



Clinical Evaluation and Parental Satisfaction with Pediatric Zirconia Anterior Crowns

Daniel M. Holsinger, DDS, MDS¹ • Martha H. Wells, DMD, MS² • Mark Scarbecz, PhD³ • Martin Donaldson, DDS⁴

Abstract: Purpose: The purpose of this study was to evaluate the clinical success of and parental satisfaction with anterior pediatric zirconia crowns. **Methods:** A retrospective analysis of maxillary anterior pediatric zirconia crowns was performed. Crowns were evaluated for retention, gingival health, color match, contour, marginal integrity, and opposing tooth wear. Parental satisfaction regarding the esthetics of the crowns and parental perception of the impact of treatment on the child's appearance and oral health were evaluated by questionnaire. **Results:** Fifty-seven crowns were evaluated in 18 children. Eight teeth were lost to exfoliation, three were extracted due to pathology, and two crowns debonded, leaving 44 available for examination. The average crown age at time of examination was 20.8 months. Sixteen crowns (36 percent) displayed gingival inflammation and color mismatch. No recurrent caries or opposing tooth wear was noted. Parents reported high satisfaction with the color, size, and shape of the crowns. The majority of parents reported that crowns improved the appearance and oral health of their child (78 percent and 83 percent, respectively). Eight-nine percent of parents reported that they would highly recommend these crowns. **Conclusions:** Zirconia crowns are clinically acceptable restorations in the primary maxillary anterior dentition. Parental satisfaction with zirconia crowns is high. (*Pediatr Dent* 2016;38(3):192-7) Received October 9, 2015 | Last Revision March 8, 2016 | Accepted March 9, 2016

KEYWORDS: ZIRCONIA, PEDIATRIC DENTISTRY, PARENTS

The surgeon general has called early childhood caries (ECC) the silent epidemic, as national data suggest that nearly 30 percent of preschoolers have caries.¹ Esthetic management of primary teeth has become essential, as parents are more involved in the clinical decision-making process and are more demanding of esthetic restorations.² A survey of pediatric dentists reported that 87 percent of parents are concerned with the esthetics of even a posterior restoration.³ In addition, children themselves prefer tooth-colored restorations. Fishman et al. found that, among children, tooth-colored composite material was the most preferred restoration, and silver-colored amalgam was the least preferred restoration.⁴ Resin strip crowns, preveneered stainless steel crowns, and open-faced crowns with a window have historically been offered as alternatives for the classic anterior preformed metal crown.

Each of these restorations has advantages and disadvantages. Historically, resin strip crowns have been arguably the most esthetic option, as the color and shape can be controlled; however, they require adequate isolation and are technique sensitive.⁵ Pre-veneered stainless steel crowns do not require as much isolation as strip crowns, since they can be cemented with a more moisture-tolerant glass ionomer cement.⁶ However, they require a more aggressive preparation and passive fit and have a resin facing that can debond.⁷ Open-faced crowns offer a more conservative preparation and are more moisture tolerant for cementation but require isolation for placing the resin facing; however, they have little literature to support their use, and the composite facing can debond.⁸

Zirconia has been used successfully for over a decade in adult dentistry.⁹⁻¹¹ The application of this material has been

adapted for pediatric dentistry to provide a more durable and esthetic alternative. Short term, *in vivo* and *in vitro* studies suggest zirconia to be an acceptable restorative material in primary teeth.¹²⁻¹⁴ EZ-Pedo (EZ-Pedo, Loomis, Calif., USA) was the first pediatric zirconia crown commercially available in the United States, originally marketed in 2008. Use of all ceramic restorations is increasing as multiple other brands (NuSmile, Houston, Texas, USA; Kinder Krowns, St. Louis Park, Minn., USA; and Cheng Crowns, Exton, Pa., USA) have since created pediatric zirconia products. Advantages to the zirconia crown are the promise of excellent esthetics, full coverage of the treated tooth, no components of the crown that might debond, and potentially a less sensitive technique for cementation compared to a resin strip crown. The potential disadvantages of the zirconia restoration are the inability to crimp the crown for mechanical retention, inability to change its color, the limited ability to trim the crown or alter its shape, and the need for more tooth reduction than a traditional preformed metal crown.¹⁵ The zirconia crowns are also more expensive. Table 1 offers a comparison of the estimated total cost of each type of esthetic anterior pediatric crown.

