

## CLINICAL SCIENCE

# Prosthodontic Management of a Combination Transosteal/Endosteal Implant Reconstruction: A Clinical Report

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This is a clinical report of a patient who was not referred for prosthodontic evaluation and treatment until after undergoing Brånemark endosseous implant placement to supplement the previously existing mandibular staple bone plate implant. This supplemental treatment was the surgeon's attempt to resolve the patient's complaint of loose dentures. Creativity with implant biomechanics and prosthodontic design were necessary to restore the patient, in a predictable manner, to normal function. A fixed, detachable cast overdenture bar rigidly connected to all the implants was constructed utilizing resilient attachments to retain the tissue-supported mandibular overdenture. A presurgical prosthodontic evaluation could have averted many of the problems encountered with treatment. More effective conventional prosthodontic treatment may have resolved the patient's complaints and eliminated the need for additional implant placement.

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**INDEX WORDS:** dental implant, mandibular staple bone plate implant, Brånemark implant, ERA attachment, implant overdenture, resilient attachments, implant prosthodontics

THE MANDIBULAR STAPLE bone plate was developed by Dr. Irwin Small in 1968.<sup>1</sup> It is an implantable orthopedic device inserted through the inferior border of the mandible and was designed to assist in the restoration of function of the edentulous atrophic mandible.

The system recommends allowance for some vertical movement of the denture. The original prosthetic design involves the use of stress-directing attachments connected to the transosteal pins, providing stability for the removable denture and gaining support from the underlying tissues.

Vertical compressive forces are undesirable against the mandibular staple bone plate.<sup>2</sup> If the prosthetic treatment vertically overloads the superstructure, it is possible to cause the staple to extrude. Small attributed a 7% incidence of stress loosening to vertical overloading.<sup>3</sup>

The mandibular staple bone plate is classified as a transosteal dental implant. Endosteal dental implants are devices placed into the alveolar and/or basal bone of the mandible or maxillae transecting only one cortical plate.<sup>4</sup> Although many early studies showed varying degrees of success with endosteal dental implants, it was not until Brånemark's studies that the scientific community began to see predictable results accurately reported. The discovery of osseointegration has allowed for the construction of rigidly designed fixed implant restorations because of the firm anchorage that is possible.<sup>5</sup>

In 1986, Albrektsson stated, "to date we have found only two dental implant systems that meet our criteria (for success): the Brånemark osseointegrated screw and the Small transosteal staple. Both these systems have presented acceptable long-term (10 years) results that have been based on the outcome of each and every inserted implant."<sup>6</sup> Although many other systems today may meet or surpass that criterion for success, these two systems

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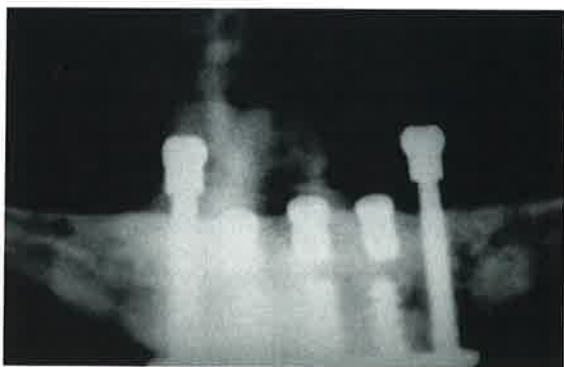
have continued to show predictably acceptable results.

The recommended prosthetic designs are different for the transosteal and endosteal dental implant systems. In 1992, Balshi described a case in which endosseous dental implants were used to treat a patient in whom a transosteal pin of a mandibular bone staple implant had fractured. The final restoration was supported by the endosseous implants only.<sup>7</sup>

This article will describe the prosthetic treatment of a patient with transosteal and endosteal dental implants that will be used in combination in the final restoration.

### Patient Evaluation and Treatment

A 62-year-old white woman not previously seen by the authors was referred for prosthodontic reconstruction 10 months after undergoing placement of three  $3.75 \times 7$ -mm Brånemark endosseous dental implants between the two transosteal pins of a five-pin mandibular staple bone plate. Four Brånemark implants (one was  $3.75 \times 10$  mm, one was  $3.75 \times 13$  mm, and two were  $3.75 \times 15$  mm) were placed in the upper jaw in conjunction with an iliac crest bone graft (Fig 1). The patient had complained to the surgeon about the lack of stability of the maxillary conventional denture and the ball attachment-retained overdenture on the mandibular staple bone plate. The surgeon decided to place the maxillary implants to retain an overdenture and the three mandibular implants to provide enough sup-



**Figure 1.** Close-up view of panoramic radiograph showing placement of three Brånemark-style endosseous dental implants in between the transosteal pins and superior to the retentive pins of the previously placed mandibular staple bone plate. Note placement of ball attachments too high on the transosteal pins, with threads exposed subgingivally.



