

Comparison of Amount of Tooth Reduction in Primary first Molar for Stainless Steel, Zirconia and Fibre-glass Crowns – In-Vitro Study

Research Article

Subramanian EMG^{1*}, Vignesh Ravindran², Ganesh Jeevanandan³

¹ Professor and Head, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Sciences, Velappanchavadi, Chennai – 77, Tamil Nadu, India.

² Senior Lecturer, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Sciences, Velappanchavadi, Chennai – 77, Tamil Nadu, India.

³ Reader, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Sciences, Velappanchavadi, Chennai – 77, Tamil Nadu, India.

Abstract

Purpose: To evaluate the amount of crown reduction required for stainless steel crown, zirconia crown and fibre glass crown in primary first molar.

Methods: Thirty primary posteriorly erupted teeth were divided into three groups and assigned to: Stainless steel crown (3M ESPE SSC), Fibreglass crown (Figarocrowns™) and Zirconia crown (NuSmile ZR). Teeth were prepared, and assigned crowns were checked for fit. Teeth were weighed prior to and after preparation. Weight changes served as a surrogate measure of tooth reduction.

Results: Analysis of variance showed a significant difference in tooth reduction among the three types. On applying Tukey's honest significant difference test, it revealed a significant high mean difference between SSC & NuSmile ZR followed by NuSmile ZR & Figaro & SSC. It implied the highest tooth reduction with NuSmile ZR and least with SSC.

Conclusions: Zirconia crowns required more tooth reduction than stainless steel crowns. Fibreglass crowns can provide an alternative due to lesser preparation and acceptable esthetics.

Introduction

Early childhood caries is defined as the presence of carious lesion in one or more teeth in children less than 71 months of age and the labial surface of the upper anterior teeth is one of the most Early Childhood Caries is a multifactorial disorder which continues to be a global health problem for decades in children which needs to be intercepted to prevent early loss of primary dentition which could lead to space loss. Stainless steel crowns (SSCs) has been the benchmark in providing a semi-permanent restoration for teeth in primary dentition affected by caries, decalcification in the cervical region, developmental defects like hypoplasia, and also as a full coronal restoration in case of teeth treated by pulpotomy or pulpectomy.[1] Their advantages with strength, retention and minimal tooth preparation could not overcome the obvious disadvantage of hampering esthetics. Modifications in the SSCs

like open-faced SSCs have been tried which make the work tedious, time consuming and also technique sensitive.[2] Pre-veneered SSCs have also been used which increased parents' satisfaction until the fracture of resin leading to facing loss.[3] Zirconia crowns made its debut in 1991 which had a paradigm shift in providing full coronal restorations in primary anterior teeth. These crowns allow the practitioners to provide patients with superior, highly polished, esthetic results. Many brands have then evolved in the manufacture of Zirconia crowns.[4] But all the manufacturers state that there is a comparatively higher tooth reduction while using Zirconia crowns. This was proved by the study done by Clark et al., which concluded that Cheng Crowns required more tooth reduction than stainless steel crowns for primary teeth among the different brands used in their study (EZ Pedo, Kinder Crowns, NuSmile ZR).[5] Fibre glass crowns were recently introduced in 2018 by Figaro Crowns™, Inc., USA. It is composed of fibre glass and also contains titanium oxide and ferrous oxide which

*Corresponding Author:

Subramanian EMG, B.D.S., M.D.S.,
Professor, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospitals, Saveetha University, Saveetha Institute of Medical and Technical Sciences, Velappanchavadi, Chennai – 77, Tamil Nadu, India.
Tel: +91 9884125380
E-mail: Subramanian@saveetha.com

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synergistically add unsurpassed strength and enhanced cosmetic value. Although the manufacturer suggests that these crowns require lesser tooth reduction as compared to Zirconia crowns [6], this study was aimed to evaluate the amount of crown reduction required for stainless steel crown, zirconia crown and fibre glass crown in primary first molar.

