Patients with major atrophy of the upper maxilla suffer loss of both bone and soft tissue support. Implant supported prosthetic rehabilitations should aim to recoup lost stomatognathic function and compensate for the loss of perioral tissue support.\(^1,2\) There are 2 basic prosthetic approaches to solve this situation: overdentures or fixed hybrid prostheses.

Overdentures offer the advantage of easier hygiene maintenance by patients but the disadvantage of being removable, which can sometimes be a psychological barrier for patients. On the other hand, hybrid prostheses are fixed and therefore behave more similarly to natural teeth. This type of prosthesis has brought an improvement to the quality of life of edentulous patients compared with conventional dentures or overdentures, since it offers functional, aesthetic, and psychological advantages.\(^3,4\) However, they tend to accumulate large quantities of plaque as they cannot be removed by the patient. This may negatively affect the health of peri-implant tissues and could compromise the long-term outcome of the implant treatment.

From a prosthetic perspective, the implant-supported treatment of atrophied edentulous maxillae should ideally unite the advantages of overdentures and hybrid prostheses. However, no descriptions of prosthetic designs aiming at these ideal characteristics could be identified in the literature. The objective of this article is to describe the Horizontal Denture, a new implant-supported prosthetic rehabilitation alternative for edentulous patients with atrophied edentulous maxillae designed to bring together the advantages of conventional removable overdentures and hybrid prostheses. Two cases treated following this prosthetic approach are presented.

**Horizontal Denture: prosthetic design**

The Horizontal Denture (Justo Rubio Dental Laboratory, Valencia, Spain) is an implant-supported removable horizontal slide-in prosthesis. The overdenture’s superstructure (or secondary structure) is inserted horizontally over a bar (primary structure) by means of an assembly mechanism that employs friction in an anteroposterior direction for retention. Unlike other overdenture designs, the primary structure (screwed to the implants) does not retain the secondary by means of a saddle design but instead makes contact on its occlusal and vestibular surfaces, with the primary structure occupying mostly palatal space.

The Horizontal Denture complex can be divided into 2 clearly differentiated parts: the implant-supported primary structure and the secondary structure/or superstructure. The primary structure is characterized by having a flat, straight occlusal face perpendicular to the lateral faces of the bar (the intersection of the two planes forming a right-angle). The lateral walls correspond to premolar and molar zones. These walls have various conically shaped grooves, which are parallel to one another and to the occlusal plane. The grooves act as stepped rails and are the features that stabilize the superstructure, preventing it from moving in response to axial and lateral forces. The primary structure’s anterior part has complementary attachments to aid assembly that boost stability against horizontal (mesio-distal) forces, preventing the separation of the posterior sector by nonaxial forces, and so avoiding torquing of the material of the secondary structure. The assembly of the Horizontal Denture requires a minimum vertical clearance of 12 mm per arch. This type of prosthesis is adequate for edentulous patients with important bone atrophy, which will present the necessary vertical space. Figure 1a through e describes the design of the horizontal denture.

**Clinical Cases**

Two clinical cases of edentulous patients with atrophied upper maxillae rehabilitated with slide-in, horizontal overdentures are presented. Before treatment, the patients received information about the aims and parameters of the treatment (including procedures, attendance at follow-up appointments, and potential risks), were given full information about all the other treatment options available as well as the opportunity to have any questions answered; they were then asked to sign a consent form that guaranteed the confidentiality of all data.

Thorough clinical and radiographic evaluations were performed to consider the adequacy of the implant treatment.
Cone beam computerized tomographic (CBCT) scans were obtained in both cases and used to evaluate available bone.

**Surgical procedures**

Surgeries were performed under local anesthesia (4% articaine with 1:100 000 adrenaline; Inibsa, Lliça Vall, Catalonia, Spain) and sedation with 1% propofol solution; this included blood pressure, pulse, and oximetric monitoring by the anesthetist.

**Case 1:**

A 55-year-old female patient without relevant medical antecedents, who had become edentulous 8 months previously, received eight Kohno SP implants (Sweden & Martina, Due Carrare, Italy). Simultaneous bilateral sinus elevations were performed using tricalcium betaphosphate synthetic particulate bone graft (Kera-Os, Keramat, Coruña, Spain). Six implants were inserted in lateral incisor, canine and second premolar areas and 2 in the pterygomaxillary area. Anterior implants were placed in palatal position.

**Case 2:**

A 58-year-old female patient without relevant medical antecedents, who had become edentulous 3 years before, received 6 Kohno SP dental implants. Simultaneous bilateral sinus elevations were made using Kera-Os tricalcium betaphosphate synthetic bone graft particulate (Keramat, Coruña, Spain). The implants were placed at first premolar, first and second molar sites. Case 2 (Figures 3a through j).

