Short Communication

Effects of Precementation Desensitizing Laser Treatment and Conventional Desensitizing Agents on Crown Retention

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This study aimed to compare the effect of precementation desensitizing laser treatment and conventional desensitizing agents on crown retention. Crowns were fabricated for 50 molar teeth, and specimens were assigned to 5 groups based on treatment method: untreated control group (CON), laser group (LAS), sodium fluoride group (FLU), Oxagel oxalate group (OXA), and Gluma primer group (GLU). All crowns were luted with glass-ionomer cement. Tensile force was applied for crown dislodgement. Recorded forces and calculated retentive strengths were as follows: CON (261 N) > LAS (223 N) = FLU (208 N) > GLU (161 N) = OXA (147 N) ($P < .05$). The differences in force magnitudes between all groups were significant ($P < .05$), except for LAS versus FLU and GLU versus OXA. The retention decrease was 15% for LAS, 20% for FLU, 38% for GLU, and 44% for OXA. Laser treatment had a less negative effect on retention for crowns luted with glass-ionomer cement than the other treatment modalities, and it may be a more suitable desensitization method if crown retention can be moderately sacrificed. *Int J Prosthodont 2007;20:289–292.*

During crown cementation, the cement is forced into the patent tubules before the luting agent sets and displaces an equal amount of dentinal fluid, thus leading to excessive hydrostatic pressure and resultant irritation of pulpal tissues.[1] The smear layer evident after tooth preparation was demonstrated to be ineffective against luting agent irritation.[2] Various desensitizing agents were used for sealing dentin before crown cementation to decrease pre- and postcementation sensitivity. However, several studies reported that these agents decrease crown retention to some extent.[1,3–5]

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The advent of dental lasers has introduced another treatment option for dentin hypersensitivity. Several clinical and in vitro studies reported the desensitizing and dentinal tubule–occluding effect of laser treatment.[6–11] Despite the well-documented effectiveness of desensitizing laser treatment, its effect on crown retention has not been investigated. The purpose of this in vitro study was to compare the effect of precementation desensitizing laser treatment and 3 topical desensitizing agents on crown retention.

Materials and Methods

Roots of 50 extracted intact molars were embedded and fixed into polyvinyl chloride rings. Standardized tooth preparation was performed in a parallel-preparation unit (D-7970, KaVo Elektronisches) with a high-speed handpiece. The preparations were 7 mm in diameter at the cervical plane, 6 mm in diameter at the occlusal plane, 4 mm in axial height, and had a 10-degree angle of convergence. The total surface area of the preparation (71 mm^2) was calculated using the formula for truncated cones. Impressions of tooth specimens were made with a condensation silicone impression material (Zetaplus; Zhermack) and master dies were obtained. Wax patterns were prepared at a thickness of 1 mm. Circular orthodontic bands, 5 mm in diameter,

Fig 1 Tooth specimens subjected to desensitizing laser treatment.

Fig 2 Uniaxial crown dislodgement with the universal testing machine.

were fixed at the center of the occlusal surfaces to form standard loops. Wax patterns were sprued, invested, and cast with a nickel-chromium alloy (Viron99, Bego).

Desensitization Treatments

The specimens were divided into 5 groups based on treatment method.

1. *Control group (CON):* Tooth specimens were left untreated.
2. *Laser group (LAS):* Rinsed and dried tooth surfaces were irradiated with ErCr: Waterlase YSGG laser equipment (Biolase) in a noncontact mode, at a 5-mm distance from and 90-degree angle to the tooth surfaces. A mode of 1,064-μm wavelength, 0.5-W potency, 20-Hz frequency, and 25-mJ/pulse energy was applied for 15 seconds, according to the manufacturer's instructions (Fig 1). Two additional treatments were applied to simulate clinical conditions. Total irradiation time was 45 seconds.
3. *Sodium fluoride group (FLU):* Three coats of 5% sodium fluoride solution were applied on previously rinsed and dried tooth surfaces with cotton swabs by gentle but firm rubbing and then spread with an air spray to provide uniform thickness.
4. *Oxagel oxalate group (OXA):* Three coats of resin-free oxalate (Oxagel, Art-Dent) were applied on previously rinsed and dried tooth surfaces and spread with an air spray.
5. *Gluma primer group (GLU):* Three coats of resin-based primer (Gluma Desensitizer, Heraeus Kulzer) were applied on tooth surfaces as previously described.

