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Original Research Article

Comparative evaluation on clinical success rate of prefabricated zirconia crowns and stainless steel crowns in primary molars

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ABSTRACT

Aim: To compare the clinical success rate of Prefabricated Zirconia crowns and stainless steel crowns on primary molars

Materials and methods: It is an in-vivo study which was performed on 52 pulpally treated primary molars of children aged 4–9 years were randomly divided into two equal groups of stainless steel crown and Prefabricated Zirconia crowns. Tooth preparation was done according to the manufacturer's recommendations and crowns were cemented. All crowns were cemented with Type I Glass ionomer cement (GIC) luting cement. Crowns were evaluated clinically for its crown retention, marginal integrity and gingival health at 3 months and 6 months.

Results: Clinical success for stainless steel crowns and Prefabricated Zirconia crowns towards crown retention and marginal integrity were similar with no statistical difference between them. All Prefabricated Zirconia crowns showed healthy gingiva whereas 53.8% (14 out of 26) Stainless Steel crowns showed mild gingival inflammation at 3 and 6 months which was statistically significant (P ≤0.01).

Conclusion: Both prefabricated zirconia and stainless steel crowns showed no statistical difference for crown retention and marginal integrity throughout the study. Gingival health was significantly higher for Prefabricated Zirconia crowns compared with stainless steel crowns. Therefore clinical success rate for Prefabricated Zirconia crowns were better when compared to stainless steel crowns. So Prefabricated Zirconia crowns can be considered as an esthetic alternative in future.

1. Introduction

Oral health is a reflection of general health and lifestyle. Dental caries is one of the most common and prevalent multifactorial disease frequently encountered in children. Early childhood caries (ECC) is a highly virulent type of dental caries which contributes to partial or complete loss of the tooth structure. A majority of pre-school children are affected at a very young age with early childhood caries.[1] The deciduous tooth can be saved either by direct or indirect restorations thereby preserving the integrity of primary dentition until their normal exfoliation. As a therapeutic and preventive care approach for carious teeth, multiple prefabricated crowns can be utilized for complete coronal restorations.[2,3] Children with early childhood caries may also suffer from numerous other anomalies that could affect their aesthetics, self-esteem, mastication, speech and arch length maintenance, thus contributing to the development of various oral habits.[4,5]

Stainless Steel crowns are one of the most widely accepted and successful option for full coronal restorations, as they are widely available with different sizes and proved its efficiency as preformed, pre-trimmed and pre-contoured crowns.[6] It was introduced by the "Rocky

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Mountain Company", and was later improved by several other companies. The various applications of Stainless Steel crown include its usage as a post endodontic restoration, as a preventive restoration for special children and as an abutment for space maintainer in multi surface caries of primary and young permanent dentition.

Various researches on Stainless Steel crowns have revealed its superiority over conventional restorations in children besides its unesthetic appearancewhich is considered to be its main drawback.[3,7]

Pani et al. & Fisher et al. stated that most of the parents were worried about the esthetics of even posterior restorations. Moreover, studies also concludes that children were more worried about esthetics as it had an impact on their psychological well being and physical appearance.[8,9]

To meet these demands, aesthetic restorations led to the introduction of open faced Stainless Steel crowns, Polycarboxylate crowns, Preveenered crowns and strip crowns. But each of these restorations had their own advantages as well as disadvantages. Fishman et al. found that, among children, tooth-colored crowns was the most preferred restoration, and Stainless Steel crowns was the least preferred restoration. Resin strip crowns, Preveneered Stainless Steel crowns, and Open-faced crowns with a window have historically been offered as alternatives for the classic posterior preformed metal crown. In few studies, Preveneered crowns showed short term success as fractures were seen in these types of crown.[3,5–12]

The advanced technology in dental materials led to the evolution of Prefabricated Zirconia crowns for primary teeth thereby fulfilling the aesthetic demands. Zirconia crowns are also known as ceramic steel as it provides good strength which is similar to metal crowns as well as colour which mimics the natural teeth.

Zirconia crowns were first introduced by E-Z Pedo and were commercially available in 2008. Later Prefabricated Zirconia crowns were popularised by various companies like Nu-smile crowns, kinder crowns, Chengcrowns and 3M signature crowns. This prefabricated crowns are available is different size, shape and shades.[12] The main advantage of Prefabricated Zirconia crowns is its esthetics when compared to other esthetic alternatives while the disadvantages include the need for excessive tooth reduction.[13,14] Another disadvantage isits inability to crimp and contour and its cost.

