

A simple technique for immediate placement of definitive engaging custom abutments using computerized tomography and flapless guided surgery

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This article describes a new technique using 3-D computerized tomography and virtual implant planning with flapless guided surgery and placement of prefabricated, custom-milled zirconia implant abutments. After extraction of the mandibular right first and second molars and healing of the sockets, a removable prosthesis replacing these teeth was fabricated and scanned. Implant placement was planned via interactive imaging and CAD/CAM software and then placed with a CAD/CAM fabricated surgical guide, using a flapless surgical technique. Custom zirconia abutments were fabricated on an altered master cast, placed, and torqued to 35 Ncm at the time of implant surgery. Abutment positions, contours, and soft tissue marginal adaptation were in close agreement with those on the master cast. Acrylic resin provisional crowns were cemented into position and left in passive occlusion during healing. Computerized tomography and interactive planning software can be used to allow precise placement of implants and the fabrication and immediate insertion of custom-made final abutments, providing clinicians with a surgically and prosthetically efficient clinical technique. (*Quintessence Int* 2007;38:755–762)

Key words: CAD/CAM, crestal bone, custom abutment, dental implant, immediate provisionalization, osseointegration

Soft tissue esthetics around dental implants has emerged as one of the most important goals of implant therapy today. Particularly in the esthetic zone, the creation of a gingival architecture around an implant restoration that matches a healthy contralateral tooth should be included in the current definition of success.

During the first year after implant placement, both 1- and 2-piece implants have been shown to undergo a process of bone remodeling at the crest.^{1–6} The causes of crestal bone loss around 2-piece implants are not fully understood, but placing the abutment at the time of implant surgery and not removing it may reduce the effect of the microgap that occurs with removal and replacement of abutments in conventional 2-piece implant systems.⁷

A virtual implant planning and placement system has been developed for fully and partially edentulous patients in which a computerized tomography (CT) scan of the patient's jaw and a secondary scan of the removable prosthesis by itself are imported into the computer software.^{8–11} The software enables presurgical 3-D planning of implant place-

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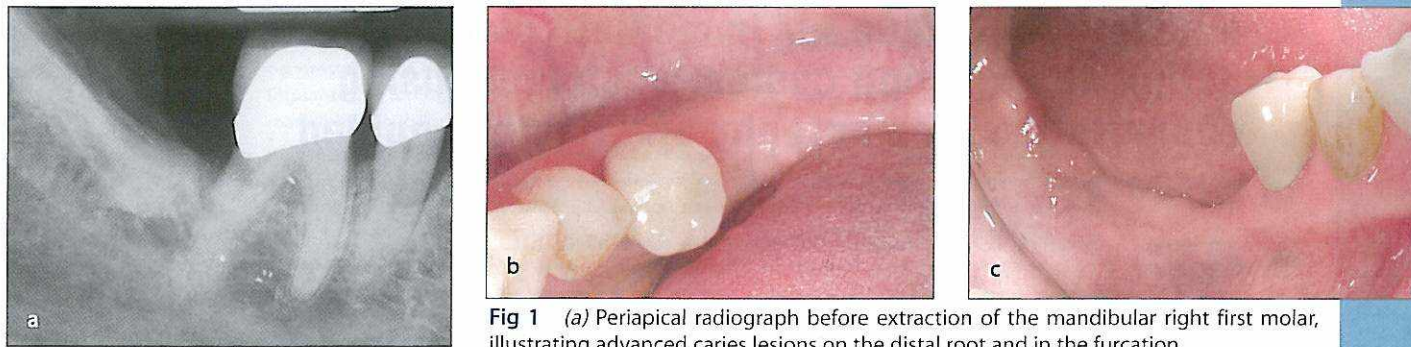


Fig 1 (a) Periapical radiograph before extraction of the mandibular right first molar, illustrating advanced caries lesions on the distal root and in the furcation. (b,c) Occlusal and lateral views of the mandibular right posterior before implant surgery.

ment while allowing the planner to visualize the intended fixed prosthesis (Nobel Biocare). When the virtual implant planning is complete, the data files are uploaded to the implant system manufacturer, where rapid prototyping computer-aided design/computer-assisted manufacture (CAD/CAM) technology is used to generate a surgical template from which a master cast is created. The cast is then articulated against the opposing model to begin fabrication of the prosthesis.¹²⁻¹⁴ At the time of implant placement, the surgical template is inserted in the mouth and rigidly fixed with stabilizing anchor pins before implant placement. This process ensures that the implant position in the mouth accurately replicates what was virtually completed on the computer.¹²⁻¹⁴

The planning software, however, does not allow the surgeon to pre-plan the rotational orientation of the internal or external connection of the implant at the time of placement. This limitation can be bypassed either by using nonengaging abutments and splinted crowns or by using nonengaging screw-retained splinted crowns.

