Paul S. Petrungaro, DDS, MS
Ned Windmiller, DDS

Abstract
The use of dental implants to reconstruct the fully and partially edentulous jaw has been well-documented in the literature.[1-6] Simplification of the healing phase with transitional implants is becoming a routine step in the management of the integration period for the patient undergoing implant reconstruction.[7,8] Restoration and maintenance of vertical dimension with transitional implants in conjunction with implant surgical therapy is an effective method to provide the patient with an immediate and comfortable transitional appliance. This approach facilitates the uneventful reconstruction with the definitive prosthesis.

Received: November 6, 2000
Accepted: November 16, 2000

Using transitional implants during the healing phase of implant reconstruction

The use of dental implants in full-arch restorations is a well-accepted treatment modality. In the early development of implant tech- nology, insufficient quality and/or volume of bone in the alveolar arch often precluded implant therapy.[9,10] Today, bone and soft tissue augmentation materials and techniques are available to repair defects that previously would have compromised an implant site.[11-13] The healing phase of these procedures requires that no pressure be placed on the grafted and/or regenerated ridge tissue or the implants themselves.[8] To address this predicament and the fact that patients often were required to refrain from wearing their dentures for 7–14 days, a transitional implant system has been developed. It is compatible with the common screw-type implant systems. Transitional implants provide benefits in implant surgical therapy in that they:

- provide uninterrupted healing of the implant site and/or bone grafted ridge.
- prevent the premature loading of the definitive implant fixtures.
- permit the patient to use a provisional restoration with form and function similar to those of the definitive prosthesis.
- eliminate the need for removable appliances during the healing phase.
- provide a stable rest for the transitional appliance, which can be modified to correct loss of vertical dimension, which is seen often in the patient requiring full arch reconstruction.
- facilitate fabrication of the transfer impression for use by the dental laboratory.

Compromised vertical dimension

The migration of natural teeth as a consequence of periodontal disease or as a result of nonreplacement following tooth loss or extraction can lead to severe malocclusion. Together with development of the malocclusion, patients frequently develop changes in vertical dimension. Moreover, the fully edentulous patient with moderate to severe bone loss exhibits varying degrees of loss in vertical dimension. This usually affects not only the stomatognathic system but also the facial structures themselves.

Vertical dimension of the face is defined as "the distance between two arbitrarily selected points; one in the maxilla and one in the mandible."[14] The difference between vertical dimension of the face in the intercuspal position (IP) and the postural position (PP) is known as the *freeway space* or *interocclusal distance*. Establishment of an optimal vertical dimension of the face in prosthodontics and implant reconstruction is crucial for the function of the stomagnathic system. Thompson believed that throughout life there is no change in the mandibular rest position; therefore, tooth wear results in an increase in the interocclusal distance if not compensated by growth of the alveolar process.[14] Impinging on or exceeding the interocclusal distance through restorative dentistry can lead to irreversible functional disturbances. Laskin notes that "overextension" of jaw elevator muscles leads to muscle spasm and sponsors the development of myofascial pain-dysfunction syndrome.[15]

Fig. 1. Initial case presentation.

Fig. 2. Preoperative panoramic view.

Fig. 3. Mounted initial study models.

Conversely, Goldspink demonstrated that striated muscles in the rat and cat adapt readily to changes in length.[16] It also is believed that the interocclusal distance varies within the same individual under different conditions. The interocclusal distance also varies during speech and swallowing.

Hellsing demonstrated that jaw muscle tonus adapts to extreme changes in vertical dimension.[17] He also believed that no logical reason exists to believe that maladaptive reactions develop after prolonged procedures that increase the vertical dimension of occlusion. Clinical experience indicates that adaptation occurs after changes in vertical dimension. The following case report demonstrates the management of a patient requiring full-mouth rehabilitation and restoration of his interocclusal distance.

Case report

A 54-year-old healthy nonsmoking man sought implant reconstruction of the mandible (Fig. 1). After preliminary findings and measurements, it was evident that in addition to numerous restorative dental concerns, the interocclusal distance required modification.

Development of a comprehensive treatment plan

The treatment plan is comprised of a thorough medical/dental diagnosis and history with periodontal evaluation and radiographic, panoramic (Fig. 2), and/or tomographic analysis. The patient's current models are articulated in centric occlusion. In this case, two additional measurements were made, the PP and the IP. Both measurements were obtained from arbitrary points at the tip of the nose and the base of the chin. The PP was obtained by the patient having light contact of the lips, where he felt comfortable with his facial profile. The IP measurement was obtained by having the patient close into his centric occlusion position. The difference between the PP and the IP provides the required interocclusal distance that the patient's dental rehabilitation will follow.

