



Retention of Veneered Stainless Steel Crowns on Replicated Typodont Primary Incisors: An In Vitro Study

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Abstract

Purpose: The purpose of this in vitro study was to determine the effect of crimping and cementation on retention of veneered stainless steel crowns.

Methods: One hundred twenty crowns, 90 from 3 commercially available brands of veneered stainless steel crowns (Dura Crown, Kinder Krown, and NuSmile Primary Crown) and 30 (plain) Unitek stainless steel crowns were assessed for retention. An orthodontic wire was soldered perpendicular to the incisal edge of the crowns; the crowns were fitted to acrylic replicas of ideal crown preparations and were divided equally into 3 test groups: group 1—crowns were crimped only (no cement used); group 2—crowns were cemented only; and group 3—crowns were crimped and cemented to the acrylic replicas. An Instron machine recorded the amount of force necessary to dislodge the crowns and the results were statistically analyzed using 2-way ANOVA and Tukey honestly significant difference (HSD) test.

Results: Group 3 was statistically more retentive than groups 1 and 2. Group 2 was statistically more retentive than group 1 ($P < .001$). In group 1, Unitek crowns were statistically more retentive than the veneered crowns ($P < .05$). In group 2, NuSmile crowns showed statistically less retention values than all other crowns ($P < .05$). In group 3, Kinder Krown crowns showed statistically better retention rates than all other brands ($P < .05$).

Conclusions: Significantly higher retention values were obtained for all brands tested when crimping and cement were combined. The crowns with veneer facings were significantly more retentive than the nonveneered ones when cement and crimping were combined. (*Pediatr Dent.* 2003;25:275-278)

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The small size of the teeth, patient cooperation, and parental expectations are major challenges in the restoration of primary incisors.^{1,2} Tooth-colored restorations are the preferred treatment in cases with mild to moderate caries, requiring minimal tooth preparation and preserving sufficient enamel to provide optimal bonding.^{3,4} When the caries extends below the gingival margin, when moisture control is not attainable, or when minimal enamel remains after caries removal, the use of resin-based materials is questionable.⁵ For these cases, stainless steel crowns (SSCs) or veneered SSCs are recommended.

According to Waggoner,³ plain (no veneer) SSCs provide a durable, easily placed, and very retentive restoration but are esthetically unpleasing to most parents. Open-faced

SSCs, though popular with many operators and shown to be more retentive than strip crowns,^{2,3,6-8} demand more chair time than the veneer-facing SSCs, and esthetic results are compromised. Veneered crowns may be the best treatment choice in that they may be placed in the presence of blood contamination without affecting the final esthetics.^{3,5}

Crimping the gingival margin of the crown and then luting the crown with dental cement provides crown retention.⁹ Crimping of veneered SSCs is limited; certain brands allow crimping only on the lingual surface and others may be crimped all the way around. The authors hypothesized that crimping of veneered SSCs placed on primary incisors had no significant effect on crown retention and that most retention was due to the effect of

cementation. The purpose of this in vitro study was to determine the effect of crimping and cementation on retention of veneered SSCs.

Methods

Kinder Crown crowns (Mayclin Dental Studios, Minneapolis, Minn), NuSmile Primary Crowns (Orthodontic Technologies, Inc, Houston, Tex) and Dura Crown crowns (Space Maintainers Laboratory, Van Nuys, Calif) are 3 commercially available veneered SSCs being used by dental practitioners. Thirty crowns from each of these manufacturers were tested and compared to 30 plain (no veneer) Unitek SSCs (3M Dental Products, St. Paul, Minn). A plastic typodont (Columbia Dentoform Corporation, Long Island City, NY) of a maxillary right primary central incisor tooth served as a standard tooth size for the study. The typodont tooth shape and size was compared to measurements of natural anterior incisors and was found to directly correlate with findings of Arnim¹⁰ and Kramer.¹¹

The crown sizes were selected based upon the mesiodistal width of the tooth, and the most suitable size was used. Tooth preparation was performed according to Helpin,⁸ as described below:

1. The incisal edge of the typodont was reduced approximately 1.5 to 2 mm with a #169 bur.
2. Interproximal reduction was done to eliminate ledges, which would make crown seating difficult.
3. The labial surface was reduced approximately 0.5 mm, and the incisal portion of the labial surface was rounded toward the lingual to allow seating of the crown.
4. The lingual surface of the tooth was reduced gingival to the cingulum area with the same bur and holding it parallel to the long axis of the tooth.
5. All sharp line angles were rounded.

Four teeth were prepared according to the criteria stated above, but only the Unitek crown fit to the standard type of preparation. Small modifications were made to the other 3 prepared teeth until ideal adaptation was obtained to each one of the tested brands. The 4 ideally prepared teeth, 1 for each different crown manufacturer, were replicated 30 times using Kerr Extrude Wash (Sybron Dental Specialties, Romulus, Mich), Kerr Compound impression material (Sybron Dental Specialties, Romulus, Mich), and Pink Orthodontic Resin (Dentsply-Caulk International Inc, Milford, Del). The replicated teeth (120) were mounted in threaded steel rings (Bencor Multi-T Testing Device, Gezina, South Africa) for further testing with the Instron Universal Testing Machine (Instron Corp, Canton, Mass).