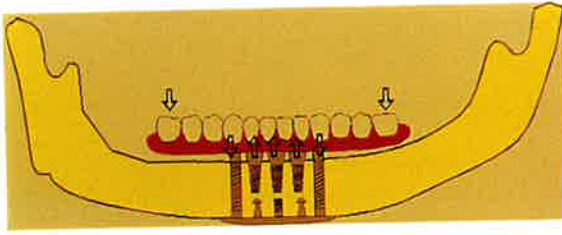
**Figure 2.** Illustration showing see-saw-type loading found in a U-shaped fixed detachable prosthesis supported by anteriorly placed endosseous implants with posterior extensions (cantilevers). Posterior implants correspond to the fulcrum of the see-saw and receive compressive force, whereas the anterior implants receive a tensile force.

port for a mandibular fixed implant-supported restoration.

The patient's medical history included high blood pressure, arthritis, and a psychiatric disorder. Intra-oral examination showed xerostomia, most probably associated with the patient's history of taking Prozac (fluoxetine hydrochloride; Eli Lilly and Co., Indianapolis, IN) and diuretics.

According to Rangert,<sup>8</sup> the U-shaped prosthesis for the edentulous mandible supported by anteriorly placed implants and with posterior extensions (cantilevers) simulates the loading of a "see-saw." The posterior implant corresponds to the fulcrum of the see-saw (receiving compressive force), whereas the anterior implants will absorb a tension force<sup>8</sup> (Fig 2). The crucial parameter is the cantilever length relative to the interimplant distance between the anterior and posterior implants.<sup>9</sup> Because of the detrimental compressive forces that would be exerted through the transosteal pins to the mandibular staple bone plate implant with a fixed implant-supported design (Fig 3), the decision was made to construct an implant-retained overdenture utilizing the edentulous areas for tissue support. According to Helfrick et al,<sup>10</sup> the most frequent complication that requires removal of the bone plate is loosening accompanied by extrusion of the implant. This can be prevented by proper prosthetic reconstruction that avoids placing vertical stresses on the staple and assures that the mandibular denture is tissue-borne.<sup>10</sup> By the type of design chosen, we could use all of the available support and best manage the surgeon's placement of additional implants.

Prosthodontic evaluation of the patient showed unsatisfactory design of the maxillary and mandibular dentures and improper placement of ball attachment abutments on the mandibular staple bone plate. The maxillary denture showed inadequate



**Figure 3.** Illustration showing see-saw-type loading, which would be found in a U-shaped, fixed, detachable prosthesis supported by the implants of this patient. With this type of design, the transosteal implants, acting as the fulcrum of the see-saw, would receive compressive forces that are contraindicated in this system. Compressive forces may cause extrusion of the mandibular staple bone plate.

extension and lack of a functional postpalatal seal. The mandibular denture borders were generally underextended and did not cover the retromolar pads. The transosteal pins of the mandibular bone staple implant were underreduced, which led to placement of the ball attachment abutments too high on the pins (Fig 1). This could result in an unfavorable mechanical situation in retaining the mandibular overdenture. Simons and Hanks found the problem of overextended pins to lead to a repeated fracture of the mandibular denture base because of inadequate space for proper thickness of acrylic resin.<sup>11</sup> Even worse, this could lead to fracture of the transosteal pin itself because of the increased length of the lever arm.

