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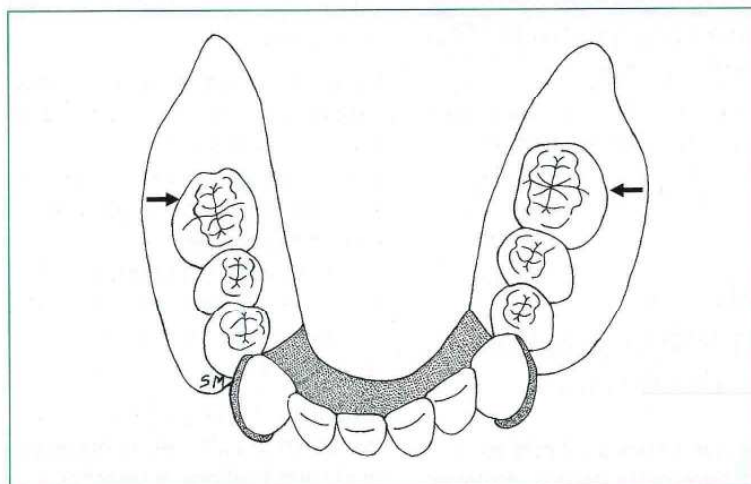
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The design of a Kennedy Class I removable partial denture can be modified with implants placed in the molar regions (arrows). These implants will either support the distal extension bases or provide additional retention for the bases. See *IMPLANT-TOOTH-SUPPORTED RPDs*.

Implant-tooth-Supported RPDs

A Kennedy Class I removable partial denture (RPD) possesses bilateral extension bases. This type of RPD can pose more problems for patients compared with RPDs for other classifications of partial edentulism. An all-tooth-supported RPD (Kennedy Class III) often offers a better prognosis than that of a Class I RPD.

It has been postulated that patient satisfaction with a Class I partially edentulous situation can be improved with the incorporation of dental implants in the RPD design. The 2 approaches to incorporating implants into an RPD design have been described as implant-supported

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Modern Removable Prosthodontics

As new materials and techniques have been introduced to the profession, removable prosthodontics has evolved over the past 30 years. Although many of the basic principles have not changed, these new developments have enhanced patient satisfaction with removable dental prostheses and have had a major impact on improving the clinical outcomes of treatment. This issue of *Prosthodontics Newsletter* reviews a series of clinical and in vitro studies that investigated advances in removable prosthodontic materials and techniques.

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- Maxillary Implant-supported Overdentures
- Color Stability of Acrylic Resin Artificial Teeth
- Wear of Resin Artificial Teeth

Implant-tooth-supported RPDs

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and implant-assisted designs. An implant-supported RPD design incorporates healing caps to provide support for the extension base. An implant-assisted RPD uses resilient implant attachments to provide additional retention.

A systematic review of articles devoted to the clinical outcomes of implant-supported/implant-assisted RPDs was conducted by Shahmiri and Atieh from the University of Otago, New Zealand. Nine articles were selected for the review. The data included 183 implants in 94 patients. Follow-up time ranged from 3 weeks to 120 months. All RPDs had bilateral extension bases with implants placed bilaterally in the molar regions (see cover illustration).

Results indicated favorable outcomes associated with implant-supported/implant-assisted RPDs compared with conventional Class I RPDs. Advantages included

- enhanced stability and retention
- improved esthetics
- improved oral hygiene
- reduced bone resorption beneath the denture bases
- ease of converting to a conventional RPD if there were implant failures
- ability to modify unfavorable arch configurations
- improved patient satisfaction
- less prosthetic maintenance
- ability to reduce the extension of the RPD bases

➤ lower cost compared with a fixed implant-supported prosthesis

➤ reduced potential for the combination syndrome

Comment

While none of the studies in this review was a randomized, controlled clinical trial, results appear very promising. The prostheses in this review were not without maintenance problems; however, patient satisfaction with this relatively uncomplicated and cost-effective treatment method was improved. Further studies are necessary to determine the long-term results of this treatment approach.

Shahmiri RA, Atieh MA. Mandibular Kennedy Class I implant-tooth-borne removable partial denture: a systematic review. *J Oral Rehabil* 2010;37:225-234.

Maxillary Implant-supported Overdentures

Milled bars attached to maxillary dental implants can provide rigid support and stability for an implant-supported overdenture. Krennmair and Piehslinger from the University of Vienna, Austria, conducted a retrospective study of the clinical outcomes of 2 different milled-bar designs.

