Scientific Article

Clinical Outcomes for Primary Anterior Teeth Treated with Preveneered Stainless Steel Crowns

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Abstract: ***Purpose:*** *The purpose of this retrospective study was to explore clinical outcomes for NuSmile anterior preveneered stainless steel crowns.* ***Methods:*** *A convenience sample of healthy children treated with anterior crowns was selected from a teaching clinic and private office. Crowns were placed by either a private practice dentist or pediatric dental resident. Clearly defined clinical outcomes were assessed by 3 calibrated examiners at recall, including: (1) presence; (2) chipping; (3) wear; (4) crazing; and (5) marginal location by clinical and radiographic examination. Factors affecting placement—such as operator experience and behavior—were also assessed.* ***Results:*** *In 46 subjects (21 females, 25 males; mean age at placement=4 years, 2 months), 226 crowns with a mean post-placement time of 12.9 months were evaluated. Only 2 crowns matched natural teeth, with NuSmile crowns lighter in 83% of subjects. Most crowns (86%) were normal in size. Eighty-eight percent resisted fracture for 6 months. All but 3 crowns resisted color change for 6 months. Canine crowns were the least successful, but overall 91% of crowns retained good to excellent clinical appearance.* ***Conclusions:*** *NuSmile anterior preveneered crowns are a clinically successful restoration for primary incisors with early childhood caries.* *(Pediatr Dent 2007;29:377-81) Received September 21, 2006 / Revision Accepted January 9, 2007.*

KEYWORDS: ANTERIOR PRIMARY TEETH, STAINLESS STEEL CROWNS, ESTHETICS

Restoring primary incisors damaged by early childhood caries (ECC) is one of the most challenging tasks for the pediatric dentist. The gingival tissue of ECC patients tends to be inflamed, leading to hemorrhage and compromising composite esthetic restoration. Primary incisor anatomy, including small overall size, thinness of enamel and surface proximity to the relatively large dental pulp, make intracoronal restoration difficult.[1] Hence, full-coverage restorations or crowns are typically placed. Behavior management further complicates treatment.

For decades, stainless steel crowns (SSCs) have been the easiest placed and most durable restoration for severely decayed primary incisors, outperforming amalgam and composite.[2,3] Unfortunately, they offer poor esthetics and some parents report they would rather have incisors extracted if SSCs are the only restorative option.[1] Because crowns play a crucial role in restoring a child's carious anterior teeth, esthetic alternatives to SSCs have been developed. These include: (1) open-faced crowns; (2) bonded strip crowns; and (3) preveneered SSCs.[4-7]

Open-faced crowns combine durability and esthetics, but are time consuming to complete.[8] Hemorrhage of gingival tissue remains an issue, and metal margins around the composite facing create an often unacceptable appearance. The bonded strip crown is the most esthetic, natural-looking, complete-coverage restoration available for primary incisors,[2,7] but is time consuming and extremely technique sensitive. Even when placed under ideal conditions, strength and resistance to wear are far from that of the SSC. A 2002 study of children whose dental treatment was accomplished under general anesthesia found that strip crowns had a failure rate of 51%, compared to a low (8%) failure rate for SSCs.[3]

Preveneered or resin-veneered SSCs (PVSSCs) resolve some problems associated with SSCs, open-faced crowns, and strip crowns1 and serve as a solution to restore severely carious primary incisors.[2] They can be placed in a single, short appointment, and their esthetics are not affected by saliva or hemorrhage.[8-10] Clinical disadvantages include:

1. relatively inflexible, brittle, resin facing material that tends to break when subjected to heavy force[8];
2. no crimping of the lingual surface or forcing crowns on to the teeth;

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3. significant removal of tooth structure in preparation of allowing a more passive fit;
4. expense;
5. limited shade choice; and
6. difficulty placing multiple approximating crowns in patients with crowding or space loss due to bulk.[1]

Over time, some preveneered crown facings may fracture.[2,8,10] Heat sterilization has unknown effects on the resin facing. The various types of PVSSCs available commercially differ in terms of the: (1) method of facing attachment to the SSC; (2) shades available; (3) crown length; and (4) clinician's ability to crimp the crown.[7]

Despite their disadvantages, PVSSCs remain very popular, but very little clinical research compares the products available.[10] Three clinical studies report outcomes for esthetic anterior crowns. Roberts et al evaluated clinical success and parental acceptance in 12 children with 38 preveneered crowns.[10] In 2003, Kupietzky et al evaluated clinical and radiographic success in 40 children with 120 strip crowns.[11] In a 2004 study by Shah et al, clinical success and parental satisfaction with Kinder Krown preveneered anterior crowns were evaluated in only 12 patients with 48 crowns.[12]

This institutionally approved, retrospective study's purpose was to determine the clinical outcomes for a sample of NuSmile preveneered SSCs used to treat anterior teeth with early childhood caries.

