Patients who present for prosthetic rehabilitation of an edentulous maxilla can often present a challenge when osseointegrated implants are chosen to assist a prosthetic reconstruction with retention, stability, and support. Obstacles to placement of implants are the endemic porous quality of bone in the maxilla, enlarged sinus cavities, and inadequate bone volume. Fifteen-year studies by Adell and Lekholm show that using osseointegrated implants in the edentulous maxilla can display reasonably successful outcomes with fixed partial dentures. Many times, the maxillary sinus cavities can become quite enlarged in those who become edentulous at an early age, which precludes placement of a full complement of osseointegrated implants into the maxilla. To overcome this problem, Boyne and James introduced a concept of adding bone to the sinus cavity to provide an additional volume into this critical area. Many of these patients were initially treated with the placement of a bone graft into the sinus; then after a 6- to 8-month consolidation period, 6 to 10 implants were placed into the entire arch for rehabilitation at a later time. Success rates ranged from 70% to 89% over 70 months.

This can be a formidable treatment option for those who cannot wear conventional dentures. However, the time delay is a disadvantage in these patients, since up to 1 year may pass before any of the prosthetic phases can be initiated. Protocols of using immediate placement of implants into these bone-grafted maxillas began to become popular in the interest of reducing the time allotted for both of these surgical phases. Some
studies indicate that this practice can also be favorable. However, a native maxillary alveolar bone height should approach 8 mm to adequately stabilize the implants, which often does not exist.

A recent technique investigated by Brånemark involves the use of an extended-length osseointegrated implant from the maxillary alveolar ridge through the sinus and engaging the dense cortical bone of the zygomatic process (Fig 1). Grafting of the sinus cavity is avoided with this scenario since two zygomatic implants engage dense cortical bone and each opposes each other’s load with an angular vector (Fig 2). This procedure is indicated for a completely edentulous maxilla with bilateral placement of two Zygomaticus implants and at least two additional auxiliary conventional root-form implants in the anterior maxilla. Compatibility of titanium implants through the sinus has been investigated and actually found to be favorable. The integration time is a standard 6 months, after which a stabilizing bar attachment is placed at uncovering to minimize forces on the zygomatic implants. A second bar attachment is made in the traditional fashion to accurately develop attachment sites and appropriate bar and superstructure height after casts are mounted and a diagnostic set-up has been verified on the patient (Figs 3 and 4).

Controversies still exist that place doubt on the success rate of implants supporting overdentures compared to those supporting fixed prostheses. However, failures associated with poor bone quality, relatively short implants, and extreme atrophy are often cases in which overdentures were the treatment chosen. Some studies comparing implants supporting fixed prostheses to those supporting overdentures have found similar success rates when both are placed in bone of similar quality and quantity.

A stable attachment mechanism is indicated for overdentures that are implant supported. The combination of electrical discharge machining and milling a connecting bar can create a very stable superstructure/infrastructure relation. However, the costs of spark erosion machining may be prohibitive. Alternative techniques of tapered milling (Figs 5 and 6) with careful superstructure fabrication can be applied to a greater number of cases with easier methods of fabrication and servicing.
The use of this technique is illustrated in a patient with maxillary atrophy and inability to wear conventional prosthetics. A 72-year-old African American woman presented to the dental clinic complaining of difficulty in wearing maxillary and mandibular complete dentures. Her medical history was noncontributory with the exception of hypertension controlled with beta-blocker medication. Oral examination showed an atrophic maxilla with redundant tissue anteriorly and limited to no vestibule. The mandibular vestibule was confluent with the floor of the mouth, and the quality and quantity of saliva were thin and scant, respectively. A panoramic radiograph revealed an atrophic maxilla with pneumatized posterior segments. The mandible measured about 18 mm from superior to inferior margins. After casts were mounted and a determination of the interarch restorative dimension was made, plans for making maxillary and mandibular overdentures were contemplated. The patient was advised of the plans for the surgical and restorative phases, including all pertinent risks, and was eager to proceed with treatment.
The patient was placed under general anesthesia for placement of two Zygomaticus implants and three (3.8-mm) nonhexed lock implants in the maxilla, and five (4.3-mm Replace) tapered implants in the mandible (Nobel Biocare, Yorba Linda, CA, USA) (Figs 7 and 8). The patient tolerated the procedure well and was allowed to heal for 6 months to permit integration to occur for 6 months.