Corrected articulated model

The procedures outlined at the initial consultation visit begin with the patient's maxillary and mandibular study models being mounted using the face-bow transfer obtained on the Kavo Protar Articulator (KaVo America Corporation; Lake Zurich, IL; 888/528-6872) (Fig. 3). After the measurements are obtained, the articulated models are adjusted to the required interocclusal distance and forwarded to the laboratory for fabrication of the Master Diagnostic Model (MDM) technique (Valley Dental Arts, Stillwater, MN; 800/328-9157).[18] The MDM allows the missing hard and soft tissues to be replaced to true anatomical form and for the proper occlusal function to be reestablished from the newly obtained interocclusal distance (Fig. 4). Once the MDMs are studied and presented to the patient, the final treatment plan is chosen.

In this case, the final treatment plan consisted of the following in the maxillary arch: periodontal therapy, including crown lengthening and regenerative procedures followed by full coverage restorations to correct decay and occlusal schemes. In the mandibular arch it was determined to reconstruct with dental implants, utilizing transitional implants and a fixed implant-supported temporary prosthesis to maintain the new interocclusal distance and provide an uninterrupted healing phase for the definitive implant and bone reconstructed ridge. The final mandibular prosthesis was planned to consist of a porcelain superstructure supported by a precision milled meso-substructure.

First surgery

Local anesthesia was provided throughout the mandibular arch through bilateral mandibular blocks and long buccal and mental nerve injections. The preoperative clinical appearance of the mandible is shown in Figure 5. After careful extraction of all mandibular teeth, a crestal incision was made from the regions distal to the previously extracted first molars. Following the crestal incision, full thickness mucoperiosteal flaps were elevated both

Fig. 4. Clinical view, Master Diagnostic Model.

Fig. 5. Preoperative clinical appearance, mandibular arch.

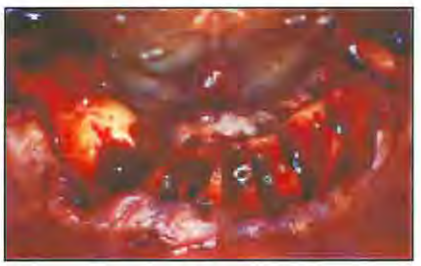

Fig. 6. Flap elevation, debridement of the extraction sockets.

Fig. 7. Implant placement in the mandibular arch.

Fig. 8. Cover screws seated on the placed implants.

Fig. 9. Placement of the MTI transitional implants.

buccally and lingually, followed by thorough debridement of all granulation tissue and periodontal ligament remnants from the extraction sockets. Osteoplasty of the ridge was performed to aid in flap adaptation for closure (Fig. 6).

Following the surgical template constructed from the MDM, osteotomies were created to predetermined lengths and diameters. Five 4.3 series, HA coated, 16.0 mm Steri-Oss Replace implants (Nobel Biocare, Yorba Linda, CA; 800/993-8100) were seated in the region between the mandibular canines and two 5.0 series, HA coated, 13.0 mm Steri-Oss Replace implants were placed in the second molar/first molar regions bilaterally (Fig. 7). All implants were placed within the housings of the extraction sockets where possible. After insertion of the implants, the carrier mechanisms were removed and cover screws were seated (Fig. 8).

Before suturing, osteotomies were prepared interstitially between the implanted fixtures for the placement of six 21.0 mm × 1.8 mm MTI transitional implants (Dentatus USA Ltd., New York, NY; 800/323-3136) (Fig. 9). The occlusal slots on the heads of the transitional implants were aligned with the curve of the ridge to facilitate placement of the interconnecting TI bar and modular copings for chairside fabrication of an interim prosthesis.

Autogenous bone, derived from the osteotomy sites, was mixed with 1.0 cc of demineralized freeze dried bone allograft to form a combined graft matrix to fill in the osseous defects of the extraction sockets and the spaces surrounding the installed implant fixtures (Fig. 10).

An absorbable collagen membrane, Biomend (Sulzer Calcitek Inc., Carlsbad, CA; 760/431-9515) was trimmed and reconstituted in a tetracycline saline solution. Once the membrane was saturated, the barrier was seated over the bone-grafted ridge using the MTI transitional implants for support and stabilization (Fig. 10). Closure was made with 5.0 Monocryl suture (Ethicon Inc., Somerville, NJ; 877/ETHICON) using a combined horizontal and vertical mattress suturing technique (Fig. 11).