Thirty-one patients were included in the study; 15 had 4 implants in the anterior portion of the maxillae, placed anterior to the maxillary sinuses. These patients were treated with a 1-piece bar that extended across the dental arch and incorporated bilateral can-

tilevers. Sixteen patients were treated with 2 free-standing bars on either side of the dental arch. These 2 unconnected bars were supported by 6–8 dental implants.

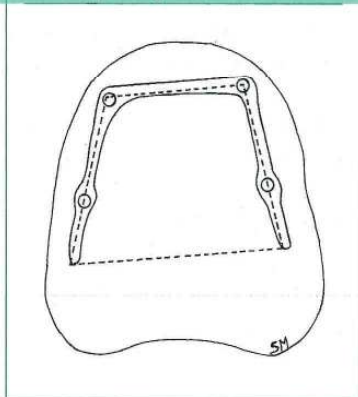
All overdentures were U-shaped, had been in function for at least 3 years (mean, 4.6 ± 1.3 years; age range, 3–8 years), were designed with a 2–4° taper to the bars and were provided with additional retentive devices (Preci-Vertex; Alphadent Co., Ltd., Seoul, South Korea). Overdentures in both groups were metal reinforced, and all incorporated 12 artificial acrylic resin teeth.

Variables included the amount of supporting area generated by the bars and postinsertion maintenance. The bar-generated supporting area was calculated mathematically after drawing lines connecting the most anterior portion and the most posterior portion of the bar to produce a cross-arch, 4-sided polygon (Figure 1).

Maintenance complications were evaluated as either implant-component complications or prosthetic-component complications. Implant-component complications included implant loss or fracture, abutment screw loosening and abutment or bar fracture. Prosthetic-component complications included retentive matrix activation or replacement, fracture or replacement of artificial teeth, fracture of the denture, denture border adjustment, overdenture rebase and maintenance of opposing prosthesis.

Results indicated that the mean supporting area for the 1-piece, cross-arch bar was $962 \pm 84 \text{ mm}^2$ and for the double-bar design,

Figure 1. Polygon representing bar-supporting area.



$1015 \pm 118 \text{ mm}^2$, a difference that was not significant. The 1-piece-bar group experienced 17 prosthetic maintenance problems (0.20 problems/year/patient); the double-bar group experienced 19 prosthetic problems (0.22 problems/year/patient). Screw loosening was the only implant-component complication evident in both groups. All other complications involved prosthetic components. These results were not significant.

Comment

With no significant differences in clinical outcomes between the 2 designs, it is difficult to claim either approach as superior. Placing 4 implants in the maxillary bone anterior to the maxillary sinuses is a much less complicated surgical procedure. When implants are placed in the posterior maxillae, bone augmentation of the sinuses is commonly required, a procedure that will complicate the surgical phase of the treatment substantially and prolong the duration of the treatment time. A less complicated surgical phase would have advantages that would not

affect the clinical outcome of the final prosthetic treatment.

Krennmair G, Piehslinger E. Removable implant-supported maxillary prostheses anchored on milled bars: a retrospective evaluation of two concepts. *Int J Prosthodont* 2009;22:576-578.

Color Stability of Acrylic Resin Artificial Teeth

Commonly used in removable prosthodontics, acrylic resin artificial teeth can become discolored over time. Intrinsic staining can occur with aging or degradation of the material resulting from alterations in physical and chemical conditions, such as thermal changes and humidity. Extrinsic factors produce discoloration from absorption and adsorption.

Assunção et al from Araçatuba Dental School, São Paulo State University, Brazil, investigated the color stability of 10 commercially available acrylic resin artificial teeth. The brands they studied included the following:

- Art Plus (Dentsply Ind. e Com. Ltd., Petrópolis, Brazil)
- Biolux (Vipi Ind. Com. Ltd., Pirassununga, Brazil)
- Biotone IPN (Dentsply Ind. e Com. Ltd.)
- Magister (Heraeus Kulzer GmbH, Hanau, Germany)
- Mondial 6 (Heraeus Kulzer)
- Premium 6 (Heraeus Kulzer)
- SR Vivadent PE (Ivoclar Vivadent, Inc., Amherst, N.Y.)

- Trilux (Ruthibras Imp. Exp. Com. de Materiais Odontol. Ltd., Pirassununga, Brazil)
- Trubyte Biotone (Dentsply Ind. e Com. Ltd.)
- Vipi Dent Plus (Vipi Ind. Com. Ltd.)

