

# Chairside Tomosynthesis in Implant Dentistry: Closing the Intraoperative Imaging Gap

## INTRODUCTION

Few innovations have influenced implant dentistry as profoundly as CBCT. Three-dimensional evaluation of bone volume, ridge morphology, vital anatomical structures, restorative space, and implant position has made implant treatment more predictable and safer.<sup>1-4</sup> Yet surgery remains dynamic. Extraction findings may differ from preoperative expectations, an osteotomy may approach a cortical plate, sinus elevation may not proceed as anticipated, or the clinician may want to confirm implant position before continuing.

This creates an intraoperative imaging gap. CBCT provides comprehensive 3D information before surgery, but obtaining another scan during treatment may require covering the surgical site, moving the patient to a separate imaging room, and then returning to the operatory. Intraoperative questions are usually more focused: Is implant trajectory appropriate? Is adequate clearance from the sinus or inferior alveolar canal maintained? Has a retained component been completely retrieved?

Chairside tomosynthesis addresses this need by providing focused sectional imaging without substantially interrupting treatment. Think of its role as not replacing established imaging protocols, but as supplying immediate information when a specific question arises during surgery. The mobile Lumos 3DX (Valkyrie BioScience) can be brought directly to the patient (Figures 1 and 2), potentially preserving surgical workflow while providing additional 3D information. The focused nature of the examination is important because the clinician usually does not need a second comprehensive diagnostic work-up. Instead, the goal is to obtain enough sectional information to resolve a specific question and determine whether treatment can proceed as planned.

## CBCT and Chairside Tomosynthesis: Complementary Roles

CBCT remains the foundation of implant imaging for comprehensive diagnosis, anatomic assessment, prosthetically driven planning, guided surgery, and complex implant sites. Chairside tomosynthesis occupies a different position in the imaging continuum (Table 1). Pre-CBCT answers, "How should this case be planned?" Chairside tomosynthesis helps answer, "Am I comfortable proceeding with the next surgical step?" This complementary relationship preserves the established role of CBCT while adding a practical option for situations in which a new question develops after the surgical procedure has begun.

The FDA 510(k) summary identifies Lumos 3DX as an extraoral x-ray source with intraoral x-ray detection for diagnostic dental radiographs, with 3D imaging produced by tomosynthesis in adult patients.<sup>5</sup> The system uses limited-angle tomography to generate 3D images from multiple projections and is described as a mobile chairside system with approximately 3-second 3D data acquisition.<sup>5</sup>



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## What is Tomosynthesis?

Conventional radiographs are rapid, inexpensive, and relatively low dose, but compress 3D anatomy into a 2D image, allowing superimposition to obscure clinically important relationships. CBCT overcomes this limitation by acquiring numerous projections during rotation around the patient and reconstructing a volumetric dataset that can be viewed in multiple planes.<sup>6</sup>

Tomosynthesis lies between these modalities.<sup>7</sup> Instead of a single projection or a complete CBCT volume, it acquires multiple low-dose projections over a limited arc and reconstructs sectional images of the region of interest.<sup>8-10</sup> Separating anatomy into slices reduces superimposition while requiring less acquisition time and less complex mobile hardware than a full CBCT system. Tomosynthesis therefore provides focused sectional information rather than comprehensive volumetric diagnosis. A useful analogy is a book: a conventional radiograph resembles viewing all pages superimposed, CBCT provides the entire book from multiple perspectives, and tomosynthesis provides the pages within the chapter most relevant to the immediate clinical question. Although the available perspectives are more limited than with CBCT, the clinician can examine the region in sequential sections rather than as a single superimposed projection.

This distinction explains why chairside tomosynthesis should complement rather than replace CBCT. Its principal

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**...the clinician can obtain additional sectional information at the point of care....**

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advantage is timing: focused 3D information can be obtained in the operatory when an intraoperative question arises, helping bridge the gap between pre-op planning and surgical execution.

## Clinical Applications of Chairside Tomosynthesis

The clinical value of imaging depends on whether the information can influence a treatment decision. Chairside tomosynthesis is most useful when additional confirmation is needed before proceeding with the next surgical step. Routine implant procedures may proceed exactly as planned, and additional 3D imaging is not required simply because the technology is available. Its value becomes more apparent when anatomy, tactile feedback, or the surgical situation creates uncertainty that could influence the next step.

