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Clinical evaluation and comparison of various aesthetic crowns in primary anterior teeth in children- A randomized clinical trial

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Abstract
Background: The necessity for good aesthetics, strength, and longevity make the providing restorations to children's anterior teeth a difficult undertaking. The Prefabricated primary anterior zirconia crowns and resin composite strip crowns on primary maxillary central and lateral incisors were compared in this study with regard to gingival health, restoration failure, and the opposing tooth wear over intervals of 3, 6, and 9 months.
Methods: Children who need restorations and were enrolled in the Department of Pediatric and Preventive Dentistry at the Govt. College of Dentistry Indore, MP, India, were screened for the eligibility. 116 teeth were treated in total; 59 were given the preformed primary anterior zirconia crowns and 57 were given strip crowns. Utilizing IBM's SPSS software 21.0 edition, basic random allocation was used for the randomization. Chi-square test was used to compare the categorical variables. P value.05 and the higher value were regarded as statistically significant. The research that was presented was retroactively registered at the Clinical Trials on 20th March, 2021, with registration number IEC/SS/21
Results: The Zirconia crowns demonstrated considerably decreased gingival bleeding at the 3, 6, 9-month follow-up intervals (p value <.05), no restoration failure (p value <.05), and no discernible difference between the two crowns in terms of wear on the opposing teeth.
Conclusion: According to our research, teeth with the zirconia crowns over time exhibit superior gingival health and fewer restoration failure. However, neither a zirconia crown nor a strip crown causes any opposing tooth wear.

Keywords: primary anterior teeth, strip crown, zirconia crown

Introduction

There are numerous alternatives for treating diseases including nursing bottle caries, enamel hypoplasia, tooth discolorations, fractured teeth, and bruxism in today's world, which affect children's appearances and increase the desire for better and more advanced materials that can correct the issue. Although the development of modern techniques for restoring decayed teeth has been beneficial to the industry, it is still challenging to satisfy patients who demand outstanding aesthetics. Pedodontists can help by offering the best solution to complex problems of space management, carious exposed anterior teeth, broken teeth, etc. that are challenging in all respects for the clinician as well [1, 2].

Choosing the ideal treatment approach for a certain patient and circumstance is, however, the hardest challenge. This study compared the latest developments in pediatric aesthetic dentistry's field of anterior crowns with their indications, prefabricated primary zirconia crowns with resin composite strip crowns on primary maxillary central and lateral incisors, with regards to gingival health, restoration failure, and opposing teeth wear over the course of 3, 6, and 12 months [3].

Aims

Study is aimed at comparing prefabricated primary zirconia crowns (Kids -e-Crown) with resin composite strip crowns (3M) on primary maxillary central and lateral incisors with regards to gingival health, restoration failure and the tooth wear of the opposing teeth over a period of 3, 6, and 9 months.

Objectives

- To evaluate Gingival health, using gingival index by Loe and Silness over a period of 3, 6, and 9 months
- To evaluate Restoration failure, using US Public Health Service “USPHS”, Alpha criteria rating system over a period of 3, 6, and 9 months
- To evaluate Teeth wear using Smith and Knight Tooth Wear Index over a period of 3, 6, and 9 months

Materials and method

This study had been planned to be conducted in Department of Paediatrics and Preventive Dentistry at Government College of Dentistry, Indore, Madhya Pradesh. Permission to carry out the study was obtained from Institutional ethical clearance committee. Study is aimed at comparing prefabricated primary zirconia crowns with resin composite strip crowns on primary maxillary central and lateral incisors To evaluate Gingival health, using gingival index by Loe and Silness,[1967] over a period of 3, 6, and 9 months To evaluate Restoration failure, using US Public Health Service “USPHS”, Alpha criteria rating system, Ryge, [1980] over a period of 3, 6, and 9 months To evaluate teeth wear using Smith and Knight Tooth Wear Index [Smith and Knight, 1984] over a period of 3, 6, and 9 months.

Inclusion criteria

1. Healthy two to six years old children.
2. Those having opposed anterior teeth.
3. No history of systemic illness or dental developmental anomalies which can affect dietary patterns, caries

susceptibility or the selection of restorative materials to the best of current knowledge.
4. Patient with Early Childhood Caries as defined by AAPD, 2016.
5. Cooperative patients who had behavioral rating “positive” or “definitely positive” followed the Frankel behavior classification scale.

