Load fatigue of teeth with different ferrule lengths, restored with fiber posts, composite resin cores, and all-ceramic crowns

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Statement of problem. There is no evidence to suggest that the ferrule length needed for an all-ceramic crown is different from that needed for a cast metal or metal ceramic crown.

Purpose. The purpose of this study was to relate different ferrule lengths with the number of fatigue cycles needed for failure of the crown cement for an all-ceramic crown cemented with a resin cement.

Material and methods. Fifteen maxillary central incisors were divided into 3 groups (n=5), with ferrules of 0.0 mm (no-ferrule group), 0.5 mm (0.5-mm ferrule group), and 1.0 mm (1.0-mm ferrule group), respectively. Each tooth was restored with a 0.050-inch glass-filled composite post (ParaPost FiberWhite) and a composite resin core (ParaCore). The posts were cemented with resin cement (ParaPost Cement), and the composite resin cores were bonded to dentin using a dentin bonding agent (ParaPost Cement, Conditioner A & B). Each specimen was prepared with a 7-mm total preparation height, a 1.5-mm lingual axial wall, and a 1.0-mm shoulder around the tooth. The crowns for all specimens were pressed with a pressable ceramic material (IPS Empress 2) and cemented with resin cement (Variolink II). A 6-kg cyclic test load was applied to each specimen at 135 degrees to the long axis of the tooth. The independent variable measured was the number of load fatigue cycles required for failure of the crown cement. The data were subjected to the Kruskal-Wallis test to detect overall significance and the Mann-Whitney U test for pairwise comparisons with Bonferroni correction (α=.017).

Results. The mean (SD) number of cycles to failure for each group was: no-ferrule group, 213 (317); 0.5-mm ferrule group, 155,137 (68,991); and 1.0-mm ferrule group, 262,872 (21,432). None of the specimens in the 1.0-mm ferrule group failed. Significant differences were found between the no-ferrule group and the 0.5-mm ferrule group, and the no-ferrule group and the 1.0-mm ferrule group (P<.017), but not between the 0.5-mm ferrule group and the 1.0-mm ferrule group (P>.017).

Conclusions. Specimens with a 0.0-mm ferrule survived few fatigue cycles despite the fact that both the post and crown were bonded with resin cement. Teeth with a 0.5-mm ferrule showed a significant increase in the number of fatigue cycles over the 0.0-mm group, whereas teeth with the 1.0-mm ferrule exhibited a significantly higher fatigue cycle count over the 0.0-mm but not the 0.5-mm group. (J Prosthet Dent 2009;102:229-234)

Clinical Implications

The 1.5-mm ferrule has been suggested for a metal crown with a cast gold post-and-core luted with zinc phosphate cement. However, due to the large standard deviation in the 0.5-mm ferrule test group, a minimum 1.0-mm ferrule length is recommended when using core bonding and bonding of an all-ceramic crown for restoration of the structurally compromised tooth.

Presented at the annual meeting of the American Association for Dental Research/Canadian Association for Dental Research (AADR/CADR) and ADEA (American Dental Education Association), March 2006, Orlando, Fla.

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A number of studies have emphasized the importance of the ferrule effect in restoring endodontically treated teeth.[1-14] However, most of these evaluated a single load to fracture resistance, which is different from the clinical situation. The clinical failure seen most often for this type of restoration is loss of crown or post retention.[15-18] Libman[19] and Fan[20] described preliminary failure in fatigue testing of endodontically treated teeth. Preliminary failure is defined as the point at which failure of the luting cement occurs. Clinically, this results in microleakage between the crown and the tooth. Microleakage was shown by Freeman et al[21] to occur after the specimens had reached preliminary failure. Microleakage is not clinically detectable, but it may be manifested eventually as recurrent caries, a dislodged post/crown, or a fractured post/crown/root. Therefore, testing with fatigue loading is more clinically relevant than a single load-to-fracture resistance test.