Various studies performed with Prefabricated Zirconia crowns have been confined to anterior teeth.[14,15 5] However, it was observed that esthetics also plays an important role for posterior primary teeth. Even though the strongest dental ceramic restoration so far known is zirconia crowns, very few literatures are available with respect to its efficacy and clinical performance. Thus this study was carried out to compare the clinical success rate of Prefabricated Zirconia crowns with Stainless Steel crowns used in posterior primary teeth.

2. Materials and Methods

This study was conducted on 52 endodontically treated deciduous molars of children aged 4-9 years (both male and female) in Department of Pediatric and Preventive dentistry, Yenepoya dental college. The study was approved by the Institutional Ethical committee (YEC2/2018/43) of Yenepoya Dental College and informed written consent was obtained from parents and participants. The Study was conducted from 1^{st} January 2019 to 20^{th} March 2020.The inclusion criteria included children with pulpally treated tooth, good general health and those free from congenital abnormalities. Mobile primary molars and root resorbed primary molars were excluded from this study. All the 52 endodontically treated teeth were restored with pediatric crowns of which 26 were prefabricated zirconia crowns and 26 were Stainless Steel crowns. The clinical success rate of these cemented crowns was assessed and compared for a period of 3 and 6 months by a single experienced clinician.

2.1. Clinical procedure

Based on the inclusion criteria, teeth were selected. Topical anesthesia (Lox*) was applied and randomly divided (by convenience sampling) to one of the following groups.

Group A-Prefabricated Zirconia crowns (Signature Crowns®) and Group B- Stainless Steel crowns (3M®)

Tooth Preparation for Stainless Steel Crowns**:** Tooth preparation was done with tapered diamond bur to reduce occlusal surface by 1- 1.5mm. Care was taken to perform uniform occlusal reduction. Inter proximal reduction was done distally and with tapered diamond bur. Rounding of line angles were done and a knife-edge finish margin of the proximal surface was obtained. Care was taken to avoid any ledge formation.

An appropriate size crown was selected according to mesiodistal width of the prepared tooth and trial fit was carried out to avoid blanching before cementation. The crown was contoured and crimped by using crown-contouring and crimping pliers. The crown was smoothened and polished the entire margins with rubber wheel. Finally the crown was luted with type 1 Glass ionomer luting cement (Global Company Corporation, Japan®) and the flash was removed with an explorer and final occlusion was checked.[16]

2.2. Maxillary view

Tooth Preparation for Prefabricated Zirconia Crowns**:** The tooth preparation was done following the manufacturer's guidelines.[16] The occlusal surface was reduced to a thickness of 1-1.5mm with Flame shape diamond bur. Interproximal contacts was broken by round end taper

Fig. 1: Stainless steel crown tooth preparation irt 64, 65

Fig. 2: Zirconia crown tooth preparation irt 74, 75

diamond bur. And 0.5-0.75 mm subgingival preparation was done with Flame shape diamond bur. Care was taken not to create any undercuts. Around 0.5 -0.75 mm buccal and lingual preparation was done with a round end taper diamond bur The prefabricated zirconia crowns was selected by measuring mesiodistal width of contra lateral molars. The Selected prefabricated crown was placed on the prepared tooth. Prepared tooth was made free from any blood or saliva. Passive fit of the crown and occlusion was checked and the crown was luted with type I glass ionomer luting cement (Global Company Corporation, Japan®). A firm finger pressure was applied during cementation. Care was taken to stabilize the crown in the position till the cement has completely hardened.

All the patients were given oral hygiene instruction after cementation of crowns.

2.3. Occlusal view

Evaluation criteria (Holsinger et al's criteria):[15] The evaluation of each crown was assessed at an interval of 3 months and 6 months. Clinical evaluation criteria included crown retention, marginal integrity and gingival health which were evaluated by scoring. Score was evaluated

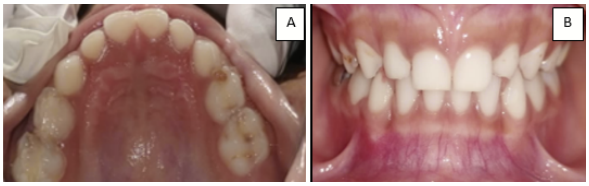

Fig. 3: A: Stainlesssteel crowns-pre operative pictures wrt 64, 65 Maxillary view; Fig-3B: Stainless steel crowns-pre operativepictures wrt 64, 65