To construct the test specimens, a 0.036-inch round stainless steel orthodontic wire was soldered perpendicular to the incisal edge of each crown. For the veneered crowns, a portion of the veneered facings on the incisal edge was removed with a "football-shaped" diamond bur to expose the metal and accomplish the soldering. During this process, as expected, crown facings were damaged; no im-

portance was given to this fact since "retention of veneered facings" was not in the scope of the study.

Ten crowns of each brand were then randomly assigned to one of 3 test groups. When indicated, crimping was performed according to the manufacturer's instructions (Unitek and Dura Crown=circumferential and Kinder Crown and NuSmile Crown=lingual only) with the Gordon plier # 137 (Henry Schein, Inc, Indianapolis, Ind).

Group 1: Forty crowns were crimped to obtain well-adapted margins and were fit to acrylic teeth. No cement was used.

Group 2: Forty crowns were cemented to acrylic teeth using Rely-X ARC (3M Dental Products, St. Paul, Minn) glass ionomer cement. No crimping was added.

Group 3: Forty crowns were crimped to obtain well-adapted margins. Each crown was cemented to an acrylic tooth using Rely-X ARC glass ionomer cement.

After adaptation to the acrylic teeth and at least 24 hours after cementation, crowns were tested for retention using an Instron machine with a self-centering vice at a crosshead speed of 0.5 mm per minute. The force necessary to dislodge the crowns from the replicas (tensile bonding strength) was recorded in newtons (N). The results were analyzed with the 2-way ANOVA followed by Tukey HSD to discriminate whether significant differences existed within and between the individual brand groups using SPSS Program for Windows. Significance was set at 0.05.

Results

When the crowns were dislodged, both cohesive and adhesive tensile bonding failures were observed. The results of 2-way ANOVA indicated significant main effects for crown brand ($F[3, 108]=18.908, P<.001$) and test type ($F[2, 108]=264.513, P<.001$). In addition, a significant interaction effect was observed ($F[6, 108]=15.521, P<.001$).

The total mean value for test group 3 (crimping+cement) was significantly higher ($P<.001$) than test groups 1 and 2. The total mean value for test group 2 (cement only) was significantly higher ($P<.001$) than test group 1.

When the effect of crimping only was analyzed, Unitek crowns were significantly more retentive than the veneered crowns ($P<.001$ for Dura Crown, $P=.001$ for Kinder Crown, and $P=.002$ for NuSmile Primary Crown). No statistical difference was found among the crowns with facings (Figure 1).

For the cement only group (Figure 2), Unitek crowns ($P=.005$), Dura Crowns ($P<.001$) and Kinder Crown crowns ($P<.001$) were significantly more retentive than NuSmile Primary Crowns.

The combined effect of crimping and cementation (Figure 3) showed that Kinder Crown crowns were significantly more retentive than the other 3 brands ($P<.001$ for Unitek and Dura Crown, and $P=.002$ for NuSmile Crown). NuSmile and Dura Crowns were significantly more retentive than Unitek crowns ($P=.001$ and $P=.025$, respectively).

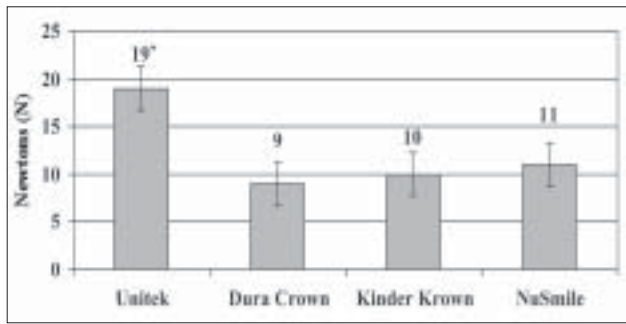


Figure 1. The effect of crimping only on crown retention.
*Statistically significantly different than the other brands ($P < .05$).

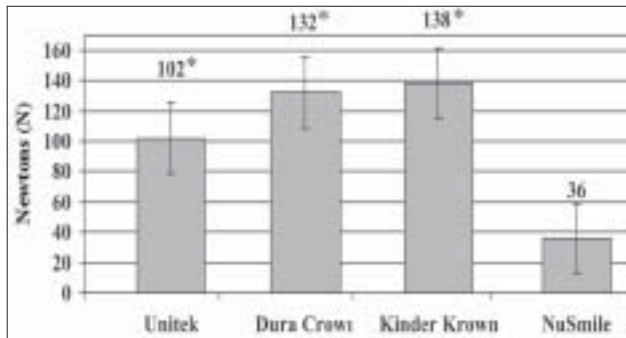


Figure 2. The effect of cementation only on crown retention.
*Statistically significantly different when compared to NuSmile Primary Crowns ($P < .05$).