Implants were left to heal submerged and 3 months following implant insertion, healing abutments were placed in a second surgical procedure to guide the peri-implant soft tissues.

Both patients were prescribed 1 g amoxicillin (GlaxoSmithKline, Madrid, Spain) twice daily for 6 days, starting 1 hour prior to surgery, 600 mg ibuprofen (Bexistar, Laboratorio Bacino, Barcelona, Spain) 3 times per day for 5 days and mouthrinse with chlorhexidine 0.12% (GUM, John O Butler/ Sunstar, Chicago, Ill) twice daily, commencing 3 days prior to surgery and for 2 weeks thereafter. Oral hygiene instructions were delivered and a soft diet was recommended for 8 weeks. Sutures were removed 7 days after the surgery.

**Prosthetic procedures**

The clinical protocol for preparing the horizontal dentures was as follows:

- Placement of conical transepithelial pillars (Disparallel Screwed Prosthesis [P.A.D system] Sweden & Martina) on subgingivally placed implants to support a prosthetic platform.
- Impressions were taken using the (single-step) double-mix technique with Sky Implant Heavy Mix and Sky Implant Light fluid silicone (Sweden & Martina), open tray technique using the P.A.D. transepithelial pillars and platform for correct impression transfer, splinted with low contraction SUN resin (Sweden & Martina).
- Verification test. A resin splint (GC Pattern Resin LS. GC EUROPE N.V. 1240 Interleuvenlaan 33 B - 3001 Leuven, Belgium) was fabricated in the laboratory to check that the master model was a faithful reproduction of the intraoral position of the implant supported prosthetic platform. Transepithelial abutments with rotational metallic prosthetic platforms were screwed to the implant replicas in the working cast and splinted using low contraction self-curing resin (Sun [Sweden & Martina]) to a full-arch steel wire that was embedded in layers of the same resin.
- Intermaxillary registers and cranio-maxillary transfers were taken and mounted on an ARL Dentatus semi-adjustable articulator set-up (Dentatus USA Ltd, New York, NY). This allowed verifying that both patients presented over 12 mm of vertical clearance (the minimum requested for the Horizontal Denture). The skeletal intermaxillary relations of...
the patient determine the position of teeth and the design of the primary and secondary structures. If we want to camouflage a class III we must protrude the teeth and the primary and secondary structures will extend more anteriorly to provide support. When we have a class I or II structures are designed to allow the retraction of teeth behind the location of the implants in the premaxilla.

- Dental testing. Occlusion and dental esthetics were checked (intra- and extra-oral).
- Primary structure testing. The correct fit between the abutment margins and the implant connections was checked using paralleled periapical radiographs.
- Secondary structure testing with the teeth set in wax. Confirmation of correct coupling and engagement between the primary and secondary structures and of the tooth set-up supported by the secondary structure (esthetics and occlusion). Both the primary and the secondary structures were constructed in the same gold alloy type IV. A specific alloy is not recommended because retention does not depend on friction between walls, but is provided by an assembly of complementary structures that once assembled act as a cold weld. However, the same alloy must be used for both structures to avoid side effects of a close contact between different metals such as wear of one of them due to different hardness.
- Placement of the Horizontal Denture (Justo Rubio Dental Laboratory, Valencia, Spain) and occlusal adjustment. The patients were shown how insert and remove the overdenture and were given oral hygiene instructions. They were instructed to, at least once a day and preferably at night, perform extraoral cleaning of the secondary structure and to complete careful cleaning of the implants and the primary structure combining tooth brush, interdental brushes and oral irrigator. They were advised to wear the prosthesis at night to avoid damage to the primary structure due to parafunctional forces and were provided with a resin splint to prevent damage to the coating material.

**Follow-up and patient satisfaction**

The patients returned for follow-up appointments 1, 6, and 12 months after prosthetic loading. Implant success was determined according to the clinical and radiographic criteria defined by Buser et al.:6 (1) absence of clinically detectable implant mobility; (2) absence of pain or any subjective sensation; (3) absence of recurrent peri-implant infection; and
(4) absence of ongoing radiolucency around the implant after 6 and 12 months of loading.

