CASE III–FULL ARCH CASE: MAXILLA ENDOSTEAL ROOT FORMS 16, 15, 14, 13, 11, 21, 23, 24, 25, AND 26 AND MANDIBLE ENDOSTEAL ROOT FORMS 36, 34, 33, 41, 43, AND 45

Thomas Schreiner, DDS

KEY WORDS

Endosteal root form implants
Full arch
Removable prothesis

***Thomas Schreiner, DDS,** is in private practice in Lisbon, Portugal. Address correspondence to Rua Pascoal de Melo 60 R/ch, 1000 Lisbon, Portugal.*

PATIENT EXAMINATION

History

On May 10, 1996, a 72-year-old male businessman came to this office with various complaints about his complete dentures and expressed a wish for dental implants. Although having been fully edentulous in the maxilla and partially edentulous in the mandible for >10 years, he had never accepted the fact that he had removable prostheses. His dissatisfaction increased after the loss of the last roots 33 and 43, carrying posts with ball attachments, which were extracted. The loss of stabilization of the lower denture in particular and a poorly fitting upper denture led to an increase in insecurity when speaking or eating in public. They were the cause of great discomfort and an inability to chew and taste food the same way as it had been with his own teeth. Although, in his opinion, the dentures served well esthetically, and the artificial teeth in form and position were very much like his own teeth, his goal was to receive fixed prostheses. Because of advanced atrophy of the mandibular alveolar ridge, satisfactory retention of the lower denture could not be achieved. The patient was mentally prepared for implants and was well informed about them and the procedures of their placement. The patient exhibited very good hygiene and claimed that he was a nonsmoker and that he only occasionally consumed alcoholic beverages.

1. His health history was within normal limits (see case I).
2. Current medication: The patient was neither undergoing medical treatment nor was he taking any medication.

Clinical examination

The clinical examination revealed fully edentulous alveolar ridges in both the maxilla and the mandible, except for one fractured root 43, which demonstrated a 3+ mobility. The soft tissue adjacent to this root was highly in-

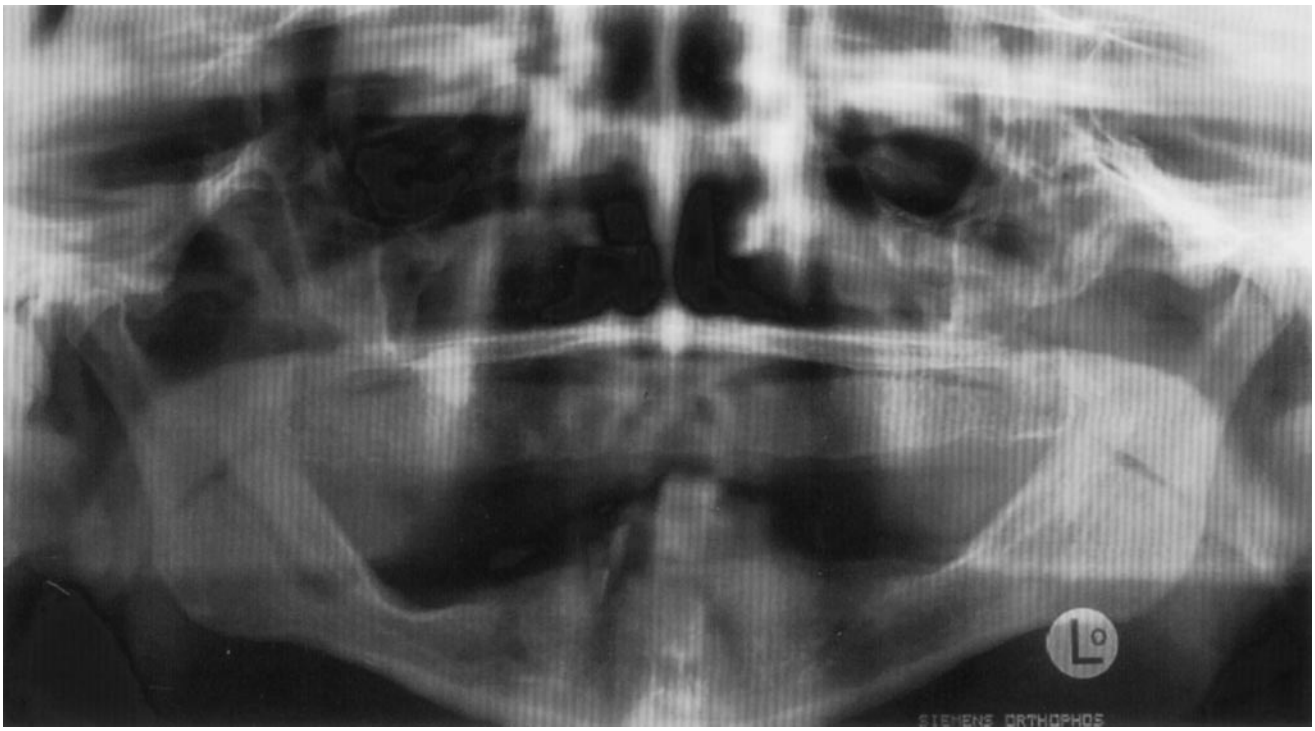

FIGURE 1. Preoperative panoramic.