Methods

The Institutional Review Board of the University of Tennessee Health Science Center (Memphis, Tenn., USA) approved this retrospective cross-sectional study. Fifty-three two- to six-year-olds who had been treated at the University of Tennessee Graduate Pediatric Dentistry Clinic (Memphis) between 2010 and 2014 and who received EZ-Pedo maxillary anterior restorations were identified from electronic patient care records for possible inclusion in the study. The study consisted of a clinical examination of the child and the administration of a questionnaire to the parent or guardian regarding his/her perception of zirconia crowns. Accordingly, the term parent in this article will apply to any parent or legal guardian who completed the questionnaire. Parents of 18 children were able to

¹Dr. Holsinger is an associate dentist in private practice, Brentwood, Tenn., USA; Drs.

²Wells and ⁴Donaldson are associate professors, Department of Pediatric Dentistry, and

³Dr. Scarbecz is a professor, Department of Bioscience Research, and assistant dean for institutional affairs, all in the College of Dentistry, University of Tennessee Health Science Center, Memphis, Tenn., USA.

Correspond with Dr. Wells at mwells18@uthsc.edu

be contacted, and the children were scheduled for their routine care appointment. Consent was obtained from each participant's parent, and verbal assent was obtained from the child during the child's appointment. Excluded were children with special needs, participants for whom English was not the primary language, individuals who were not the parent of the child, and children who received crowns not placed in ideal conditions (such as following ineffective sedation).

All of the children in this cohort of patients had ECC and received EZ-Pedo maxillary anterior crowns placed by either a first- or second-year pediatric dental resident under the supervision of an attending faculty member. All crowns were placed in ideal conditions while the children were under general anesthesia or sedation. Subjects had at least one crown cemented on a primary maxillary incisor with glass ionomer cement (Ketac, 3M ESPE, St. Paul, Minn., USA) at least six months prior to evaluation. Only zirconia anterior crowns purchased commercially and manufactured by EZ-Pedo were evaluated. All patients were given standard postoperative instructions, which included oral hygiene instructions and dietary restrictions such as avoiding sticky foods that could cause the crowns to debond.

Table 1. ESTIMATED TOTAL COST OF THREE DIFFERENT ANTERIOR PEDIATRIC ESTHETIC RESTORATIVE DENTAL CROWNS

Product	Approximate crown form cost*	Cost of bonding/cementing	Estimated total cost of materials
Strip crown	\$6.18	\$15.65†	\$21.83
Resin-veneered stainless steel crown	\$18.70	\$5.43‡	\$24.13
Zirconia crown	\$23.48	\$4.90§	\$28.38

* Cost shown is an average of commercially available products in their unit-dose forms and may vary across brands and distributors and would vary when purchasing in bulk. Products represented in the average cost comparison are the costs provided by the individual manufacturers and/or Henry Schein Dental (Palatine, Ill., USA): (1) strip crown forms—3M ESPE Strip Crown Forms (3M ESPE, St. Paul, Minn., USA) and pediatric strip crowns (Space Maintainers Laboratory, Chatworth, Calif., USA); (2) resin-veneered stainless steel crowns—NuSmile (Houston, Texas, USA), Kinder Krowns (St. Louis Park, Minn., USA), and Cheng Crowns, (Exton, Pa., USA); (3) zirconia crowns—EZ-Pedo (Loomis, Calif., USA), NuSmile, Kinder Krowns, and Cheng Crowns.

† Estimated cost of unit-dose etchant, unit-dose prime and bond, and unit-dose ampule of composite resin. Products represented in the average cost comparison are: Henry Schein 40% Etch Gel, Delton EZ Etch (DENTSPLY, York, Pa., USA), Adper Single Bond Plus (3M ESPE), Opti-Bond Solo Plus (Kerr, Orange, Calif., USA), Prime & Bond NT (DENTSPLY Caulk, Milford, Del., USA), TPH Spectra (DENTSPLY Caulk), Filtek Z100 Restorative (3M ESPE), Tetric (Ivoclar Vivadent, Amherst, N.Y., USA).

