Veneer Retention of Preveneered Primary Stainless Steel Crowns After Crimping

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ABSTRACT

Purpose: The purpose of this study was to determine if crimping the lingual aspect of commercially available, preveneered, anterior stainless steel primary crowns affects the fracture resistance of the veneer facings.
Methods: Twenty-six anterior NuSmile crowns (size A1) were divided into 2 groups: group 1 served as the control, and group 2 was manually crimped evenly on the lingual cervical portion. All crowns were cemented onto a screw-mounted resin core duplicated from a manually prepared Kilgore tooth and tested under compression. Recorded were fracture resistance, percent of veneer facing loss, and fracture to the gingival margin. Differences between the control and experimental groups were analyzed by independent *t* test and chi-square (alpha=0.05).
Results: The mean shear force required to fracture the veneers of the noncrimped crowns was 510.11 N (±79.66 SD), and 511.02 N (±62.37) for the crimped crowns. The mean percentage of veneer facing removed in the noncrimped crowns was 33% (±12.18), and 43% (±14.30) in the crimped crowns. No significant difference in shear strengths (P=.970) and in percentage of veneer loss (P=.063) was shown between crimped and noncrimped crowns. A mean of 8% of the noncrimped crowns and 23% of the crimped crowns had veneers fracturing to the gingival margin. The chi-square test showed no significant difference (P=.297).
Conclusions: The veneer resistance to fracture for the crimped crowns was comparable to noncrimped crowns. The crimped crowns, however, were associated with greater veneer surface area loss. (J Dent Child 2008;75:44-7) Received July 14, 2006 | Last Revision September 28, 2006 | Revision Accepted November 6, 2006.

KEYWORDS: VENEER, CROWN, ESTHETIC

Restoration of decayed anterior primary teeth that are strong, durable, and esthetically pleasing has always been a challenge for pediatric dentists. This is due to the small size of primary teeth, limited patient cooperation, and increased parental expectations.[1,2] From extensive baby bottle tooth decay to smaller incipient lesions, dentists seek restorative options with high success rates. There are many options for anterior restorations not limited to composite resins, stainless steel crowns, open-faced stainless steel crowns, strip crowns, pedo jackets, and preveneered stainless steel crowns.[3] Composite resins tend to be more technique sensitive, require a dry field and be better suited for smaller carious lesions. While they are quite unesthetic,[2,4-6] stainless steel crowns are more durable, easiest to place, very retentive and better for larger carious lesions in which little tooth structure remains.

Open-face resin crowns are a good semi-esthetic yet time consuming alternative to stainless steel crowns. They require longer operator chair time and greater patient cooperation, and the metal margins can still be somewhat perceptible peripherally.[1,2,3,5,7-9] Strip crowns, although one of the most esthetic options, are also time consuming and technique sensitive and can fracture or debond when traumatized.[5,6,10,11] They are contraindicated for grossly decayed teeth with little tooth structure remaining for retention, deep subgingival

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caries, an impinging deep overbite, and the presence of periodontal disease.[9,12] Overall, the more esthetic options tend to be the most fragile and time consuming.

Preveneered stainless steel crowns are a good restoration for anterior teeth with significant decay and do not require extensive additional chair time. They, however, are also not without their disadvantages. Long-term retention and resistance to fracture of the veneer has been shown to be somewhat low.[2] The dentist is limited in the choice of resin shades, and the preveneered crowns are sometimes so white that they appear artificial.[5] The color change and fracture resistance of the veneers are also affected by different modes of sterilization.[9,13] The pressure and high heat from sterilization can destroy the attached resin layer.[5] Also, they are approximately 5 to 8 times more expensive than a plain stainless steel crown or strip crown.[2,5,6,14]

Another disadvantage of the preveneered crowns is the adaptability of the crown to the tooth by limited crimping, contouring, or squeezing of the crown.[2,6] Crimping the gingival margin of crowns and then luting the crown with dental cement tends to increase crown retention.[1] Some preveneered crown manufacturer's instructions recommend that the operator should not crimp the crowns. To obtain a better fit and increase crown retention, however, many dentists have been noted to crimp the lingual aspect since it is not bonded to the resin veneer. A study by Guelmann[1] showed that crimping has a significant effect on the retention of SSCs to primary incisors. Furthermore, it was demonstrated that cement significantly improves crown retention and crowns with veneer facings are significantly more retentive than crimped and cemented crowns with no veneers. The main problem noted was the lack of retention of the veneer facings.

Many clinicians are using preveneered crowns as their first choice for full coverage severely decayed primary incisors.[6] This study's purpose was to determine if crimping of these commercially available preveneered stainless steel crowns affects the fracture resistance of the veneer facings.

METHODS

Twenty-six commercially available, preveneered, primary stainless steel crowns (NuSmile, Orthodontic Technologies, Inc, Houston, Texas) each chosen from the same batch, were divided into 2 groups, (N=13). The crown size (A1) was selected based on the mesiodistal width of the Kilgore maxillary primary right central incisor.