flamed and presented an advanced loss of the periodontal ligament. Bleeding on probing revealing pocket depths of 6–7 mm. The remaining soft tissues showed no sign of inflammation, and the attached gingiva was of normal thickness and average mobility. Extraorally, the patient showed no sign of a decrease of vertical dimension. A maxillary medium to high lip line required careful planning of future implant sites in the anterior region and the resulting type of prosthesis in the maxilla (FP2, FP3, or RP5). Examining the temporomandibular joint (TMJ) revealed no abnormalities, such as clicking, popping, or deviation on opening or closing, and no limitations of jaw openings or movements. The existing dentures showed no abnormal pattern of wear or abrasions that could lead to a conclusion of parafunctional habits. The generally well-preserved alveolar ridge in the maxilla showed some bone loss in the anterior region buccolingually (division B). The alveolar ridge in the mandible was generally more atrophic, with advanced bone loss in the anterior region and more severe bone loss in the posterior regions, especially on the right side (right: division D, front: division C-w, left: division C-h). The width of the attached gingival band was reduced as a result of high muscular insertions.

Radiographic examination (Fig 1)

The initial panoramic X-ray confirmed the clinical diagnosis of moderate bone atrophy in the premaxilla and advanced atrophy of the alveolar ridge in the posterior region of the mandible, especially on the right side, where the alveolar ridge was reduced to the level of the inferior alveolar nerve. A dense mass probably of dental origin (odontoma) was revealed in the region of site 17. Bone height in the maxilla was more than adequate for implant placement in all areas except the premaxilla. The panoramic X-ray also confirmed the clinical diagnosis of advanced atrophy of the posterior regions in the mandible but contradicted the clinical finding of a division C-w ridge in the anterior region, instead indicating division A or division B bone due to its elevated density. The TMJ revealed no pathology, and the sinuses were clear. Implant placement in the mandible was restricted to the anterior region and was compromised in the premaxilla, reducing the possibility of fixed prosthodontics in the maxilla because of a resulting lack of lip support due to the advanced bone loss. A second orthopantomography was taken with the patient wearing radiographic templates that had been previously fabricated by copying the existing dentures with transparent methacrylate. Those precise copies of the patient's dentures were marked with gutta-percha points in a vertical position at each denture tooth. In this fashion, not only could the interocclusal space be evaluated, but the bone quantity related to each potential implant site could also be evaluated.

Preoperative diagnosis

A moderate atrophic maxilla with excellent soft tissue conditions and an advanced to severe atrophic mandible

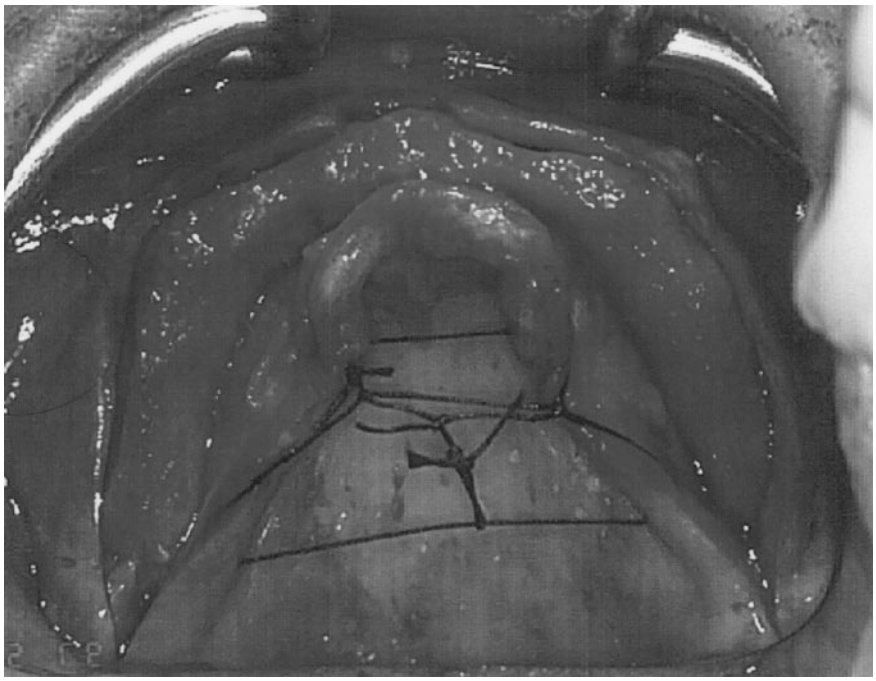

FIGURE 2. Maxilla surgical site exposed.

with partially compromised soft tissue health allowed for an implant treatment limited to the anterior region in the mandible and a full arch implant placement in the maxilla, with the eventuality of a bone graft procedure or bone expansion technique in the anterior region.