Methods

Sample selection. Children were patients of either a private pediatric dental practice or public health clinic and had crowns placed by first- or second-year pediatric dental residents or a dentist in private practice. In total, crowns were placed by any of 10 clinicians. Subjects had 1 or more NuSmile crowns (Orthodontic Technologies, Houston, Tex), used as the PVSSC of choice in both settings. These were placed on maxillary and/or mandibular primary anterior teeth at least 6 months prior to evaluation and cemented with glass ionomer cement. Excluded were children with: (1) special needs; (2) traumatized teeth; (3) crowns placed by other than the study operators; and (4) teeth near normal exfoliation.

Procedures. Subjects in this convenience sample were approached by telephone or at their scheduled 6-month preventive care appointment and invited to participate. Following consent, an examination was done using a mouth mirror and an overhead dental light, after a supracoronal polishing with rubber cup and prophylaxis paste. Each child's oral hygiene (plaque index) was assessed by 1 of 3 calibrated examiners and recorded by a trained dental assistant prior to cleaning. A periapical radiograph of the crown(s) was made, and a standardized anterior segment digital intraoral photographic image was made of the crown(s)—displaying a minimum of 4 maxillary anterior teeth, as well as canines, if crowned. Three nonblinded, calibrated examiners (JKM, CEC, and WFW) evaluated the crowns, and data were recorded by a trained dental assistant. The parent or guardian completed a written survey in English or Spanish to assess parental satisfaction, administered by a trained dental assistant without the presence of the examiner.

Criteria. Criteria selected for this study reflect those used in other studies and considered important in clinical acceptance of preveneered crowns. Historical and clinical variables and the scoring technique used are shown in the Figure. Calibration sessions were held prior to data collection to improve intra- and inter-rater examiner reliability, including: (1) measurement using specified instruments; (2) use of intraoral photography; and (3) identification of variables (crazing, chipping, margins, etc).

Analysis. Data were entered into an Excel spreadsheet (Microsoft Corp, Redmond, Wash) and imported into SPSS 12.0 software (SPSS, Inc, Chicago, Ill) for statistical analysis. Descriptive statistics were used to describe the demographic information. Percent response frequencies were subsequently computed. A P-value of .05 or better was considered significant.

Results

Patient characteristics. A total of 226 NuSmile crowns were evaluated in 46 of 49 eligible patients—21 females (46%) and 25 males (54%)—with 3 patients eliminated due to inability to obtain consent or identify the provider. Mean age at the time of crown placement was 4 years, 2 months (range=2 years, 2 months to 7 years, 9 months), and age at evaluation was 5 years, 4 months (range=2 years, 10 months to 8 years, 4 months). Mean time between placement and evaluation was 12.9 months (range=6-45 months).

Each patient had an average of 5 crowns (range=1 to12). Twenty patients were treated by first-year pediatric dental residents (43%), 22 by second-year pediatric dental residents (48%), and 4 by a private practice pediatric dentist (9%). One patient was managed with nonpharmacologic behavior management techniques alone (2%), 2 patients with nitrous oxide (4%), 1 with oral conscious sedation (2%), and 42 under general anesthesia (91%). Forty-four patients had positive behavior (96%), and 2 had negative behavior (4%). Parents reported 11 patients with a history of bruxism (24%) and 13 patients with a history of trauma to the crowned teeth (28%).

Crown functional characteristics. The functional variables are described by tooth type in the Table. When comparing the shade of the NuSmile crown to natural teeth, only 2 patient's

Figure. CRITERIA FOR ASSESSMENT OF VARIABLES RELATED TO CROWN FUNCTION.