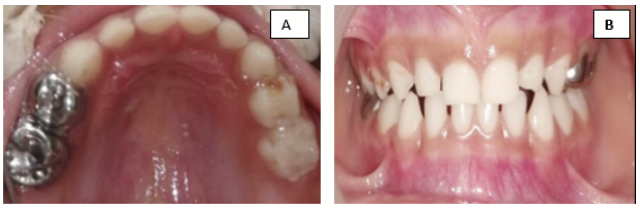

Fig. 4: A: Stainless steel crowns-postoperative picture wrt 64 & 65 maxillary view Fig-4 B: Stainless steel crowns-postoperative picture wrt 64 & 65 occlusal view

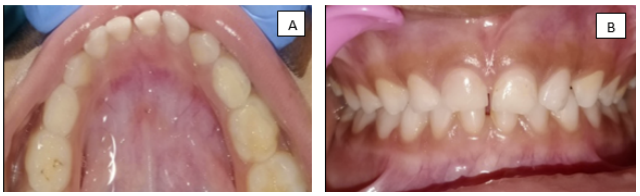

Fig. 5: A: Prefabricated zirconia crowns-preoperative picture wrt 74, 75 mandibular view Fig-5B: Prefabricated zirconia crowns-pre operative picture wrt 74,75 occlusal view

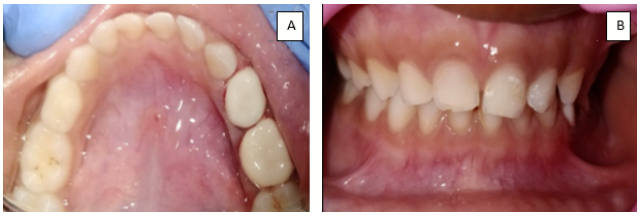

Fig. 6: A: Prefabricated zirconia crowns-post operative pictureswrt 74, 75 mandibular view Fig-6B: Prefabricatedzirconia crowns-post operative pictures wrt 74, 75 occlusal view

through visual and tactile examination with an explorer and probe for crown retention, marginal integrity and gingival health respectively.[15] For crown retention, intact was scored as 0, chipped/small but noticeable area of loss of material was score 1, large loss of material was scored as 2 and complete loss of crown was scored as 3. Marginal integrity was evaluated as score 0 for closed margin and score 1 for open margin. Gingival health was scored 0 for normal gingiva, score 1 for mild gingival inflammation, score 2 for moderate gingival inflammation and score 3 for severe gingival inflammation. Score 0 was considered clinically

Table 1: Comparison of crown retention between the groups (Stainless steel crowns and prefabricated zirconia crowns)

			Stainless steel		**Prefabricated zirconia**		
			Count	Column N %	Count	Column N %	Chi square test
Crown retention	3 Months	Intact	26	100%	26	100%	–NS
		Chipped/Small but noticeable area of loss of material	0	0.0%	0	0.0%	
		Total	26	100%	26	100%	
	6 Months	Intact	26	100%	26	100%	–NS
		Chipped/Small but noticeable area of loss of material	0	0.0%	0	0.0%	
		Total	26	100%	26	100%	

Table 2: Comparison of marginal integrity between the groups (Stainless steel Crowns and prefabricated zirconia crowns)

			Stainless steel		**Prefabricated zirconia**			
			Count	Column N %	Count	Column N %	Chi square test	
Marginal integrity	3 Months	Closed margin	26	100%	26	100%	–	NS
		Open margin	0	0.0%	0	0.0%		
		Total	26	100%	26	100%		
	6 Months	Closed margin	26	100%	26	100%	–	NS
		Open margin	0	0.0%	0	0.0%		
		Total	26	100%	26	100%		

Table 3: Comparison of gingival health between the groups (Stainless steel crowns and prefabricated zirconia crowns)

			Stainless steel		**Prefabricated zirconia**			
			Count	Column N %	Count	Column N %	Fishers exact test	
Gingival health	3 Months	Normal gingiva	12	46.2%	26	100%	0.000	HS
		Mild inflammation	14	53.8%	0	0.0%		
		Total	26	100%	26	100%		
	6 Months	Normal gingiva	12	46.2%	26	100%	0.000	HS
		Mild inflammation	14	53.8%	0	0.0%		
		Total	26	100%	26	100%		

successful during the follow up period.

