RESEARCH ARTICLE

Clinical Evaluation of Stainless Steel Crown versus Zirconia Crown in Primary Molars: An *In Vivo* Study

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Abstract

Aim: The objective of this clinical trial was to evaluate and compare two full-coronal restoration [stainless steel crowns (SSCs) and zirconia crown] in carious primary posterior teeth.

Materials and methods: Forty endodontically treated primary teeth in children within the age-group of 3–9 years were selected and divided into two equal groups (20 SSCs and 20 zirconia crown). The two crowns were evaluated for retentivity of crown, temporomandibular joint (TMJ) problem, gingival response, plaque accumulation, and tooth wear in opposing teeth after 1st and 3rd month follow-up.

Results: Both the crowns showed 100% results regarding TMJ problems, but SSCs performed better in terms of retention of crown, gingival response, plaque accumulation, and tooth wear in opposing teeth. The statistics showed significant result by using Mann–Whitney *U* test and Wilcoxon signed-rank test.

Conclusion: Stainless steel crowns performed better among both the full-coronal restoration for posterior primary teeth.

Clinical significance: Stainless steel crowns remain "Gold Standard", for posterior full coverage restorations in primary molars as compared to zirconia crowns.

Keywords: Randomized controlled trial, Wilcoxon signed ranks test, Zirconia crown.

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Introduction

Dental decay in children's teeth is a significant public health problem. In today's world, with increase in prevalence of caries it has become important to maintain the functional activity of the primary dentition by performing various restorative treatments.[1]

Preformed metal crowns (PMCs), more commonly known as the SSCs, are the good choice in managing extensive carious lesions, particularly in primary molars.[2] Stainless steel crowns offer many advantages; however, they lack in esthetics so accordingly many more new materials, such as, open-faced crowns and pre-veneered SSCs were developed to replace SSCs. These materials improve esthetics but had many shortcomings.

More recently, zirconia crowns, which is also known as "ceramic steel," have been introduced with reasonable esthetics and excellent mechanical properties for the restoration of permanent and primary teeth.[3] They are contoured anatomically, free of metal, bio inert completely, white colored, and resistant to dental decay.[4]

The present study was clinically compared and evaluated two full coronal coverage restorations (SSCs and zirconia crown) on primary molars at 1st and 3rd months' follow-up regarding retentivity of crown, TMJ problem, gingival response, plaque accumulation, and tooth wear in opposing teeth.

Materials and Methods

The present study was conducted in KD Dental College and Hospital, Mathura, UP in the Department of Pedodontics and Preventive Dentistry. The research protocol was reviewed and approved by the institutional ethical committee and informed consent was obtained from parents.

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Sample Size Calculation

This research study was a randomized controlled trial with an allocation ratio of 1:1. Clinical procedures were done by a single operator to eliminate operator induced errors. Sample size was calculated at 95% confidence level with level of significance set $p = 0.05$ (95%). $p < 0.05$ was significant and $p > 0.05$ was insignificant using statistical package for social sciences version (SPSS) 17.0 for Windows. A total sample of 40 primary molar was calculated and equally distributed into 2 groups of 20 samples in each group randomly using odd and even method. The two groups are as follows (as shown in Flowchart 1).

Group A: SSC
Group B: zirconia crown

Clinical Procedure

In this *in vivo* study, a total of 40 primary molars in healthy children of both sex from 3 to 9 years of age were selected. The brief medical and dental history of the patient was taken on the first visit.

All the subjects were free to withdraw from the study at any time. The sample would then be subjected to statistical analysis. All tooth preparations and procedures of restorations were completed. Local anesthesia was given using 2% lidocaine hydrochloride (Lignox) with epinephrine at 1:100,000.

Group A (Stainless Steel Crown)

The crown was selected according to the mesiodistal width of the prepared teeth and trial fit was done prior to cementation. Reduction of the occlusal surface by 1.0 to 1.5 mm was done using a pear-shaped bur to produce uniform occlusal reduction. Interproximal slicing mesially and distally was done using tapered diamond bur. The reduction was done in a manner that allowed probe to pass through the contact area. Interocclusal clearance was checked using wax sheet (1.5–2 mm). The selected crown was not more than 1 mm subgingivally and if there was excessive shrinking of the gingival tissues then the segment of the crown was decreased. After reduction with white stone bur the margins of the crowns was smoothened using rubber disk bur. Then the crown was luted using type 1 GIC (GC Gold Label 1).

