COMPUTERIZED TOMOGRAPHY SCAN INTERPRETATION OF A BONE EXPANSION TECHNIQUE

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KEY WORDS

Labial plate
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Bone manipulation
Bone expansion

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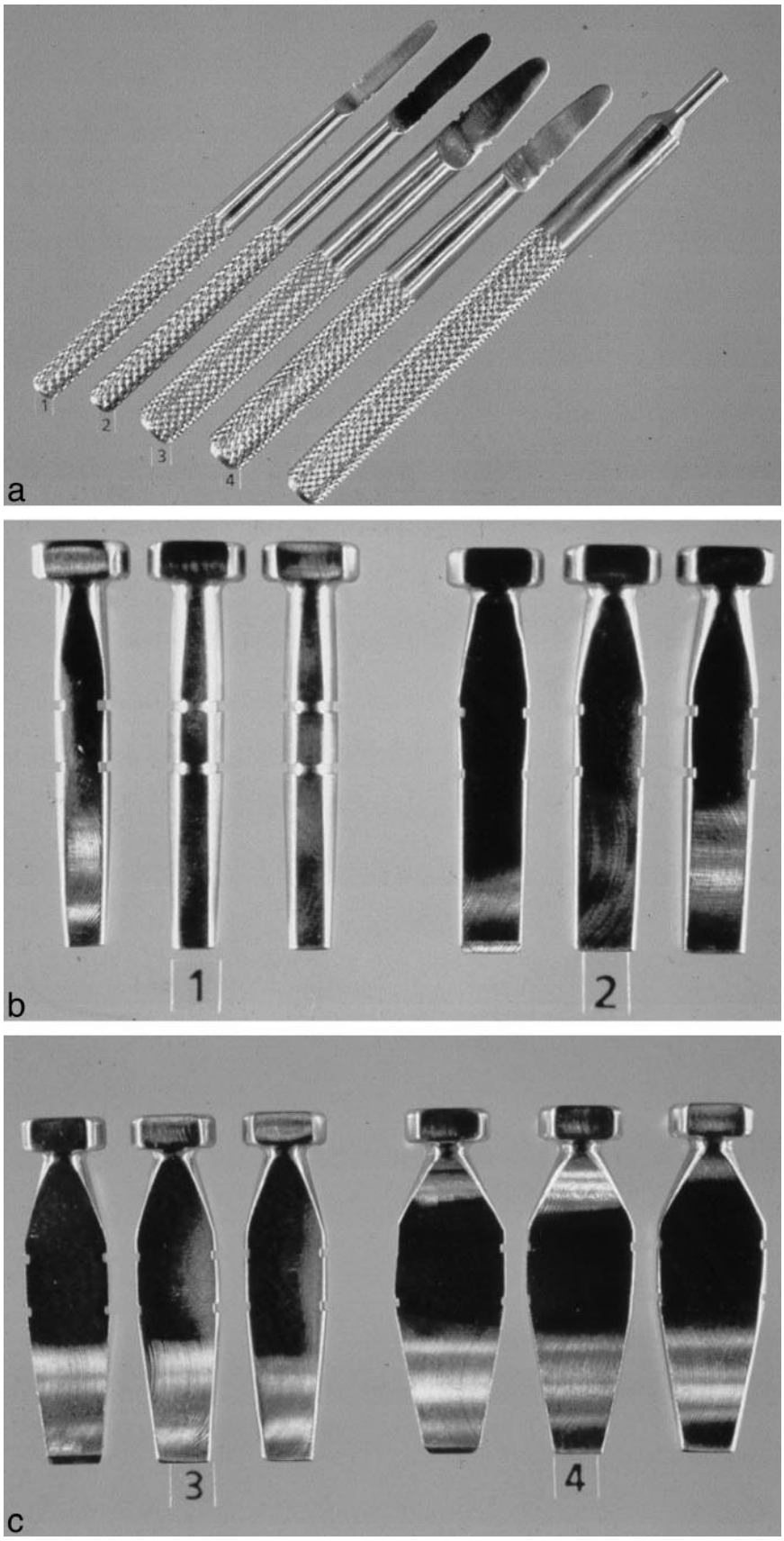
Bone expansion can be defined as the manipulation of bone to form a receptor site for an implant without the removal of any bone from the patient. The way this technique is used provides a number of advantages to patients. There is a marked decrease in the need to graft ridges, even those as narrow as 1 mm. This results in less surgical time for the surgeon and much less cost to the patient. It also allows for the significant improvement of atrophic arch morphology and interarch relationships for the restorative phases. Soft tissue revisions at the time of implant placement allow for the development of keratinized tissue surrounding the implant, thus saving the patient the morbidity and cost of another surgical procedure. Cortical bone is preserved by not raising the periosteum during the manipulation of bone.