This report outlines a technique that enables the clinician to place implants, using a CAD/CAM flapless guided protocol, with engaging custom definitive abutments at the time of implant surgery. These abutments are anatomic in form with a pre-planned customized emergence profile on all sides based on a master cast generated from the initial CT scan of the prosthesis and the patient.

It is also the intention of the authors to place final abutments at the time of implant

surgery, reduce the number of restorative visits for the patient, simplify the restorative sequence to more closely resemble conventional fixed partial denture protocol, decrease treatment cost and time, and increase overall patient satisfaction. An additional goal of placing an immediate final abutment is to reduce multiple disturbances to the epithelial attachment that occur with placement and removal of healing and provisional abutments, with the intention of decreasing the role of the biologic width formation and the microgap on the loss of crestal bone around implants.

TECHNIQUE

A 77-year-old woman presented with an advanced caries lesion on the mandibular right first molar (Fig 1a). This tooth was surgically extracted and the sockets were filled with freeze-dried bone allograft (LifeLink). The graft material was covered with a collagen membrane (Ace Surgical Supply). The buccal flap was mobilized to allow for primary closure using 5-0 polypropylene sutures (Hu-Friedy). The surgical site healed uneventfully for 3 months (Figs 1b and 1c).

A removable partial denture was fabricated to replace the missing mandibular right first and second molars. The prosthesis was prepared according to the guided surgery system protocol¹³⁻¹⁴ with a radiographic registration (gutta percha; Coltène-Whaledent). Cone-beam CT was used to gather the data

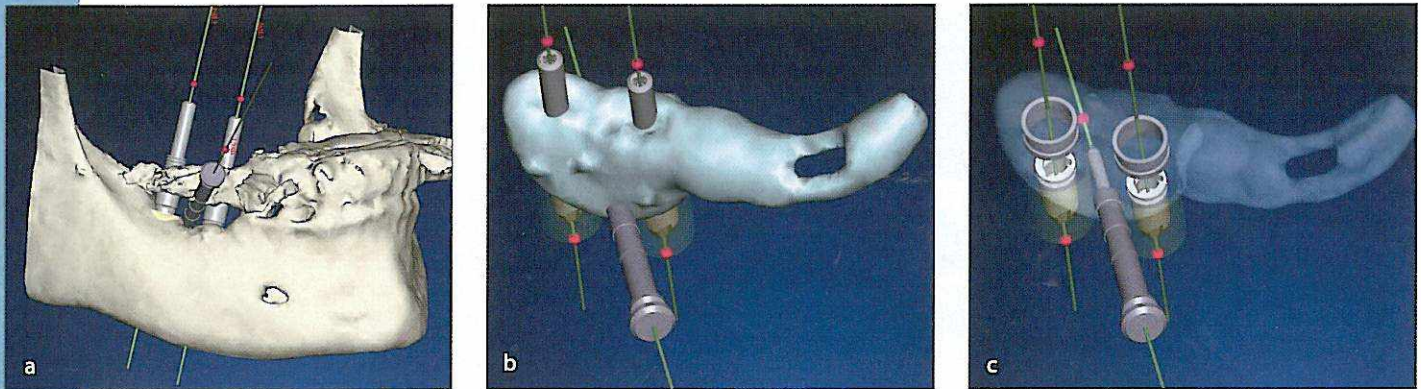


Fig 2 (a) Computer-generated 3-D image of the mandibular arch that was converted from the double computerized tomography scan technique using the guided implant system software package. Two internal connection implants and 1 horizontal anchor pin are planned into the 3-D scene. Scatter from the anterior teeth is present, but did not affect careful placement of the virtual implants. (b) Computer-generated 3-D image of the scanning prosthesis that indicates the screw access location based on the virtual implant positions. (c) Computer-generated 3-D image of the scanning prosthesis with some transparency, indicating the position of the surgical sleeves that will be placed in the surgical template.

required for CAD/ CAM planning. The implants were planned using the guided software package (Procera, Nobel Biocare) and uploaded to Sweden for fabrication of the surgical template (Figs 2a to 2c).