2.4. Statistical analysis

The data was collected, tabulated, and statistically analyzed using the Fisher's exact test (IBM SPSS Statistics Version 23, IBM Corporation, New York, USA). Fishers exact test were used at a significance level of P≤0.01.

3. Result

The clinical success rate for crown retention, marginal integrity and gingival health are summarized in Tables 1, 2 and 3 respectively. Clinical success rate of stainless steel and zirconia crowns (Group A & Group B) for crown retention and marginal integrity showed 100% throughout the follow up period. In terms of crown retention and marginal integrity there was no statistical significant difference observed between 3 and 6 months (Tables 1 and 2). For gingival health (Table 3) prefabricated zirconia (Group A) showed 100% healthy gingival throughout the study period where as stainless steel (Group B) showed 46.2% of normal gingiva and 53.8% mild inflammation in gingiva during follow up period of 3 and 6 months which was statistically significant (P≤0.01).

Comparison of crown retention between the groups shows 100% intact crown, in both stainless steel (Group B)

and prefabricated zirconia (Group A) at 3 and 6 months. Hence, there is no statistically significant difference seen among the groups with respect to crown retention (Table 1).

Comparison of marginal integrity between the groups shows 100% closed margins in both stainless steel crowns (Group B) and prefabricated zirconia crowns (Group A) at 3 and 6 months. Hence, there is no statistically significant difference seen among the groups with respect to marginal integrity (Table 2). Comparison of gingival health between groups shows 46.2% (12 out of 26) Stainless Steel crowns towards normal gingiva and 53.8%(14) towards mild inflammation at 3 and 6months whereas pre fabricated zirconia showed 100% normal gingiva at 3 and 6 months which is statistically significant (P less than 0.01) (Table 3).

4. Discussion

Full coronal restorations are the most prevalent part of rehabilitation in children with early childhood caries. Even at a very young age children are exposed to the concept of beauty. The attributed reasons for this could be the present day life style, influence of media and their will to socialize. This has led to similar aesthetic concerns in children as that of adults.[8] The perception about aesthetics has started gaining attention among children and parents which has paved the pathway for Prefabricated Zirconia crowns to gain popularity.[15] But regarding their clinical performance very limited literatures are available. So the present study was conducted to compare the clinical performance of Prefabricated Zirconia crowns with that of Stainless Steel crowns for deciduous posterior teeth.

In the present study Prefabricated Zirconia crowns (Signature ® crowns designed by 3M Lava ™ Zirconia) was used. These crowns are available in various sizes for molars. The sizes varies from 1to 6 for each tooth. They have strength of about 1000MPa which is 6 times more than normal biting force of a child. It has polished surface and retentive features.[17] For Stainless Steel crowns also 3M ® primary molars were used. Sizes vary from 2 to 7 for molars.[18] Zirconia crowns are more expensive when compared to Stainless Steel crowns.[15] In the present study, the cementation of the crowns were done using type I GIC (luting cement).[16–21] The criteria which was assessed in present comparative study was crown retention, marginal integrity and gingival health.

A total of 52 endodontically treated teeth were selected and randomly divided into 2 groups (26 Prefabricated Zirconia crowns and 26 Stainless Steel crowns). The crowns were evaluated for each criterion at 3months and 6 months according to Holsingers criteria.[15]

The Present study showed 100% crown retention with both zirconia and Stainless Steel crown at 3months and 6 months follow up. Meticulous tooth preparation was required for prefabrication zirconia when compared to Stainless Steel crowns.[8] As per manufactures guidelines Stainless Steel crowns should have snap-fit,[1,2] where as Prefabricated Zirconia crowns requires passive fit.[9–15,18] Despite these differences, there was equal crown retention for both groups. The retention of Prefabricated Zirconia crowns, could be due to the internal retention system which increases the surface area and creates a cement anchor.[16–19] This quality of crown helps it to mechanically lock the restoration to the prepared tooth which remains firm.[16]

The result of present study was in accordance with findings of Abdulhadi et al.[7] and Mathew et al.[19] which showed intact crown at 12 months and 48 months respectively in both Prefabricated Zirconia crowns and Stainless Steel crown. These results are contrary to the findings of Gayathri et al.[17] who showed 96.7% retention for Stainless Steel crowns & 93.77% retention for Prefabricated Zirconia crowns at 12 months of follow up.