Exclusion criteria
1. Teeth with proximity to exfoliation and resorption of the root passed its half.
2. Presence of single surface caries not involving the proximal surfaces.
3. Teeth that have been subjected to trauma.
4. Anxiety and lack of cooperation which required treatment under general anesthesia.
5. Bruxism.
6. Special health needs.
7. Presences of teeth wear on the opposing teeth, or absence of opposing.

Indices used
Table 1: Modified Gingival Index (MGI) by Loe and Silness (1967),

0	Normal gingiva
1	Mild inflammation -- Slight change in color, slight edema. No bleeding on probing
2	Moderate inflammation-- Redness, edema and glazing. Bleeding on probing
3	Severe inflammation — Marked redness and edema. Ulceration Tendency to spontaneous bleeding.

Table 2: Tooth wear of opposing teeth by Smith and Knight Tooth Wear Index (Bardsley, 2008; Smith and Knight, 1984)

0	No loss of enamel surface characteristics, no loss of contour
1	Loss of enamel surface characteristics, minimal loss of contour
2	Loss of enamel exposing dentine for less than one third of surface, loss of enamel just exposing dentin, defect less than 1 mm deep
3	Loss of enamel exposing dentin for more than one third of surface, loss of enamel and substantial loss of dentin, defect less than 1–2 mm deep
4	Complete enamel loss, pulp exposure, secondary dentin exposure, pulp exposure or exposure of secondary dentin, defect more than 2 mm deep, pulp exposure, secondary dentin exposure

Table 3: Restoration failure (US Public Health Service “USPHS”, Alpha criteria rating system, Ryge, 1980)

Alpha	Crown appears normal, no cracks, chips, or fracture
Bravo	Small but noticeable area of loss of material
Charlie	Large loss of crown material
Delta	Complete loss of crown

Methodology
On the basis of inclusion and exclusion criteria, the study population aged 2-6 years is selected from OPD of the Department of Pediatric and Preventive Dentistry, Government College of Dentistry, Indore. A written consent is obtained from each willing parent/ guardian.

Procedure
(Fig:1) In the first appointment, using split-mouth design a primary incisors and its contralateral tooth in same arch will be randomly assigned to a specific crown treatment group (Strip crown or zirconia crowns), Shade and size selection done. The contra-lateral primary incisor of the same pair will be restored by either strip crown or Zirconia crowns in the same visit or next visit.
The patient’s tooth is anaesthetized the carious lesion will be removed with an excavator and a burs. The bulk removal of the soft and Leathery dentin was done using round bur. After that, crown preparation was done for both strip crown and zirconia crown, the tooth will be isolated with cotton rolls and cheek retracted for Acid etching and bonding agent applied for strip crown placement and finishing and polishing done on the same day or in the next appointment and zirconia crown were cemented using 3M Espe Luting cement and light cured for 5 seconds. Excess cement was removed.
Children were given both the crown on contralateral right and left side of the upper anterior teeth. Assessment of gingival health, restoration failure, and opposing teeth wear between zirconia crowns to anterior strip crowns in primary incisors will be done at follow-ups at 3, 6 and 9 months. (Fig:2)
Data were entered into the excel sheet and analyzed using SPSS (Statistical Package for Social Sciences) 21.0 version, IBM, Chicago. Data were described as frequency and percentages. Comparison between the categorical variables was done using Chi-square test. P value <.05 was considered statistically significant.

Procedure

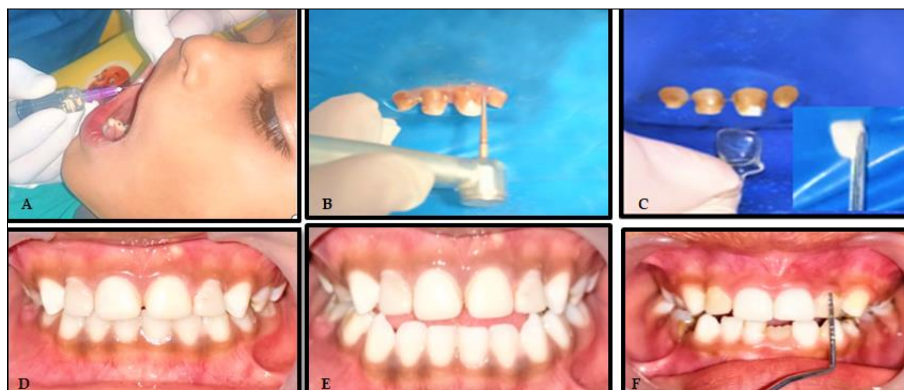

Fig 1: A) Anaesthetizing the tooth, B) Removal of demineralised dentin and tooth preparation, C) Crown selection, D) Post-op photograph preformed zirconia crown given w.r.t 51 and 61, strip crown given w.r.t 52 and 62, E & F) Assessment of gingival health, restoration failure and opposing tooth wear