The surgical template (Fig 3) was sent to a dental laboratory to fabricate a master cast from the surgical template. An altered cast technique was used, removing the edentulous area of the cast. The surgical guide was then fully seated on the cast, and soft and hard tissue pours were made.

The clinicians and laboratory discussed and coordinated the orientation of the internal connection of the implant analogue on the master cast. It was agreed that the implant analogues would be oriented so that one of the lobes of the internal aspect of the implant platform would be positioned to the buccal aspect (Fig 4). Then, 2 definitive custom zirconia abutments were designed with custom emergence profiles (Fig 5). Provisional acrylic resin crowns were prepared to fit precisely over the custom abutments with light occlusion.

Preoperatively, the patient was lightly sedated orally with 0.50 mg triazolam (Greenstone). Local anesthesia using 3.4 mL 2% lidocaine and epinephrine 1:100,000 (Henry Schein) was administered, and the surgical template was inserted and stabilized with rests on adjacent teeth and one 1.5-mm



Fig 3 Stereolithically-constructed surgical template containing 2 stainless steel sleeves to direct implant placement and 1 anchor pin sleeve.

anchor pin. Guided transmucosal site preparation and osteotomies were performed, followed by implant placement (Fig 6). The surgical template was removed, and the rotational positions of the implant internal connections were assessed. Rotational adjustment of less than 20 degrees was performed to closely match the buccal lobe positions of the implant platforms on the master cast. Tactilely, it was determined that the implants could be rotated in a clockwise direction. Adjustment can be made in a counterclockwise direction if the clinician prefers and is

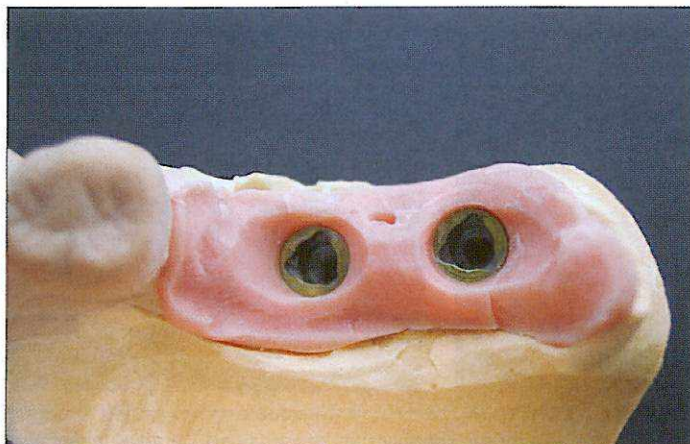


Fig 4 Occlusal view of the altered master cast. The implant analogues were specifically positioned so that 1 of the 3 internal connection lobes was facing buccally.

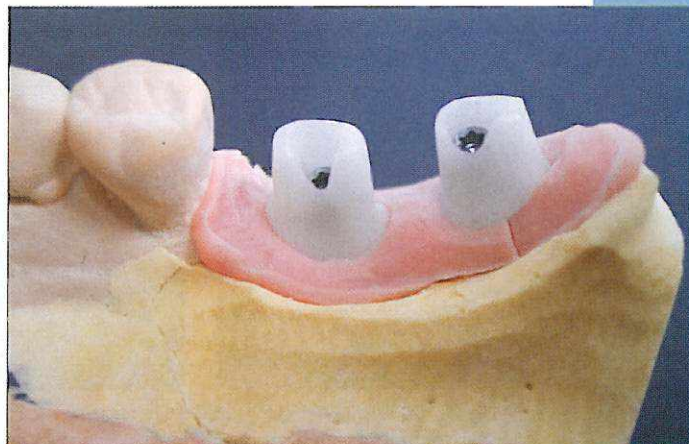


Fig 5 Lingual view of the custom milled zirconia abutments in place on the master cast.

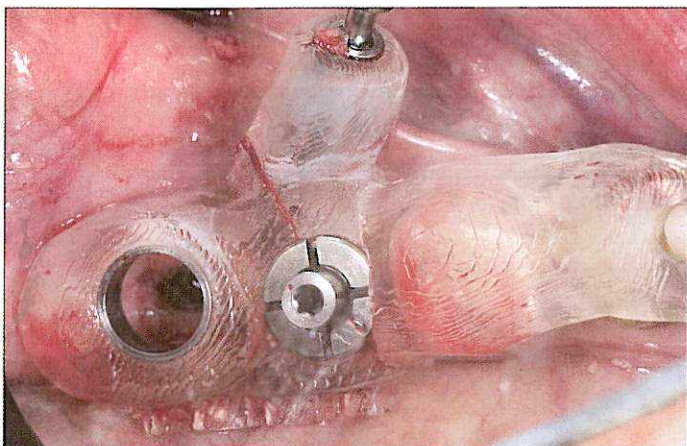


Fig 6 Occlusal view of the surgical template locked in place with a template abutment in the area of the first molar. The template abutment secures the position of the surgical template for placement of the implant in the area of the second molar.