Methods

Thirty primary mandibular left first molar typodont teeth (Kilgore International, Inc., Coldwater, Mich., USA) were obtained and divided into three groups: (1) 3M ESPE SSCs (3M ESPE GA, St. Paul, Minn., USA); (2) Figaro crowns (Figaro Crowns, Inc.; USA); and (3) NuSmile ZR (NSZ; Orthodontic Technologies, Houston, Texas, USA); Each group contained 10 samples. The description about the crowns used in the study are given in table 1. Each typodont tooth was weighed three consecutive times to the ten thousandths of a gram using a calibrated Wensar™ precision electronic balance (Wensar Weighing Scales Limited, Chennai, Tamilnadu, India). All measured weights were recorded using an Excel spreadsheet (Microsoft, Inc., Redmond, Wash., USA), and the arithmetic mean was calculated for each sample tooth. The size of the crowns used for each group was determined by measuring the mesio-distal width of the typodont tooth to be prepared to receive the restoration. The images of the crowns used in the current study is shown in figure 1. Manufacturer’s recommendations for both tooth preparation and bur use were reviewed for each brand of crown. NuSmile ZR suggested various burs such as tapered diamonds or diamond footballs but did not require specific burs. Figaro Crowns Inc. suggested use of medium wheel or doughnut diamond bur for occlusal reduction and flame diamond for proximal reduction.[7] Teeth were prepared as per manufacturer instructions by a single operator to properly receive the crown. The typodont preparations for the different crowns used are shown in figure 2. The operator and a senior faculty member calibrated themselves with three trial preparations in which they mutually agreed upon the amount of

reduction necessary to achieve the required fit. These teeth were not included in the study. During the course of the study, the faculty member randomly selected three prepared teeth from each group to verify the proper fit. If the operator, based on faculty evaluation, did not achieve a proper fit, the sample in question was reduced to a greater extent until both operator and faculty member were in agreement. When this occurred, two additional samples from that group were randomly selected for evaluation for proper fit, resulting in 50 percent of the samples within that group being evaluated by the faculty member. Post-weights for each tooth were then obtained in triplicate and recorded in the same manner as pre-weights. Each tooth’s change in weight was calculated and used in statistical analysis as a surrogate measure of the degree of aggressiveness of tooth preparation required for the proper fit of each crown. The data were normally distributed, as tested by Shapiro-Wilk tests, so differences were assessed with one-way analysis of variance using the conventional alpha of 0.05 to identify any statistically significant difference. The source of significance was assessed using Tukey’s HSD as the post hoc test. Pre-treatment weights of the posterior teeth weighed an average of 0.738 grams (±0.001 standard deviation [SD]), with all 30 specimens ranging between 0.736 to 0.739 grams.

Results

Using One-way ANOVA, there was no significant difference in the pre mean weight of tooth substance in all three brands. However, there is a highly statistical significant difference (p = 0.000) in the post mean weight of tooth substance in all three crowns used (Table 2). On pair wise comparison using Tukey’s HSD post Hoc test, there is a significant high mean difference between SSC & NuSmile ZR followed by NuSmile ZR & Figaro and Figaro & SSC. This implies that the mean tooth substance removed is high for NuSmile ZR compared to SSC and Figaro (Table 3). The percentage reduction in weight is more for NuSmile ZR followed by Figaro and SSC. SSC has less tooth removal compared to Figaro and NuSmile ZR. (Table 4).

Table 1. Comparison of Features of the different crowns used in the current study.

Crowns	Sizes	Manufacturer recommended bur use	Manufacturer reduction requirements	Key features
3M ESPE [SSC]	7-Feb	Recommendations are provided	Occlusal surface: 1.0-1.5 mm Proximal: 1mm Remove any cervical shoulders Bevel line angles Final seat: Active	Crimping increases retention
NuSmile ZR [Zirconia]	0-6	Recommendations are provided	Incisal edge: 1.5-2.0 mm occlusal: 1.0-1.5 mm Circumferential axial reduction: 0.5-1.25 mm (or 20-30%) SubgingivaL: feather margin circumferentially 1-2 mm Round all line and point angles Final seat: passive	NuSmile ZR try in crowns avoids contamination of the crown actually cemented NuSmile ZR adjustment burs available Light and extra light shades
Figaro [Fibre-glass]	XS, Sm, M, L, XL	Recommendations are provided	Incisal/occlusal edge: 1.0-2.0 mm Circumferential axial reduction: 1.0-1.5 mm SubgingivaL: feather margin circumferentially 1-1.5 mm Round all line and point angles Final seat: slightly active / passive	Pre-beveled margins – no crimping [Flex Fit] Polishing burs recommended for high point reduction on the crown

Table 2. Comparison of Mean of tooth substance removed (grams) for the three crowns.