After this time the patient was prepared for second-stage surgery. PME abutments (Nobel Biocare) were placed on all maxillary implants and torqued to 32 Ncm to affirm integration (Fig 9).
Plastic/gold copings were luted together with pre-fabricated round bars (Attachments International, San Mateo, CA, USA) and Triad gel (Caulk/Dentsply, York, PA, USA) splinting all maxillary implants (Fig 10). The assembly was gently removed from the mouth, attached to analogs, and immediately placed into a stone patty for stable transport. The subsequent framework was then invested and cast in gold alloy and delivered to the patient 24 hours later (Fig 11). The use of an immediate splint of this type reduces the amount of lateral loads placed upon the zygomatic implants. During the time taken for definitive prosthesis fabrication, the existing denture may be modified or a transitional denture may be made to rest over the transitional bar attachment.

After soft tissues were given a chance to heal properly, transfer copings were placed on all abutments and a diagnostic impression was made with irreversible hydrocolloid for fabrication of custom trays. A final impression was made with polyether to transfer the position of implants in making a master cast (Figs 12 and 13). Occlusion rims were fabricated and teeth were set to proper vertical dimension (Fig 14). The set-up was verified for esthetics and phonetics (Fig 15), and then diagnostic cores were fabricated to aid in constructing bar attachments for both arches. Vacuum-formed ma-

**Fig 12** Maxillary master cast after final impression.

**Fig 13** Mandibular master cast after final impression.

**Fig 14** Mounted master casts after diagnostic wax-up has been completed.

**Fig 15** Verification of wax-up on patient for esthetics and phonetics.
trices were made on duplicate casts of the wax-up to “ghost” the silhouette of the final external prosthetic contours to plan placement of the attachment mechanism (Figs 16 and 17).

The bar attachments were made of pattern resin splinting plastic/gold copings and were milled with a 2-degree taper on a parallel milling machine. The bars were then placed into the mouth for verification indexing (Figs 18 and 19). Several areas were sectioned and re-relation was made with pattern resin. The bar fit was then verified radiographically (Fig 20). The resin bars were placed into a transfer index using analogs and low expansion stone. Both bar attachments were cast in gold alloy and placed on the transfer indices to verify fit (Figs 21 and 22). Custom trays were made on the bar/master cast to properly reconstruct corrected master casts after bar sectioning. Both bars were returned to the mouth with long screws for a pick-up impression with polyether material in the custom trays (Figs 23 to 26). Corrected master casts were constructed from these impressions, and both bars were duplicated in refractory material on which superstructures were fabricated.

The metal-based superstructures were made on the refractory duplicates from a conventional method of cobalt-chromium casting. Incorporated into these superstructures were Swissloc NG attachments (Attachments International) from the original design. The superstructures were retrofitted to the bars with disclosing media, and the teeth were attached with baseplate wax using previously constructed matrices on the original master casts. The cast bars were attached again in the mouth (Figs 27 and 28), and the wax-up was then verified again on the patient to ensure ideal occlusal relationships (Fig 29). Clearance for hygiene procedures is evident in a frontal view of both bar attachments (Fig 30). After successful try-in and minor modifications, the superstructures were free pattern invested and wax eliminated; silicoating/opaquing procedures were then carried out followed by conventional processing procedures.

The prostheses were remounted in the laboratory and finished. The insertion appointment included instructions for placement, removal, and care. Both prostheses were stable upon delivery and allowed the patient improved function (mastication and speech) and esthetics (Figs 31 to 33).
Fig 18  Resin pattern is placed over all maxillary implants.

Fig 19  Resin pattern is placed over all mandibular implants.

Fig 20  Radiographic verification of all semi-burnable copings and abutments for accurate fit.

Figs 21 and 22  Cast bar attachments on verification indices with long abutment screws.
Figs 23 and 24  Bar attachments with long abutment screws are placed for transfer impression.

Figs 25 and 26  Transfer impressions with polyether material to make more accurate master casts.

Figs 27 and 28  Cast bars are placed for support of secondary superstructure.
Zygomaticus Implants: A New Treatment Modality for the Edentulous Maxilla

Fig 29 Wax try-in of secondary prosthesis for aesthetics/phonetics and centric relation.

Fig 30 Frontal view of bar attachments showing clearance.

Figs 31 and 32 Occlusal views of completed prostheses with disengaged attachments.

Fig 33 Frontal view of both prostheses engaged in centric relation.
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