Group 1 crowns were not crimped (NCP) on the lingual aspect and served as the control group, whereas group 2 crowns were crimped (CP) on the lingual aspect only and served as the experimental group. A Kilgore maxillary primary right central incisor was prepared to the basic standards of facial reduction of 1 mm, incisal reduction of 1.5 mm, lingual and proximal reduction of 0.5 mm and a feather-edge gingival margin. All line angles were rounded. The prepared typodont tooth was modified slightly until ideal adaptation was obtained to fit the size A1 crown.

The prepared tooth was:

1. duplicated 26 times using:
   a. transparent silicone material (Clear Bite, Discus Dental); and
   b. dual cure resin core material (Luxacore, Zenith/DMG); and
2. mounted in a threaded steel screw compatible with the custom holder for the mechanical testing machine (Instron model no. 4465, Instron Ltd., Norwood, Mass).

Group 2 crowns were crimped on the lingual gingival aspect from the mesiolingual to distolingual line angle to obtain well-adapted margins to the duplicated resin cores (Figure 1). All crowns were crimped by the same operator using an anterior crown crimping instrument. Group 1 crowns were left uncrimped (Figure 1). Each crimped and noncrimped crown was cemented (Ketac Cem Aplicap, 3M/ESPE, St. Paul, Minn) onto the duplicated resin cores.

Twenty-four hours post cementation, each specimen was placed into the custom holder on the Instron machine (Figure 2). A force was applied to the veneer, with bevel placement 1 mm facial to the veneer-crown junction at the incisal edge. The force was applied at an angle of 180 degrees, with a crosshead speed of 1mm/minute until the veneer fractured or was completely or partially dislodged. The force required to fracture or dislodge the veneer was recorded in kilonewtons (kN) and later converted to newtons (N). The

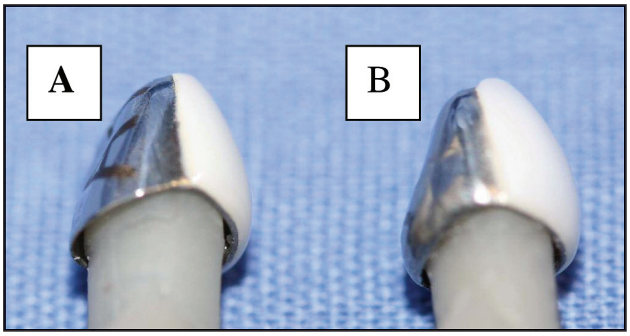

Figure 1. The crown veneer on the left (A) remained uncrimped. The crown veneer on the right (B) was crimped on the lingual gingival aspect from the mesiolingual to distolingual line angle.

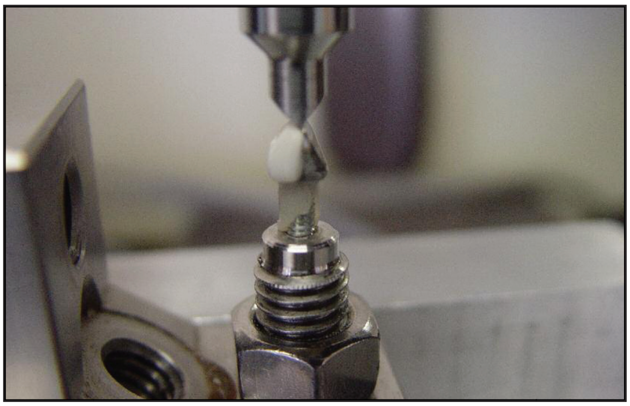

Figure 2. Instron custom holder and application of force to veneers of preveneered stainless steel crowns.

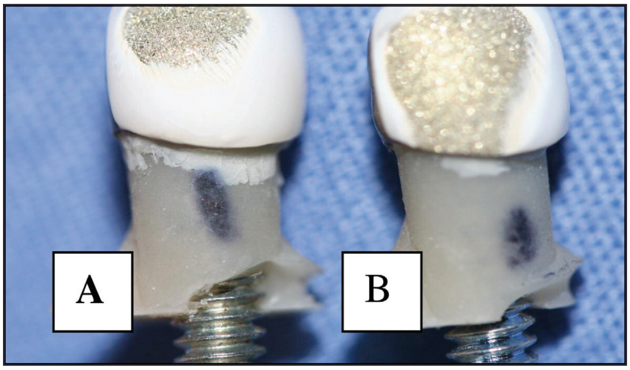

Figure 3. The crown veneer on the left (A) is not fractured to the gingival margin. The crown veneer on the right (B) is fractured to the gingival margin. Also note percent of veneer loss: A=approximately 40% veneer loss; B=approximately 85% veneer loss.

