Retentive Strength of Bands Cemented to Altered Pediatric Crowns

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ABSTRACT

Purpose: The objective of this study was to evaluate the retentive strength of stainless steel (SS) bands cemented to zirconia pediatric crowns (ZRCs) with surface alterations.

Methods: Mandibular primary second molar ZRCs (Kinder Krown) and SS crowns (3M) were mounted on acrylic crown preparation dies. The crowns were divided into 5 groups (n=10): 1) no preparation of ZRC surface (ZR-C, control); 2) ZRC roughened with diamond bur (ZR-R); 3) ZRC primed with Z-prime (zirconia-alumina-metal primer, BISCO) (ZR-P); 4) no preparation of SSC (SSC-C); and 5) SSC primed with Z-prime (SSC-P). Mandibular SS bands (space maintainer, DeNovo) were cemented with RelyX Luting Plus cement (3M) on each crown. All samples were stored at 37°C for 24 hours prior to testing. The arm attachment of each space maintainer was pushed downward in a universal testing machine (Instron) at a rate of 1mm/min until the band dislodged. Interfaces of all dislodged bands were inspected under a stereomicroscope.

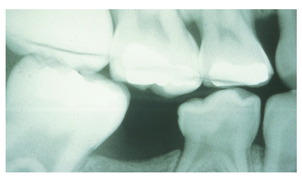
Results: Maximum dislodging loads in Newtons (mean ± standard deviation) for the 5 groups were: ZR-C (200 ± 20), ZR-R (201 ± 63), ZR-P (189 ± 27), SSC-C (210 ± 26), and SSC-P (196 ± 21). No significant differences were found among the groups (P=0.7527). Most debonding occurred at the band-cement interface: ZR-C (100%, N=10), ZR-R (100%, N=10), ZR-P (100%, N=10), SSC-C (90%, N=9), and SSC-P (100%, N=10).

Conclusion: Altering a zirconia or stainless steel crown surface with a diamond bur or applying Z-prime to the crown surface and band did not improve retention of a band cemented with RelyX Luting Plus.

INTRODUCTION

The deciduous dentition plays a key role in the growth and development of children, including mastication, esthetics, and phonetics. Deciduous teeth serve as the best natural space maintainer until natural exfoliation occurs. In many cases, premature loss of the primary tooth is unavoidable and the best option to maintain arch space is to place a space maintainer. Premature loss of primary teeth may result in tipping of teeth adjacent to the lost tooth, reduction of arch length, ectopic eruption, midline deviation, and potential blocked eruption of permanent teeth.

Traditional space maintenance has been completed with stainless steel bands and wires. The band and loop fixed appliance is one of the most frequently used space maintainers in the case of a single tooth lost unilaterally. Several studies have examined various cements (glass ionomer, resin-modified glass ionomer, adhesive resin cements) and alterations of the band surface to improve retention with varying degrees of success. Roughened crown and band surface for stainless steel has shown superior retention in laboratory studies.



PURPOSE

Zirconia (ZR) crowns are becoming more popular in the world of pediatric dentistry. Posterior ZR has been shown in a few clinical studies to be equivalent to the SSC. As ZR crowns become more popular, the clinical scenario of a primary first molar being lost prematurely and a second primary molar having a zirconia crown is more applicable.

To date, few studies have examined bonding the stainless steel band of a fixed space maintainer to a prefabricated zirconia crown using resin modified glass ionomer cement. The objective of this study was to evaluate the retentive strength of stainless steel (SS) bands cemented to zirconia pediatric crowns (ZRCs) with surface alterations.

MATERIALS AND METHODS

30 ZRs (Kinder Krown) and 20 SSC crowns (3M) were mounted onto custom-made acrylic crown preparation dies:

- The 30 ZR crowns were divided into 3 groups (n=10 each group): 1) no preparation of crown surface (ZR-C, control); 2) crown roughened with diamond bur (ZR-R); 3) crown was primed with a zirconia-alumina-metal primer (ZR-P).
- The 20 SSCs were divided into two groups (n=10): 1) no preparation of SSC (SSC-C) and 2) crown was primed with a zirconia-alumina-metal primer (SSC-P).

Three of the 5 crown groups involved altering the crown surface to test if surface alteration improved bond strength:

- For the ZR-R group, a super coarse football diamond bur (Komet) was used to roughen the buccal, mesial, and lingual surfaces of the ZRC in a 1x2 mm wide band at the height of contour. For the ZR-P and SSC-P groups, Z-Prime (BISCO) was applied to the crown and SS band per the manufacturer's instructions.
- Stainless steel bands (L32) (DeNovo) were roughened with super coarse football diamond bur (Komet) circumferentially such that all intaglio surface of the band was roughened. Bands were then cemented with RelyX Luting Plus cement (3M) for all crowns.

Maximum bonding loads for each group are reported in Table 1. There was no significant difference between any group. Most of the samples showed debonding occurred at the band-cement interface with the following frequencies recorded: ZR-C (100%, N=10), ZR-R (100%, N=10), ZR-P (100%, N=10), SSC-C (90%, N=9), and SSC-P (100%, N=10). Figure 1 shows a sample from the ZR-R group before and after dislodgement to illustrate where the cement failure occurred.

RESULTS

The cemented crown-band unit was submerged in a water bath at 37°C for 24 hours prior to testing. The arm attachment of each space maintainer was pushed downward in a universal testing machine (Instron) at a rate of 1mm/min until the band dislodged. Measurements were recorded until dislodgement of the stainless steel band from the crown. The maximum compression load was recorded in Newtons. Interfaces of all dislodged bands were inspected under a stereomicroscope. Images were taken to document where the cement failure occurred. Normal distribution was verified using the Kolmogorov-Smirnov test. Statistical analysis was carried out using one-way analysis of variance (ANOVA). Significance level was 0.05.

RESULTS

Table 1: Maximum debonding loads (N; mean ± standard deviation) and nominal debonding stress values (MPa)

Groups	Debonding load (N)*	Nominal Debonding Stress (MPa)**
ZR – R (zirconia crown roughened with diamond bur)	201 ± 63	1.63
ZR – P (zirconia crown with primer)	189 ± 27	1.53
ZR – C (no alteration of crown)	200 ± 20	1.62
SSC – P (SSC with primer)	196 ± 21	1.55
SSC – C (no alteration of crown)	210 ± 26	1.70

*One-way ANOVA test found no significant differences in maximum debonding load among the 5 groups (p=0.7527). **Nominal debonding stress is load/surface area of band.

Area of cement failure for stainless steel band cemented over zirconia and stainless steel crowns before and after dislodgement.

CONCLUSION

1. Altering a zirconia or stainless steel crown surface with a diamond bur does not improve retention of a band cemented with RelyX Luting Plus cement.
2. Applying Z-prime to a zirconia or stainless steel crown and band does not improve retention of a band cemented with RelyX Luting Plus cement.

FUTURE DIRECTIONS

- Compare the use of different cements: GIC, self-adhesive resin cements, RMGIC
- Cyclic loading and thermocycling of the crown-band unit
- Alterations of "roughening" or enhancing mechanical retention with grooves
- Contamination of crown or band
- Less than ideal fit of the band to the crown

ACKNOWLEDGEMENTS: Supported by the UT College of Dentistry Alumni Endowment Fund and the Tennessee Dental Association Foundation.