A 1.5-mm ferrule has been suggested for a metal crown with a cast gold post-and-core luted with zinc phosphate cement.[19] Periodontal crown lengthening, or orthodontic extrusion, may be indicated to increase the ferrule height. The disadvantage of these procedures is that the crown-to-root ratio is worsened, and the resistance to fracture may be decreased,[22] or the procedure will compromise the strength of the teeth even more.[23,24] In addition, in the situation of a shorter root, these options may not be advisable. Saupe et al[25] demonstrated that when a bonded resin system was used in structurally compromised teeth, there was no statistically significant difference in fracture resistance between post-and-core restorations that used a ferrule and those without a ferrule. Other research has shown that there is an increase in the number of fatigue cycles to crown cement failure when: (1) a resin cement is used for post cementation[26]; (2) a dentin bonding agent is used to bond the core to the tooth[27]; and (3) a resin cement is used for crown cementation, as opposed to zinc phosphate cement, with no dentin bonding agent.[28,29] However, there is no evidence suggesting that the ferrule length needed for an all-ceramic crown is different from that needed for a cast metal or metal ceramic crown. Thus, the purpose of this in vitro study was to relate different ferrule lengths with the number of fatigue cycles needed for failure of the cement for an all-ceramic crown cemented with a resin cement. The null hypothesis was that there would be no difference in the number of fatigue cycles among groups with different ferrule lengths.

MATERIAL AND METHODS

Fifteen extracted human maxillary central incisors were used in this study. Inclusion criteria were that these teeth be free of caries, cracks, or fractures in the cervical and root areas and have a minimal root length of 12 mm. Calculus was removed with both ultrasonic and hand scaling. The buccolingual (BL) dimension of each tooth was measured using a digital caliper with an accuracy of 0.1 mm (Mitutoyo America Corp, Aurora, Ill). The teeth were arranged in a descending order according to BL dimension. Specimens were assigned to 3 groups of 5 teeth each, according to a random number table. Teeth were kept moist at room temperature in distilled water at all times during the study except during the operative procedures.

All test teeth were sectioned horizontally, approximately 2 mm coronal to the cemento-enamel junction (CEJ), with a supercoarse diamond wheel (KS7; Brasseler USA, Savannah, Ga). Six retentive notches were cut into the root surface with a high-speed diamond rotary cutting instrument (6848.018; Brasseler USA). The root canal was prepared with #3 and #4 Gates Glidden drills (Miltex Inc, York, Pa) and a #5 ParaPost drill (Coltène/Whaledent, Inc, Cuyahoga Falls, Ohio). The tooth was attached to a surveyor (Ney Surveyor; Dentsply Ceramco, York, Pa) with the ParaPost drill in the canal, and the tooth was lowered into a hollow brass cylinder containing autopolymerizing resin (Pattern Resin; GC America, Alsip, Ill). The depth of embedment allowed for 2.5 mm of tooth height apical to the facial CEJ. Acrylic resin embedment provided stabilization during specimen preparation and fatigue testing.

The 3 test groups were prepared as follows. The no-ferrule group had 0.0-mm ferrule; this preparation was level with the facial CEJ. The other 2 groups were prepared with 0.5-mm and 1.0-mm ferrules coronal to the facial CEJ, respectively. The canal space was prepared using twist drills (ParaPost drill; Coltène/Whaledent, Inc) to a definitive 0.05-inch (1.25 mm) diameter, with a depth of 8 mm. Each glass-filled composite post (ParaPost FiberWhite #5; Coltène/Whaledent, Inc) was reduced to a 12-mm length by cutting the distal end with a high-speed diamond rotary cutting instrument (6848.018; Brasseler USA). This adjustment resulted in a post that extended 4.0 mm incisal to the prepared coronal surface when fully seated. Autopolymerizing resin cement with an incorporated conditioner (ParaPost Cement; Coltène/Whaledent, Inc) was used to cement the post in the canal. Manufacturer's directions were followed for all procedures. The core was fabricated with a dual-polymerizing composite resin material (ParaPost ParaCore Automix; Coltène/Whaledent, Inc) and bonded to the tooth with a dentin bonding agent (ParaPost Cement, Conditioner A and B; Coltène/Whaledent, Inc). A transparent matrix (Mylar Matrix Strips; Henry Schein, Inc, Melville, NY) was placed on the tooth, completely filled with the core material, then light polymerized with a visible light-polymerizing unit (Optilux 501; Kerr Corp, Orange, Calif) with an output of 850 mW/cm^2 at a 2-mm distance for 40 seconds per surface. Each specimen was then prepared us-