Cementation was performed with glass-ionomer cement (Ketac-Cem, 3M ESPE). After thermocycling, the specimens were mounted on a universal testing machine (Instron 1195, Instron), and axial tensile force was applied at a crosshead speed of 0.5 mm/min until dislodgement (Fig 2). Force values and types of crown failure were recorded.

Statistical Analysis

Dislodgement forces and retentive strength values were analyzed with a statistical software program (SPSS 9.0, SPSS). Prior to analysis, distributions of the data were evaluated using a 1-sample Kolmogorov-Smirnov test. Normally distributed data ($P > .05$) were analyzed with 1-way analysis of variance (ANOVA) followed by post hoc tests (least significant difference) at a significance level of $P < .05$.

Results

Results of the 1-way ANOVA and post hoc tests of dislodgment forces (N) and retention strengths (MPa) are presented in Tables 1 and 2, respectively. Recorded forces and calculated retentive strengths were as follows: CON (261 N) > LAS (223 N) = FLU (208 N) > GLU (161 N) = OXA (147 N) ($P < .05$). Post hoc tests revealed that the differences between all groups were significant ($P < .05$), except for LAS versus FLU and GLU versus OXA (Table 2). Decreases in crown retention were as follows: 15% for LAS, 20% for FLU, 38% for GLU, and 44% for OXA.

Crown failure types are presented in Table 3. The highest rate of adhesive failure on dentin was observed in OXA, followed by GLU, and tooth fracture was not observed for these groups. Likewise, the highest rate of cement on crown was also recorded for OXA and GLU. The most frequent failure type for all groups was cement on both crown and dentin, and the highest rate was observed for the control group.

Discussion

Crown cementation often leads to excessive hydrostatic pressure and resultant irritation of pulpal tissues.[1] The smear layer evident after tooth preparation remains ineffective against luting agent irritation.[2] Various desensitizing agents with different chemical compositions are used to interfere with the hydrodynamic mechanism by acting on the exposed sensitive area to reduce the number of open dentinal tubules or decrease their diameter, thereby minimizing the movement of dentinal fluid. The present in vitro study compared the effects of precementation desensitizing laser treatment, sodium fluoride solution, resin-based primer, and resin-free oxalate desensitizer on the retention of crowns luted with glass-ionomer cement. Within the limitations of this study, it was found that laser and sodium fluoride treatments moderately decreased the crown retention (15% and 20%, respectively) compared to other tested desensitizing agents. Oxagel and Gluma dentinal sealer considerably decreased the crown retention (38% and 44%, respectively). This is evidenced by the proportion of cement retained on prepared tooth surfaces after crown debonding. When dentin desensitizers were used with glass-ionomer cement, the proportion of cement retained on the tooth surfaces after crown dislodgement was remarkably reduced relative to the control group (Table 2).

The results of the present study are consistent with the findings of previous studies. Mausner et al[1] evaluated the effect of resin desensitizing agents on crown retention and observed a reduction in retention for zinc phosphate and polycarboxylate cements with one of the resin agents used in the study. Glass-ionomer cement was affected by the second resin agent used. Johnson et al[3] used a glutaraldehyde sealer and demonstrated a decrease of 42% in retention of crowns cemented with zinc phosphate. Yim et al[4] reported a retention strength of 2.3 MPa for the untreated control group for full crowns luted with glass ionomer, which was reduced to 1.9 MPa after Gluma treatment. In another study, Johnson et al[5] reported that a retention strength of 4.2 MPa for full crowns luted with glass ionomer decreased to 2.7 MPa after a resin-based sealer treatment. The 10-degree angle of convergence used in this study may also have minimized the influence of mechanical retention and emphasized the retention arising solely from the cement. Furthermore, the cementation area (71 mm^2) was smaller than in previous studies, resulting in decreased crown retention values.

Desensitizing laser treatment has been shown to be an effective method for dentinal tubule occlusion, and there is a growing trend toward its use. Kimura et al[6] reviewed the effects of different desensitizing laser treatment modalities. Goodis et al[7] stated that all desensitizing laser wavelengths applied in vitro reduced the permeability of the dentin, and suggested that shorter treatment times and lower power settings may be necessary if used in vivo. Bonin et al[8] reported that different energy levels of a carbon dioxide laser had different effects on the permeability of dentin. Further, Tani et al[9] reported that treatment with carbon dioxide and Nd:YAG lasers resulted in tubule closure, as recorded by scanning electron microscopy and decreased dye penetration compared to the untreated control group. Dederich and Zakariasen[10] found that the surface of dentin could be fused or glazed by