DEVELOPMENT OF THE TREATMENT PLAN

Treatment goals

The patient desired a fixed prosthesis or, if not possible, at least a prosthesis of equivalent stability in order to feel secure when speaking in public as well as to improve function and maintain the same level of esthetics as with his existing dentures. Functionally, the goal was an improvement of the phonetic situation, since a prosthesis of a fixed nature and also a removable implant-supported prosthesis (RP5) in the maxilla would offer a palate-free solution to this problem. In the mandible, even a reduced quantity of implants would present a stable prosthesis and an improvement in stability. A very important goal was to achieve the same esthetics with the future prosthesis as he had had with his existing denture. He was especially concerned about the reclined position of the upper central incisors being overlapped by the lateral incisors, which he wanted to be copied in the new denture. Given the age of the patient, the access for daily hygiene was especially to be addressed in this phase of the treatment plan and later in the design of the prosthesis. Proper implant hygiene by the patient had to be possible with limited effort. The patient's extraordinary good physical and psychological condition favored a treatment with implants. The patient was well informed as to the length of treatment necessary to achieve an acceptable esthetic and functional result. Several treatment options were presented and discussed. The possibility of a bone graft procedure and a bone spreading technique was explained to him, and the patient elected to have 8–10 implants placed in the maxilla and four to six implants in the mandible. The exact implant sites were planned, and a fixed solution both in the maxilla and the mandible were considered, but a definite decision regarding the final restoration was left for after second-stage surgery.

Interarch relationships

The existing dentures demonstrated class I occlusion, bilaterally balanced. Normal jaw relations and no sign of functional problems were noted relating to the TMJ.

Evaluation of the edentulous ridge

Classification

Maxilla. Division B bone was in the anterior and division A bone in the posterior region.

Mandible. Division C-w was in the anterior region, division D in the posterior right, and division C-h in the posterior left region.

Soft and Hard Tissue Anatomy

Deficiencies. In the maxilla, no soft tissue deficiencies were detected. The preoperative radiograph indicated reduced density, which was to be verified during surgery. Limitations existed in the anterior area, where conditions for the placement of implants were not favorable due to the lack of width (division B) unless a bone graft or bone expansion techniques were to be performed.

Limitations. In the mandible, the partially high muscle insertion called for careful soft tissue management during both stage I and stage II surgery in order not to lose but rather to gain some attached zones of gingivae. The advanced bone resorption in the posterior regions limited implant placement to the anterior mandible if the existing division C-w was converted to division C-h by osteoplasty. The osteoplasty would convert the ridge to a width suitable for acceptance of root-form implants.

Prosthetic restoration plan

Because of the bone atrophy in the premaxilla, anatomically correct implant placement for a fixed prosthesis could not be achieved. As the subsequent lack of lip support would compromise the esthetic result, and the patient favored a solution that came as close as possible to a fixed prosthesis, a remov-

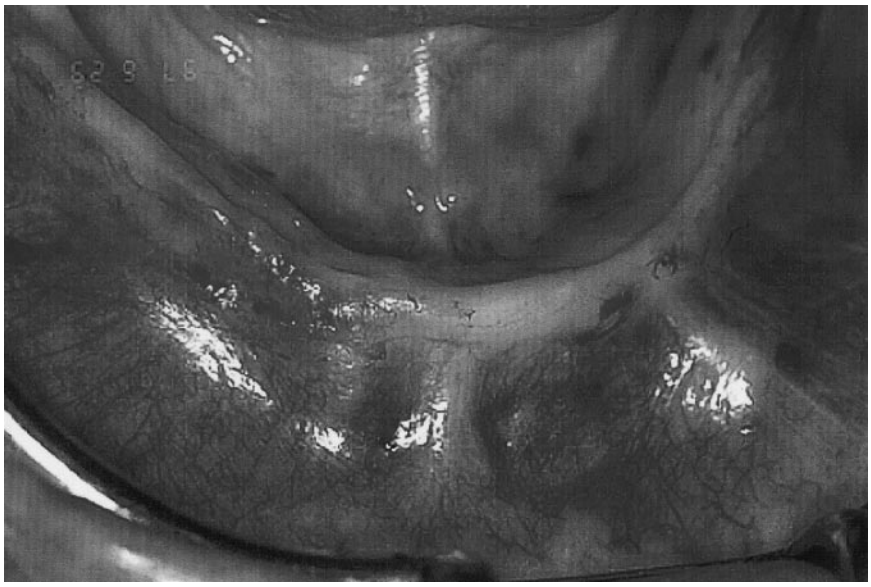

FIGURE 3. Mandible presurgical site.

able prosthesis with 10 implant-supported telescopic crowns was planned. The combination of 10 friction-fitting females would supply retention and dimensions comparable with that of a cemented bridge. The telescopic crowns made the removable prosthesis advantageous, because its retrievability would add to proper oral hygiene without lacking the advantages of a fixed prosthesis (esthetics and retention). Another alternative was an overdenture over a mesostructure in the form of a milled bar. Hygiene would not be as easy as with telescopic crowns because of the implant-splitting mesostructure, and an evaluation of the status of osteointegration of each implant would require the removal of the bar. For the mandible, an overdenture over a milled bar mesostructure was considered, as well as a fixed-detachable prosthesis (hybrid design). As the exact implant sites could not be determined prior to surgery, the fabrication of a telescopic crown-supported prosthesis was taken into consideration but could not be assured. As for daily hygiene, there was little or no difference between a screw-attached milled bar and a fixed detachable prosthesis. Since there was no economic limitation related to the number of implants, a final decision on the type of prosthesis would be made after the exact amount and position of the implants were established. As in the maxilla, the situation in the mandible was unfavorable for a fixed prosthesis because of the necessity to compensate for soft tissue loss, which was required to create lip support.