Crowns	N	Pre Mean \pm SD	F Value	p Value	Post Mean \pm SD	F Value	p Value
SSC	10	0.7387 \pm 0.0003	1.997	0.155	0.6838 \pm 0.0004	4079.452	0.000*
NuSmile ZR	10	0.7378 \pm 0.0012			0.5849 \pm 0.0039		
Figaro	10	0.7386 \pm 0.0012			0.6441 \pm 0.0015		

*Sig at 0.05 level, One-way ANOVA

Table 3. Pairwise Comparison of mean tooth substance removed in all three crowns.

Crowns	Mean difference	p Value	95% Confidence Interval
SSC vs. NuSmile ZR	0.099	0.000*	0.0961 - 0.1015
NuSmile ZR vs. Figaro	0.059	0.000*	0.0564 - 0.0618
Figaro vs. SSC	0.040	0.000*	0.0369 - 0.0424

*Sig at 0.05 level, PostHoc test - Tukey's HSD

Table 4. Typodont tooth weights before and after tooth preparation for the three different crowns tested.

Crowns	Pretreatment tooth weight (grams)	Post-treatment tooth weight (grams)	Mean \pm SD weight of tooth substance removed	% reduction in weight
SSC	0.739	0.684	0.0549 \pm 0.0005	7.4
NuSmile ZR	0.738	0.585	0.1529 \pm 0.0030	20.7
Figaro	0.739	0.644	0.0945 \pm 0.0019	12.8

Each value represents the arithmetic mean of the averaged three repeated weights for each of the 10 specimens.

Discussion

SSCs have been used for decades in pediatric dentistry but have gone through various modifications and makes it time consuming for the operator and the patient. Zirconia crowns are esthetically pleasing alternative to SSCs and are widely used due to parent satisfaction. The flexural strength of zirconia oxide materials has been reported to be between 900 - 1100 MPa which is five times greater than standard glass ceramics.[8] Another important property is their fracture toughness making them perdurable and a highly strong restoration.[9, 10] Currently many brands of Zirconia crowns are available that allows practitioners to provide patients with superior, highly polished, esthetic results.[11, 12] The recently introduced fibre-glass crowns (Figaro™Inc.) are made of multiple fiber mesh sheets of fiberglass, aramid, carbon or quartz fibers embedded with an outer cosmetic composite resin. The titanium oxide and ferric oxide helps to increase strength and adds esthetics. The tooth preparation as suggested by the manufacturer is that it is minimal as similar for SSCs. There is enhanced adaptation by the Flex fit technology used which reduces crimping step and also allows the operator to make any occlusal reduction on the crown if necessary.

In the current study, a highly statistical significant difference was noted in the post mean weight of tooth substance among all three crowns used. The typodont tooth weights before the preparation had a standard deviation of 0.001 gms, i.e. the typical typodont tooth differed less than a thousandths of a gram from others in the sample. Therefore they were considered homogeneous in size

and weight, as received from the manufacturer. This uniformity of the typodont teeth helped achieve statistically significant differences and completely attribute the results to the different crowns used in the study.

A significant high mean difference was noted when compared between SSC and Zirconia crowns i.e. higher removal of tooth structure in the latter. This shows that the former needs lesser tooth reduction (7% reduction in weight) and therefore a less likely exposure of pulp than the latter which had a close to 3 times greater tooth reduction than SSC (20.7% reduction in weight). Hence the chances of pulpal exposure with the use of zirconia crowns is more likely. This was similar to the study done by Clark et al., which concluded zirconia restorations required slightly less than twice as much tooth structure removal when compared to the SSCs (upto 185 percent).[5]

A significant mean difference was also noted when compared between SSC and Fibre-glass crowns but was approximately half the mean difference lesser when compared to Zirconia crowns. Although a significant mean difference was noted when compared between fibre-glass and zirconia crowns, the mean difference in reduction of tooth substance was comparatively higher than the mean difference between fibre-glass and SSCs. This shows that the fibre-glass crowns had a tooth reduction as closer to the SSCs which can provide an operator's ease, faster crown preparation and lesser chances for pulpal exposure.