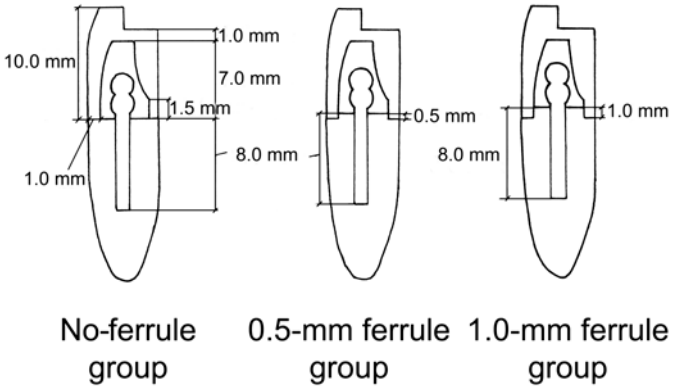
ing flat-end tapered diamond rotary cutting instruments (8848.018 and 6848.018; Brasseler USA). The total preparation height was 7 mm coronal to the facial CEJ. The lingual axial wall was 1.5 mm, and the circumferential shoulder was 1.0 mm (Fig. 1). These measurements were made with a periodontal probe under x20 magnification (Wolfe Stereomicroscope; Carolina Biological Supply Co, Burlington, NC).

Impressions were made with vinyl polysiloxane impression material (Aquasil Rigid and Aquasil XLV; Dentsply Caulk, Milford, Del) and poured with type IV dental stone (Fujirock; GC America). The stone was allowed to set for 24 hours. One layer of die hardener (Stone Die and Plaster Hardener Resin; George Taub Products & Fusion Co, Inc, Jersey City, NJ) and 2 coats of die spacer (Tru-Fit; George Taub Products & Fusion Co, Inc) were applied to each die. Plastic copings (Hardcast; Scheu Dental GmbH, Iserlohn, Germany) were fabricated and transferred to the corresponding test specimen. This, in turn, was positioned in a custom waxing jig, as previously described by Libman.[19] The waxing jig provided a standardized notch location on the waxed crown where the fatigue load was to be applied. The notch was located 8.0 mm above the lingual finish line, and the total crown height was 10.0 mm. After the crown had been waxed, each pattern was transferred back to the appropriate die, and the crown contours were refined. Each waxed crown was then invested (IPS Empress 2 Speed Investment Material and IPS Empress paper ring; Ivoclar Vivadent, Amherst, NY). Manufacturer's instructions for setting and burnout were followed. The crown was then pressed with pressable ceramic material (IPS Empress 2; Ivoclar Vivadent) in an oven (EP 500; Ivoclar Vivadent). After divesting, the crown was inspected under x20 magnification to evaluate the fit on the die.

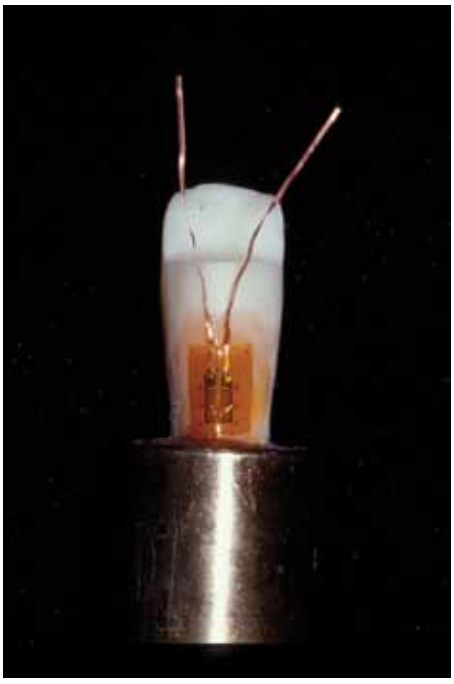
The intaglio surface of the ceramic crowns was etched with 5% hydrofluoric acid (IPS Ceramic Etching Gel; Ivoclar Vivadent) for 1 minute, then rinsed and dried. A silane agent (Monobond-S; Ivoclar Vivadent) was applied to the inside of the crown, allowed to remain in contact for 60 seconds, and then dried with a light air blast. Next, a bonding agent (Excite; Ivoclar Vivadent) was applied to the inside of the crown. The crown was fully protected from light before cementing onto the tooth. The tooth was etched with 37% phosphoric acid (Total Etch; Ivoclar Vivadent) for 15 seconds. The etchant was thoroughly rinsed off using water spray for 5 seconds. Then the tooth was dried with a light air blast. The same bonding agent (Excite; Ivoclar Vivadent) was applied on the tooth specimen for at least 10 seconds, then light polymerized for 20 seconds. All crowns were cemented with a resin cement (Variolink II; Ivoclar Vivadent), mixed according to manufacturer's directions. Each of the 4 surfaces was light polymerized for 40 seconds.