Fig 2: Intra-oral photographs showing the treatment of teeth no. 51 and 52 by strip crown and teeth no. 61 and 62 by zirconia crown at different follow up intervals (3month, 6 month and 9 month

Results

Present study included 32 subjects. Both subjects received strip crown and zirconia crown. So that the total number of strip crown placed was 57 and total number of zirconia crown was 59 at the beginning of the study. At 6 months, 3 teeth with strip crown and 3 teeth with zirconia crown were physiologically exfoliated. Further, at 9 months, 6 teeth with zirconia crown were exfoliated physiologically. Thus, by the end of 9 months a total of 54 teeth with strip crown and 50 teeth with zirconia crown were present.

The study included patients aged 2-6 years. Maximum number of patients were 4 years old (40.6%). The number of male subjects was greater than the number of female subjects (43.8% vs 56.3%).

Gingival evaluation at different time intervals

Gingival health as measured by bleeding with probing is depicted in Fig:1(F). It can be seen that at different follow-up time interval significantly more teeth in the strip crown group were bleeding compared to the zirconia groups. (Table 4)

Zirconia crown

Chi-square value-12.104, df-2, p value-.002*

There was a significant increase in the number of teeth with gingival score ‘1’ over the period of time. Accordingly, there was a significant decrease in the number of teeth with gingival score ‘0’ over the period of time (p value <.05). None of the teeth with zirconia crown had gingival score ‘2’.

Strip crown

Chi-square value-37.972, df-4, p value- .000*

There was a significant increase in the number of teeth with gingival score ‘1’ and ‘2’ over the period of time. Accordingly, there was a significant decrease in the number of teeth with gingival score ‘0’ over the period of time (p value <.05).

Table 4: Comparison of gingival score of zirconia crown and strip crown at different time intervals. Score obtained according to Modified Gingival Index (MGI) by Loe and Silness (1967)

			Time interval						Total	
			3 months		6 months		9 months			
			Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown
Score	Score ‘0’	Frequency	59	55	56	48	45	29	160	132
		Percentage	100.0%	96.5%	100.0%	88.9%	90.0%	53.7%	96.9%	80.0%
	Score ‘1’	Frequency	0	2	0	6	5	21	5	29
		Percentage	0.0%	3.5%	0.0%	11.1%	10.2%	39.6%	3.0%	17.6%
	Score ‘2’	Frequency	0	0	0	0	0	4	0	4
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	7.5%	0.0%	2.4%
Total		Frequency	59	57	56	54	50	54	165	165
		Percentage	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Restoration failure evaluation

Crown failure during follow up intervals (Table 5) was clinically evaluated by visual assessment according to the US Public Health Service “USPHS”, Alpha criteria rating system. Restoration failure was more in the strip crown group Compared to Zirconia Crown group.

Zirconia crown

Chi-square value-2.512, df-4, p value- .643

Amongst Zirconia crown, over the period of time, there was no significant change in number of crowns with score ‘alpha’ ‘Bravo’, ‘Charlie’ and ‘Delta’ (p value >.05).

Strip crown

Chi-square value-36.727, df-6, p value-.000*

Amongst strip crown, over the period of time, there was a significant reduction in number of crowns with score ‘alpha’ and there was a significant increase in the number of crown scoring ‘Charlie’ and ‘Delta’ (p value <.05).

Table 5: Comparison of restoration failure of zirconia crown and strip crown at different time intervals. (According to Restoration failure US Public Health Service “USPHS”, Alpha criteria rating system, Ryge, 1980)

			Time interval						Total	
			3 months		6 months		9 months			
			Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown
Rating	Alpha	Frequency	58	12	54	0	47	0	159	12
		Percentage	98.3%	21.1%	96.4%	0.0%	94.0%	0.0%	96.3%	7.3%
	Bravo	Frequency	1	42	1	45	1	35	3	122
		Percentage	1.7%	73.7%	1.8%	83.3%	2.0%	66.0%	1.8%	74.4%
	Charlie	Frequency	0	3	0	7	0	13	0	23
		Percentage	0.0%	5.3%	0.0%	13.0%	0.0%	24.5%	0.0%	14.0%
	Delta	Frequency	0	0	1	2	2	5	3	7
		Percentage	0.0%	0.0%	1.8%	3.7%	4.1%	9.4%	1.8%	4.3%
Total		Frequency	59	57	56	54	50	53	165	164
		Percentage	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Tooth wear evaluation