Each group ($n = 24$) was divided into 2 subgroups. One subgroup was subjected to a simulated denture-base processing cycle in a microwave oven (500 W for 3 minutes); the other subgroup was subjected to a simulated conventional water-bath polymerization cycle (74°C for 9 hours).

All specimens were then thermal cycled (5–55°C, 30-second dwell time, 5000 cycles). Specimen colors were measured with a spectrophotometer with the use of the CIE $L^*a^*b^*$ system. Measurements were made at baseline (B), after simulation of polymerization (P) and after thermal cycling (T). Color changes (ΔE) between PB, TP and TB were evaluated. Results indicated that minor ΔE changes occurred after polymerization and after thermal cycling. There were no significant differences between the 2 polymerization techniques. The greatest changes were evident in Biotone IPN and SR Vivodent PE teeth. Nevertheless, in all groups and under all conditions, the ΔE change was <3.3 . Changes ≤ 3.3 are considered clinically acceptable.

Comment

Color changes resulting from polymerization of the denture base or normal aging, including temperature changes in the mouth during normal function, are not likely to result in any clinically detectable



alteration in the shades of the teeth studied. The authors selected only 1 shade for each brand of tooth. Because each manufacturer has its own shade selection guide, shades for this study could not be standardized. Those selected for the study tended to represent the most popular shades; however, it should not be assumed that similar results would occur with different shades of the same brand of tooth.

Assunção WG, Barão VAR, Pita MS, Goiato MC. Effect of polymerization methods and thermal cycling on color stability of acrylic resin denture teeth. *J Prosthet Dent* 2009;102:385-392.

Wear of Resin Artificial Teeth

Resin artificial teeth, commonly used with removable dental prostheses, are subject to wear over time. Occlusal wear is undesirable and can result in loss of occlusal stability. Manufacturers of artificial teeth claim that wear resistance has been improved by new developments in the chemistry of the resin materials used to manufacture the teeth.

A study by Stober et al from Heidelberg University Hospital, Germany, evaluated the 3-body wear resistance of 11 commercially available artificial teeth. Three types of artificial teeth were studied:

- **Conventional and cross-linked acrylic resin teeth:** SR Orthotyp PE (Ivoclar Vivadent AG, Schaan, Liechtenstein), Orthognath (Heraeus Kulzer GmbH, Hanau, Germany),

Premium 8 (Heraeus Kulzer GmbH), SR Postaris DCL (Ivoclar Vivadent AG), Trubyte Portrait (Dentsply International, York, Pa.) and Artiplus (DeguDent GmbH, Hanau, Germany)

- **Composite resin teeth with inorganic fillers:** SR Orthotyp PE (Ivoclar Vivadent AG) and Vitapan (VITA Zahnfabrik, Bad Säckingen, Germany)

- **Composite resin teeth with inorganic nanofillers:** NC Veracia Posterior (Shofu Dental GmbH, Ratingen, Germany), e-Ha (Heraeus Kulzer GmbH) and Mondial (Heraeus Kulzer GmbH)

Human enamel and feldspathic ceramic artificial teeth served as control groups.

Tests were performed in a wear machine, with a foxtail millet suspension as the abrasive material. After 100,000 wear cycles, the loss of material as a result of wear was measured with a profilometer. Results indicated that none of the artificial teeth had 3-body wear resistance comparable to that of human enamel or ceramic artificial teeth. Composite resin teeth with conventional fillers were more resistant to wear than were conventional or cross-linked acrylic resin teeth without fillers. The incorporation of nanofillers did not result in improved wear resistance.

Comment

With implant-supported removable prostheses, patients can generate considerably more force than can be generated with conventional removable prostheses. As a result, accelerated wear of the artificial teeth

has been observed. The results suggest that composite resin teeth with conventional inorganic fillers will demonstrate improved resistance to wear compared with acrylic resin teeth without fillers and nanofilled composite resin teeth. Nevertheless, ceramic artificial teeth provide the best approach to reducing the potential for accelerated wear.

Stober T, Henninger M, Schmitter M, et al. Three-body wear of resin denture teeth with and without nanofillers. *J Prosthet Dent* 2010;103:108-117.

In the Next Issue

- Retention of pressed ceramic crowns
- Fracture rate of pressed ceramic crowns
- Effect of cuspal inclination on stress distribution with implant-supported crowns

Our next report features a discussion of these issues and the studies that analyze them, as well as other articles exploring topics of vital interest to you as a practitioner.

Do you or your staff have any questions or comments about **Prosthodontics Newsletter**? Please write or call our office. We would be happy to hear from you.
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