Prosthodontics Newsletter

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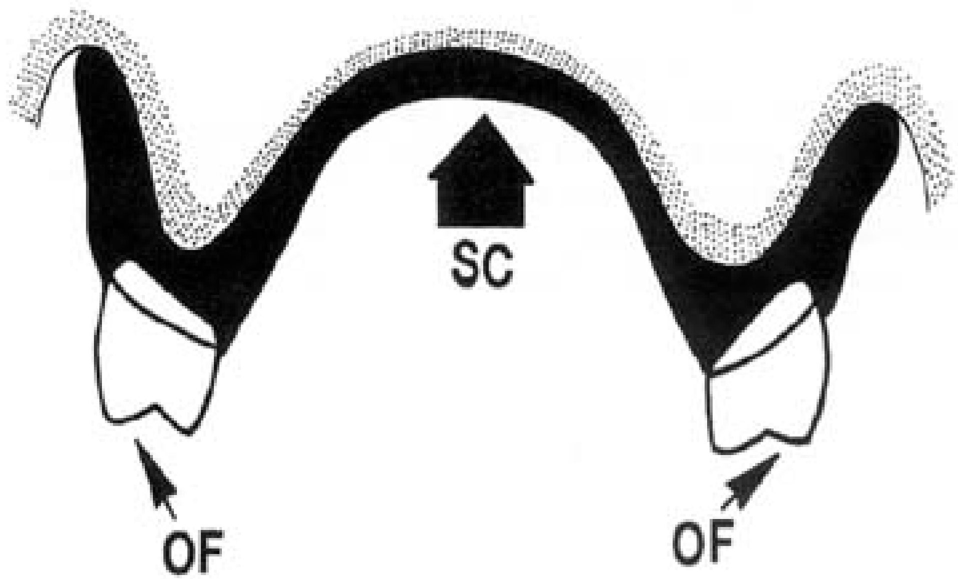
In This Issue:



Functional and parafunctional occlusal forces (OF) cause stress concentration (SC) at midline of complete denture base that may produce midline fracture. See *Methods of Reinforcing Polymethyl Methacrylate Resins*, inside, for a review of recent research devoted to strengthening denture base resins.

Prosthodontic Materials and Devices—an Update

The specialty of prosthodontics continues to advance at a rapid rate. Future progress in prosthodontics can be expected, and many improvements will be the result of new knowledge and developments in the materials and instrumentation available to the clinician. This issue of *Prosthodontics Newsletter* is devoted to a review of recent articles on contemporary materials and devices used by the prosthodontist.

Methods of Reinforcing Polymethyl Methacrylate Resins

Polymethyl methacrylate (PMMA) resin is the most commonly used polymer material for the fabrication of denture bases. This synthetic resin has been used successfully for more than half a century, and its shortcomings are well understood. Its most noteworthy weakness is related to its fracture resistance.

Because cost-effective, practical substitutes for PMMA resin are not currently available, improved resistance to fatigue fracture of this resin has been a goal of researchers. A recent study by John et al from Bapuji Dental College, India, evaluated the effects of various methods of fiber reinforcement on the flexural strength of PMMA resin.

The investigators used a conventional heat-polymerized PMMA resin (Travalon; Dentsply Int, York, Pa.) as a control. This same PMMA resin was then reinforced with glass (Ahlstrom Corp, Karhula, Finland), aramid (Kevlar; DuPont, Wilmington, Del.) or nylon (MRF Ltd, Chennai, India) fibers, to form 3 experimental groups.

All samples were tested for flexural strength with the use of a universal testing machine and subjected to a 3-point bending test. The control group and the nylon group recorded statistically similar flexural strengths. Glass-reinforced PMMA resin possessed the highest mean flexural strength, followed by the aramid group. These differences were statistically significant.

Comment

Midline fracture of a denture base is the result of fatigue failure (see cover illustration) and occurs after many cycles of flexural deformation during function and parafunction. Increasing the flexural strength of the denture base material will improve its resistance to fracture.

This study indicates that either glass or aramid fibers can be used to improve the physical properties of PMMA resin for a variety of clinical applications, including denture bases for complete dentures, removable partial dentures and provisional fixed partial dentures.

John J, Gangadhar SA, Shah I. Flexural strength of heat-polymerized polymethyl methacrylate denture resin reinforced with glass, aramid, or nylon fibers. J Prosthet Dent *2001;86:424-427.*

Alumina Ceramic Abutments for Single Implant-supported Crowns

A densely sintered alumina ceramic CerAdapt abutment (Nobel Biocare) for use with single implant-supported crowns was evaluated by Anderson et al from SIM/Prosthetic Dentistry, Sweden, in a multicenter clinical trial.