According to Smith and Knight Tooth Wear Index The incisal and labial surfaces of the teeth opposing the full-coronal restorations were clinically observed for any sign of abrasion. both the crown showed no sign of opposing teeth wear at the interval of 3, 6 and 9 month follow up. (Table 6)

Table 6: Comparison of wear of opposing tooth of zirconia crown and strip crown at different time intervals. According to Tooth wear of opposing teeth by Smith and Knight Tooth Wear Index (Bardsley, 2008; Smith and Knight, 1984)

			Time interval						Total	
			3 months		6 months		9 months			
			Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown	Zirconia crown	Strip crown
Score	Score‘0’	Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Score‘1’	Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Score‘2’	Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Score‘3’	Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Score‘4’	Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total		Frequency	0	0	0	0	0	0	0	0
		Percentage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Discussion

Walia *et al* [5]. (2014) compared the restoration failure, tooth wear of opposing teeth, and gingival health of three aesthetic full-coronal restorations (composite strip crowns, preveneered SSCs, and prefabricated primary zirconia crowns). Zirconia crowns had the highest retention rate (100%) followed by preveneered SSCs (95%). Strip crowns were least durable (78%) while zirconia crowns revealed low-grade abrasion in four opposing teeth. According to Holsinger *et al* [6]. and Pani SC, Saffan AA, AlHobail S, *et al* [7]. (2016) For both crowns, there was no evidence of opposing tooth wear. Clinical and radiological effectiveness of 112 composite resin strip crowns in 40 children was documented by Kupietzky *et al* [8, 9]. in 2003 and 2004. A mean follow-up period of 18 months was found to have an 88% retention rate for the crowns. Although none of the crowns were totally destroyed, 12% of the teeth experienced a partial resin loss. One year later, the same retrospective study sample was utilised to gauge parental approval of the strip crowns' aesthetic appeal. which they said they were "very satisfied" with in 78% of cases. In 2005 same authors included clinical and radiological data collected after three years of follow-up revealed a 78% retention rate of strip crowns. Similar to the first study, the "lost" crowns only showed partial removal of the composite resin substance. In retrospective research from 2006, Ram and Fuks [10] discovered comparable outcomes for crown retention. Comparing the 12-month clinical results of primary maxillary incisors restored with composite strip crowns (CSCs), Nu Smile preveneered stainless steel crowns (PVSSCs), and NuSmile zirconia crowns was the goal of a study by Gill A[11]. *et al* (ZCs). Children were 3.4 years old on average, with a mean decayed, missing, and filled primary teeth (dmft) index score of 10.6, and were 55% female. Composite strip crowns demonstrated significantly lower clinical success in retention, durability, marginal adaption, and colour after 12 months. For Nu Smile ZCs, parental aesthetic satisfaction was highest. Alaki, S.M., Abdulhadi, B.S., AbdElBaki, M.A. *et al*. [12] conducted a randomised clinical trial in 120 primary teeth, When compared to strip crowns, zirconia crowns dramatically reduced gingival bleeding at the 3- and 6-month follow-up intervals, but there was no change at the 12-month follow up. At all subsequent visits, there was less plaque buildup around zirconia crowns. In comparison to zirconia crowns, strip crowns saw greater crown failures and recurrent caries at the 12-month follow-up.

The gingival health, restoration success, and tooth wear of the primary maxillary central and lateral incisors were evaluated in the present study between prefabricated primary zirconia crowns and resin composite strip crowns on 32 children aged 2 to 6 years. When compared to strip crowns, zirconia crowns dramatically reduced gingival score at 3, 6, and 9-month follow-up intervals, but there was no difference in the opposing teeth wear. When compared to zirconia crowns, strip crowns had a higher rate of crown failures at 9-month follow-up, similar to a study done by Alaki, S.M., *et al* (2020) [12]