Hard and soft tissue modifications

1. In the premaxilla, either a bone graft or an adequate bone expansion technique was indicated. The former required a relatively large amount of autogenous bone in block form to be harvested from the illiac crest or the symphysis. The patient rejected a hip graft, and since the anterior region was planned to receive implants, this area was unavailable for bone harvesting. Bone expansion became the treatment of choice.
2. In the mandible, the alveolar ridge of division C-w required a bone block graft or an osteoplasty. The patient rejected the former, so the latter remained the treatment of choice.

Implant selection rationale

For both maxilla and mandible, root forms were chosen. As bone density (which was to be evaluated during the surgical procedure) was probably reduced in the posterior maxilla and the buccal cortical plate in the premaxilla about to be weakened or perforated during the bone spreading procedure, HA-coated implants were chosen. In the maxilla, a total of 8–10 root-form implants were planned in the areas of 16, 15, 14, 13, 11, 21, 23, 24, 25, and 26. In the mandible, four to six implants were planned in the anterior region between 35 and 45. The surface coating of choice was titanium plasma spray (TPS), as it would provide a much larger surface area, thus enhancing osseointegration compared with non-coated implants. Peri-implant osseous resorption following exposure of the TPS surface progresses less rapidly than with HA coatings.

SURGICAL REPORT

Presurgical procedure

The denture duplicates in clear acrylic were modified to be used as surgical guides. Axial perforations were performed at the location of each potential implant site using soft tissue models mounted in an articulator.

Surgical procedures

A written, witnessed, and informed consent was obtained prior to surgery. The operative procedure, risks, and rationale were reviewed with the patient. The patient stated that he fully understood what was explained to him. The same medications were prescribed prior to surgery as in case I.

Implant Surgery of the Maxilla

Bilateral maxillary (second division) blocks were given, followed by an incisive superior alveolar block. A midcrestal incision was made and extended from the right to the left tuberosities using a 15 blade, followed by a vertical midline incision. A full-thickness mucoperiostal flap was elevated using curved and straight sharp periosteal elevators (Fig 2).

After completing the reflection of the

palatinal flaps, the right and left flaps were sutured together with 2-0 silk using the suture as a retractor. The surgical template was removed from a chlorhexidine solution and positioned in the mouth. Using a 1.5-mm pilot drill that was inserted into each hole left a bony mark at each planned implant site. As expected, the template drillholes in the premaxilla region did not coincide with the crestal midline. The pilot bur exited the stent in a more labial position, which confirmed the clinical diagnosis of labial atrophy and the necessity for bone expansion. This was done using a set of sharp, pointed osteotomes 2.0, 2.7, and 3.25 mm in diameter. After drilling a hole with the 1.5-mm pilot drill, the osteotome was inserted in the drill mark and, by gently tapping with a surgical mallet, driven into the crestal bone as far as possible. This was performed very slowly to allow the bone to expand without macrofracturing. Even after reaching its final position, the osteotome was kept in place for several minutes. The 2.7-mm-diameter osteotome was used in the same way to enlarge the site, and the final osteotome of 3.25-mm diameter completed the site preparation, greenstick fracturing the labial plate in several areas and fracturing off the labial plate in the area of implant site 11. Preparation of the posterior implant sites was done using a sequence of internally irrigated drills (2.0-mm pilot drill, 2.7-mm depth drill, and 3.25-mm depth drill). Implant sites 3 and 14 were enlarged still more with a 3.8-mm depth drill. Counterboring was performed for sites 3, 4, 5, 12, 13, and 14 using the 3.8- and 4.5-mm counterbores, respectively. Cold sterile saline solution was copiously used for internal and external irrigation during all drilling procedures to avoid bone trauma by overheating. An electric-motored console was used with a 14:1 reduction gear handpiece, and drilling speeds were maintained at 1500 rpm. An autografter connected to the suction tube was used to filter and retain particles of bone for later use as graft material, which had been suctioned along with standard irrigation during surgery. The approximate implant lengths were defined using the panoramic X-rays taken with the radiographic template positioned and a 25% magnified implant overlay chart from the implant manufacturer. Bone tapping was exclusively done in the anterior region because of the poor bone density in the posterior maxilla. No complications or difficulties were encountered in preparing the osteotomy sites. Ten HA-coated implants of appropriate dimension were placed in the maxilla.