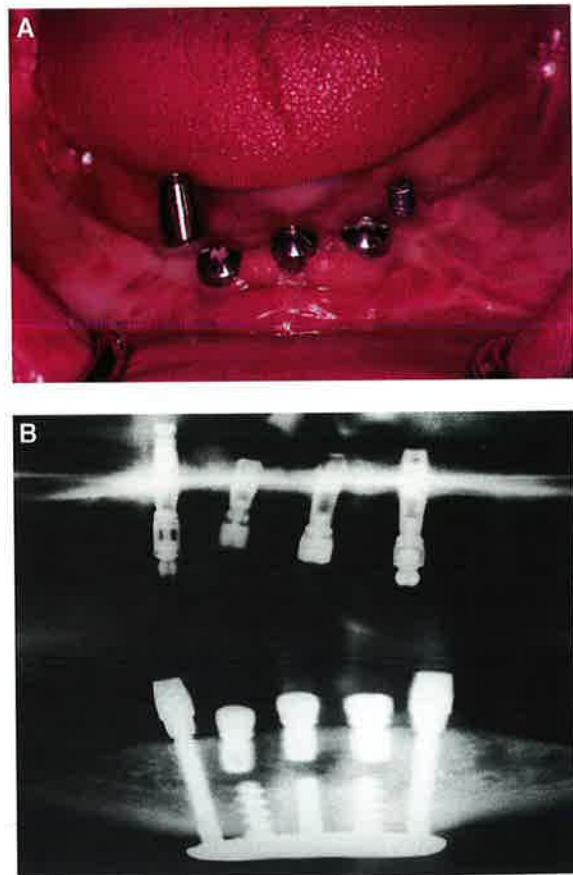
Because of financial limitations, Bränemark ball attachment abutments were connected to the two maxillary canine area implants. Healing abutments on the anterior implants would function as vertical stops for the maxillary ball-retained implant overdenture.

The five mandibular implant posts were connected with a fixed detachable bar, incorporating nonrigid attachments for an implant-retained, tissue-supported overdenture. To gain maximum stability and to incorporate all available implant support, tapered abutments capable of accepting a screw-retained prosthesis (straight-sleeved nut and screw; Hall Surgical, Carpinteria, CA) were selected for the transosteal pins. The ball attachment abutments were removed from the transosteal pins. The pins were reduced in height, using a diamond bur in a high-speed handpiece with water irrigation, and then the tapered abutments were placed (Fig 4).

A combination open and closed tray impression technique was conducted on the mandibular arch. Because of the severe divergence between the trans-

osteal pins and the endosseous implants, the decision was made to select the abutments for the endosseous implants in the laboratory. Screw-retained, fixture-impression copings (impression coping, titanium, complete with guide pin; Nobelpharma USA, Chicago, IL) were used on the Bränemark implants, whereas plastic impression sleeves (straight-sleeve nut transfer copings; Hall Surgical) were picked up from the tapered abutments on the transosteal pins. The maxillary impression was obtained using the closed tray technique.

Wax trial dentures were constructed and evaluated intraorally. Buccal and lingual indexes were



**Figure 4.** (A) View showing placement of the right side-tapered abutment after reduction in the height of the transosteal pin and the exposed threaded transosteal pin left side after reduction in height but before placement of the tapered abutment. Healing abutments are in place on Bränemark-style endosseous implants. (B) Close-up view of a panoramic radiograph showing Bränemark ball attachment abutments on maxillary posterior implants, healing abutments on anterior maxillary implants, tapered abutments on mandibular transosteal pins, and healing abutments on anteriorly placed Bränemark-style endosseous implants in the mandible.

then made for the mandibular master cast to aid in the fabrication of the overdenture bar within the confines of the mandibular denture as established in the wax trial denture.

Screw-retained plastic sleeves (retrievable wax-up and occlusal screw, Hall surgical) were used for the transosteal-tapered abutments. Castable plastic non-hexed UCLA abutment sleeves (UCLA-type abutment/UCAB2; Implant Innovations, West Palm Beach, FL) were used for the endosteal implants to begin correction of the severe facial angulation and divergence from the transosteal pins at the implant fixture level and to reduce the bulk of the facial aspect of the bar and overdenture (Fig 5).

ERA attachments (APM-Sterngold, Attleboro, MA) were incorporated into the plastic overdenture bar pattern. Two overdenture-style attachments were placed anteriorly on the bar, and two partial denture-style attachments were placed off the distal aspect of the bar. The attachments were placed perpendicular to the midline of the mandibular denture to allow for proper rotation in design (Fig 6). The mandibular denture was allowed to rotate with its fulcrum on the posteriorly placed partial denture-type attachments, whereas the anteriorly placed overdenture-type attachments resist movement of the mandibular denture away from the bar when force is applied posteriorly.