According to Eidelman *et al*. [13], cases performed under general anaesthesia yielded better results for strip crowns than those performed under sedation. The use of general anaesthesia enables medical care to be delivered under ideal circumstances, meaning better results. The experiments conducted by Kupietzky *et al*. [8], Waggoner *et al*. [14], and Ram and Fuks [10] all revealed success rates between 80 and 88%. Zirconia crowns had a 100% retention rate at 6 months. According to Manicone *et al* [15], these crowns have no facial upper structure because they are built entirely of solid zirconia, which means there is no risk of facial veneer fracture. According to reports, zirconia oxide materials have a flexural strength between 900 and 1,100 MPa. Its strength is about four times stronger than that of typical glass ceramics and about twice that of currently available alumina oxide ceramics [15]. They are durable and a very strong repair due to their fracture toughness, which is another significant characteristic [16]. For clinical interventional research, randomized controlled trials are regarded as the most trustworthy method. [17] The tooth's preparation and finishing are two factors that may affect the gingival health of the crowns, according to Hackmyer and Donly (2010) [18]. The position of the crown margin and where the gingiva's free margin is located are directly related to the degree of gingival inflammation [5]. When utilised as a tooth material, zirconia is incredibly biocompatible and has a smooth, polished surface that helps to reduce plaque buildup and consequently, gingival discomfort. The findings of Abdulhadi *et al*. (2017) [19] that less gingival inflammation was caused by a lesser tendency for plaque build-up were supportive of our investigation. The removal of surface layer material (such as enamel) by the opposing teeth surface during function could be characterised as wear of the opposing dentition [20]. Holsinger *et al* (2016) [6]. reported no wear of the opposing dentition in zirconia crowns at roughly 20.8 months, which is in contrast to our study. The surface and physical characteristics of zirconia, including as its bending strength, hardness, density, and fracture toughness, are consistent with antagonistic tooth wear in zirconia crowns [20]. Only glazed and improperly polished teeth, according to research from the University of Zurich, can impair the opposing teeth's structure [5]. Ryge's direct (USPHS) alpha evaluation criteria were used in our study to evaluate restoration failure. P- value .05 Significant statistically 94.0% of zirconia crowns exhibited no restorative failure after 9 months. 64.1% of strip crowns exhibited discoloration. Strip crown's score was lower than the zirconia crown's, and distinction was Strip crown discoloration may be connected to changes in composite restoration brought on by the creation of colour deterioration products, variations in surface topography brought on by wear, and external staining [21]. At the 9 month follow up, we had 94% normal zirconia crowns in the group with no chips, cracks, or material fracture. In the randomised controlled trial, Holsinger *et al*. (2016) [6] reported that 96% of zirconia crowns were still in place at an average follow-up of 20.8 months, and Sharma M *et al*. (2021) [22] reported that 100% of the zirconia crowns were in perfect condition with no chips, cracks, or fractures of the material and had a higher success rate. Tate *et al* (2002) [23] reported 51% failure rate for strip crowns placed under general anaesthesia in patients who returned for follow-up visits for at least 6 months. In contrast to our study, studies by Kupietzky *et al*. (2005) [9] Ram and Fuks (2006) [10], and Kupietzky *et al*. revealed that strip crowns had a success rate between 80% and 88% (2003) [8]. Strip crowns require appropriate haemostasis and composite curing and are highly technique-sensitive [6].

Our study adds significant value to the literature with regards to the clinical performance of zirconia crowns and

strip crown in anterior primary incisors [24]. Zirconia crowns are more moisture-resistant and less technique-sensitive than strip crowns, but they do depend on the cement. Different manufacturers suggest different cements; some offer glass ionomer cement; in this study, 3M luting cement (Light curable) was used; other manufacturers offer bioactive cement; and still others offer glass ionomer cement [6].

Limitation

Although zirconia crowns are more expensive than strip crowns, we should keep in mind that strip crowns fail more frequently, necessitating additional dental appointments and retreatment of failing strip crowns. This aspect may actually make zirconia crowns more affordable since they have a high percentage of success and little need for re-treatment.

Source of support: Nil

Conflict of interest: None

Ethical clearance: Obtained

Conclusion

This study concluded that:

1. Gingival health as measured by bleeding with probing, it was observed that Zirconia crown shows better gingival health as compared to strip crown at 9 months follow up.
2. Restoration failure evaluated clinically by visual assessment, strip crown shows more restoration failure at 9 month follow up as compared to zirconia crown.
3. Zirconia crown and strip crown both showed no sign of opposing teeth wear at the interval of 3, 6 and 9 month follow up.

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