Implant placement was performed using a 100:1 reduction gear handpiece at a speed of 35 rpm under simultaneous external irrigation with cold sterile saline. Surgical cover screws were placed. Autogenous bone retrieved from the bone filter and the fractured cortical plate of 23 were used to graft sites 13, 12, 22, and 23. Two 20- × 30-mm resorbable membranes were shaped and conditioned to cover the graft material and the exposed implant threads. No bone tacks or screws were used to fix the membranes. With the considerable increase of the buccolingual dimension of the alveolar ridge in the anterior maxilla, the surgical flap became inadequate for tension-free suturing and required flap mobilization. This was achieved by making several periosteal cuts at the flap base and by undermining the muscular insertions with a scissors. Interrupted sutures with 3-0 Vicryl were done, and the patient was released with instructions not to use his dentures for the following 2 weeks. The patient was given an ice pack, which was placed alternately over the procedure sites. Instruction was given to rest at home for 48–72 hours, to avoid rinsing the mouth, and to avoid hard labor or sportive activities. A prescription for chlorhexidin in gel form was filled out, and the patient was instructed to softly apply the gel to the suture areas three to five times a day. An appointment for follow-up and suture removal was scheduled in 6 days, at which time a panoramic X-ray and a lateral cephalogram were taken. Only a little swelling and practically no pain had occurred during the week after surgery, but the patient reported prolonged hemorrhage. Two weeks after surgery, on June 2, 1997, the sutures were removed, and the existing upper denture was modified and relined with Viscogel. At this time, a mild dehiscence had occurred, and the 1.3, 1.4 area was already starting to close by secondary epithelialization. The surgical sites were healing nicely, and no sign of infection was detected.

Implant Surgery of the Mandible (Fig 3)

On June 29, 1997, the patient arrived for implant placement in the mandible. As for the maxilla, the same medication had been prescribed, and the patient was asked to have the prescription filled and to bring it to surgery. After preparing the patient for surgery with his medications, bilateral inferior alveolar blocks were administered. The soft tissues and the ridge height were evaluated; the lingual aspect of the mandible was palpated for undercuts and to determine ridge angulation. A comparison was made with the existing lateral cephalogram. A midcrestal incision extending from 3.6 to 4.6 was performed, a full-thickness mucoperiosteal flap was reflected to the lingual sides, and retraction sutures with 2-0 surgical silk were applied by tying the left canine area to the right molar region and vice versa. This reduced the risk of traumatizing the lingual soft tissues with elevators or drills and improved visibility. A midline incision followed, and the surgical flaps of the buccal were carefully reflected. The use of sharp elevators was avoided around the presumed regions of the mental foramina in favor of a moist 2 × 2 sponge, which was used to expose the neurovascular bundle uninjured. The buccal flaps were then sutured to the buccal mucosa. After exposing the mental foramen, a clinical and radiographic evaluation followed to deter-

mine the possible existence of an anterior loop on the right side, which could be verified. The exposed alveolar ridge proved to be a division C-w, which would not allow immediate implant placement. An osteotomy was performed using a crestotome, which reduced the ridge height. Boundary score lines on the crest of the ridge corresponding to the anterior position of the loop/anterior position of the mandibular canal were determined, and a pilot hole on the crest of the ridge 4 mm mesial to each score line was placed using a 2 round bur. Five implants were planned in the A, B, C, D, and E positions. A center pilot hole was drilled in the C position, and the remaining space between the center pilot hole and the distal pilot hole was divided equally. Osteotomies were performed using a sequence of drills, which allowed for an approach to the final size in steps of 0.2–0.5 mm. As the alveolar ridge distal to the implant site designated ''E'' was of sufficient height above the mental foramen for an additional implant and as the idea was favored by the patient, a sixth site was prepared distally from the left score line. Six TPS-coated restore implants were placed using a 1:100 reduction gear handpiece at a speed of 35 rpm in the positions (Fig 4).

A continuous horizontal mattress suture using 3-0 Vicryl sutures was performed to close the crestal incision, and interrupted sutures were applied to close the midline incision in the vestibule. A postoperative panoramic X-ray was taken to evaluate the implant position and its proximity to the neurovascular bundle, and the patient was released with ice packs and instructions to take his medication according to doctor's instructions. The patient was appointed for follow-up care and suture removal in 12 days and was discharged in good condition. On July 10, 1997, the sutures were removed, and a complete closure without any dehiscence was achieved. The patient had no complaints of pain or swelling or any kind of paresthesia. On July 16, 1997,