INTRODUCTION

O. Hilt Tatum, Jr, DDS, developed a technique of using incremental wedging procedures to reposition the buccal plate of maxillary bone in the late 1960s. This has been refined to an implant placement procedure that is now referred to as the ''bone expansion technique.''[1] Recent modifications to this technique that combine such manipulation with the impaction of bone for placement of round implants[2] work well when the planned site is at least 3 mm wide. In the severely atrophic ridge, it is preferable to move bone only in a buccal direction in order to restore the normal bone morphology, which was lost at the expense of the facial dimension. Gaining access to a ridge 1 mm wide requires splitting it with a scalpel, which does not permit the formation of round osteotomies. To expand bone, a series of wedging devices (osteotomes) called channel formers and socket formers (Fig 1; Unipost System, Suncoast Dental, St Petersburg, Fla) are used. They facilitate the expansion of bone even as thin as 1 mm, ultimately allowing its expansion to 5 or 6 mm, which permits the seating of a specially designed, elliptical (D-shaped) root form implant (Fig 2).

This technique necessitated the design of an implant (the D implant/Unipost system), which has been in use for 19 years. The D implant is unique in



its mesiodistal and buccolingual diameters; it is also unique in that its design maximizes surface area and promotes compression-stress loading. The D implant design substantially reduces the detrimental effects of sheer stress on the implant–bone interface, a vital point often understated by those less knowledgeable. Its asymmetrical mesiodistal configuration also eliminates traumatic lateral or rotational forces, which often are placed on an implant.

D implants have fins, which are available in a range of mesiodistal widths: 4 mm, 5.5 mm, 7.5 mm, and 10 mm. In the buccolingual dimension, the fins on all D implants are 3.5 mm (Fig 2) at their thickest crestal portion; they then taper to the apex. They are 20 mm long. The abutments, or vertical female component, of the implants are straight or angled and are available with 3.5-, 4-, 4.5-, or 5-mm-diameter posts. These dimensions permit more aesthetic emergence profiles.

Throughout the development process, it was observed that the expanded bone does not assume a round or rectangular configuration but rather expands to a D shape. The bone expands toward the labial with the flat side of the D on the palate and the convex part on the labial (Fig 3). The palatal slope in this region is relatively dense cortical bone, whereas the labial cortical shelf is quite thin. Therefore, the natural expansion of the bone would routinely occur labially, compensating for the original dimensional loss of bone, which occurs at its expense. Thus, bone manipulation enables one to recontour the bone in the direction of its loss, place the implant in a position closer to that of the original tooth socket, and ultimately restore normal root morphology planned to support the restorative crown.

Bone expansion procedures generally preclude placement of side-by-side

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FIGURE 1. The instruments that serve to expand the maxillary ridge. (a) Osteotomes. (b) Channel formers. (c) Socket formers.

implants to provide adequate space for proper healing. The exception is at locations 8 and 9, directly below the nose, because of the anatomic structure of the midline suture. For all other edentulous areas, the implants are usually placed in an alternative tooth configuration.