In this study, 34 test and 35 control abutments were included. The control abutment was the titanium CeraOne (Nobel Biocare). Abutment selection for the implants was randomized. The restorations were observed after 1 year, and 10 test and 10 control abutments were followed for 3 years.

None of the 69 implants in the study failed during the observation period. Five planned CerAdapt abutments fractured during preparation or placement, prior to restoration. Four of these implants received different abutments after the fractures occurred, resulting in 30 remaining implants that were restored with CerAdapt abutments and loaded.

Two of the 30 CerAdapt abutments fractured after loading—1 after only a month and the other after 7 months. None of the control abutments failed during the duration of the study.

Comment

Single implant-supported crowns have been in use for >15 years, and the first paper on this topic was published in 1986. Success rates have been favorable; therefore, this treatment method is now considered a viable alternative to a 3-unit fixed partial denture for the replacement of a single tooth.

One inherent shortcoming of implant-supported crowns is gingival discoloration as a result of altered light transmission from a metallic abutment (Figure 1). The CerAdapt ceramic abutment was introduced in 1993 to overcome this problem. This abutment will mimic the light transference that occurs from a natural root through the translucent gingiva.

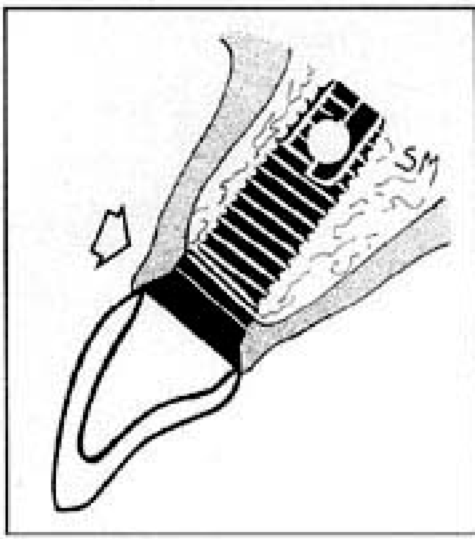


Figure 1. *Titanium implant abutment can alter the optical effects of light transmission through overlying soft tissue to produce a graying effect (arrow).*

Ceramic materials are brittle, and results of this study indicate a higher potential for catastrophic failure for a ceramic abutment attached to an implant. A 7% failure rate for the ceramic abutment was observed during the first year, compared with a 0% failure rate for the titanium abutment.

Structural weakness of the abutment may be an acceptable trade-off for some patients with high esthetic expectations, but may not be prudent for patients who are bruxists or those with unfavorable occlusal relationships.

Anderson B, Taylor Å, Lang BR, et al. Alumina ceramic implant abutments used for single-tooth replacement: a prospective 1- to 3-year multicenter study. Int J Prosthodont *2001; 14:432-438.*

Stress Analysis of Metal-free Polymer Crowns

Due to concerns about esthetics and allergic or toxic side effects of metal alloys, metal-free crowns have become more popular. Also, new composite materials have recently become available and can be used for both the anterior and posterior regions.

A 3-dimensional finite element analysis (FEA) of a posterior composite crown was conducted by Nakamura et al from Osaka University, Japan. Each crown was 1.5 mm thick at the occlusal surface and 1.0 mm thick at the margins. Crowns made of 2 composite materials were studied and results were compared with those obtained from a simulated pressed-glass ceramic crown and a metal-ceramic crown.

The mechanical properties of Artglass (Heraeus Kulzer) and Estenia (Kuraray) composites were used for the analysis of composite crowns. Properties of Empress ceramics (Ivoclar) were used for the pressed-glass ceramic crown material, and those of VMK68 porcelain (Vita) with KIK gold alloy (Ishifuku) were used for the metal ceramic crown materials.

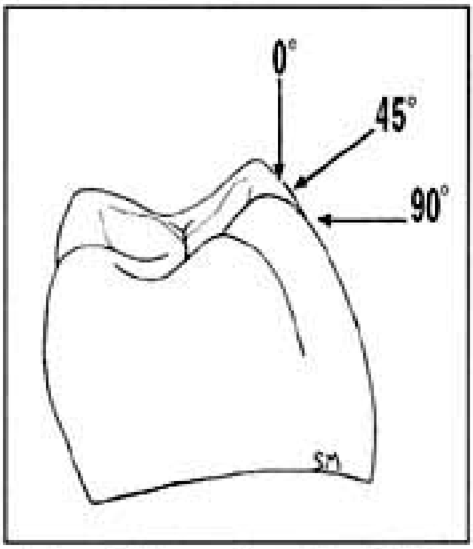


Figure 2. *Forces directed at 0°, 45° and 90°.*

In the FEA analysis, the crowns were subjected to simulated maximal occluding force; results were similar for all crowns. The effects of directional loading at 0°, 45° and 90° were also studied for all crowns (Figure 2). Similar stress distribution patterns were obtained for the 2 composite crowns and the Empress crown when loads were applied in the 3 directions. Higher tensile stresses were recorded for the metal ceramic crown at its cervical region when a load was applied horizontally.