History of bruxism	Present		Non-present	
Plaque index	No plaque	Plague on gingival one third of crown		Plaque on >50% of crown
Provider type	Private practice DDS	First-year resident		Second-year residentt
Behavior management	Nonpharmacologic	Nitrous oxide	Oral sedation	General Anesthesia
Patient behavior	Positive: Quiet and cooperative		Negative: Disruptive, moving, crying	
Overall appearance	Excellent: Superior result, very natural	Good: Esthetic result, minor rotation or size discrepancies	Poor: Chipped facing, un-natural, needs improvement	Very poor: Not esthetic, detracts from appearance
Crown type	Regular	Short		Unclear
Retention	Present	Recemented *		Absent
Crazing	None	<1 mm	>1 <3 mm	>3 mm
Fracture/ chipping	None	<1 / 3	<2 / 3	Complete loss
Attrition/ wear	None		Noticeable wear	
Margin	Subgingival	At the margin		Supragingival
Pulp therapy	None	Indirect	Pulpotomy	Pulpectomy
Trauma history	Traumatized		Not traumatized	
Color stability	No Change	Change	Yellow	Brown Gray
Shade match	Same as other teeth	Lighter		Darker
Crown size	Natural	Bulky		Too small
Gingival margin discoloration	None		Gray	
Gingival health	Healthy	Mild inflamation		Inflamation with bleeding
Radiographic pulpal health	Healthy	Changes not requiring treatment		Changes requiring treatment

* Same or new crown.

(4%) shades matched. The NuSmile crown shade was lighter than the natural teeth in 38 patients (83%). This variable was not applicable in 6 patients (13%), because all adjacent teeth were either crowned or extracted. When the nonapplicable patients were eliminated, 95% of the NuSmile crown facings were lighter than the patient's natural teeth.

One hundred ninety-four crowns (86%) appeared natural in size, while 32 (14%) appeared bulky. A total of 199 crowns (88%) resisted fracture for at least 6 months, but 27 fractured facings were observed in 19 patients. Of the fractured crowns: (a) 24 lost less than one third of the white facing; (b) 3 lost less than two thirds of the facing; but (c) 0 had complete facing loss.

All 3 crowns with less than two thirds facing loss were maxillary laterals.

A total of 161 NuSmile crowns (71%) resisted attrition/incisal wear for at least 6 months, but 65 (29%) had noticeable wear in 28 patients. The majority of crowns, 224 (99%), resisted crazing for at least 6 months.

All but 3 crowns resisted color change for at least 6 months, with 3 canines (1 maxillary and 2 mandibular) observed to have changes in facing color (yellow) when compared to a new, unused crown.

Regarding appearance: (a) 17 patients (37%) had an excellent overall appearance; (b) 23 (50%) had a good overall appearance; (c) 4 (9%) had a poor result; and (d) 0 (0%) had very poor results.

Differences and associations between crown function and selected variables. Overall appearance was significantly associated with positive behavior (P=.005). There was a significant increase in the incidence of attrition with the amount of time since crowns were placed (P=.007). There was also a significantly higher incidence of attrition in the crowns that were identified as being bulky (P=.045). Additionally, there was a significant increase in the incidence of trauma in patients with PVSSC fractures when compared to patients without attrition or fractures (P=.025).

There were no statistically significant differences in the prevalence of bruxism:

Table. DISTRIBUTION OF CROWN FINDING VARIABLES BY TOOTH TYPE.

Historical or clinical variable	Tooth type receiving crown (tooth name)						
	E,F	D,G	C,H	O,P	N,Q	M,R	Row total
Number placed	66	66	44	18	22	10	226
Bruxing	6	4	12	4	4	2	32
Fractured facing	5	9	10	1	0	2	27
Wear	9	14	27	1	6	8	65
Crazing	0	0	2	0	0	0	2
Color change	0	0	1	0	0	2	3
Crown size (bulky crowns)	6	4	12	4	4	2	32

1. and trauma between patients with and without PVSSC attrition or fracture; and
2. between patients without PVSSC attrition or fracture and patients with fractures. Additionally, there were no gender differences in the number of fractured facings and presence of attrition and no significant increase in the number of fractures associated with the amount of time that had passed since crowns were placed.

Discussion

The vast majority (91%) of NuSmile crowns was placed under general anesthesia, and 96% of patients had positive behavior. Since preveneered crowns are less susceptible to local factors such as gingival hemorrhage, the authors conclude that the majority of the crowns evaluated in this study were placed under ideal conditions.

A total of 224 NuSmile crowns (99%) were retained at the time of examination. Despite some findings of clinical failure such as fractures and attrition, 91% of all patients maintained a good to excellent overall appearance after at least 6 months. NuSmile crowns are a clinically successful complete coverage restoration for anterior primary teeth, as evidenced by: (a) 86% resistance to fracture; (b) 71% resistance to attrition; (c) 99% retention; (d) 99% resistance to crazing; and (e) 99% color stability over a minimum of 6 months.