Clearance for the bar and attachments was visually confirmed when the wax trial denture was placed on the master cast, and the bar was viewed through the lingual window created in the denture (Fig 7). After accuracy of the casting and clearance for the denture and attachments were confirmed, the denture wax-ups were completed and the dentures were flaked and processed (Fig 8).



**Figure 5.** Occlusal view of master cast with screw-retained castable plastic sleeves on transosteal tapered abutments and plastic castable nonhexed UCLA abutment sleeves for Brånemark implants. Note the severe divergence between the transosteal and endosteal implants.

Care was taken to avoid contact of the mandibular overdenture with the gold bar on areas other than the four ERA attachments. Pressure-indicating paste was used in the laboratory and again intraorally to detect and remove any interferences. Such interferences would negate the nonrigid function of the ERA attachments and provide a rigidly attached mechanism, which might be detrimental to the system.

The gold bar was then secured into place intraorally (Fig 9). The distal extension portions of the mandibular overdenture were relieved, and a laboratory reline procedure was initiated to provide for an even more accurate fit for the mandibular overdenture. After the lower reline was completed, it was adjusted and delivered. The maxillary denture was also tried and adjusted accordingly for delivery. The patient functioned comfortably and had excellent retention of the maxillary denture for several weeks without activating the ball attachments. Proper border extensions and the presence of a postpalatal seal made this possible. The ball attachment housings were then picked up and transferred to the denture intraorally using GC pattern resin (GC America, Inc, Chicago, IL) through windows created in the denture after all soft tissue irritations were adjusted accordingly and the patient was comfortable. Occlusion was adjusted in centric relation occlusion and in all excursive movements (Fig 10).

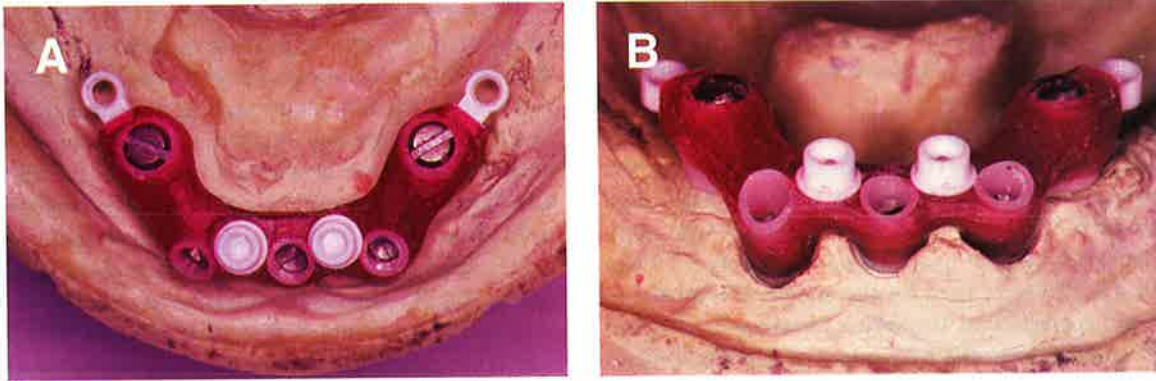
Comparison of the previously and the newly made mandibular dentures shows the proper extension achieved in fabricating the new denture (Fig 11).

The patient has been followed up closely for the past 26 months, since the delivery of the prostheses. Initially, weekly recall visits were focused on relieving tissue soreness and eliminating occlusal discrepancies. The patient repeatedly complained of the feeling of an occlusal prematurity in the right premolar region even after adjustments were made and deemed clinically acceptable by the operators (authors). This feeling may be attributed in part to the patient's lack of neuromuscular coordination, which impeded the registration of an accurate centric relation record.

Examination at the 6-month recall showed that the prosthetic screw on the right-side transosteal abutment had become loose and had been lost without the patient noticing. The screw was replaced but subsequently became loose and was lost again.

The patient was not satisfied with the amount of retention offered by the lowest retention level of attachments, the white ERA male attachments. The next level of retention, the orange males, were placed at the day of activation of the maxillary ball





**Figure 6.** (A) Occlusal and (B) facial views of completed screw-retained acrylic pattern on master cast, showing two ERA overdenture-style attachments on the anterior section of the pattern and two partial denture style attachments off the distal portion of the pattern. Attachments were placed perpendicular to the midline of the lower denture to allow for proper rotation.

attachments. In the operators' opinions, these offered excellent retention and stability, although the patient desired even more. At 6-month recall, the blue males, the third level of retention, were placed, and at 1-year recall, the fourth and final level, the gray males, were placed. The denture presently has a very high degree of retention with which the patient is now satisfied. Radiographically, the bone response to the mandibular implant rehabilitation appears excellent (Fig 12).