**Implant Placement  
and Osteotomy Verification**

Accurate implant placement requires maintaining the planned trajectory while respecting surrounding anatomy. Dense cortical bone, limited visibility, or unexpected tactile feedback may create uncertainty regarding depth or angulation. Focused tomosynthetic images can verify osteotomy trajectory or implant position before treatment is completed, allowing correction when necessary, rather than relying solely on postoperative imaging. This may be especially relevant when the osteotomy is adjacent to a vital structure or when limited access makes visual assessment difficult. Confirmation before final seating creates an opportunity to modify the osteotomy or implant position while the site remains accessible.

**Posterior Implant Placement  
in the Mandible**

Conventional periapical radiographs confirm mesiodistal implant position relative to adjacent teeth and crestal bone but cannot accurately demonstrate buccolingual angulation or the 3D relationship to the inferior alveolar canal (Figure 3). Lumos 3DX adds immediate cross-sectional information (Figure 4). In the illustrated case, sequential slices demonstrate implant depth, buccolingual angulation, and relationship to the canal while confirming that the implant remains within the planned restorative envelope. If excessive depth, unfavorable angulation, or canal proximity were identified, corrective treatment could be initiated



**Figure 1.** The Lumos 3DX mobile chairside tomosynthesis system (Valkyrie BioScience).

before completing the procedure.

**Anterior Maxillary Implant  
Placement**

Implant placement in the aesthetic zone requires precise 3D positioning and preservation of the facial cortical plate. A periapical radiograph confirms mesiodistal position (Figure 5) but cannot determine buccolingual position, facial plate thickness, or whether the implant is centered within the alveolar housing. Chairside tomosynthesis provides cross-sectional visualization (Figure 6), permitting evaluation of facial and palatal plates and implant posi-



**Figure 2.** The Lumos 3DX unit being used in the operator.

**We view the technology  
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tion within the available “triangle of bone.” Recognition of excessive facial positioning or cortical perforation before completion may permit immediate correction and reduce the risk of dehiscence, recession, or compromised aesthetics.

**Immediate Implant Placement**

Immediate implant placement is another potential application because socket morphology becomes fully evident only after

extraction. Residual septal bone, facial plate thickness, and available apical engagement may differ from expectations based on pre-op imaging. This provides a supplemental sectional imaging particularly useful when these findings create uncertainty, including molar sites where socket anatomy may be difficult to appreciate clinically. Following extraction, the clinician can directly compare the developing implant position with the actual socket anatomy rather than relying exclusively on the pre-extraction appearance. Focused sectional imaging may therefore help confirm that the implant remains consistent with both the available bone and restorative objectives before final seating.

**Posterior Maxillary Implant Surgery  
and Sinus Augmentation**

CBCT remains essential for pre-op evaluation of posterior maxillary and sinus anatomy. During surgery, however, a focused question may arise regarding implant position relative to the sinus floor or a grafted site. Chairside tomosynthesis can provide supplemental confirmation while allowing treatment to continue in the operator. The intraoperative purpose is narrower than the original CBCT examination: rather than reassessing the entire sinus, the clinician may simply need to confirm a localized relationship before continuing grafting or implant placement.

**Multiple Implants and Full-Arch  
Rehabilitation**

In full-arch treatment, small deviations in implant angulation can accumulate as implants are placed sequentially. Selective intraoperative confirmation may allow adjustments before those deviations influence subsequent implant positions or prosthetic design. Because each implant can influence the restorative envelope available for the remaining implants, early recognition of an unfavorable trajectory may prevent a small positional discrepancy from becoming a larger prosthetic problem later in the procedure.

**Revision Surgery and Retrieval  
Procedures**

Revision procedures may involve altered anatomy, retained compo-

**Table 1. Comparison of Imaging Modalities in Implant Dentistry**

| Imaging Modality         | Primary Purpose                                | Strengths                                                                          | Limitations                                                                         |
|--------------------------|------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Conventional Radiography | Routine diagnosis and followup                 | Low dose, inexpensive, rapid                                                       | Two-dimensional image with anatomical superimposition                               |
| Chairside Tomosynthesis  | Focused intraoperative sectional imaging       | Reduces anatomical overlap, obtained chairside, supports real-time decision making | Limited field of view; not intended for comprehensive diagnosis                     |
| CBCT                     | Comprehensive diagnosis and treatment planning | Complete 3D visualization of anatomical structures                                 | Dedicated scanner, higher cost, may interrupt surgery if repeat imaging is required |

nents, fractured prosthetic screws, or previous grafting. Conventional imaging can be limited by superimposition, while metallic artifacts may reduce CBCT diagnostic value in localized regions.<sup>11-14</sup> Focused sectional imaging may assist localization, confirm retrieval, or document implant-related complications. Representative indications and the specific questions that chairside tomosynthesis may address are summarized in Table 2.