‡ Average cost of unit-dose glass ionomer cement; products represented in the average cost comparison are: Ketac (3M ESPE) and GC FugicEM 2 (GC America, Alsip, Ill., USA).

§ Average cost of unit-dose bioactive cement; products represented are Biocem (NuSmile) and Ceramir (Doxa Dental Inc, Chicago, Ill., USA).

One examiner completed all clinical evaluations and administered a written parental questionnaire. The examiner was available for questions from the parents regarding the questionnaire. This examiner was calibrated in the first three examination sessions with one faculty member during the clinical evaluation of the crowns for consistency of chairside clinical assessment. The examiner and faculty member each evaluated the patients independently and reviewed their scoring after the examination was complete. For all three sessions, the examiner and faculty were in 100 percent agreement.¹⁶

Data collected included the child's age, sex, overjet, overbite, and gingival score, as described in previous studies.¹⁷⁻¹⁹

Table 2. CLINICAL OUTCOMES OF EZ PEDO PRIMARY MAXILLARY ANTERIOR ZIRCONIA CROWNS REPORTED AS FREQUENCIES

Clinical Outcomes	N (%)
Characteristic	N (%)
<i>Crown retention</i>	
Intact	44 (96)
Chipped/small but noticeable areas of loss of material	0 (0)
Large loss of material	0 (0)
Complete loss of crown	2 (4)
<i>Gingival index</i>	
No inflammation	28 (64)
Mild inflammation	14 (32)
Moderate inflammation	2 (4)
Marked inflammation	0 (0)
<i>Color match</i>	
No noticeable difference from adjacent teeth	28 (64)
Slight shade mismatch	14 (32)
Obvious shade mismatch	2 (4)
<i>Crown contour</i>	
Crown is cosmetic, natural looking	39 (89)
Size/shape is acceptable, not ideal	4 (9)
Crown not esthetic, detracts from appearance of the mouth	1 (2)
<i>Opposing tooth wear</i>	
No wear	44 (100)
Wear	0 (0)
<i>Marginal integrity</i>	
Closed margin	38 (86)
Open margin	6 (14)
<i>Recurrent caries</i>	
Yes	0 (0)
No	44 (100)

Data recorded included: the tooth/teeth treated, the date the crown was cemented, whether the tooth was present or absent/exfoliated, the crown's retention, color match, contour, marginal integrity, the presence of recurrent caries, and opposing tooth damage. Color match was scored by comparing each zirconia crown to the color of adjacent teeth, as done in previous studies of this nature.^{6,18,20} Marginal integrity was determined through visible inspection and tactile examination with an explorer. Each of these criteria was assessed and recorded according to the scales illustrated in Table 2.

The questionnaire captured sociodemographic information, such as ethnicity/race, education level, and type of dental insurance. Criteria collected in the survey included the parent's perception of the color, shape, and size of each crown. These characteristics of the crowns were scored using a five-point Likert scale, which was similar to scales used in other studies: one equals very dissatisfied; two equals dissatisfied; three equals neutral/satisfied; four equals satisfied; five equals very satisfied.^{18,19} Parents were also asked if the crowns had ever come off (debonded). Questions were asked regarding whether the child's oral health, appearance, and/or frequency of smiling were improved after placement of the crowns in order to determine the parental perception of the impact of the restorations. Responses were recorded on a Likert scale score of one to five, with one being not at all and five being very much. Parents were asked to rate their overall experience with the crowns on a scale of one to 10, similar to other studies,^{18,19,21} with one being very dissatisfied and 10 being very satisfied. Parents were asked if they would recommend (not recommend, recommend, or highly recommend) these crowns to another parent whose child needed anterior crowns. Parents were also asked to choose from a prepared list of potential difficulties the child may have experienced with the crowns, such as bleeding around the gums when brushing, food lodging in between the crowns, and sensitivity with hot/cold foods (more than one response was allowed). Finally, parents had the opportunity to give additional comments on their experience with the crowns.