The lingual crown margin-tooth finish line interface was lightly ground with a diamond disk (VisionFlex, 934.11.180; Brasseler USA) to create a flat, rough surface. This surface was etched with 37% phosphoric acid (Total Etch; Ivoclar Vivadent), rinsed with water, dried with air, and a strain gauge (EA-06-062AP 120; Micro-Measurements Division, Vishay Measurements Group, Raleigh, NC) was cemented over the tooth-crown interface (Fig. 2) with an epoxy resin (DP 460, 3M Scotch-Weld; 3M ESPE, St. Paul, Minn). The strain gauge was completely covered with impression tray adhesive (VPS Tray Adhesive; 3M ESPE) to ensure water exclusion during fatigue testing. Finally the strain-gauged specimen was allowed to set for at least 8 hours before testing. All procedures were performed by a single operator.

The fatigue-loading device used in this study has been previously described.[30] All teeth were immersed in a room temperature water bath during fatigue testing. The load applied was 6.0 kg at an angle of 135 degrees to the long axis of the tooth. The cyclic load rate was 2.5 cycles per second. The definition and measurement of preliminary failure has been described by Libman.[19] The strain gauges placed over the lingual margin registered the micromovement of the crown margin relative to the tooth finish line under applied cyclic loading. Output from the strain gauge was recorded on a chart recorder (LR4110; Yokogawa Corp of America, Newnan, Ga). At the outset, an upper limit of 250,000 cycles was set. If, during testing, a specimen went beyond this number of cycles, testing was stopped. The cycle count recorded was the number of cycles reached when the machine was stopped. This allowed a nonzero standard deviation for any group for



1 Diagrammatic representation of study groups. All specimens have preparation height of 7 mm coronal to facial CEJ, 1.5-mm lingual axial wall, and 1.0-mm circumferential shoulder.



2 Strain gauge cemented over lingual crown margin with epoxy resin. Strain gauge was completely covered with impression tray adhesive to block out moisture during testing. Note notch on crown where load was applied was 8 mm above finish line.

which all specimens reached this upper limit before failure.

The independent variable recorded was the number of load cycles required to induce preliminary failure in the crown cement. Since Levene's test showed unequal variances, the nonparametric Kruskal-Wallis test and Mann-Whitney U test were used. The fatigue cycle data was subjected to the Kruskal-Wallis test first, to detect overall significance, followed by the Mann-Whitney U test to define significant differences between the study groups at the 95% significance level.

RESULTS

One specimen in the 0.5-mm ferrule group did not fail after 250,000 cycles, while no specimens in the 1.0-mm ferrule group failed after this number of cycles. The actual number of cycles at which the machine was stopped was recorded and used for the statistical analysis. The mean (SD) number of cycles to failure for each group was: no-ferrule group: 213 (317); 0.5-mm ferrule group: 155,137 (68,991); and 1.0-mm ferrule group: 262,872 (21,432). A significant difference was found among these 3 groups (P=.003) by the Kruskal-Wallis test. The Mann-Whitney U test with Bonferroni correction (α=.017) was used for pairwise comparison and indicated that the no-ferrule group was significantly different from the 0.5-mm ferrule group (P=.008) and 1.0-mm ferrule group (P=.008), and there was no significant difference between the 0.5-mm and 1.0-mm groups (P=.032).