Following closure, the prosthetic steps necessary to fabricate a fixed transitional implant-supported prosthesis were begun. Rubber protective spacers were placed over the necks of the transitional implants to the level of the sutured gingival tissues. The spacers act to prevent adhesion of the soft acrylic to exposed suture tabs. The titanium grooved bar was inserted in the aligned slots of the transitional implants and the single modular copings were seated and secured over the bar and implant assembly (Fig. 12).

Using the plastic shell constructed from the duplicated MDM, the temporary prosthesis was completed with a self-curing injectable acrylic material. Following correction of any occlusal interferences and after polishing the prosthesis, it then was cemented with Improv temporary cement (Nobel Biocare) (Fig. 13). The corrected interocclusal distance having been reestablished from the measurements obtained previously, the patient was monitored over the two-week postoperative period.

After cementation of the prosthesis, required periodontal surgery was accomplished in the maxillary arch. For the sake of brevity, further details are limited to treatment of the mandibular arch. An immediate postsurgical panoramic radiograph is seen in Figure 14.

Fig. 10. Barrier membrane secured by the MTI, covering the combined graft matrix.

Fig. 11. Closure using continuous sling and horizontal mattress suturing techniques.

Fig. 12. Coping/bar assembly seated over the transitional implants.

Fig. 13. Initial MTI-supported mandibular temporary prosthesis to the corrected interocclusal measurement.

Fig. 14. Postoperative Panorex, first surgery.

Fig. 15. Two-week postoperative view.

Please note the placement of the transitional implants in relation to the permanent implants.

A two-week postoperative view is shown in Figure 15. Note the maturity of the gingival tissues between the cover screws of the permanent implants and around the transitional implants. At this appointment, the restorative dentist initiated construction of a laboratory-processed acrylic custom temporary for the mandibular arch that would be seated at the preparation appointment of the maxillary arch. After seating the MTI impression copings and following standard impression techniques, the final temporary impression was sent to the laboratory for construction of a fixed acrylic temporary that mimics the MDM.

Two weeks later, the maxillary teeth were prepared and fitted with temporary prosthetics according to the maxillary MDM. The laboratory-fabricated mandibular temporary was seated at the same appointment. The clinical appearance seven days later is shown in Figure 16. The patient has tolerated the reestablished interocclusal distance well with no adverse signs or symptoms. The patient is recalled on a bimonthly basis for four months after the initial surgery.

Second surgery

A four-month, post initial surgery Panorex view is shown in Figure 17. Note that only four MTI remain now, as two MTI were removed with the temporary prosthesis before re-cementation at the three-month follow-up visit. The transitional implants were removed with apical pressure placed along the long axis of the fixture, followed by counterclockwise rotation (Fig. 18 and 19). Note how three of the transitional implants that were bent during the initial surgery to aid in fabrication of the temporary have been removed uneventfully (Fig. 19). The flexibility of the MTI pure titanium implant, in addition to its strength, provides routine uneventful insertion and removal when the techniques outlined in previous publications cited above are followed.

Once the MTIs are removed, small access holes are present in the gingival tissues; these sites usually are closed no later than seven days after the MTI removal (Fig. 20).

At the same appointment, standard SteriOss Replace impression copings were seated (Fig. 21) and their fit was confirmed radiographically. Following routine impression techniques, the impression copings were removed and placed into the final impression. Additional bite registrations were taken at this appointment as well. Temporary abutments were prepared and seated (Fig. 22) and the original laboratory-fabricated prosthesis was relined and cemented. Continued maintenance of the interocclusal distance has been provided (Fig. 23).

A panoramic radiograph taken immediately after temporary placement is shown in Figure 24. Note the close adaptation of the alveolar bone to the permanent fixtures, seen as early as four months after an aggressive surgical episode. The success of the implant fixtures at this point, especially in this case with reestablishment of the interocclusal distance, can be attributed to the stress-breaking effects that the

Fig. 16. Laboratory-processed mandibular temporary, temporization of the maxillary arch maintaining corrected interocclusal space.

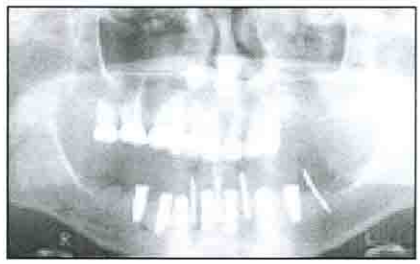

Fig. 17. Four-month panoramic view, first surgery.