Fig 7 Buccal view of the custom milled zirconia abutments in place.

concerned about reaching the apical depth of the osteotomy. Minimal vertical changes are likely to occur since the amount of rotation will be less than 60 degrees. The buccal aspects of 2 custom zirconia abutments were marked on the master cast to facilitate orientation in the mouth, positioned intraorally, and torqued to 35 Ncm (Fig 7).

The abutment screw access holes were filled with cotton and light-curing provisional restorative material (Fermit, Vivadent). The provisional crowns were sectioned to facilitate placement on the abutments, seated, and adjusted with light occlusion (Fig 8). Flowable composite material (Renamel flow-

able microfilm, Cosmedent) was placed and cured between the crowns to splint the individual units. Periapical and panoramic radiographs were taken to confirm implant placement, abutment seating, and level of crestal bone (Fig 9).

Healing proceeded uneventfully (Fig 10), and 3 months after implant placement, the provisional restorations were replaced with permanent crowns fabricated using Lava milled zirconia substructure (3M Espe) and Noritake CZR veneering porcelain (Vivadex). The permanent restorations were luted using glass-ionomer luting cement (GC FujiCem, GC America) (Figs 11 and 12).



Fig 8 Buccal view of the provisional crowns positioned with passive occlusion.

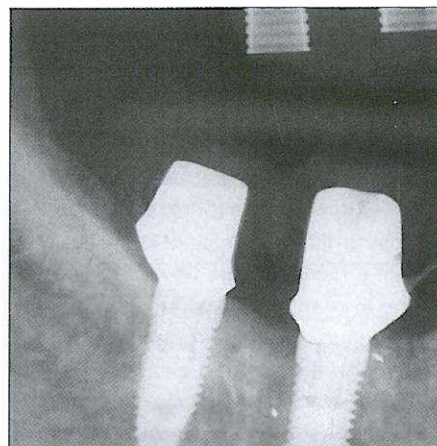


Fig 9 Bitewing radiograph immediately after implant and abutment placement.

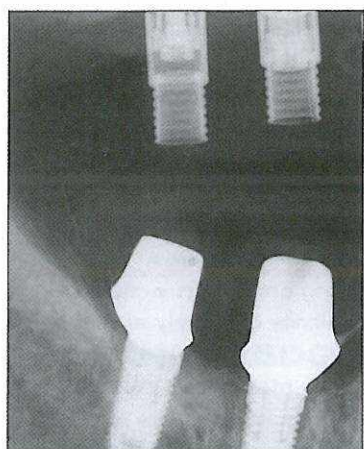


Fig 10 Three-month postoperative bitewing radiograph.



Fig 11 Three-month postoperative view of abutments and gingival tissue.



Figs 12a and 12b Occlusal and lateral views of final crowns cemented in place.



Fig 8 Buccal view of the provisional crowns positioned with passive occlusion.

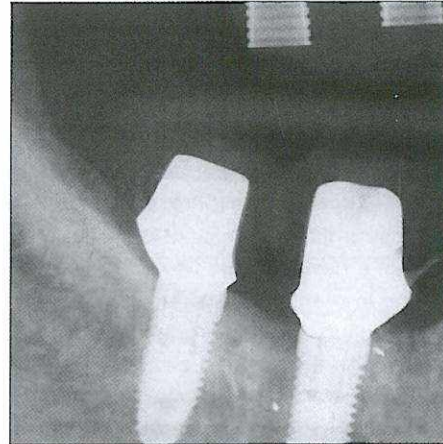


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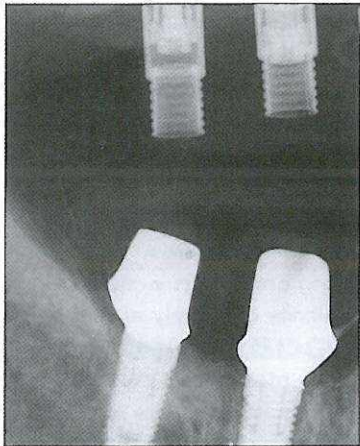


Fig 10 Three-month postoperative bitewing radiograph.