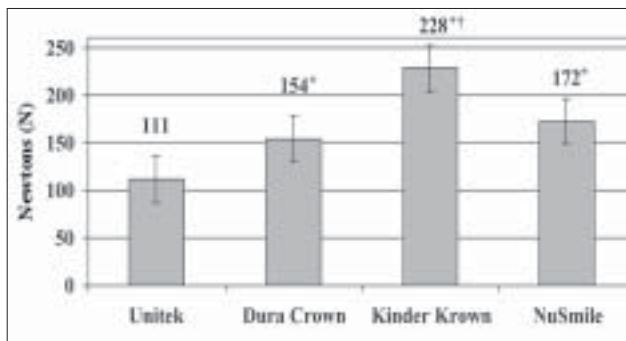


Figure 3. The effect of crimping and cementation on crown retention.
*Statistically significant with Unitek crowns.
††Statistically significantly different than Dura Crowns and NuSmile Primary Crowns ($P < .05$).

Discussion

The results of this study confirmed other reports that SSC retention is largely dependent upon cement.^{9,12} In addition, this study demonstrated the beneficial effects of crimping in conjunction with cementation. In a previous *in vitro* study⁹ evaluating the retention of SSC in primary molars, higher retention values than the ones obtained in this study were found. For mechanical retention only, the mean value obtained was 32.42 N and for crimping and cement 245.76 N. The higher bonding results may be explained by the utilization of natural teeth, resulting in a stronger bonding between tooth, cement, and SSC.

One clinical study evaluated the retention of veneered SSCs (Whiter Biter II Crown), reporting 100% success after 32 months.¹

The main problem reported was the lack of retention of the veneer facings. Research studies assessing this topic have been reported.^{13,14}

Because the manufacturers did not share information regarding their crown manufacturing or veneer processing, it was unclear as to whether any of the crowns tested in this study were manufactured differently. With this in mind, the outcomes of testing led to some interesting discoveries regarding the retention of different crowns.

The results obtained for the “crimping only” category showed the Unitek crowns to be significantly more retentive than the Dura Crown, Kinder Krown and NuSmile Primary Crown. The increased retention was also deemed a direct result of the “snug fit” obtained from the internal walls of the crown being in direct contact with the tooth structure. The “snug fit” of the Unitek crown may also play an important role in the lower retention results obtained when using cement alone or crimping and cement combined. The “snug fit” of the Unitek crown likely did not allow sufficient thickness of cement to remain around the tooth after seating. The clinical significance of this is apparently irrelevant based on the high retention rate reported for open-faced SSCs.^{2,5,7,8}

The Dura Crown manufacturer claims that crimping on both facial and lingual surfaces can be performed without compromising the veneer integrity. Although this study did not test the durability of the esthetic facings, it was a challenge to crimp the facial margin of these crowns without damaging the facings in some way. Dura Crown was not found to be significantly more retentive than the other crowns tested with or without cement despite the all around crimping.

Kinder Krown crowns allowed crimping on the lingual surface only. When crimping was performed, it was also important to stay approximately 2 to 3 mm from the facing-metal junction; crimping too close to this junction occasionally lead to stress fractures and chipping of the facing. Kinder Krown crowns are designed with an “incisal lock” technology to provide additional retention of the esthetic facings by mechanically forcing a portion of the facing material through openings on the incisofacial edge to the internal aspect of the crown. While the added retention from the incisal lock may be beneficial, the same button of composite prevented the Kinder Krown crowns from fully seating on the ideal tooth preparation used in this study. Removal of the internal composite was necessary to achieve complete seating. Alternative options would have been to further reduce the incisal edge of the prepared tooth or not fully seat the crown. With the incisal lock totally removed, it is unknown if the facings integrity would be compromised. The higher retention values obtained for

these crowns may be explained by very good metal-cement-acrylic bonding.

The significant metal-cement bonding failure (cohesive failure) for NuSmile Primary Crowns in the cementation only group were difficult to be explained. This failure was not unusual to the study but was very significant compared to the other brands. Rely-X ARC was selected for this study due to its ability to dispense equal amounts of 2 pastes, facilitating its mixture and making the cement consistent for all specimens. The use of natural teeth and a different luting cement from the one used in this study may have a different impact on the results. Extrapolation of this study's results to the clinical environment should not be made.

Conclusions

1. Crimping does have a significant effect on retention of SSCs to acrylic replicas of primary incisors.
2. The presence of cement significantly improved crown retention.
3. Significantly higher retention values were obtained for all brands tested when crimping and cement were combined.
4. Crowns with veneer facings were significantly more retentive than the no-veneer (Unitek) crowns when cement and crimp were combined.

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