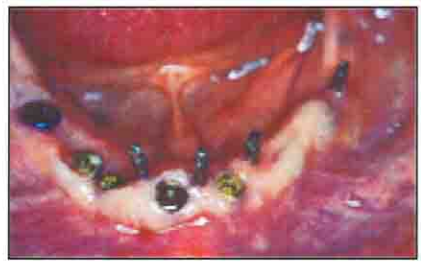

Fig. 18. Clinical view, four months postsurgery.

Fig. 19. Removed MTI implants at the Stage II/impression visit.

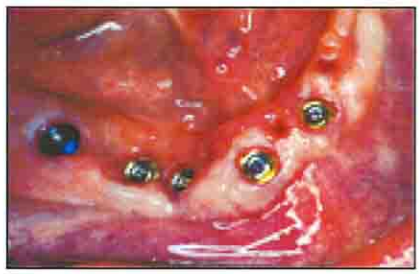

Fig. 20. Small access openings present after removal of the MTIs.

Fig. 21. Placement of the impression copings.

Fig. 22. Placement and preparation of the temporary abutments.

Fig. 23. Retrofitting and cementation of the original laboratory-processed acrylic temporary, maintaining the interocclusal space.

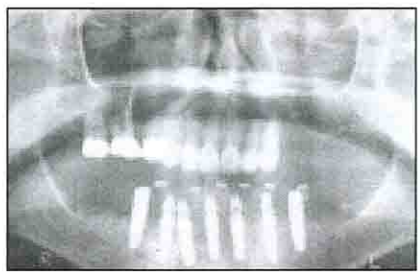

Fig. 24. Panoramic view, temporary abutments seated, post-MTI removal.

Fig. 25. Occlusal view, mandibular meso-structure substructure.

Fig. 26. Lingual view, mandibular completed restoration.

Fig. 27. Facial clinical view, mandibular implant-supported restoration.

transitional implants have provided from their immediate loading.

Following additional bite registration and confirmation, the laboratory completed fabrication of the precision milled meso-substructure, which is screw-retained into the implant fixtures themselves (Fig. 25). The porcelain-to-metal reinforced superstructure is depicted in Figure 26, which shows the lingual setscrews that insert into the substructure for additional support and retention. The final mandibular implant-supported precision milled restoration is seen in Figure 27. Note the maturity and health of the gingival tissues and the space at the restoration/gingival junction. This promotes access for oral hygiene.

Fig. 28. Final implant-supported, precision milled, meso-substructure mandibular restoration maintaining interocclusal space.

Fig. 29. Completed case, panoramic view.

The final maxillary and mandibular restorations, with the reestablished interocclusal space, can be seen in Figure 28. Note how the final restorations mimic the transitional restorations, which mimic the original MDM. Arriving at a sound, definitive treatment plan and diagnostic blueprint has contributed significantly to the success of this case. A six-month postinsertion panoramic radiograph, shown in Figure 29, demonstrates the excellent response to the treatment provided.

The decision to restore the maxillary left posterior to the canine only was driven entirely by the monetary requirements placed on the patient by the overall treatment plan. Treatment has been planned for the left side of the maxilla, including sinus augmentation and implant reconstruction to the first molar in the near future. The patient has tolerated the procedure well and has stable occlusal stops in addition to bilateral canine function.

Conclusion

An effective method has been described for the reestablishment of the interocclusal space in patients requiring extensive surgical and reconstructive treatment to correct severe overbites. As reported by Rather, Goldspink, and Hellsing, jaw muscle behavior is dynamic and adaptive to environmental changes. Treatment of situations such as the one presented here can be accomplished as described above with a high degree of success and comfort for the patient.

The use of transitional implants to provide a stable, functional prosthesis can be paramount to the success of cases such as the one described. In addition to allowing the surgical site to heal uneventfully, they also allow the implant/reconstructive team to manage occlusal and interarch issues immediately and effectively.

Author information

Dr. Petrungaro is a fellow of the International & American College of Dentists and a Diplomate of the International Congress of Oral Implantologists. He has been in the private practice of periodontics and implantology since 1988 and holds a license in both Illinois and Minnesota. Dr. Windmiller has a private, fee-for-service cosmetic, restorative, and implant practice in Stillwater, Minnesota.

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