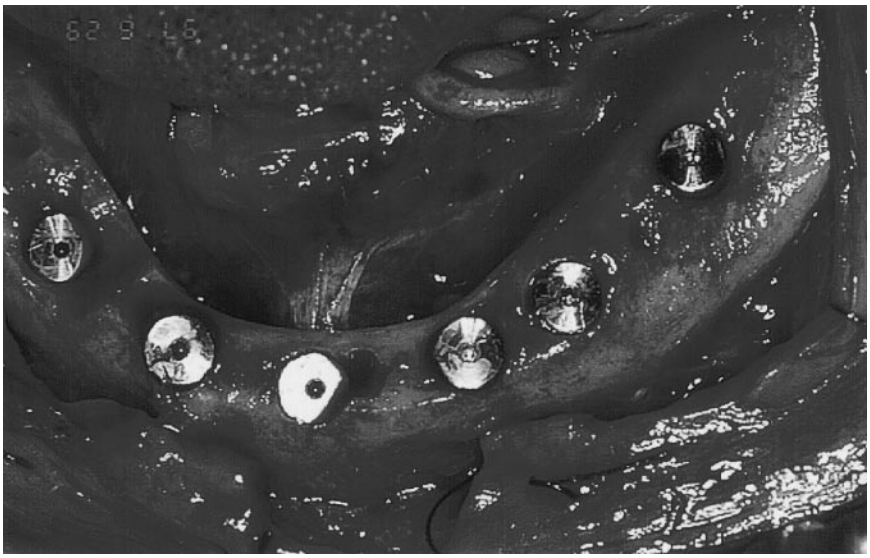

FIGURE 4. Mandible before suturing with six implants inserted and cover screws in place.

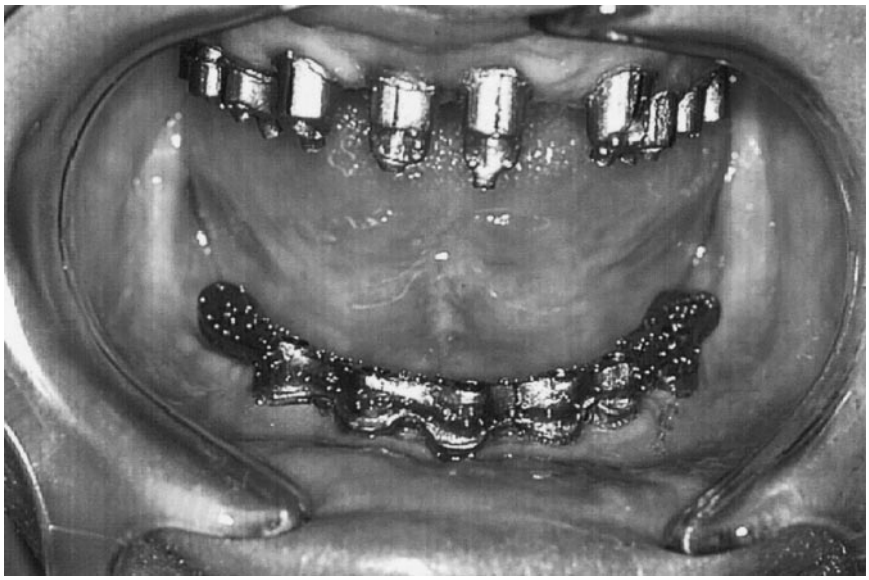

FIGURE 5. Fit check of the metal framework and the primary telescopic crowns.

photographs of the maxilla and mandible were taken, and both dentures were modified and lined with Viscogel. On September 18, 1997, the dentures were modified again according to the new hard and soft tissue dimensions and relined with Coe-Soft. The same procedure was repeated on November 5, 1997. On November 25, 1997, stage II surgery was performed for the implants in the mandible. After Ultracain DS forte was deposited in the labial and lingual mucoperiosteum to provide anesthesia of the mandible, a midcrestal incision was made, and the mucoperiostal flaps were reflected to expose the implant cover screws. All were overgrown by new bone, which had to be eliminated using excavators and a specially designed 3i bone trephine to make sure that the polymorphonuclear eosinophils could be properly seated into their final positions. Interrupted sutures with Vicryl were used to join lingual and buccal flaps around each implant, and the patient

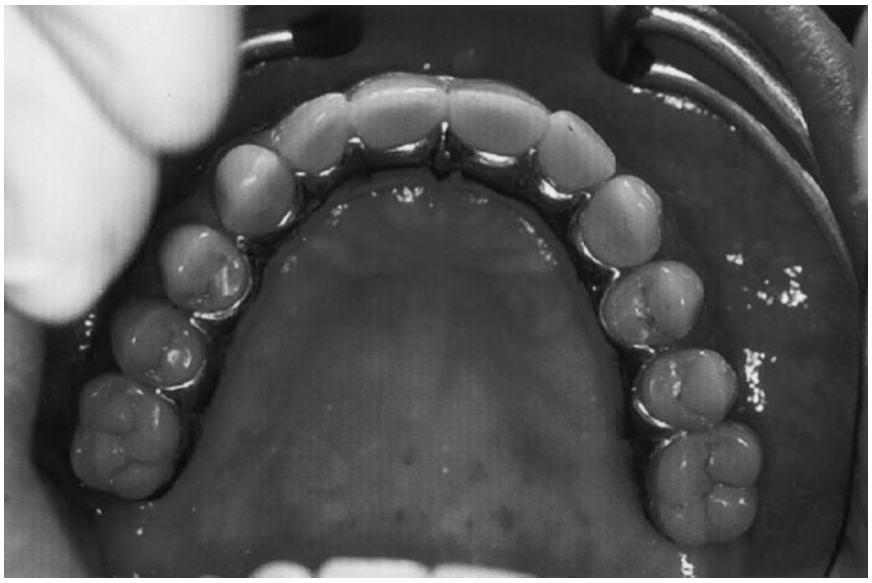

FIGURE 6. Maxilla Seatec prosthesis occlusal view.