The success of the bone expansion procedure relies on maintaining the integrity of the labial wall, which occurs as long as the periosteum remains intact. Since 80% of the blood supply is from the periosteum,[3] we feel the high degree of the success in expanding very thin ridges is due to our ability to manipulate the thin cortical bone without disrupting the periosteal attachment to this bone.

If a wider implant is to be used, the channel former corresponding to that implant's dimensions is next placed into the osteotomy, and the same procedure of supporting the bone with finger pressure is followed as the channel former is tapped into the expansion site.

If the floor of the nose limits the vertical height of bone to less than 12 mm, the socket formers can be used to elevate the floor of the nose several millimeters. To achieve this, all instruments being used in the same sequence would be seated approximately 4 mm below the floor of the nose. When the last socket former is inserted and seated to this depth, its blunt end can be used to elevate the nasal floor several millimeters.

With the osteotomy completed, the appropriate D implant is selected, and a resorbable graft material or autogenous bone is placed in the implant's crestal fins in order to deter soft tissue ingrowth. The implant is then seated in the same manner as were the socket formers. During the final seating and placement of the implant, careful attention must be given to holding the crestal soft tissue away from the implant fins. This prevents any epithelium or other soft tissues from being carried inadvertently into the socket.

The implant is seated so that its head emerges from the crestal bone. Ultimately, the top of the head should be flush with the soft tissue once the flap is repositioned. After the implant is seated, bone or resorbable graft material is placed in the crestal portion of the socket around the mesial and distal portions of the neck of the implant to cover the most superior fin and to fill the exposed site to the crest of the ridge.

Before suturing (Figs 4, 5), a post guide is inserted into the implant to determine the correct angle for the restoration post. After verifying the angle of the post guide and making any other corrections in the position of the implant, a healing screw is placed into

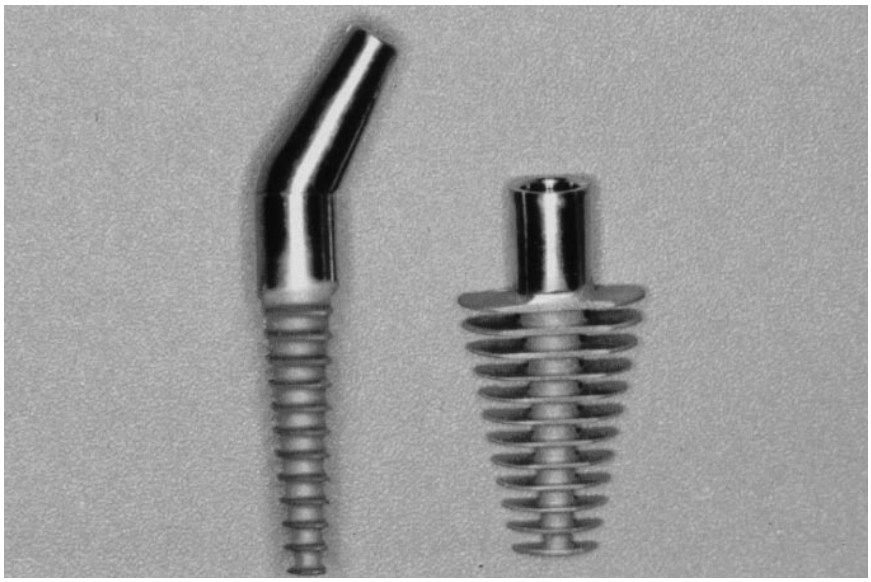

FIGURE 2. The elliptical root form D implant, which has fins of varying dimensions and is available in a 20-mm length.