DISCUSSION

The data supported rejection of the null hypothesis, as there was a difference in the number of fatigue cycles among groups with different ferrule lengths. However, the difference between the 0.5-mm ferrule group and the 1.0-mm ferrule group was not statistically significant. Only a single specimen of the 0.5-mm ferrule group reached the upper cycle limit, but all specimens of the 1.0-mm ferrule group went beyond the upper limit. This suggested that a larger number of cycles would be required for failure of the 1.0-mm group. Testing these 1.0-mm specimens to final failure would increase the mean cycle count to failure for this group, which, in turn, could likely change the statistical outcome between the 1.0-mm and 0.5-mm ferrule groups.

In this study, no veneering porcelain was fired to the crown, since the strength of veneering material was not tested. The bond between the intaglio of the crown and the tooth was the primary concern. The current findings are consistent with Isidor et al[31] in that an increased ferrule length resulted in an increased fracture resistance under cyclic loading for crowned teeth.

The preparation height in this study remained constant for each of the 3 groups (Fig. 1). This attempted to simulate certain clinical limitations found when an orthodontic extrusion and/or a crown lengthening procedure are contraindicated. Libman et al[19] reported that a ferrule of 1.5 mm or longer significantly increased the number of load cycles to preliminary failure when restoring with a cast post-and-core and a metal crown cemented with zinc phosphate cement. In the current study, the 0.5-mm ferrule group demonstrated an average of 155,000 cycles, which was more than double the mean cycles for both the 1.5-mm and 2.0-mm groups in the previously mentioned study. This occurred despite the fact that the load used in the current study was 50% higher (6 kg versus 4 kg). Under certain clinical restrictions, it is beneficial to bond the post, core, and crown. These results are also consistent with the conclusions reported by Junge et al[28] and Wiskott et al.[29] Both of these groups of investigators showed that using a resin cement resulted in a higher cycle count when fatigue testing was applied, compared to other cement types.

The large standard deviation shown in the 0.5-mm ferrule group may be attributed to small sample size, different tooth sizes, or different dentin bonding quality. Yoshiyama's study[32] showed that microtensile

bonding strength of sclerotic dentin is 30% to 40% lower than normal dentin. However, it is difficult to distinguish the dentin quality clinically.

The no-ferrule group failed immediately under cyclic loading. In some clinical situations, forced eruption and/or crown lengthening to gain additional ferrule height are contraindicated when there is a short root length. Bonding of the post, core, and crown may be used in these situations to restore structurally compromised teeth with inadequate ferrule, to increase the fatigue load cycles. However, due to the large standard deviation in the 0.5-mm ferrule group, a minimum 1.0-mm ferrule length is recommended when using core bonding and bonding an all-ceramic crown for restoration of the structurally compromised tooth.

One limitation of this study is that it is an in vitro test. No periodontal ligament was simulated in the design of the test specimen, and the specimens were not subjected to thermal cycling. Bonding procedures were performed in vitro, and the manufacturer's recommendations were followed, whereas clinically, the moisture control may not be as ideal. The post space in this study was prepared with parallel walls, and the post always adapted to the post space well. However, clinically, it may not be possible to create an ideal canal space. The root canal space is always flared towards the coronal part after endodontic treatment. Further research is needed to determine if the adaptation of post to root canal space affects the fatigue cycles of endodontically treated teeth.

CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. Teeth with a 0.0-mm ferrule survived few fatigue cycles despite the fact that both the post and crown were bonded.

2. Teeth with a 0.5-mm ferrule demonstrated a significantly higher number of fatigue cycles than the no-ferrule group (P=.008).

3. Teeth with a 1.0-mm ferrule showed a significantly higher fatigue cycle count than the no-ferrule group (P=.008), but were not statistically different from the 0.5-mm ferrule group (P=.032).