was discharged with instructions not to wear his lower denture and to apply chlorhexidin over the suture site three times a day. On December 4, 1997, stage II surgery for the maxilla was performed. Local infiltration was given on the buccal surfaces, and a series of injections were applied about 1 cm below the crest toward the palate. One injection was applied directly into the incisive canal. A midcrestal incision was made from the 27 area to the 17 area. A vertical releasing incision was made in the labial zone between 11 and 21, and the two mucoperiosteal flaps were reflected labial side. The labial plates, which at the time of implant surgery had been rough and thin, now presented themselves with a thick and smooth consistency. All implants were covered by solid bone, and the previous bony defects were filled. Bone had partially grown over the cover screws, which made its removal necessary. The healing abutments were placed, and interrupted sutures were used to adapt the mucoperiosteal flaps between the abutments. Spaces were left open, allowing for adjacent attached gingiva to granulate and, in this way, enhancing the band of attached gingiva surrounding the implants. An analgesic was administered, and prescriptions for Augmentin and Brufen were issued.

PROSTHETIC PROCEDURES

On December 15, 1997, the upper and lower dentures were adapted to the new tissue morphology by using conditioner. Alginate impressions were made to permit the fabrication of custom impression trays from the laboratory. On January 5, 1998, final impressions of the maxillary implants were taken using the open-tray technique with two-piece, screw-retained impression copings. Before making the impressions, perioapical radiographs were taken of each implant site to verify the complete impression copings. On December 8, 1998, the final impression of the inferior arch was taken using an occlusally open custom impression tray and two-piece impression posts with long screws. The choice of impression material for both impressions was a polyether material. At the same appointment, a primary bite registration was done using the patient's second set of dentures lined with Permadyne in a closed-mouth mode. During the registration, the healing abutments were *in situ* and captured by the impression material. Plaster models were made transferring the healing abutments. A face bow was used to determine the position related to the condylar axes. Based on the interarch relation transferred to the articulator, implant-borne wax bite rims were made for the upper and lower arches. They were fabricated to avoid contact with the soft tissues. The implant-borne bite rims allowed precise positioning on the working model, which contained the implant analogs into which the healing abutments were screwed. On January 28, 1998, a second registration using the implant-borne wax bite rims was performed, and adjustments were made to determine the future interarch space. The laboratory fabricated wax try-in dentures. The patient's desire to keep exactly the same position of his upper incisors had to be respected. The wax try-in was evaluated and modified with the patient's approval on February 17, 1998. It was noted unequivocally that the situation for a fixed prosthesis was not favorable due to the lack of labial support. The plan called for a removable bridge on 10 telescopic crowns with pink acrylic on the labial aspect to provide proper lip support (Fig 5). In the mandible, a fixed-detachable, purely implant-borne prosthesis with acrylic teeth was planned. Silicone masks were fabricated in the laboratory, which allowed for a more precise evaluation of each tooth-abutment relationship and later were used to transfer the teeth from the wax try-in to the final prosthesis. UCLA hexed plastic sleeves were used to fabricate milled custom abutments for the upper and a metal framework for the lower implants. The patient was appointed for a metal try-in on March 16, 1998, the date on which an impression of the milled gold custom abutments was taken using an open custom impression tray. Again, digital radiographs verified the correct position of the gold abutments. The position of the metal frame was evaluated radiographically and examined clinically to ensure a passive fit. New soft tissue models

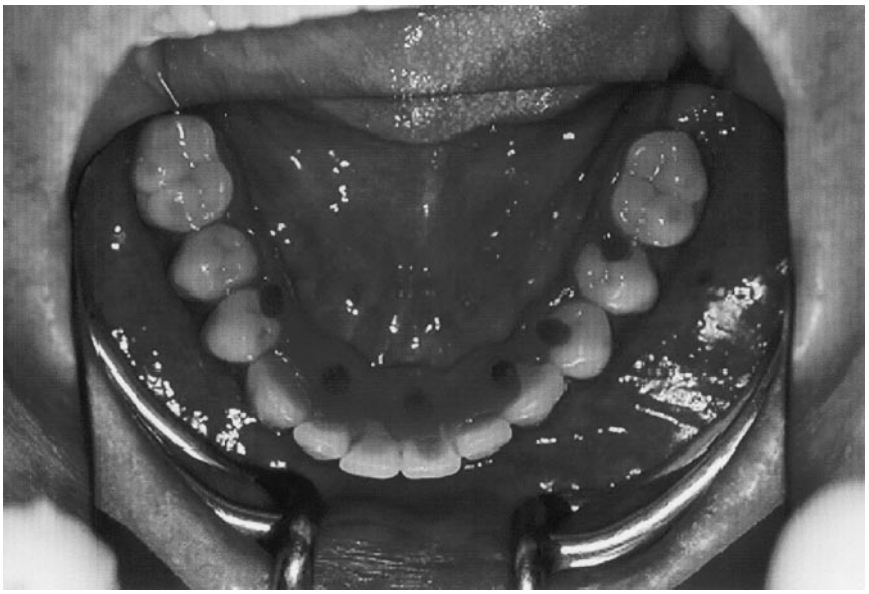

FIGURE 7. Lower prosthesis after 1 year.