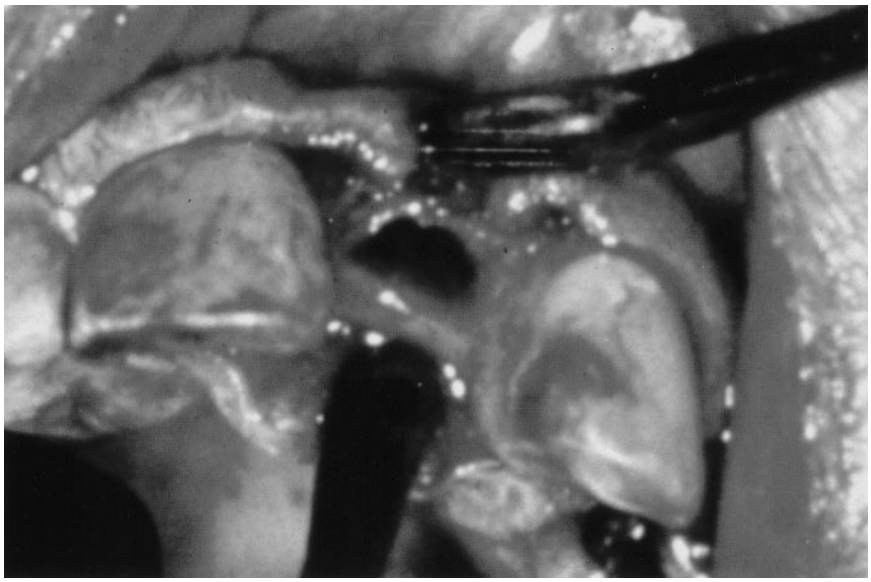

FIGURE 3. The D-shape configuration of an osteotomy with the bone expanded to the labial side.

the female component of the implant. The gingiva is scalloped for adaptation around the head of the implant and sutured tightly (Fig 6). Care must be taken to ensure that no force will be transferred to the exposed implant head from the provisional prosthesis, in order to encourage osseointegration.[4]

Case Report

A 53-year-old man missing a maxillary left central incisor and with atrophy of the buccal plate (Fig 7) was seen at the Loma Linda Oral Implant Surgical Center, Loma Linda, Calif. A computerized tomography (CT) scan series was taken before manipulation and placement of a single 20-mm-long root form implant. Another CT scan series was taken immediately after implant placement, and the resulting dimensional changes were compared.

Methods

The patient was imaged prospectively and retrospectively using computerized tomography with a GE-9800 Hi-Speed Zeus scanner in the axial mode. Imaging parameters included 140 kVp, 200 ma-s, a 1-second scan, and a 15-cm field of view; reconstructions used a bone algorithm. Thirty-three axial images were obtained, resulting in an imaging time of 66 seconds. The patient was oriented in the scanner so that the plane of maxillary alveolar crestal bone was perpendicular to the horizontal plane and tangential to the axial plane. Positioning was verified with scout views for both the prospective and retrospective scans.

The axial image data was transferred to a Columbia Scientific (Columbia, Md) workstation for reprocessing into cross-sectional oblique and curved plane images. The reconstructed images were spaced in 1-mm increments, and section thickness was 0.25 mm. The axial curved plane and cross-sectional–oblique images were subsequently downloaded to disk for independent viewing on a personal workstation.

Findings

Prospective CT imaging demonstrated the edentulous region in the maxillary left central incisor region (Fig 8). This region indicated an unusually prominent nasopalatine canal and foramen. The cross-sectional images (Fig 9) demonstrated moderate atrophy of the buccal aspect of the alveolus and slight atrophy of the crestal aspect of the alveolus. The alveolus was reasonably corticate and trabeculated, with a trabecular density of about 400 Hounsfield units, equivalent to type II bone. The height of the alveolus measured 15 mm, and the width at midalveolus measured 8 mm.

Retrospective CT imaging demonstrates the edentulous region with the implant in place (Fig 10). The alveolus demonstrates an increased labial extent of almost 6 mm (Fig 11) and an apical enlargement of almost 5 mm (Fig 12) as a result of bone manipulation for implant placement.

Summary and Conclusions

The process of placing the implant resulted in reforming the alveolus, thus producing greater facial and apical dimensions to the alveolus. This resulted in a more stable implant-borne prosthesis. The preoperative moderate atrophy with collapse of the labial contour demonstrated a return to normal morphology. This permitted an aesthetic, hygienic restoration of the region, with a pleasant appearance and an avoidance of ridge laps (Figs 13, 14).