**Workflow Advantages**

The principal advantage of chairside tomosynthesis may be workflow rather than image quality. Traditional 3D imaging requires the patient to travel to the scanner; a mobile system brings imaging to the patient. This can preserve the operative field, surgical setup, team concentration, and procedural momentum while supplying additional information when needed. Instruments and materials can remain organized, assistants can

maintain their established sequence, and the clinician can review the images without transferring the patient to another area of the practice. The resulting efficiency is particularly relevant when the additional image is intended to answer only one focused question.

However, chairside tomosynthesis should not necessarily be used during every implant procedure. Its greatest value is selective use when a focused question could alter the next surgical step. In that setting, imaging becomes an active intraoperative decision-support tool rather than solely a pre-op planning resource.

**Imaging During Sedation**

The workflow benefit may be especially important during intravenous or oral sedation. Moving a sedated patient for additional CBCT imaging requires personnel, monitoring, and additional safety considerations. Chairside tomosynthesis permits supplemental imaging while the

patient remains positioned in the dental chair, maintaining monitoring and reducing disruption. This may be particularly useful during longer procedures such as multiple implant placement, full-arch rehabilitation, or sinus augmentation.

**Documentation and Communication**

Intraoperative images also provide documentation of implant position, anatomical relationships, and clinical decisions.<sup>15</sup> They may facilitate communication between surgical and restorative clinicians, laboratory discussions, insurance documentation when indicated, and patient education. It may also be of value in establishing baseline post-op images and documenting key treatment stages, particularly as implant therapy becomes increasingly interdisciplinary. Sectional images obtained at critical stages can create a visual record of why a particular surgical decision was made and may help

restorative colleagues understand the anatomical conditions encountered during placement.

**DISCUSSION**

CBCT transformed implant dentistry by providing comprehensive 3D visualization before surgery. Chairside tomosynthesis extends sectional imaging into the operative environment. The modalities should not be considered competitors: CBCT remains preferred for comprehensive diagnosis and treatment planning, whereas chairside tomosynthesis provides focused supplemental information when additional visualization is needed during treatment. The roles of conventional radiography, CBCT, and tomosynthesis across implant therapy are summarized in Table 3. Chairside tomosynthesis is therefore best understood as part of an imaging continuum rather than as a new universal imaging standard. Conventional radiographs remain appropriate for many routine



assessments, CBCT supplies comprehensive 3D information when indicated, and tomosynthesis can be inserted selectively when a focused intraoperative question cannot be adequately answered by 2D imaging.

This distinction reflects different imaging objectives. Before surgery, the clinician needs broad anatomical assessment. During surgery, the question is often limited to one relationship that must be confirmed before proceeding. The conceptual contribution of chairside tomosynthesis is therefore its ability to make 3D imaging available as an intraoperative resource. The practical significance is that the clinician can obtain additional sectional information at the point of care without changing the fundamental diagnostic role of pre-op CBCT or the routine follow-up role of conventional radiography.

Clinical experience with chairside dental tomosynthesis remains developing, and its indications, limitations, diagnostic accuracy, and effect on outcomes require further study. It should be used according to clinical need and radiation-justification principles rather than as routine additional imaging. We view the technology as a natural extension of modern implant imaging, with potential future applications in endodontics, oral surgery, periodontics, and other procedures where focused sectional information may aid decision making.

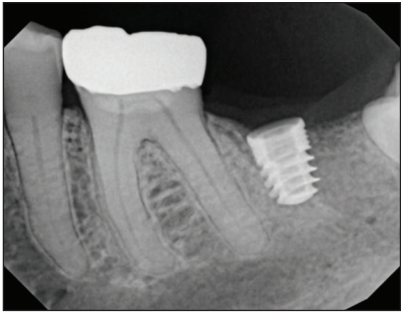


**Figure 3.** Conventional periapical radiograph following placement of a mandibular implant. While the radiograph demonstrates the implant position relative to the adjacent tooth and crestal bone, it cannot accurately evaluate the buccolingual angulation of the implant or its relationship to the inferior alveolar canal.