were fabricated on which the bridge-type overdentures were set up. At a final try-in appointment on March 30, 1998, before processing the dentures, the metal framework and the upper denture in wax with the secondary telescopes were checked again for precise fit, correctness of occlusion, and esthetic and functional approval by the patient (Fig 6). The finished prostheses were delivered to the patient on April 8, 1998. The telescopic abutments and the lower denture were seated, hand tightened, and finally secured with 30 N/cm force using a torque wrench. Occlusion and correct canine guidance were checked. A panoramic X-ray was taken for control. On March 8, 1999, 11 months after delivery of the prosthesis, the patient was appointed for recall. Photographs (Fig 7) and two panoramic X-rays plus a lateral cephalogram were taken. All implants appeared to be well integrated, and no bone loss was noted around the implants. Soft tissues appeared to be firm and pink in all areas (Fig 8).

CLINICAL RESUME

The preoperative diagnosis was a totally edentulous alveolar ridge in the maxilla and the mandible with moderate to advanced bone atrophy in the premaxilla and the posterior regions of the mandible. Existing dentures were of inadequate fit and function. The accomplished treatment was designed to restore the function and esthetics comparable to natural teeth. Treatment progressed without complications. The patient had no complaints and was comfortable throughout the treatment. The alveolar ridge of the premaxilla, which had been inadequate for implant placement, was successfully modified using a bone expansion technique with

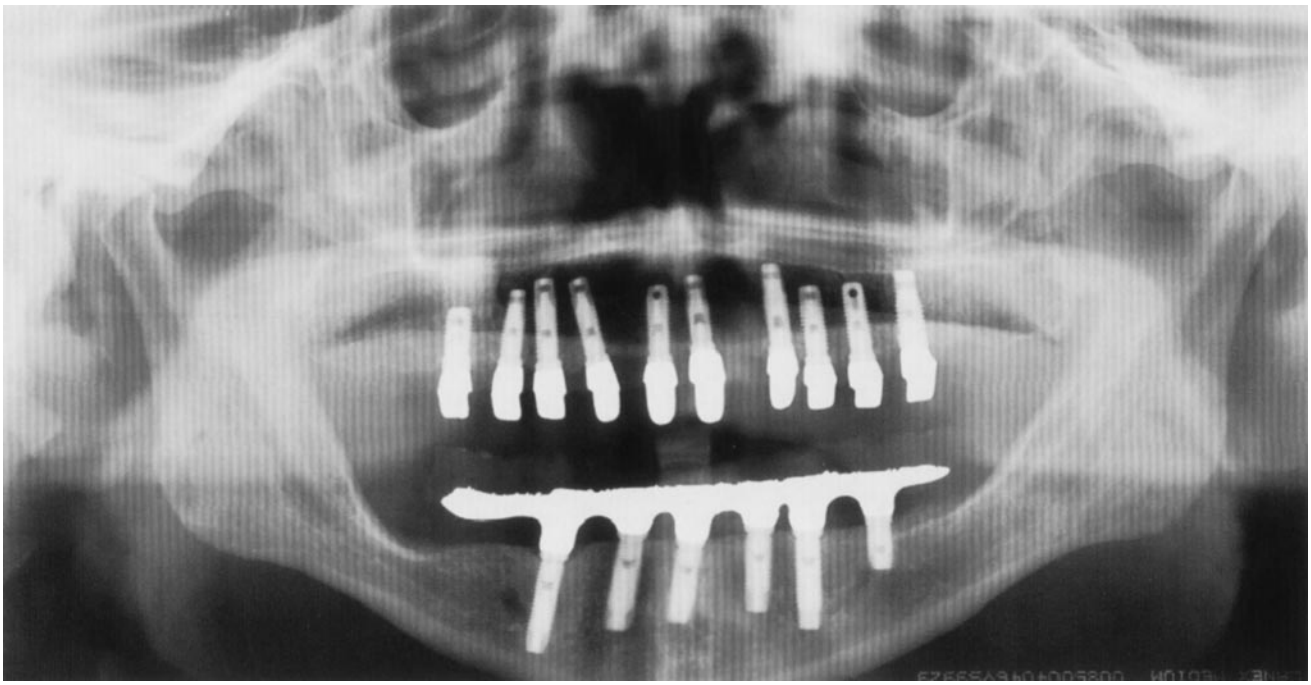

FIGURE 8. Restored case panoramic after 1 year without overdenture.

pointed osteotomes (from division C-w to division B). The division C-w type ridge in the anterior mandible was transformed into a division C-h category by osteoplasty. The patient was well informed about the dangers of loading the implants prematurely, and it was explained that he should not use his dentures for 2 weeks after the implants had been placed. The patient's discipline throughout the lengthy treatment helped to achieve the final result. With the delivery of the final prostheses, the expectations of the patient were satisfied. He now feels totally at ease when speaking or eating in public, since the dentures feel like natural teeth. ■