Apart from the longevity of crowns, the operators' ease in handling the crown and esthetical concerns of the parent needs to

be taken into account. Though zirconia crowns can fulfil the esthetical point of view, it lacks the operators ease as it has a higher tooth reductions and requires a passive fit. SSCs can provide an operators' ease but doesn't meet the esthetical requirements. While fibre-glass crowns may provide an alternative by bridging the gap between the two.

The major limitation of this study was that it is in-vitro in nature. While zirconia crown preparations are significantly more aggressive than SSC preparations, determining the clinical repercussions of aggressive tooth reduction, such as mechanical exposure of the pulp, is beyond the scope of this study. A randomised clinical trial would be necessary in the future to determine the longevity and esthetical satisfaction among the parents using the new fibre-glass crowns to justify its clinical performance.

Conclusion

The following conclusions could be made within the limitations of the current study:

1. Stainless steel crowns had the least tooth reduction among the crowns used
2. Fibre-glass crowns (Figarocrowns™ Inc.) can provide an aesthetic alternative along with minimal reduction of tooth structure.
3. Zirconia crowns required significantly more tooth reduction than stainless steel crowns in the posterior primary dentition.

References

- [1]. Abdulhadi BS, Abdullah MM, Alaki SM, Alamoudi NM, Attar MH. Clinical evaluation between zirconia crowns and stainless steel crowns in primary molars teeth. *J Pediatr Dent* 2017;5:21-7.
- [2]. Yilmaz Y, Koçoğullari ME. Clinical evaluation of two different methods of stainless steel esthetic crowns. *J Dent Child (Chic)*. 2004;71(3):212-4.
- [3]. Shah PV, Lee JY, Wright JT. Clinical success and parental satisfaction with anterior preveneered primary stainless steel crowns. *Pediatr Dent*. 2004;26(5):391-5.
- [4]. Townsend JA, Knoell P, Yu Q, Zhang JF, Wang Y, Zhu H, et al. In vitro fracture resistance of three commercially available zirconia crowns for primary molars. *Pediatr Dent*. 2014 Sep-Oct;36(5):125-9. PubmedPMID: 25303499.
- [5]. Clark L, Wells MH, Harris EF, Lou J. Comparison of Amount of Primary Tooth Reduction Required for Anterior and Posterior Zirconia and Stainless Steel Crowns. *Pediatr Dent*. 2016 Jan-Feb;38(1):42-6. Pubmed PMID: 26892214.
- [6]. NuSmile. Beyond Innovation, Pediatric Crown Perfection. Available at https://www.nusmile.com/ZR_Zirconia. Accessed: 2019-03-08. (Archived by WebCite® at <http://www.webcitation.org/76jh9Ogje>)
- [7]. Figaro Crowns, Inc. Why Figaro crowns. Available at <https://figarocrowns.com/pages/why-figaro-crowns>. Accessed: 2019-03-08. (Archived by WebCite® at <http://www.webcitation.org/76jhQJTsd>)
- [8]. Manicone PF, Rossi Iommetti P, Raffaelli L. An overview of zirconia ceramics: basic properties and clinical applications. *J Dent*. 2007 Nov;35(11):819-26. PubmedPMID: 17825465.
- [9]. Denry I, Holloway JA. Ceramics for dental applications: a review. *J Dent Mater* 2010;3:351-368.
- [10]. Walia T, Salami AA, Bashiri R, Hamoodi OM, Rashid F. A randomised controlled trial of three aesthetic full-coronal restorations in primary maxillary teeth. *Eur J Paediatr Dent*. 2014 Jun;15(2):113-8. Pubmed PMID: 25102458.
- [11]. Townsend JA, Knoell P, Yu Q, Zhang JF, Wang Y, Zhu H, et al. In vitro fracture resistance of three commercially available zirconia crowns for primary molars. *Pediatr Dent*. 2014 Sep-Oct;36(5):125-9. Pubmed PMID: 25303499.
- [12]. Ashima G, Sarabjot KB, Gauba K, Mittal HC. Zirconia crowns for rehabilitation of decayed primary incisors: an esthetic alternative. *J ClinPediatr Dent*. 2014 Fall;39(1):18-22. PubmedPMID: 25631720.
- [1]. Abdulhadi BS, Abdullah MM, Alaki SM, Alamoudi NM, Attar MH. Clinical evaluation between zirconia crowns and stainless steel crowns in primary