REFERENCES

1. Varvara G, Perinetti G, Di Iorio D, Murmura G, Caputi S. In vitro evaluation of fracture resistance and failure mode of internally restored endodontically treated maxillary incisors with differing heights of residual dentin. J Prosthet Dent 2007;98:365-72.
2. Al-Omiri MK, Al-Wahadni AM. An ex vivo study of the effects of retained coronal dentine on the strength of teeth restored with composite core and different post and core systems. Int Endod J 2006;39:890-9.
3. Aykent F, Kalkan M, Yucel MT, Ozyesil AG. Effect of dentin bonding and ferrule preparation on the fracture strength of crowned teeth restored with dowels and amalgam cores. J Prosthet Dent 2006;95:297-301.
4. Pereira JR, de Ornelas F, Conti PC, do Valle AL. Effect of a crown ferrule on the fracture resistance of endodontically treated teeth restored with prefabricated posts. J Prosthet Dent 2006;95:50-4.
5. Tan PL, Aquilino SA, Gratton DG, Stanford CM, Tan SC, Johnson WT, et al. In vitro fracture resistance of endodontically treated central incisors with varying ferrule heights and configurations. J Prosthet Dent 2005;93:331-6.
6. Creugers NH, Mentink AG, Fokkinga WA, Kreulen CM. 5-year follow-up of a prospective clinical study on various types of core restorations. Int J Prosthodont 2005;18:34-9.
7. Akkayan B. An in vitro study evaluating the effect of ferrule length on fracture resistance of endodontically treated teeth restored with fiber-reinforced and zirconia dowel systems. J Prosthet Dent 2004;92:155-62.
8. Zhi-Yue L, Yu-Xing Z. Effects of post-core design and ferrule on fracture resistance of endodontically treated maxillary central incisors. J Prosthet Dent 2003;89:368-73.
9. Mezzomo E, Massa F, Libera SD. Fracture resistance of teeth restored with two different post-and-core designs cemented with two different cements: an in vitro study. Part I. Quintessence Int 2003;34:301-6.
10. Milot P, Stein RS. Root fracture in endodontically treated teeth related to post selection and crown design. J Prosthet Dent 1992;68:428-35.
11. Hemmings KW, King PA, Setchell DJ. Resistance to torsional forces of various post and core designs. J Prosthet Dent 1991;66:325-9.
12. Sorensen JA, Engleman MJ. Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990;63:529-36.
13. Barkhordar RA, Radke R, Abbasi J. Effect of metal collars on resistance of endodontically treated teeth to root fracture. J Prosthet Dent 1989;61:676-8.
14. Rosen H, Partida-Rivera M. Iatrogenic fracture of roots reinforced with a cervical collar. Oper Dent 1986;11:46-50.
15. Sorensen JA, Martinoff JT. Intracoronal reinforcement and coronal coverage: a study of endodontically treated teeth. J Prosthet Dent 1984;51:780-4.
16. Bergman B, Lundquist P, Sjögren U, Sundquist G. Restorative and endodontic results after treatment with cast posts and cores. J Prosthet Dent 1989;61:10-5.
17. Mentink AG, Meeuwissen R, Käyser AF, Mulder J. Survival rate and failure characteristics of the all metal post and core restoration. J Oral Rehabil 1993;20:455-61.
18. Ferrari M, Cagidiaco MC, Goracci C, Vichi A, Mason PN, Radovic I, et al. Long-term retrospective study of the clinical performance of fiber posts. Am J Dent 2007;20:287-91.
19. Libman WJ, Nicholls JI. Load fatigue of teeth restored with cast posts and cores and complete crowns. Int J Prosthodont 1995;8:155-61.
20. Fan P, Nicholls JI, Kois JC. Load fatigue of five restoration modalities in structurally compromised premolars. Int J Prosthodont 1995;8:213-20.
21. Freeman MA, Nicholls JI, Kydd WL, Harrington GW. Leakage associated with load fatigue-induced preliminary failure of full crowns placed over three different post and core systems. J Endod 1998;24:26-32.
22. al-Hazaimeh N, Gutteridge DL. An in vitro study into the effect of theferrule preparation on the fracture resistance of crowned teeth incorporating prefabricated post and composite core restorations. Int Endod J 2001;34:40-6.
23. Gegauff AG. Effect of crown lengthening and ferrule placement on static load failure of cemented cast post-cores and crowns. J Prosthet Dent 2000;84:169-79.
24. Meng QF, Chen YM, Guang HB, Yip KH, Smales RJ. Effect of a ferrule and increased clinical crown length on the in vitro fracture resistance of premolars restored using two dowel-and-core systems. Oper Dent 2007;32:595-601.
25. Saupe WA, Gluskin AH, Radke RA Jr. A comparative study of fracture resistance between morphologic dowel and cores and a resin-reinforced dowel system in the intraradicular restoration of structurally compromised roots. Quintessence Int 1996;27:483-91.
26. Goto Y, Nicholls JI, Phillips KM, Junge T. Fatigue resistance of endodontically treated teeth restored with three dowel-and-core systems. J Prosthet Dent 2005;93:45-50.
27. Hsu YB, Nicholls JI, Phillips KM, Libman WJ. Effect of core bonding on fatigue failure of compromised teeth. Int J Prosthodont 2002;15:175-8.
28. Junge T, Nicholls JI, Phillips KM, Libman WJ. Load fatigue of compromised teeth: a comparison of 3 luting cements. Int J Prosthodont 1998;11:558-64.