Despite the inability to crimp the crown's facial aspect, NuSmile crowns may be successfully retained after at least 6 months. Only 2 crowns (1%) had fallen off in 2 patients. Of these 2 patients, 1 crown was lost subsequent to trauma sustained from a fall.

There was no statistically significant difference between: (1) first-year residents; (2) second-year residents; and (3) private practice practitioners in any variable. Dentists with all levels of experience had similar successful results in: (1) overall appearance; (2) resistance to wear; and (3) resistance to attrition.

Although canines were often the least observed, they represented the greatest number of failures. Canine NuSmile crowns were the only type to have color change or crazing and: (1) had the greatest number of fractures (44%); (2) had the most noticeable wear (54%); and (3) were most likely to appear bulky (38%). The disproportionately higher number of failures in canine NuSmile crowns may be attributed to canine protected occlusion and, as the most likely crown type to be bulky, showed a statistically significant increase in the incidence of attrition.

All 226 crowns observed in this study were extra light, the original shade offered by NuSmile. This extra light shade was found to match only 2 of the patients' natural teeth (5%) and was lighter than the remaining unrestored teeth in 95% of patients. This color discrepancy was particularly noticeable when only a few teeth were restored with NuSmile crowns. To remedy this unnatural, "too white" appearance, NuSmile now offers a new light shade, slightly more yellow like natural teeth. Only 3 canine crowns (1%) were found to have a yellow color change when compared to a new, unused crown. The cause of this color change is unknown, but color changes in the crown facing have been observed following repeated steam sterilization. To decrease the risk of color change from repeat sterilization, careful crown selection prior to reducing the tooth may be the best approach.

The crown's length (regular or short) was not consistently recorded by the operator at the time of placement, and it was not always possible to determine the length of every NuSmile crown . As a result, no comparisons were made of: (1) either of the two commercially available crown lengths to margin; (2) position; (3) margin discolorization; or (4) gingival health. Examiners were not able to make adequate periapical films for all 46 study participants. Reasons for this failure include: (1) lack of patient maturity and cooperation;

and (2) poor film placement. As a result, radiographic pulpal health and pulpal treatment were not included in the data analysis.

Bias may have been introduced, since the examiner may have placed some of the crowns in some subjects—although in the teaching setting, patients were often seen by multiple operators. In addition, because of this study's retrospective nature, the preoperative condition of the restored teeth was not known and variations in the size and shape of the prepared crown may have influenced results in some way. Finally, intra-and inter-rater reliability was not assessed and, in spite of calibration, variability may have existed since 3 examiners were involved.

Conclusion

Based on this study's results, the following conclusions can be made:

1. NuSmile crowns are a clinically successful restoration for anterior primary teeth.
2. Despite some negative clinical changes, 91% of NuSmile crowns retain a good to excellent overall appearance after 6 months.
3. Canine NuSmile crowns are the least clinically successful. They are most likely to fracture, wear, and appear bulky.
4. There is an increased incidence of attrition with increased time and with bulky crowns.
5. Successful results with NuSmile crowns may be obtained by both the experienced operator and the novice.

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Abstract of Science of Literature

Two different protocols for hydroxyzine sedation

Dosages and schedules for oral administration of hydroxyzine have varied widely in clinical reports, ranging from 20 to 60 mg taken 45 minutes to 1 hour before treatment. The purpose of this study was to evaluate the effectiveness of sedation using two different dosages of hydroxyzine with nitrous oxide inhalation sedation. Thirty uncooperative, fearful children between 31 and 120 months old and ASA I were assigned randomly to 1 of 2 oral sedation treatment groups. Group 1 received 20 mg/kg hydroxyzine (Atarax) from the parents 24 hours prior to the procedure and 3.7 mg/kg hydroxyzine on the day of the procedure. Group 2 received 3.7 mg/kg hydroxyzine on the day of the procedure only. All patients in both groups received 50% nitrous oxide inhalation. The mean age of the children was 61.9 months (SD 11.9) for group 1 and 53.7 (SD 12.8) months for group 2. The overall sedation success rate was 90% regardless of group. There were no statistically significant differences between Groups 1 and 2. All the SaO2 readings were above 94%, which was not clinically significant. The authors concluded that there was no significant benefit of 20 mg hydroxyzine administered 24 hours preoperatively for the effective sedation of fearful and uncooperative children.

Comments**: As with any other sedative agent, hydroxyzine should only be given by the dental provider, particularly when the results show that drugs given at home have no better effect on the behavior during sedation.* ***FMS

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