Results

Fifty-three patients received EZ-Pedo crowns between 2010 and 2014. Eighteen children (six females and 12 males) were contacted and scheduled for a routine care appointment. A total of 57 crowns were identified in the 18 children. Eight of the teeth were lost to exfoliation, two crowns debonded, and three were extracted due to pathology (five percent). Of the three teeth extracted, one had received pulpal therapy. Forty-four crowns were available for evaluation, yielding a mean of 2.4 (± 3.2 SD) crowns per patient. The average crown age at the time of examination was 20.8 months (range equals six to 37 months; 14 crowns were followed for six to eight months after initial placement while the other 30 crowns were followed for at least 14 months after placement). Seventeen mothers and one father were surveyed. Fifty-six percent of parents were black/African American, 33 percent were Hispanic, and 11 percent were white/Caucasian.

The children receiving the anterior crown treatment were generally from lower socioeconomic status. Eighty-nine percent were on public or government insurance, while the remaining 11 percent had private insurance. Sixty-seven percent of parents had no higher than a high school degree, and 28 percent had an associate/junior college/vocational degree.

Clinical outcomes are reported as frequencies in Table 2. Most crowns were retained (96 percent) and had closed margins (86 percent). Color shade mismatch and gingival inflammation were reported for 16 crowns. No recurrent caries was



Figure 1. Maxillary incisors restored with EZ-Pedo zirconia crowns, A) 7 months post-treatment, B) 34 months post-treatment, the maxillary left central had 3+ mobility consistent with normal exfoliation.



Figure 2. Maxillary incisors restored with EZ-Pedo zirconia crowns at 29 months post-treatment. The shape of the maxillary left central incisor was rated as not esthetic due to its small size; the crown color was rated as a slight shade mismatch. The maxillary right lateral incisor showed mild gingival recession.

noted, and no wear was observed on any of the teeth opposing the crowns. Figure 1 depicts two patients with clinically acceptable zirconia restorations, one at seven months follow-up and one at 34 months follow-up. Figure 2 depicts a patient with less than ideal esthetics at 29 months follow-up. The crown size/contour for the maxillary left central incisor is too small and detracts from the esthetic appearance of the dentition (the only crown scored with this rating in the study), and the crowns displayed a slight shade mismatch. Additionally, gingival recession and an open margin could be noted on the facial of the maxillary right lateral incisor.

The majority of parents were satisfied with the color, size, and shape of the crowns, as these characteristics all received a mean Likert scale rating of equal to or greater than 4.4 (Table 3). When asked if any of the crowns had ever fallen off, 83 percent of parents reported that the crowns had never debonded and 17 percent reported that the crowns had fallen off at least once. Table 4 details parents' perceptions of the impact of treatment on their children's oral health and appearance. Most parents reported that the crowns improved their children's oral health and appearance (83 percent and 78 percent, respectively). Seventy-eight percent of parents reported having concerns about the appearance of their children's teeth prior to dental treatment (selecting a four or five on the rating scale). However, the majority of parents (83 percent) did not report smile avoidance prior to dental treatment.

When asked to select any problems the child may have experienced with the crowns from a prepared list, 11 parents (61 percent) reported no difficulties. Of the seven parents (39 percent) who reported problems (multiple responses were allowed), four reported "bleeding around the crowns when brushing," three reported "hot/cold sensitivity," and three reported "food got stuck between the crowns." Parents rated their overall experience with these crowns very high, with a mean rating of 9.3 on a 10-point Likert scale. All parents replied that they would "recommend" these crowns, and 16 of the 18 parents surveyed (89 percent) reported that they would "highly recommend" these crowns to another parent whose child was in need of anterior restorations.