29. Wiskott HW, Nicholls JI, Belser UC. The effect of tooth preparation height and diameter on the resistance of complete crowns to fatigue loading. Int J Prosthodont 1997;10:207-15.
30. Fissore B, Nicholls JI, Yuodelis RA. Load fatigue of teeth restored by a dentin bonding agent and a posterior composite resin. J Prosthet Dent 1991;65:80-5.
31. Isidor F, Brøndum K, Ravnholt G. The influence of post length and crown ferrule length on the resistance to cyclic loading of bovine teeth with prefabricated titanium posts. Int J Prosthodont 1999;12:78-82.
32. Yoshiyama M, Sano H, Ebisu S, Tagami J, Ciucchi B, Carvalho RM, et al. Regional strengths of bonding agents to cervical sclerotic root dentin. J Dent Res 1996;75:1404-13.

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Acknowledgements
The authors thank Mr Jeff Barber of Coltène/Whaledent, Inc, and Mr Gary Klise of Ivoclar Vivadent for their donation of materials.

NOTEWORTHY ABSTRACTS OF THE CURRENT LITERATURE

The effects of smoking on the survival of smooth- and rough-surface dental implants

Balshe AA, Eckert SE, Koka S, Assad DA, Weaver AL.
Int J Oral Maxillofac Implants 2008;23:1117-22.

Purpose: To compare the long-term survival rates of smooth- and rough-surface dental implants among smokers and nonsmokers.

Materials and Methods: A retrospective chart review was conducted for 2 time periods: January 1, 1991, through December 31, 1996, during which smooth-surface implants were utilized, and January 1, 2001, through December 31, 2005, during which rough-surface implants were utilized. This review included all implants placed and restored in 1 institution during the 2 timeframes. Data were specifically collected relative to patient age, gender, smoking status, implant diameter, implant length, and anatomic location of implants. Implants from the first and second time periods were followed through mid-1998 and mid-2007, respectively. Associations of patient/implant characteristics with implant survival were evaluated using marginal Cox proportional hazards models (adjusted for age and gender) and summarized with hazard ratios (HR) and corresponding 95% confidence intervals (CI).

Results: A total of 593 patients (322 [54.3%] female; mean [SD] age, 51.3 [18.5] years) received 2,182 smooth-surface implants between 1991 and 1996, while 905 patients (539 [59.6%)] female; mean [SD] age, 48.2 [17.8] years) received 2,425 rough-surface implants between 2001 and 2005. Among the rough-surface implants, smoking was not identified as significantly associated with implant failure (HR = 0.8; 95% CI = 0.3 to 2.1; P = .68). In contrast, smoking was associated with implant failure among the group with smooth-surface implants (HR = 3.1; 95% CI = 1.6 to 5.9; P < .001). Implant anatomic location was not associated with implant survival among patients with rough-surface implants (P = .45) and among nonsmokers with smooth-surface implants (P = .17). However, anatomic location affected the implant survival among smokers with smooth-surface implants (P = .004). In particular, implant survival was the poorest for implants placed in the maxillary posterior areas of smokers.

Conclusions: Based on this retrospective study, the following observations were made: Smoking was identified as a risk factor for implant failure of smooth-surface implants only; among the smokers who received smooth-surface implants, an association was identified between implant failure and location of the implant placement; no association was identified between implant failure and location among the smokers who received rough-surface implants.