The result of present study was in accordance with the findings of Sana et al.[20] and Potik et a.[21] were they concluded that, there was no significant difference in crown retention when zirconia crowns and stainless steel crowns were luted either with type 1 glass ionomer cement and resin modified glass ionomer cement. In this study cement used to lute the crowns were type 1 glass ionomer cements. Therefore, in the present study, Type 1 Glass ionomer luting cement did not influence on crown retention.

Holsinger et al.[15] showed, 86% closed margin for Prefabricated Zirconia crowns where as Gayathri et al.[20] showed 100% closed margins for both the crowns at 6, 9 and 12 months. In the present study both the crowns showed closed margin at 3 and 6 months.[15] This could be attributed to the morphological qualities of signature® crowns. The feather edge marginal preparation of crowns could have contributed in good adaptation to the tooth structure irrespective of excessive tooth preparation for Prefabricated Zirconia crowns.[16] Stainless Steel crowns can be easily contoured and crimped, which makes them well adapted to the prepared tooth structure.[18]

All the Prefabricated Zirconia and Stainless Steel crowns were evaluated for gingival health. Out of 26 Stainless Steel crowns, 14 crowns caused mild gingival inflammation at 3 and 6 months follow up but none of Prefabricated Zirconia crowns caused inflammation in gingiva. The present study result supports the findings of Tarans et al.,[22] Abduheli et al.[7] and Wakwak et al.[23] at 12 month follow up, which showed 100% healthy gingiva for Prefabricated Zirconia crowns and 75% healthy gingiva for Stainless Steel crowns. Good gingival health and reduced plaque accumulation in zirconia crowns can be attributed to the polished and smooth, glazed surfaces of these crowns.[22] Mathew et al.[24] showed an increased adhesion of streptococcus mutans on Stainless Steel crown when compared to Prefabricated Zirconia crowns. This difference observed can be due to the ultra smooth and glazed surface of zirconia which did not favor bacterial adhesion and biofilm deposition,[25]

whereas Myers et al.[26] reported that plaque will readily form on the surface of Stainless steel crown. The role of surface properties such as surface free energy, and surface roughness influences the adhesion of S. mutans. The characteristics of Stainless steel crowns such as surface roughness and surface free energy influence the microbial growth. The higher the surface roughness and surface free energy of the crowns, the higher is the occurrence of bacterial adhesion. Prefabricated Zirconia crown has a very smooth surface which lowers surface roughness and surface free energy, thereby preventing microbial adhesion.[24–28]The other factors attributing for gingival inflammation are generalised plaque, lack of oral hygiene and oral health education.[29]

The results of present study suggests that Prefabricated Zirconia crowns performed better than Stainless Steel crowns with respect to gingival health, were as both crowns maintained good marginal integrity and crown retention. It indicates that acquired skills are necessary in preparing and placement of crowns to achieve a better result.

Prefabricated Zirconia crowns have also found to be biocompatible, less plaque accumulating leading to decreased gingival irritation, where as Stainless Steel crowns found to have gingival irritation due to gingival inflammation, plaque accumulation and it can also cause allergies to children who are allergic to nickel.[18]The main disadvantage of Prefabricated Zirconia crown is that, it needs excessive tooth preparation, the crowns are bulkier with a universal shade, highly expensive and cannot be trimmed or polished like Stainless Steel crowns.[17]

5. Limitations

Limitation of this present study was small sample size. The split mouth design was not followed in this study due to the consideration of follow up period. Further studies are advocated to test different brand of Zirconia crowns with varied morphology and with different luting cements. Further studies are recommended for radiographic evaluation of crowns, placement of multiple crowns and dentition with occlusal variations.

However, Prefabricated Zirconia crowns performed better in terms of gingival health. Henceforth posterior Prefabricated Zirconia crowns can be considered clinically acceptable and an esthetic alternative to Stainless Steel crown in primary molars even though Stainless Steel crowns are economical.

6. Conclusion

The present study concluded that both Prefabricated Zirconia and Stainless Steel crowns showed no statistical difference for crown retention and marginal integrity. Gingival health was significantly higher for Prefabricated Zirconia crowns compared with Stainless Steel crowns. Therefore clinical success rate of Prefabricated Zirconia crowns were better when compared to Stainless Steel crowns. Further studies are recommended to corroborate our findings

7. Source of Funding

None.

8. Conflict of Interest

None.

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