Discussion

Parents are demanding more esthetic restorations,²² and few studies exist regarding the clinical performance of zirconia crowns in the primary dentition.^{12,14} Prior to the introduction of zirconia restorations, the esthetic options for the pediatric dentist were strip crowns, veneered resin stainless steel crowns, or stainless steel crowns which the dentist open-faced and in which a resin composite was placed. Strip crowns have been shown to have high parental acceptance²¹ but are highly technique sensitive and require adequate hemostasis and curing of the composite. Additionally, several authors have reported an increase in gingival inflammation with strip crowns, most likely due to subgingival margin placement.^{14,20} Veneered stainless steel crowns also have high parental acceptance but require a passive fit and are subject to the esthetic facing debonding or fracturing.^{18,19}

Zirconia crowns are less technique sensitive and more moisture tolerant, though this is cement-dependent, and different manufacturers recommend different cements; some manufacturers recommend a glass ionomer cement such as the one used in this study, while other manufacturers

recommend a bioactive cement. Zirconia products have also been found to be biocompatible and highly polished and have less plaque accumulation, leading to decreased gingival irritation both in permanent²³ and primary teeth.¹⁴ Disadvantages of zirconia crowns for primary teeth are: they cannot be altered in color, trimmed, or crimped for retention (retention is dependent upon the strength of the luting cement); they have limited ability to be reshaped; and they require more aggressive tooth reduction than stainless steel crowns.¹⁵ An additional possible disadvantage to zirconia primary crowns is that they are slightly more expensive restorations compared to the other restorative materials available; overall, however, they are less than 20 to 30 percent more expensive.

Given the disadvantages noted for zirconia regarding the limited ability to change the shape or color of the crown, the first question to be answered is: Are pre-fabricated zirconia crowns esthetic for child patients? In this study, the esthetics of the zirconia crowns were evaluated by scoring the variables of size, color, and shape compared to adjacent teeth. Acceptable to excellent esthetics were noted, as most crowns had a natural, cosmetic shape (89 percent) and an imperceptible difference in color to adjacent teeth (64 percent). Additionally,

Table 3. PARENTAL SATISFACTION RATINGS OF ESTHETIC CHARACTERISTICS OF EZ PEDO PRIMARY ANTERIOR ZIRCONIA CROWNS

Characteristic of EZ-Pedo Crowns	Rating for parental satisfaction N (%)					Mean Likert scale rating
	1 (not at all)	2	3	4	5 (very much)	
Size	0	0	1 (6)	7 (39)	10 (55)	4.5
Shape	0	0	3 (17)	4 (22)	11 (61)	4.4
Color	0	0	1 (5)	5 (28)	12 (67)	4.6

Table 4. PARENTAL RATINGS OF THE IMPACT OF TREATMENT ON THEIR CHILDREN WITH EZPEDO PRIMARY MAXILLARY ANTERIOR ZIRCONIA CROWNS

Characteristic	Parental ratings N (%)					Mean Likert scale rating
	1 (not at all)	2	3	4	5 (very much)	
Oral health of child improved after crowns	0	1 (6)	0	2 (11)	15 (83)	4.7
Parents concern about appearance before the crowns	2 (11)	0	2 (11)	5 (28)	9 (50)	4.1
Child avoided smiling before crowns	15 (83)	0	2 (11)	1 (6)	0	1.4
Child smiled after crowns	1 (5.5)	0	5 (28)	1 (5.5)	11 (61)	4.2
Crowns improved appearance of the child's teeth	0	0	1 (6)	3 (16)	14 (78)	4.7

even if a material is found to be esthetic, it must also be adequately retained in order to be a viable primary tooth restorative material. In this study, 96 percent of crowns were intact. Walia et al. also examined anterior esthetic restorations for primary teeth in a recent randomized controlled trial; similar to this study, the authors found a high retention rate for zirconia crowns (100 percent after six months).¹⁴

Given that dental professionals experience parental influence on choice of restorative material, parental opinion of esthetics, durability, and impact on a child's overall oral health is important.² In this study, the dentist's clinical findings regarding color, size, and shape correlated well with parent satisfaction, as parents rated all variables with an average score of 4.4 or higher on a five-point scale. Another study, Salami et al., which examined parental satisfaction of 13 parents regarding zirconia crowns, found similar results to this study, reporting the mean overall satisfaction as 4.6 on a five-point scale. No parents were dissatisfied with the durability, shape, or size of the crowns; one parent reported being dissatisfied with the color of the crowns.²

Parents expressed a clear opinion that the crowns improved the oral health and appearance of their child. The lowest average score was in response to the child avoiding smiling before the crowns were placed. In this population, parents did not report smile avoidance prior to treatment. One possible explanation for this finding is that the children were very young and arguably too young to be self-conscious of appearance. However, a recent study noted that young children (four to five years old) have negative social perceptions of altered esthetics in the primary maxillary dentition.²⁴ While the children did not avoid smiling prior to restorations, the parents were clearly concerned about the appearance of their child's teeth, as 50 percent selected the highest rating on the Likert scale, which indicated being very concerned. And finally, while parents did identify some problems with the crowns, their overall satisfaction with anterior zirconia restorations was very high. Hence, parents seem to find these restorations highly acceptable.