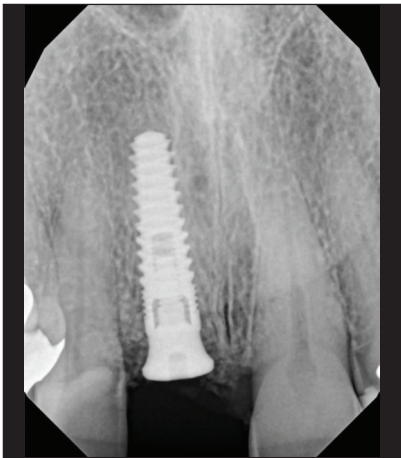


**Figure 5.** Conventional 2D periapical radiograph of a maxillary central incisor implant following placement. Although the image confirms implant position relative to the adjacent teeth and crestal bone, it cannot accurately assess the buccolingual angulation of the implant within the premaxilla or the thickness of the facial cortical plate. These inherent limitations of 2D imaging may mask facial bone deficiencies, dehiscence, or fenestration that are only reliably detected with 3D imaging.

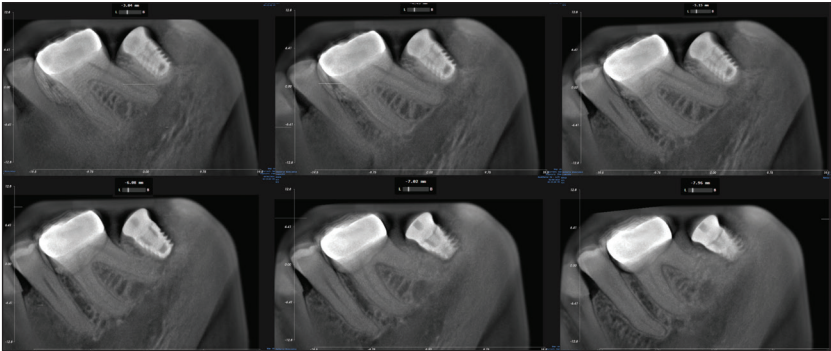


**Figure 4.** Sequential Lumos 3DX tomosynthetic slices obtained immediately following mandibular implant placement. The cross-sectional images verify implant depth, buccolingual angulation, and its relationship to the inferior alveolar canal, information that cannot be accurately assessed on the conventional 2D periapical radiograph shown in **Figure 3**.

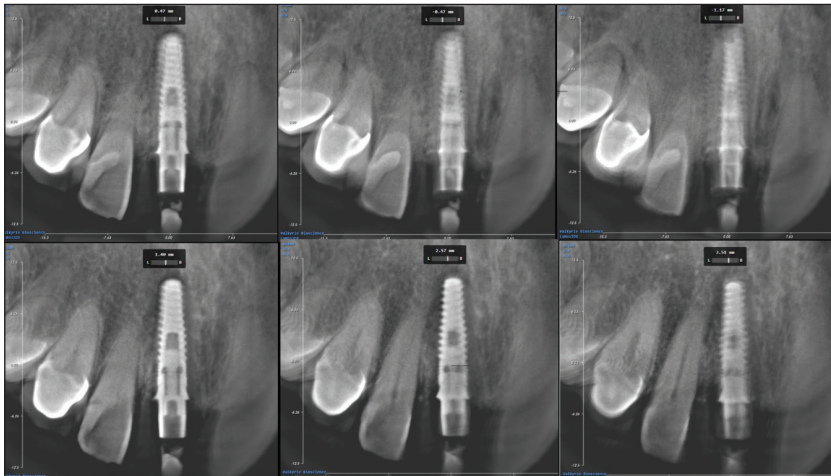


**Figure 6.** Chairside Lumos 3DX tomosynthetic images confirming palatal implant positioning within the anterior maxillary alveolar housing while maintaining facial plate integrity prior to implant placement.

**CONCLUSION**

CBCT will remain the foundation of comprehensive implant diagnosis and treatment planning. Chair-

side tomosynthesis complements that foundation by providing focused sectional imaging when an intraoperative question arises. By bringing the imaging system to the patient, Lumos 3DX may preserve workflow, support real-time decision making, and permit corrective action before a procedure is completed. Continued clinical experience and research will define its ultimate role, but its ability to help close the intraoperative imaging gap represents a practical advancement in implant imaging. ♦

**References**

1. Bornstein MM, Horner K, Jacobs R. Use of cone beam computed tomography in implant dentistry: current concepts, indications and limitations for clinical practice and research. *Periodontol* 2000. 2017;73(1):51-72.

2. Jacobs R, Salomon B, Codari M, et al. Cone beam computed tomography in implant dentistry: recommendations for clinical use. *BMC Oral Health*. 2018;18(1):88.