The investigators concluded that each of the materials studied possessed a diametral tensile strength that exceeds the tensile stresses recorded in the study. They also suggested that forces applied from a horizontal direction are most critical when predicting the success or failure of these crowns.

Comment

In this study, a maximal occluding force of 600 N was used, which is similar to the values reported from human studies. Chewing forces of 225 N were used (37% of the maximal occluding force) in the directional-loading portion of the study to simulate loads obtained from clinical studies.

Fracture of a crown will likely occur if the tensile stresses exceed the tensile strength of the material used to fabricate the crown. Results of this FEA computer-generated study suggest that all materials tested should withstand normal intraoral forces.

Nevertheless, horizontally directed forces produced tensile stresses that were twice as great as the stresses recorded for vertical loading. Male patients with heavy bruxing habits have been reported to produce forces in excess of 900 N on posterior teeth. During bruxing movements, horizontal loading of the teeth can occur. Under this hypothetical situation, the physical properties of the materials tested may be exceeded and fracture could occur.

Another important consideration is occlusal wear of the artificial crown. The wear resistance of any composite resin is inferior to the wear characteristics of ceramic materials. Loss of occlusal restorative material can jeopardize the occlusal stability of the patient, especially when multiple teeth in a series are restored with a material that possesses a relatively low resistance to wear.

The long-term prognosis of posterior complete crowns made from this new generation of composite restorative material is unknown since they have not been used for a sufficient period of time. Prospective clinical trials are necessary before any meaningful conclusions can be drawn.

Nakamura T, Imanishi A, Kashima H, et al. Stress analysis of metal-free polymer crowns using the three-dimensional finite element method. Int J Prosthodont *2001:14:401-405.*

Next:

- Effects of seating force, margin design and cement on complete metal crowns
- Interchangeability of articulators
- Occlusal wear and bone loss around dental implants

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.

Electrosurgery and Laser Surgery in the Presence of Implants

Both electrosurgery and laser surgery have been proposed as ideally suited for procedures to make minor revisions of soft tissue surrounding a dental implant.

Concerns have been raised, however, that increasing the temperature of bone surrounding an osseointegrated implant might cause loss of osseointegration.

Several authorities on implant prosthodontics have suggested that the use of electrosurgery or laser surgery in the vicinity of a dental implant can cause irreversible damage to peri-implant bone as a result of overheating. Nevertheless, there is little research published to support or refute these concerns about electrosurgery, while studies of laser surgery present conflicting results.

An in vitro study by Wilcox et al from Creighton University, Nebraska, evaluated local heat effects generated from the use of:

- 2 different conventional electrosurgical units—unipolar units (model 400E, Whaledent, New York, N.Y.; model 90FFP, Ellman, Hewlett, N.Y.),
- a bipolar electrosurgical unit (Bident, Philadelphia, Pa.),
- a neodymium:yttrium-aluminum-garnet (Nd:YAG) laser unit (model E-008, HGM, Salt Lake City, Utah).

Root-form implants were placed in fresh bovine rib sections in conjunction with an internal thermistor (Tandy, Fort Worth, Tex.). Temperature increases were measured during a simulated in vitro surgical procedure to remove the soft tissue covering the implant.

Statistical analysis was used to summarize the results and test the hypothesis that no significant difference in temperature change would be produced with any of the tested units in typical clinical use. Analysis of variance for repeated measures was used for hypothesis testing.

The laser surgical device produced cumulative temperature increases ≤1°C. The bipolar electrosurgical unit produced temperature increases ≤5°C. The traditional electrosurgical unit routinely produced damaging temperature increases that exceeded 10°C.

Comment

Prosthodontists commonly use a conventional electrosurgical handpiece to remove or recontour redundant soft tissue and to expose finish lines of tooth preparations for impression making. The results of this study suggest that conventional electrosurgical units should not be used to cut soft tissue around osseointegrated implants.

The bipolar electrosurgical device is a newly developed unit with a built-in safety feature to reduce heat generation. It appears that the bipolar electrosurgical unit and the Nd:YAG laser unit have potential for use under highly controlled conditions for minor soft-tissue surgery in the vicinity of an osseointegrated implant.

Additional studies may confirm the safety of the bipolar unit and the laser device. However, dentists are advised to proceed with caution. A conventional scalpel or tissue punch is probably the best approach because it is safe, relatively efficient and highly cost effective.

Wilcox CW, Wilwerding TM, Watson P, Morris JT. Use of electrosurgery and lasers in the presence of dental implants. Int J Oral Maxillofac Implants *2001;16:578-582.*

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.*