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FIGURE 4. A socket former is in place, with the labial bone and tissue moved to the labial side.

FIGURE 5. A post guide is in place to determine the correct angle for the restoration post or abutment.

FIGURE 6. The head of an implant is in place, and the soft tissue has been sutured around it tightly.

FIGURE 7. (a) A radiographic view of left central incisor site with an atrophic labial plate. (b) A facial view of left central incisor site with an atrophic labial plate. (c) An occlusal view of left central incisor site with its atrophic labial plate.

FIGURE 8. Of note is the narrow bridge of bone between the concave labial plate and the incisal canal. For proper positioning of a crown, it must be placed on an implant located labial to the existing bone.

FIGURE 9. Although the alveolus is 15 mm in length, a 20-mm-long implant will be placed.

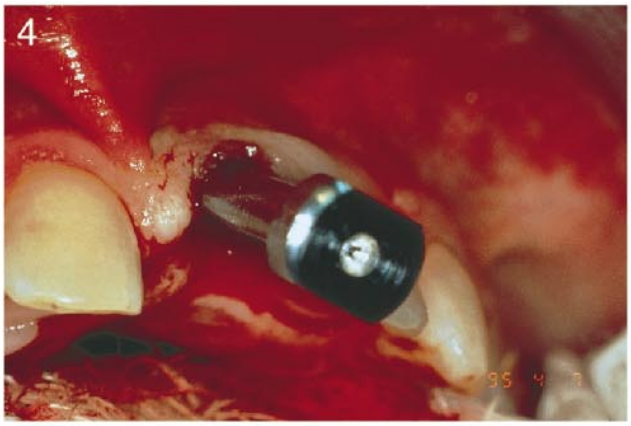
FIGURE 10. In expansion procedures no bone is removed; therefore, the implant is placed entirely in an intrabony environment (confirmed with an exploratory probe before the implant was placed).

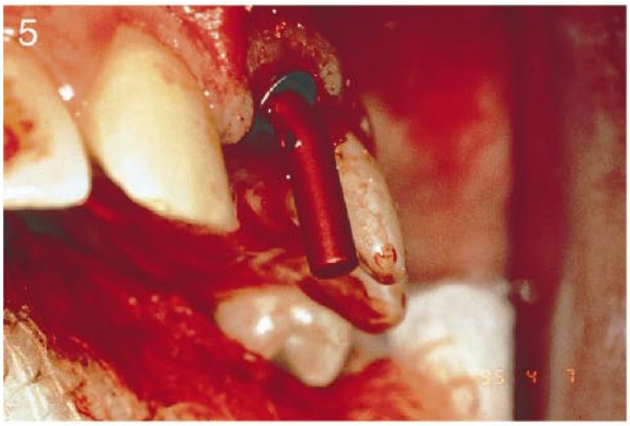
FIGURE 11. Of note is the labial position of the newly placed implant, which permits proper aesthetic positioning of the prosthesis in relationship to the adjacent teeth.

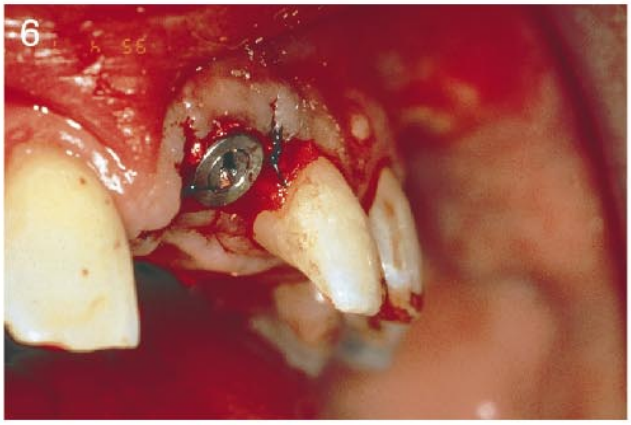
FIGURE 12. Of interest is the plug of bone apical to implant, movement of labial plate in a labial direction, and bone covering that portion of the implant occupying a portion of the incisal canal.