### Discussion

Dental professionals should listen to the patient's complaints, recognize the etiology of the complaint, and attempt to resolve the problem in an efficient manner. Prosthodontic evaluation is necessary be-



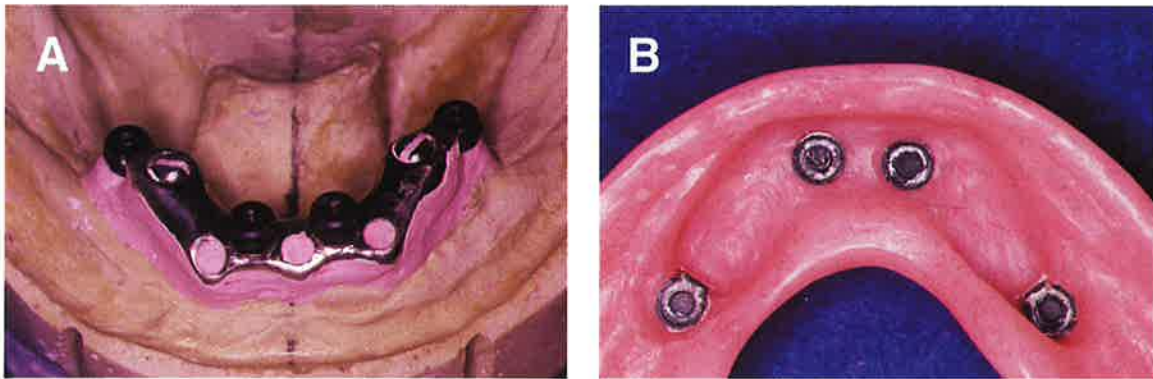
**Figure 7.** View through lingual window created in the mandibular wax trial denture showing adequate clearance for the gold overdenture bar and components.

fore the surgical placement of dental implants, especially if the patient's complaints are of a prosthodontic nature. Dental implant placement is not the cure for poor prosthesis design.

For this particular patient, adjusting the height of the transosteal pins and redesigning the maxillary and mandibular dentures might have resolved the patient's complaints of loose dentures. The transosteal pins could have been adjusted by removing the ball attachment abutments and reducing the height of the pin enough so the collar of the ball attachment abutments could be placed at the level of the osseous crest. This would have (1) reduced the possibility of soft-tissue irritation created by the exposed threads, (2) improved hygiene measures, (3) reduced the risk of denture and transosteal pin fracture, (4) reduced the fulcrum created on the pins, and (5) increased the stability of the overdenture. If after this adjustment implant surgery was still indicated, presurgical prosthodontic treatment involving fabrication of surgical guides would have aided in proper implant positioning and angulation.

Recognition of the biomechanical limitations of an implant system are necessary before treatment. The patient was expecting a fixed prosthesis to be fabricated; however, it appeared to be contraindicated from a biomechanical standpoint. If a fixed implant prosthesis had been desired, placement of endosseous implants posterior to the transosteal pins after an inferior alveolar nerve-repositioning surgery would have been indicated.

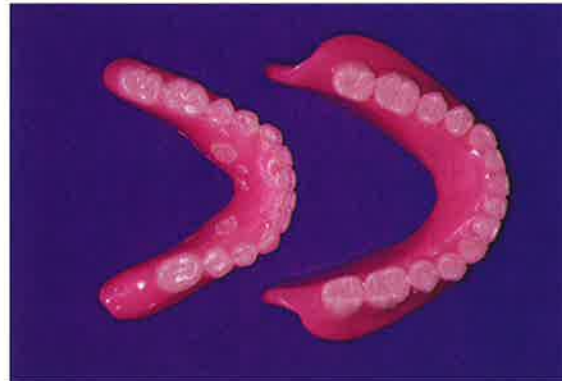
To the authors' knowledge, no reports exist that combine a transosteal implant with endosteal implants. The design chosen was that of an implant-



**Figure 8.** (A) Facial view of casted gold overdenture bar screw retained to the master cast with plaster block-out of screw slots, screw access holes, and undercuts in implant overdenture bar. The block-out will facilitate removal of the denture from the bar after processing. Note the perpendicular alignment of attachments to the line on the master cast, which indicates the midline of the mandibular denture. (B) View of underside of the processed mandibular denture showing the four black processing analogues, which when removed will create receptor sites for the ERA prosthetic attachments.