Additional factors to be examined in determining if zirconia crowns are an acceptable restorative material are the effects on the periodontium and the opposing dentition. Home care and oral hygiene practices would affect gingival index results; however, in this study, plaque scores were not recorded. This could have been valuable information to determine if the crown itself caused gingival inflammation or if poor oral hygiene was the culprit. Given that the majority of crowns had closed margins (86 percent) and no inflammation (64 percent), poor oral hygiene most likely played a significant role in the inflammation recorded. Additionally, as discussed earlier, zirconia has been shown to show low plaque accumulation, and Walia et al. found a significant decrease in the gingival index after restoration with zirconia.¹⁴

Another clinical concern was opposing tooth wear, since permanent zirconia crowns have been shown to cause wear to the opposing tooth.²⁵ In this study, no wear was noted in the opposing primary dentition. Walia et al. found that four opposing teeth (10 percent) of the 38 zirconia primary crowns showed minimal loss of contour indicative of a loss of enamel surface. These authors state that this was not statistically significant but could be clinically significant. However, the crowns used in the study were Zirkiz crowns (Hass, Gangwon-do, South Korea), which could have had a different amount of polish or gloss compared to EZ-Pedo crowns.

A major limitation of this study was the small sample size. Of the 53 patients identified, only 18 patients could be contacted and/or presented for a routine care appointment. During phone contact, it was found that many patients had invalid phone numbers or lost phone service and were unable to be contacted or the families had moved. This low response rate must be considered in terms of the generalizability of this study's findings. For example, it is possible that many of the crowns in the patients lost to follow-up could have been clinical failures. Furthermore, a more varied population regarding ethnicity and socioeconomic status would also be ideal. Another limitation to this study was the large range in follow-up times from initial crown placement. Fourteen of the teeth were followed for between six to eight months after initial placement, and some failures may not become evident as early as six months. This is also the primary limitation of the Walia et al. study, which had only a six-month follow-up time. Other limitations to the study were the reliance on the parent to be a good historian and the fact that multiple operators performed the treatment.

Future research should examine oral hygiene practices and plaque scores to determine the true effects of the crowns on the gingival health. Additionally, different brands of zirconia crowns may have different levels of polish or gloss, which would affect their wear effects on the opposing dentition. Also, some manufacturers recommend utilizing a bioactive cement. Bioactive cements, which bond to both zirconia and tooth structure, may have increased bond strength and could show a different retention rate than crowns cemented with a glass ionomer cement.

Conclusions

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

1. EZ-Pedo crowns cemented with glass ionomer cement were well retained at 20.8 months (range equals six to 37 months). (96 percent for the teeth evaluated).
2. EZ-Pedo crowns displayed clinically acceptable outcomes in terms of:
 - a. gingival index, displaying either no inflammation or mild inflammation (96 percent);
 - b. closed margins (86 percent);
 - c. indiscernible color difference to adjacent teeth (64 percent);
 - d. natural looking contours (89 percent)
 - e. no opposing tooth wear; and
 - f. no recurrent caries.
3. Overall, parents are satisfied with EZ-Pedo crowns as a restoration in the primary maxillary anterior dentition, as they rated their overall experience a 9.3 on a 10-point scale.
4. Parents reported that EZ-Pedo crowns improved the appearance and oral health of their children (both with mean ratings of 4.7 on a 5 point scale).
5. EZ-Pedo zirconia crowns are an acceptable restorative option in the primary maxillary anterior dentition.

References

1. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Health Stat* 11 2007;248:1-92.