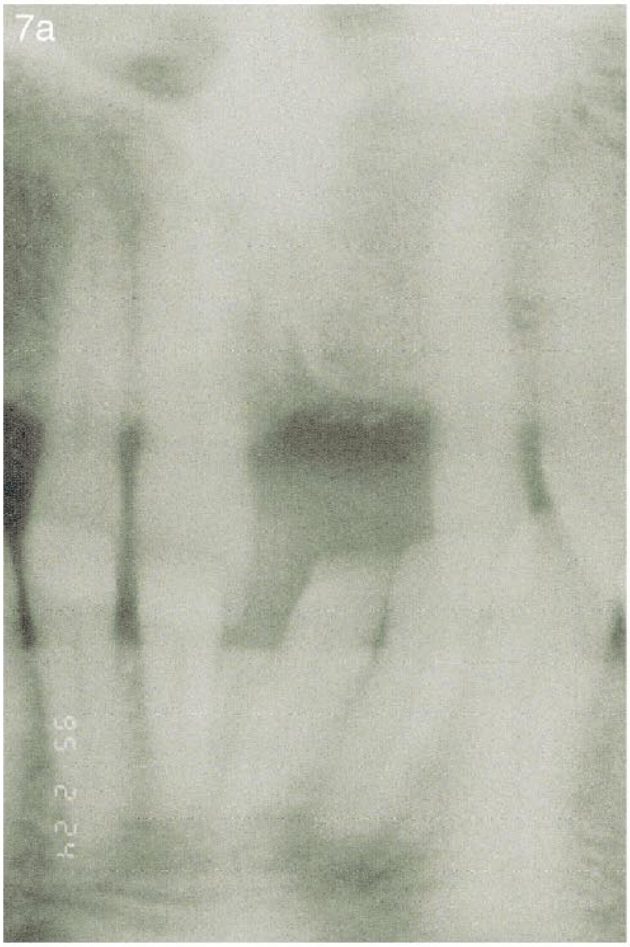
FIGURE 13. After normal healing, the healing screw is in place; healthy keratinized tissue surrounds the implant and a normal-appearing alveolus with festooning over the implant in a root-type configuration is seen.

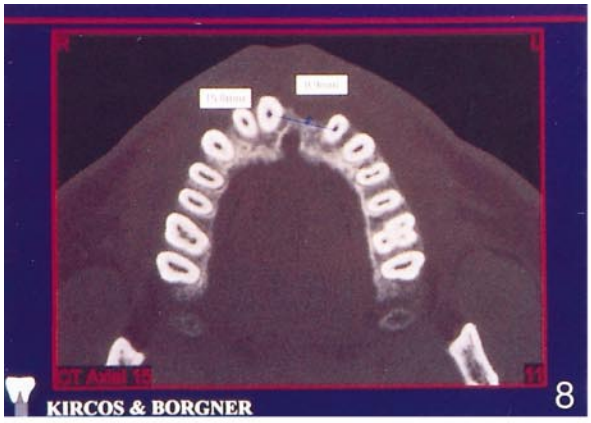
FIGURE 14. Restoration of the implant shows normal soft and hard tissue morphology with a natural-appearing single tooth replacement.