Fig 11 Three-month postoperative view of abutments and gingival tissue.



Figs 12a and 12b Occlusal and lateral views of final crowns cemented in place.

DISCUSSION

According to the work of King et al,¹⁵ Callan et al,¹⁶ and others,¹⁷⁻¹⁹ it has been shown that the implant-abutment interface, known as the microgap, harbors bacteria, which stimulate an inflammatory cell infiltrate contributing to the circumferential loss of bone and reformation of a new biologic width around the neck of the implant. The average amount of bone remodeling around implants using a non-submerged, unloaded protocol was approximately 1 mm after 6 months, with greater remodeling occurring where the rough-smooth border was placed in a more apical position.²⁰ One-piece implants have been shown to form a narrower biologic width similar to that of natural teeth, compared to a longer biologic width in 2-piece implants.²¹

Piatelli et al²² found in monkeys that moving the microgap away from the crest of bone resulted in decreased bone loss around the neck of the implant. Moving the microgap closer to the crest of bone resulted in increased loss of bone. Hartman and Cochran²⁰ studied in humans the effect of the position of the rough-smooth border on the extent of crestal bone loss in 1-piece non-submerged implants and confirmed that the deeper the location of the rough-smooth border, the greater the loss of crestal bone.

The loss of crestal bone around implants has a direct effect on the esthetic outcome of treatment, particularly if the implant is positioned too close to a thin buccal cortical plate or if 2 implants are placed too close to each other.

By controlling factors that contribute to the loss of crestal bone, it may be possible to enhance soft tissue esthetics, including the preservation of papilla height around implants, therefore increasing esthetic success and overall patient satisfaction. The presence of a microgap and its distance from the crest of bone appears to be an important contributing factor to crestal bone loss. Fabricating a custom abutment to be placed at the time of implant surgery, torquing it to 35 Ncm, and never removing it may be helpful in reducing the influence of the microgap on the loss of crestal bone. Placing an abutment at the time of implant

surgery may also decrease the disturbances of the epithelial attachment that occur with removal and replacement of healing provisional and final abutments. This may, in turn, decrease the apical migration of the epithelial attachment, reducing the extent of crestal bone loss around the neck of the implant.

The guided surgery technique described in the literature⁹⁻¹⁴ uses the guided abutment, a nonengaging abutment that seats fully on the implant platform and uses a friction grip connection between the abutment and prosthesis. The characteristics of this abutment allow for some adjustability, and when properly torqued to 35 Ncm, create an engineered metal-to-metal connection with the prosthesis that is maintainable over time without screw loosening. The guided abutment is particularly useful in conjunction with a complete-arch fixed hybrid-type prosthesis, which replaces both teeth and missing hard (osseous) and soft (gingival) tissue anatomy, often seen in severely resorbed cases. It is not the ideal solution for partially edentulous cases or, in particular, if gingival anatomy is not being replaced in the prosthesis.

Individual engaging abutments were chosen so that the feasibility of closely approximating the rotational position of the implants to their position on the master cast could be assessed and performed at the time of surgery. The definitive abutments could then be torqued and never removed. The rotational position of the implant internal connection cannot currently be predicted before implant insertion. Therefore, after implant placement and removal of the surgical template, the implants were gently rotated to the same position as on the master cast. This resulted in the chamfered margins of the zirconia abutments being at the same location in the mouth as on the master cast. The provisional crowns were received from the lab splinted together. They were sectioned and relieved slightly, interproximally, before seating, to allow for any minor discrepancy that may have occurred. Flowable composite was then syringed into the proximal contact area to relute the provisional crowns together, maximizing their stability during the initial period of osseointegration.²³ The insertion torque to place both implants exceeded 40 Ncm, suggesting good initial stability of the implants.

The crowns were left in light occlusion for 3 months, opposing an immediately loaded complete-arch fixed implant-supported prosthesis, using a guided surgery protocol. Three months after implant placement, the provisional restorations were replaced with permanent crowns.

CONCLUSION

Placement of a definitive abutment at the time of implant surgery using a guided surgery protocol increases placement accuracy and treatment efficiency. It also decreases treatment time and provides a stable, early implant-abutment connection that may have a positive impact on the preservation of crestal bone around the implant. This technique also eliminates the need for an implant-level impression. Long-term follow-up and increased samples are required to definitively demonstrate preservation of crestal bone.

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