Presurgical Implant-Site Assessment and Restoratively Driven Digital Planning

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KEYWORDS

• Cone beam computed tomography • Presurgical virtual implant planning
• Three-dimensional imaging • Digital registration

KEY POINTS

- Cone beam computed tomography imaging and 3-dimensional (3D) computer software allow for greatly enhanced visualization of bone, critical anatomy, and restorative plans. These systems allow clinicians to alter and process patients' 3D images and restorative templates, facilitating dental implant planning.
- Effective assessment of proposed implant sites requires that clinicians interpret implant sites for many factors related to successful implant restorations, including adequate bone volumes, distance away from teeth/implants, sufficient prosthetic space for restoration, and precise implant placement.
- The combination of soft-tissue and occlusal separation, digital registration of patient scans with prosthesis, and soft-tissue scans greatly enhances the ability to visualize planned restorative outcomes and accommodating implants within these outcomes.
- Crown-down digital implant treatment planning permits clinicians to have more control over the implant treatment plan by creating ideal, virtual restorations and managing implant positions based on the virtual plan.
- 3D treatment flow significantly improves on the traditional workflow by supplementing more complicated and expensive diagnostic information with simpler and equally effective treatment protocols.

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INTRODUCTION

Proper dental implant placement for single crowns, multiple fixed partial dentures, implant-retained overdentures, or fixed implant–supported restorations relies on adequate pretreatment visualization of the proposed bone recipient site, evaluation of bone density, and assessment of restorative goals. Radiographic visualization of facial and cervical tooth positions, bound restorative space, and bone configuration is a necessary step in the treatment sequence and planning of implant restorations. The ultimate success of the dental implant relies on this radiographic assessment in combination with proper restorative evaluation to ensure that the final outcome is compatible with expected outcomes.[1–3]

Many imaging options are available for the assessment of dental implant sites, and their use depends on several factors:

- Availability
- Experience of the clinician
- Amount of radiation exposure
- Restorative planning goals
- Cost

Although these factors affect the decision of the clinician to request a certain radiographic approach, the patient is typically concerned most about the radiation exposure and cost. The advent of digital 3-dimensional (3D) imaging in conjunction with cone beam computed tomography (CBCT) allows for a maximum amount of information available to the clinician and laboratory while minimizing the amount of radiation exposure.[4] Furthermore, popularization of CBCT imaging and moderate growth into the private practice group imaging sector has allowed an increase in availability of digital scanning to patients while reducing cost. Recent advancements in software development have allowed for greater visualization of implant sites, complete control of restorative plans, and fabrication of precise computerized surgical guides. The purpose of this article is to describe methods of preoperative assessment of implant sites based on a philosophy of crown-down digital implant treatment planning, using CBCT scanning and 3D digital imaging.

TWO-DIMENSIONAL VERSUS 3D IMAGING

Traditional 2-dimensional (2D) radiographic imaging of dental implant sites typically involve the use of periapical radiographs for partially dentate patients, with single implant sites and panoramic radiographs for edentulous patients and multiple implant sites.[5] In combination with calibration markers, such as ball-bearing spheres of a known diameter, the clinician is able to estimate maximum height and mesiodistal width of implant sites (**Figs. 1** and **2**). Although this approach has historically allowed the clinician the ability to rapidly visualize potential implant sites, it gives little information in regards of buccal-lingual bone width, configuration, or density. In addition, these methods of radiographic imaging are also subject to angulation discrepancies between the planned implant position, where the radiograph indicates there is adequate bone volume, and the resultant implant site.[6] When an implant is to be placed in proximity to a vital structure, such as a nerve, artery, or sinus cavity, with 2D radiography only limited information with which to properly assess the distance is possible. The resulting errors from the reliance on the traditional imaging leads to potential complications, including prosthetic complications, soft-tissue insufficiency, implant failure, and paresthesia.[7,8] Complications may lead to an unsatisfactory patient outcome, referral to other specialists, and medicolegal claims.[9,10] These