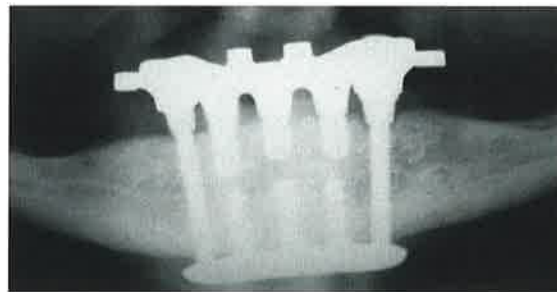
**Figure 9.** Facial view showing both maxillary and mandibular implant components.



**Figure 11.** Comparison of the patient's previous denture (*left*) and the newly made denture (*right*) shows the proper denture border extensions achieved in fabricating the patient's new denture.



**Figure 10.** Facial view of completed maxillary and mandibular dentures in centric relation-occlusion position.



**Figure 12.** Close-up view of the anterior section of the panoramic radiograph 18 months after prosthodontic rehabilitation. Thus far the osseous response has been satisfactory.

retained, tissue-supported, resilient overdenture. Use of resilient attachments, along with their proper placement, was essential to provide for a nonrigid design.

In regard to treatment of the maxilla, the patient had complications after the iliac crest bone grafting procedure that affected her gait and made her reliant on a cane to walk. Because of financial limitations, the suggested treatment of the maxilla with a connecting bar was declined by the patient. A gold bar connecting the four maxillary implants would have been preferred to the design used with two ball attachments and two healing abutments to rigidly join the four implants for better force distribution to the implants and better stability of the prosthesis.

The excellent retention of the newly fabricated maxillary conventional denture with proper extensions and the presence of a more functional postpalatal seal disputed the need for the bone grafting and implant placement in the maxilla. Proper border extensions of the mandibular denture, covering of the retromolar pads, and reduction in the height of the transosteal pins may have provided a similar effect in the mandible.

The numerous postdelivery appointments that were necessary to adjust occlusal discrepancies may be attributed in part to the patient's lack of neuromuscular coordination, which impeded the registration of an accurate centric relation record.

The repeated loosening and loss of the lower right Hall prosthetic-retaining screw is perplexing because clinically and radiographically the bar fits well. This is the side, however, on which the patient has complained of premature occlusion. It is possible that the patient may chew exclusively on this side or have a parafunctional habit concentrating more stress on this side.

The patient's sense of progressively decreasing retention may be more realistically due to the wear of the plastic attachments themselves. The authors are aware of other patients using ERA attachments in whom rapid wear and need for frequent replacement has occurred. Initially, the patients like the level of retention achieved, but as time goes on and the attachments wear, patients become dissatisfied with the retention of the overdenture. As with all types of overdenture attachment systems, the patient should be made aware of the need for and cost of maintenance involving replacement of the attachments at various intervals throughout the lifetime of the overdenture.

Prosthodontic evaluation is essential to avert sur-

prises in implant treatment. Without a well-designed plan for the final restoration, it is difficult for the surgeon to provide the optimal foundation for biomechanical support. Communication between the surgeon, the prosthodontist, and the patient during treatment planning is mandatory and will improve the results of prosthodontic reconstruction.

## Summary

A clinical report was presented of a patient who was first seen for prosthodontic evaluation and treatment after endosteal implants were placed between the transosteal pins of a mandibular staple bone plate implant. Recognition and efficient treatment of the cause of the patient's complaint is advisable. There is a need for evaluation by the prosthodontist when the patient presents with a complaint of prosthodontic origin. Conventional prosthodontic treatment may have averted the additional surgical intervention. Preoperative prosthodontic evaluation is necessary to inform the patient of the options for reconstruction and the fee for such treatment, as well as to plan the design for surgical placement.

Knowledge of implant biomechanics and prosthodontic design were necessary to restore this patient to acceptable function without risk to the supporting implants. A fixed, detachable gold implant overdenture bar was constructed incorporating receptor sites for resilient attachments that will retain the tissue-supported overdenture.

## Acknowledgments

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