2. Salami A, Walia T, Bashiri R. Comparison of parental satisfaction with three tooth-colored full-coronal restorations in primary maxillary incisors. *J Clin Pediatr Dent* 2015;39:423-8.
3. Zimmerman JA, Feigal RJ, Till MJ, Hodges JS. Parental attitudes on restorative materials as factors influencing current use in pediatric dentistry. *Pediatr Dent* 2009;31:63-70.
4. Fishman R, Guelmann M, Bimstein E. Children's selection of posterior restorative materials. *J Clin Pediatr Dent* 2006;31:1-4.
5. Kupietzky A. Bonded resin composite strip crowns for primary incisors: clinical tips for a successful outcome. *Pediatr Dent* 2002;24:145-8.
6. MacLean JK, Champagne CE, Waggoner WF, Ditmyer MM, Casamassimo P. Clinical outcomes for primary anterior teeth treated with veneered stainless steel crowns. *Pediatr Dent* 2007;29:377-81.
7. Kratunova E, O'Connell AC. Chairside repair of veneered primary molar stainless steel crowns: a pilot study. *Pediatr Dent* 2015;37:46-50.
8. Waggoner WF, Cohen H. Failure strength of four veneered primary stainless steel crowns. *Pediatr Dent* 1995;17:36-40.
9. Zarone F, Russo S, Sorrentino R. From porcelain-fused-to-metal to zirconia: clinical and experimental considerations. *Dent Mater* 2011;27:83-96.
10. Conrad HJ, Seong WJ, Pesun IJ. Current ceramic materials and systems with clinical recommendations: a systematic review. *J Prosthet Dent* 2007;98:389-404.
11. Al-Amleh B, Lyons K, Swain M. Clinical trials in zirconia: a systematic review. *J Oral Rehabil* 2010;37:641-52.
12. Ashima G, Sarabjot KB, Gauba K, Mittal HC. Zirconia crowns for rehabilitation of decayed primary incisors: an esthetic alternative. *J Clin Pediatr Dent* 2014;39:18-22.
13. Townsend JA, Knoell P, Yu Q, et al. In vitro fracture resistance of three commercially available zirconia crowns for primary molars. *Pediatr Dent* 2014;36:125-9.
14. 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;15:113-8.
15. Clark L, Wells M, Harris E, Lou J. Comparison of amount of primary tooth reduction required for anterior and posterior zirconia and stainless steel crowns. *Pediatr Dent* 2016;38(1):42-6.
16. Champagne C, Waggoner W, Ditmyer M, Casamassimo PS. Parental satisfaction with veneered stainless steel crowns for primary anterior teeth. *Pediatr Dent* 2007;29:465-9.
17. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity. *Acta Odontol Scand* 1963;21:533-51.
18. Roberts C, Lee JY, Wright JT. Clinical evaluation of and parental satisfaction with resin-faced stainless steel crowns. *Pediatr Dent* 2001;23:28-31.
19. Shah PV, Lee JY, Wright JT. Clinical success and parental satisfaction with anterior veneered primary stainless steel crowns. *Pediatr Dent* 2004;26:391-5.
20. Kupietzky A, Waggoner WE, Galea J. Long-term photographic and radiographic assessment of bonded resin composite strip crowns for primary incisors: results after 3 years. *Pediatr Dent* 2005;27:221-5.
21. Kupietzky A, Waggoner WF. Parental satisfaction with bonded resin composite strip crowns for primary incisors. *Pediatr Dent* 2004;26:337-40.
22. Gosnell ES, Thikkurissy S. Management of dental caries and esthetic issues in the pediatric patient. *J Calif Dent Assoc* 2013;41:619-29.
23. Sailer I, Feher A, Filser F, et al. Five-year clinical results of zirconia frameworks for posterior fixed partial dentures. *Int J Prosthodont* 2007;20:383-8.
24. Soares FC, Cardoso M, Bolan M. Altered esthetics in primary central incisors: the child's perception. *Pediatr Dent* 2015;37:29-34.
25. Stober T, Bermejo JL, Rammelsberg P, Schmitter M. Enamel wear caused by monolithic zirconia crowns after 6 months of clinical use. *J Oral Rehabil* 2014;41:314-22.