3. Harris D, Horner K, Gröndahl K, et al. E.A.O. guidelines for the use of diagnostic imaging in implant dentistry 2011. *Clin Oral Implants Res*. 2012;23(11):1243-1253.

4. Bornstein MM, Scarfe WC, Vaughn VM, et al. Cone

**Table 2. Suggested Clinical Applications for Chairside Tomosynthesis**

| Clinical Situation           | Intraoperative Question                                                        | Potential Benefit                                 |
|------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------|
| Posterior mandibular implant | Is implant trajectory appropriate relative to the inferior alveolar canal?     | Confirmation before final implant placement       |
| Immediate implant placement  | Is implant position consistent with socket anatomy and restorative goals?      | Supports implant positioning before final seating |
| Sinus augmentation           | Is implant or graft position satisfactory relative to the sinus floor?         | Supplemental confirmation during surgery          |
| Full-arch rehabilitation     | Are sequential implant positions maintaining the planned restorative envelope? | Improves confidence before continuing treatment   |
| Revision surgery             | Has a retained component been completely retrieved?                            | Focused localization and documentation            |
| Sedated patient              | Can additional imaging be obtained without moving the patient?                 | Preserves workflow and patient positioning        |

Table 3. Proposed Imaging Continuum in Implant Dentistry

| Phase of Care            | Primary Clinical Objective                     | Preferred Imaging                                                  |
|--------------------------|------------------------------------------------|--------------------------------------------------------------------|
| Initial Evaluation       | Detect pathology and assess patient needs      | Conventional radiographs & CBCT                                    |
| Treatment Planning       | Comprehensive 3D evaluation                    | CBCT                                                               |
| Implant Surgery          | Answer-focused intraoperative questions        | Chairside tomosynthesis (when indicated)                           |
| Postoperative Assessment | Verify implant position and establish baseline | Conventional radiographs ± tomosynthesis when clinically indicated |
| Long-Term Maintenance    | Monitor peri-implant health                    | Conventional radiographs                                           |

beam computed tomography in implant dentistry: a systematic review focusing on guidelines, indications, and radiation dose risks. *Int J Oral Maxillofac Implants*. 2014;29 Suppl:55-77.

5. U.S. Food and Drug Administration. Lumos 3DX 510(k) Summary K223780. Silver Spring, MD: FDA; 2023.

6. Scarfe WC, Farman AG. What is cone-beam CT and how does it work? *Dent Clin North Am*. 2008;52(4):707-730.

7. Webber RL, Horton RA, Underhill TE, et al. Tuned-aperture computed tomography (TACT). Theory and application for three-dimensional dento-alveolar imaging. *Dentomaxillofac Radiol*. 1997;26(1):53-62.

8. Webber RL, Messura JK. An in vivo comparison of diagnostic information obtained by means of tuned-aperture computed tomogra-

phy and conventional dental radiography. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 1999;88(2):239-247.

9. Nair MK, Seyedain A, Agarwal S, et al. Tuned aperture computed tomography to evaluate osseous healing. *J Dent Res*. 2001;80(7):1621-1624. PMID: 11597021. 6 Scarfe WC, Farman AG. What is cone-beam CT and how does it work? *Dent Clin North Am*. 2008;52(4):707-730.

10. Nair MK, Nair UP, Seyedain A, et al. Fractal analyses of osseous healing using tuned aperture computed tomography images. *Eur Radiol*. 2001;11(8):1510-1515.

11. Schulze R, Heil U, Gross D, et al. Artefacts in CBCT: a review. *Dentomaxillofac Radiol*. 2011;40(5):265-273.

12. Benic GI, Sancho-Puchades M, Jung RE, et al. In vitro assessment of artifacts induced by titanium

dental implants in cone beam computed tomography. *Clin Oral Implants Res*. 2013;24(4):378-383.

13. Schulze RK, Berndt D, d'Hoedt B. On cone-beam computed tomography artifacts induced by titanium implants. *Clin Oral Implants Res*. 2010;21(1):100-107.

14. Terrabuio BR, Carvalho CG, Peralta-Mamani M, et al. Cone-beam computed tomography artifacts in the presence of dental implants and associated factors: an integrative review. *Imaging Sci Dent*. 2021;51(2):93-106.

15. Kim MJ, Lee SS, Choi M, et al. Developing evidence-based clinical imaging guidelines of justification for radiographic examination after dental implant installation. *BMC Med Imaging*. 2020;20(1):102.

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*Disclosures: Dr. Hansen has invested in Valkyrie BioScience. Dr. Kurtzman received compensation from Valkyrie BioScience for writing this article.*

