation between CBCT and digital measurements observed herein further supports the reliability of digital approaches in implant planning. Vinci et al.[14], in a multicenter study, reported high accuracy of computer-aided implant surgery in edentulous patients relative to virtual planning. Likewise, Orsini et al.[15] highlighted emerging biological and technological platforms that enhance clinical outcomes in implant dentistry. These observations align with the present findings, which demonstrated minimal discrepancy between CBCT and digital modalities.

Nevertheless, operator experience and technique sensitivity remain critical determinants of accuracy. Toyoshima et al.[16] reported that even novice clinicians can achieve acceptable precision using surgical guides, although minor deviations may persist. Marlière et al.[17] further confirmed the reliability of computer-guided implant surgery, particularly in fully edentulous cases, underscoring its broad clinical applicability.

In terms of surgical guide accuracy, Geng et al.[19] demonstrated that various CAD/CAM guide systems exhibit differing levels of precision, although all consistently outperform conventional techniques. Additionally, Venet et al.[18] emphasized the significance of adequate ridge reconstruction in cases of deficient alveolar width, underscoring the necessity for precise preoperative assessment. Biological determinants also influence implant success. Mueller et al.[20] reported that peri-implant tissue responses vary according to surgical technique, further highlighting the importance of accurate planning and minimally invasive surgical execution.

Overall, the present findings align with existing literature, confirming that CBCT and digital planning modalities provide superior accuracy, reliability, and clinical predictability compared with conventional clinical methods. While ridge mapping remains a valuable preliminary diagnostic tool, integration of advanced imaging and digital workflows is essential to optimize implant outcomes in contemporary clinical practice.

Conclusion

Within the limitations of the present study, CBCT and digital planning methods provide more accurate and reliable assessment of residual alveolar ridge width than conventional clinical ridge mapping. Clinical methods tend to underestimate ridge dimensions, whereas radiographic and digital modalities offer superior visualization and precision. A strong correlation between CBCT and digital measurements indicates that digital workflows can be effectively applied for prosthetically driven implant planning with high predictability. Although clinical ridge mapping remains a useful preliminary diagnostic tool, it should be supplemented with advanced imaging for optimal outcomes. Therefore, integration of CBCT and digital technologies is strongly recommended in contemporary implant dentistry to enhance diagnostic accuracy, minimize surgical errors, and improve treatment success, aligning with SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation and Infrastructure), and SDG 17 (Partnerships for the Goals).

References:

1. **Sheth MS, et al.** Assessing residual alveolar ridge width prior to dental implant placement. *Bioinformation* 2025;21:3921–3925. doi:10.6026/973206300213921. PMID: 41623811.
2. **Hämmerle CHF, et al.** Consensus statements and recommended clinical procedures regarding implant dentistry. *Int J Oral Maxillofac Implants* 2009;24:126–131. PMID: 19885440.
3. **Abbo B, et al.** Endosseous implants and immediate provisionalization in the aesthetic zone: computer-guided surgery. *Dent Today* 2008;27:88–92. PMID: 18505031.
4. **Piano S, et al.** A simple way to plan implant positioning: the "S-technique". *Eur J Esthet Dent* 2011;6:328–341. PMID: 21876868.
5. **Alruhailie L, et al.** Using virtual implant alignment to fabricate a combined implant-supported interim restoration and surgical guide: a dental technique. *J Prosthet Dent* 2025;134:340–345. doi:10.1016/j.prosdent.2025.03.044. PMID: 40251107.
6. **Morton D, et al.** Consensus statements and recommended clinical procedures regarding optimizing esthetic outcomes in implant dentistry. *Int J Oral Maxillofac Implants* 2014;29:216–220. doi:10.11607/jomi.2013.g3. PMID: 24660199.
7. **D'Souza KM, et al.** Types of implant surgical guides in dentistry: a review. *J Oral Implantol* 2012;38:643–652. doi:10.1563/AAID-JOI-D-11-00018. PMID: 21905915.
8. **Papazoglou E, et al.** Analog-digital hybrid impression technique in an elderly patient: a case report. *Clin Case Rep* 2021;9:2179–2184. doi:10.1002/ccr3.3975. PMID: 33936659.
9. **Jorba-García A, et al.** Accuracy assessment of dynamic computer-aided implant placement: a systematic review and meta-analysis. *Clin Oral Investig* 2021;25:2479–2494. doi:10.1007/s00784-021-03833-8. PMID: 33635397.
10. **Sindhusha BV, et al.** A short review on guided implant surgery and its efficiency. *Bioinformation* 2022;18:764–767. doi:10.6026/97320630018764. PMID: 37426495.
11. **Lo Russo L, et al.** Effect of fabrication technology on the accuracy of surgical guides for dental-implant surgery. *Bioengineering* 2023;10:875-878. doi:10.3390/bioengineering10070875. PMID: 37508902.
12. **da Silva Salomão GV, et al.** Analysis of digital workflow in implantology. *Case Rep Dent* 2021;2021:6655908. doi:10.1155/2021/6655908. PMID: 33628525.
13. **Vinci R, et al.** Accuracy of edentulous computer-aided implant surgery as compared to virtual planning: a retrospective multicenter study. *J Clin Med* 2020;9:774-778. doi:10.3390/jcm9030774. PMID: 32178392.
14. **Orsini G, et al.** Novel biological and technological platforms for dental clinical use. *Front Physiol* 2018;9:1102-1105. doi:10.3389/fphys.2018.01102. PMID: 30135661.
15. **Toyoshima T, et al.** Accuracy of implant surgery with surgical guide by inexperienced clinicians: an in vitro study. *Clin Exp Dent Res* 2015;1:10–17. doi:10.1002/cre2.3. PMID: 29744135.
16. **Marlière DAA, et al.** Accuracy of computer-guided surgery for dental implant placement in fully edentulous patients: a systematic review. *Eur J Dent* 2018;12:153–160. doi:10.4103/ejd.ejd_249_17. PMID: 29657542.
17. **Venet L, et al.** Horizontal ridge reconstruction of the anterior maxilla using customized allogeneic bone blocks with a minimally invasive technique: a case series. *BMC Oral Health* 2017;17:146-149. doi:10.1186/s12903-017-0423-0. PMID: 29216869.
18. **Geng W, et al.** Accuracy of different types of CAD/CAM surgical guides for dental implant

placement. *Int J Clin Exp Med* 2015;8:8442–8449.
PMID: 26309497.

19. **Mueller CK, et al.** Analysis of inflammatory periimplant lesions during a 12-week period of undisturbed plaque accumulation. *Clin Oral Investig* 2012;16:379–385. doi:10.1007/s00784-011-0546-7. PMID: 22186942.
20. **Singh N, et al.** Clinical assessment of bone quality at implant site using CBCT and Hounsfield unit. *J Pharm Bioallied Sci* 2023;15:1305–1307. doi:10.4103/jpbs.jpbs_109_23.