Biological and prosthetic complications were recorded at the regular follow-up visits and any incidence of patient complaint. Based on the Consensus Report of the VI European Workshop on Periodontology, the patients with peri-implant gingival redness, swelling, bleeding on probing, and without radiographic signs of bone loss were considered to present peri-implant mucositis. Those implants in which the soft tissue lesion was associated with marginal bone loss and sometimes with suppuration and/or increased probing depth were considered to present peri-implantitis. Prostheses were checked for fractures, screw loosening, and adequate occlusal scheme. The prosthetic treatment was considered successful when comfortable rehabilitation of oral functions was achieved and the prosthesis did not have to be removed to be repaired or due to implant loss.

The degree of patient satisfaction was assessed using a 10-cm visual analogue scale (VAS) 6 months after prosthetic placement. This evaluation assessed general satisfaction with
the implant-retained prosthesis, and specific satisfaction regarding comfort, stability, phonetics, ease of cleaning, function, esthetics and self-esteem. The anchor words were “totally dissatisfied” and “completely satisfied.” Patients marked the scale independently, although a research assistant was available to offer help or explanations as needed.

At the 12-month follow-up, none of the implants had failed and neither prosthetic nor biological complications were observed. The patients presented high satisfaction with the overall treatment, giving VAS scores of 8 and 9, respectively. Table 1 details the satisfaction of both patients with the horizontal denture regarding comfort, stability, mastication, phonetics, esthetics, self-esteem, and ease of cleaning.

**Discussion**

Esthetic demands tend to be much greater for maxillary than mandibular prostheses. Unlike mandibular implant-supported prostheses, whose hygienic-type designs have proved to be functionally and esthetically acceptable, Zarb and Schmitt state that maxillary implant-supported prostheses demand different sized and shaped labial/buccal flanges that may compromise esthetics (including lip support), phonetics, and masticatory function (food impaction between intaglio surfaces and edentulous areas). If flanges are fabricated to aid upper lip support and phonetics, they may obstruct access for adequate peri-implant oral hygiene procedures.

Real-Osuna et al. carried out a retrospective study of 43 patients wearing implant-supported hybrid prostheses and evaluated problems associated with this kind of treatment. They concluded that the most frequent complication after the placement of an implant-supported hybrid prosthesis was mucositis (24% of patients), which they associated mainly with prosthetic flanges/tails that are too long and to the consequent difficulty of maintaining adequate oral hygiene. Peri-implantitis, fractures of the resin teeth and problems related to the prosthetic pillars occurred in a further 13.7% of cases. Moreover, hybrid prostheses need to have the screw holes camouflaged. On the other hand, overdentures can be easily removed by the patient, while the bar, that stays fixed, allows a good access for adequate peri-implant oral hygiene procedures. A uniform distribution of fixtures is necessary to prevent damage due to excessive forces on any of the implants but, like when using bar-supported overdentures, the Horizontal Denture is less sensitive to implant positioning than fixed prosthetic alternatives.

Despite that the Horizontal Denture technique has the potential to offset errors committed during the surgery—especially regarding implant position, treatment planning is essential before the surgery because the patient must understand how the rehabilitation will operate and must be willing to accept a removable solution. For this it is very important that the patient be thoroughly explained the importance of a good access to the implants for their correct maintenance and their long-term success and, in this sense, he has to be informed about the advantages of the Horizontal Denture technique with respect to other alternatives. The indication of this technique can be easily determined by clinicians as it coincides with that of hybrid prostheses.

A very high precision is required for the 2 structures to perfectly bind together and permit a performance similar to that of a fixed prosthetic solution. The primary and secondary structures in the two presented cases were casted and the complicated laboratory work increased significantly the cost of the rehabilitation (it was almost double of the cost of a hybrid prosthesis at the treatment center). However, the application of CAD/CAM technology with predetermined designs for the structures depending on the intermaxillary relations of the patient, and the standardization of the processes should allow overcoming this economic limitation.

No report was found of any prosthetic design using a similar mechanism to the Horizontal Denture. Further studies are necessary, including finite element analysis and clinical controlled studies with bigger samples, longer follow-up and calibrated hygiene assessments, to confirm this system as an equivalent to the conventional prosthetic alternatives and to investigate on the possible advantages that it might provide for the treatment of atrophic maxillae.

**Conclusions**

The Horizontal Denture prosthetic design was described with the aim of providing solutions to the clinical and laboratory limitations of hybrid prosthetics. Two patients with atrophied maxilla were rehabilitated with this technique, which allowed camouflage of the fixing screw access holes and removal of the prosthesis to facilitate cleaning of the implants. Both patients were highly satisfied with the treatment. Studies with larger numbers of patients are required to confirm that this treatment might offer a valid alternative to implant-supported hybrid prostheses.
ABBREVIATIONS

CBCT: cone beam computerized tomography
VAS: visual analogue scale

REFERENCES