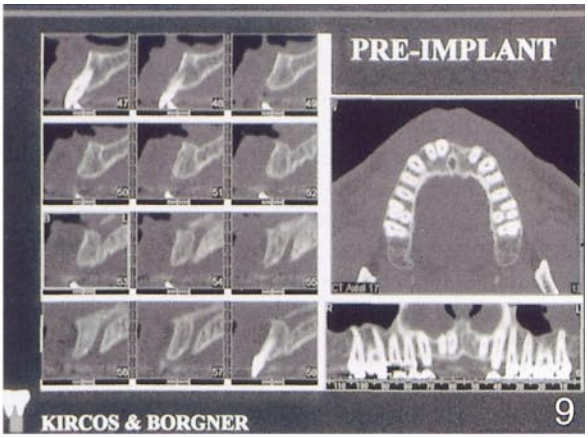


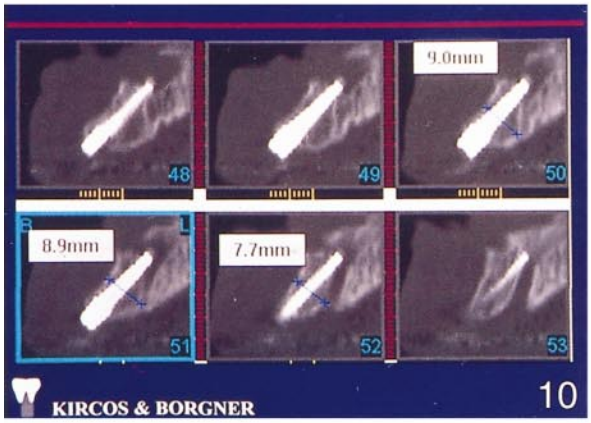


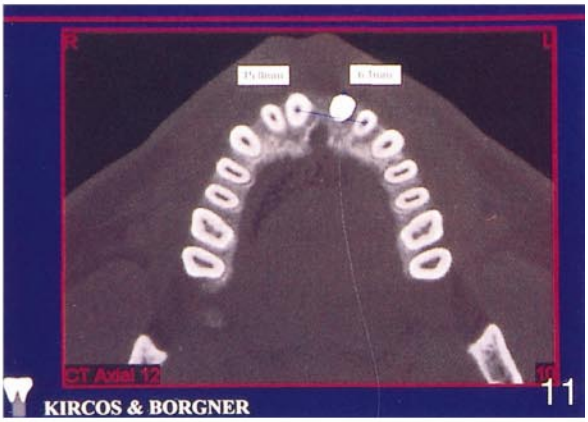


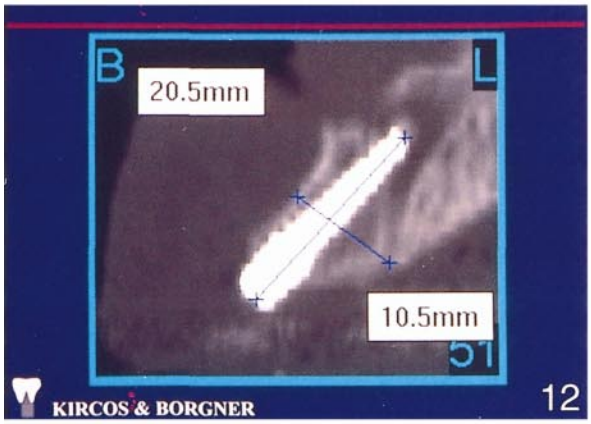


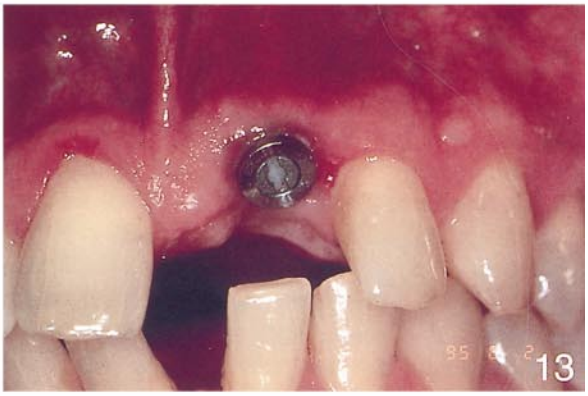












The procedure allowed for implant placement, proper recontouring of the hard and soft tissues, and conservation of keratinized tissues with only one surgical procedure and with no compromise in aesthetics or stability of the dental implant. Had an implant placement been attempted without these procedures or previous bone grafting, the prosthetic component would have been placed too far lingually, and because of the very large incisal foramen, the implant would not have had bone available to abut its mesial aspect.

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