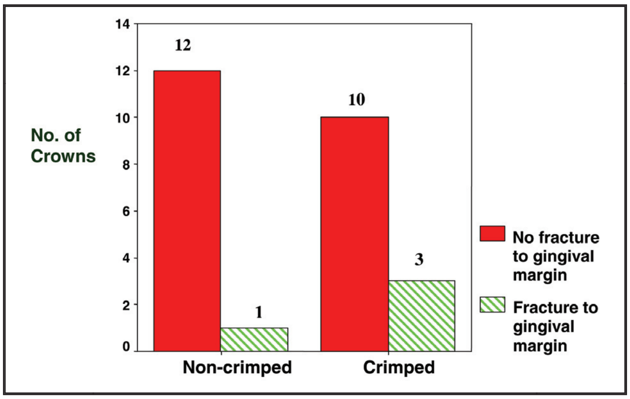

Figure 4. Number of crown veneers fracturing to the gingival margin.

percentage of veneer loss upon fracture was recorded for each crown tested (Figure 3). Each sample was also observed for fracture to the gingival margin (Figure 3).

An independent *t* test was used to determine the significance in retention of veneered facings (alpha=0.05) between the NCP and CP groups. An independent *t* test was also used to determine if the percentage of veneer loss during the fracture test was significantly related to crimping or noncrimping. Lastly, the chi-square test was used to determine if the crimped crowns were more prone to fracture to or at the gingival margin. Differences between the control and experimental groups were analyzed with SPSS 10.0 (SPSS, Chicago, Ill).

Table 1. Mean Shear Force, Percent of Facing Loss, and Fracture to Gingival Margin

	Mean shear force (N)	% of facing loss	% of fracture to gingival margin
Noncrimped	510.11±79.7	32.69±12.2	8
Crimped	511.02±62.4	42.85±14.3	23
***P*-values**	0.970*	0.063*	0.297†

** T test.*
† Chi-square.

RESULTS

The mean shear force required to fracture the veneers was 510.11 N (±79.7) and 511.02 N (±62.4) for the noncrimped crowns and crimped crowns, respectively. The mean percentage of veneer loss was 33% (±12.2) and 43% (±14.3) for the noncrimped crowns and crimped crowns, respectively. A mean of 8% of the noncrimped crowns and 23% of the crimped crowns had veneers fracturing to the gingival margin (Table 1, Figures 3 and 4).

The independent *t* tests showed that there was no statistically significant difference in shear strengths required to fracture the veneers (*P*=.970) or in the percentage of veneers lost upon fracture (*P*=.063) between both groups. The chi-square test showed no significant difference (*P*=.297) in fracture to the gingival margin between the control and experimental groups (Table 1).

DISCUSSION

Although there was no statistically significant difference in veneer loss upon fracture between the crimped and noncrimped group (*P*=.063), the crimped crowns in general showed a trend associated with a greater loss percentage (NCP vs CP=33% vs 43%). The majority of the crimped samples had a smaller distribution of percentage of veneer loss. There were, however, some larger outliers. The noncrimped samples showed a greater distribution of results around the median value. The crowns failed due to partial loss of the veneers. The veneers separated at the metal-resin interface and never dislodged completely. It is thought, however, that once even partial veneer loss occurs in the patient's mouth, the esthetic result is deemed unesthetic regardless of the amount of veneer lost. Bakke et al reported the average biting force of 5- to 10-year-old children to be 357±64 N[15]. The mean force required to fracture the veneers of these crimped and noncrimped crowns were in the range of 510 to 511 N, which is much greater than the average biting force of a 5- to 10-year-old child. According to Waggoner[6], breakage of the veneers is probably due to traumatic forces, not incisive forces. He also speculates what effect water absorption may have on veneer strength. Since composites tend to absorb water over an extended period of time, it is possible that increased water absorption may change the strength of the bond or veneering material.[14]

Studies conducted by Waggoner and Cohen (1995) and Baker et al (1996) showed the failure strength of NuSmile Primary Crowns to be 447.2±78.5 N[14] and 445.7±81.0 N.[3] The slight difference in shear force may be attributed to the fact that the crowns in the earlier experiments were thermocycled and soaked in water for 24 hours and 90 days, respectively. Also, modifications to the manufacturing process since the time of the prior noted studies may account for the improved performance.

Other variables which may have also influenced the results include the custom fabrication of each crown, variable thickness of the veneer material, operator standardization and modulus of the core material. Wagonner and Cohen[14] tested shearing forces of NuSmile, Cheng, Kinder Krown, and Whiter Biter II crowns and found that the latter were significantly more resistant to shearing forces. Further studies involving crimping the lingual aspect of other preveneered crown manufacturers' crowns and evaluating the retention of their veneer facings should be investigated.

CONCLUSIONS

Based on this study's limitations, there is no significant difference in veneer fracture resistance between the lingually crimped and noncrimped crowns.

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