Table 1 One-Way Analysis of Variance of Dislodgment Forces (N)

Group	Mean force (N)	SE	95% Confidence interval		Minimum	Maximum
CON	261	8.37	242.07	297.93	221	299
LAS	223	7.36	206.36	239.64	186	260
FLU	208	7.09	191.95	224.05	172	244
GLU	161	6.32	146.71	175.29	128	194
OXA	147	5.11	135.44	158.56	119	175
Overall	200	6.64	186.65	213.35	119	299

Table 2 Post-Hoc Test of Dislodgement Forces (N)

Group	Mean difference (N)	SE	P	95% Confidence interval	
CON					
LAS	38*	9.81	.000	18.25	57.75
FLU	53*	9.81	.000	33.25	72.75
GLU	100*	9.81	.000	80.25	119.75
OXA	114*	9.81	.000	94.25	133.75
LAS					
FLU	15	9.81	.133	–4.75	34.75
GLU	62*	9.81	.000	42.25	81.75
OXA	76*	9.81	.000	56.25	95.75
FLU					
GLU	47*	9.81	.000	27.25	66.75
OXA	61*	9.81	.000	41.25	80.75
GLU					
OXA	14	9.81	.160	–5.75	33.75

*Statistically significant difference ($P < .05$). Negative mean differences are neglected.

Table 3 Types of Crown Failure

Group	Cement on crown	Cement on dentin	Cement on crown and dentin	Tooth fracture
CON	1	-	6	3
LAS	3	-	5	2
FLU	4	-	5	1
GLU	6	-	4	-
OXA	7	-	3	-

continuous-wave, 1.06–μm wavelength Nd:YAG laser treatment, resulting in closed tubules. In an in vitro study, Sipahi et al[11] tested the effect of different irradiation times and potencies on dentinal tubule closure and reported that elapsed irradiation time with low laser potency was the most effective method for tubule closure. The irradiation mode used in the present study is the most frequently used and most effective for dentinal tubule occlusion.[6,11] The effect of desensitizing laser treatment on crown retention has not been previously studied, and thus no comparative study is available. However, the results found for topical desensitizing agents are in correlation with those reported in previous studies.[1,3–5]

Conclusion

Laser and sodium fluoride treatments moderately decreased the retention of crowns luted with glass-ionomer cement and had a less negative effect on retention than the other 2 treatment modalities. Compared to topical chemical desensitizing agents, laser treatment may be a more suitable method of desensitization if crown retention can be moderately sacrificed.

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Literature Abstract

Influence of pH and oxygen-inhibited layer on fluoride release properties of fluoride sealant

This study tested the hypothesis that the oxygen-inhibited layer on a light-cured methacrylate-based resin and the pH of the storage medium would significantly increase the initial fluoride release and long-term release rate from fluoride dental sealant. Forty-eight discs each (16 mm diameter, 1 mm thick) were made from FluroShield (< 5 wt%, NaF) and Helioseal F (< 30 wt% fluorosilicate glass) sealants. For each sealant, 24 discs were cured through a Mylar strip that covered the surface, and the remaining 24 discs were cured in air to allow formation of the oxygen-inhibited surface. Each specimen in the 24-disc groups was stored individually in 25-mL vials,and divided into 4 six-vial groups to receive 10 mL of pH 4 to pH 7 (designation of pH 4 to 7) lactate buffer solutions. The buffer solutions were replaced periodically up to 121 days. The released fluoride ion concentration was analyzed using a fluoride-specific ion electrode and a digital pH/mV meter. The cumulative fluoride release over time was used to determine the coefficients for short-term and long-term release. Two-way analysis of variance showed that the mean coefficient values for either sealant were significantly influenced by the curing condition ($P < .0001$) and pH ($P < .0001$), except for short-term release from NaF sealant. The duration of short-term release was much longer for the fluorosilicate glass sealant. Both pH and the source of fluoride incorporated in the sealant play significant roles in fluoride release.

Shen C, Shokry TE, Anusavice KJ. *J Dent* 2007;35:275–281. **References:** 32. **Reprints:** Dr C. Shen. PO Box 100446, 1600 SW Archer Road, Gainesville, FL 32610-0446, USA. Fax: +1 352 392 7808. E-mail: cshen@dental.ufl.edu—*Tapan N. Koticha, National University of Singapore Faculty of Dentistry, Singapore*