Group B (Zirconia Crowns)

After giving local anesthesia, crown size was selected according to the mesiodistal width of the prepared teeth and trial fit was done prior to cementation.

Occlusal, Proximal, and Supragingival Reduction

Occlusal reduction was done by 1 to 1.5 mm using pear-shaped bur. Tapered diamond bur was used for proximal reduction to permit the chosen crown to fit passively. The tooth was trimmed circumferentially by 0.5 to 1.25 mm as per need.

Subgingival Reduction

The edges were stretched out and polished to a feather edge to around 1 to 2 mm subgingivally on every area so that no undercuts or subgingival ridges remain.

Completion of the Preparation

Eliminate line and point angle to allow all areas of the prepared teeth to be rounded marginally.

Crown Seating

Prepared teeth was confirmed to be free from any blood or residues, saliva, and gingival blood. Then the zirconia crown was seated using type 1 GIC (Fig. 1).

Evaluation Criteria

The performance of the two crowns was evaluated using United States Public Health Service (USPHS), alpha criteria rating system for retentivity of crown.[5] Helkimo M. Criteria (1979) for TMJ problem, Loe and Silness index (1967) for plaque accumulation and gingival response, Smith and Knight Tooth Wear Index for tooth wear in opposing teeth.[6]

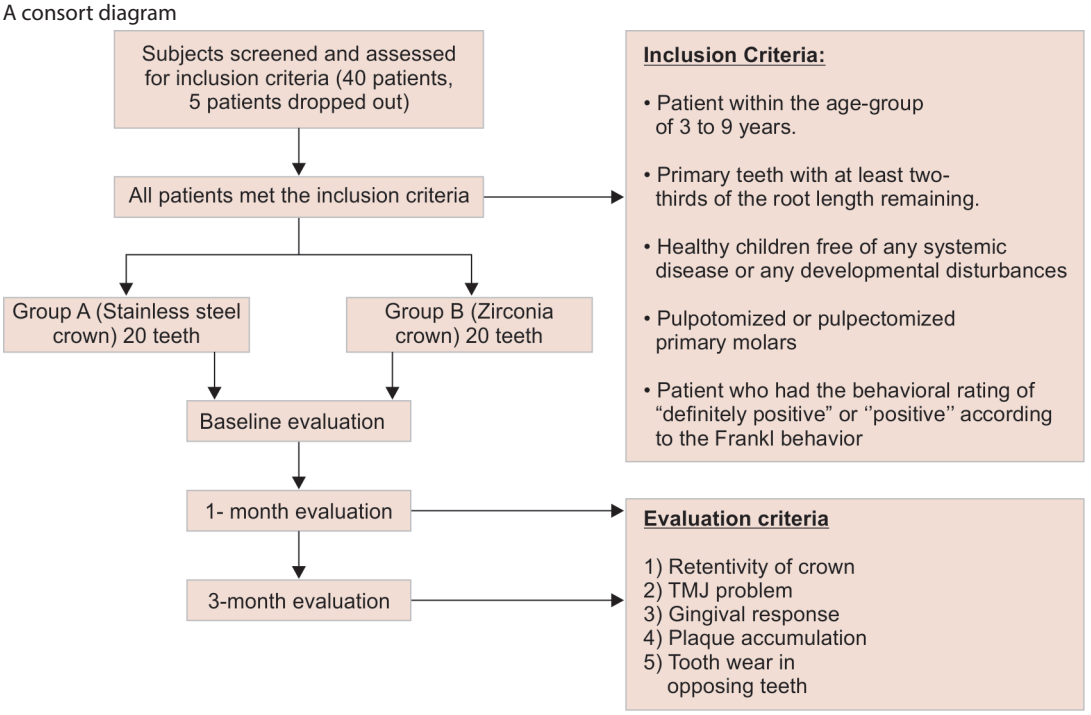
Results

This study comprises a total of 40 children in the age group of 3 to 9 years. Out of them, 20 were male and 15 were female and 5 patients did not come for follow-up after placement of zirconia crowns after 1 and 3 months so they were excluded from the study.

Retentivity of Crown

Ninety-five percent of SSCs were normal with no cracks, chips, or fractures with only 5% complete loss of SSC, while 86.67% zirconia crown appeared to be normal and 6.67% was small but noticeable area of loss of material and complete loss of zirconia crown, respectively at the end of first month follow-up.

Flowchart: 1 A consort diagram



Figs 1 A to D: (A) Preoperative maxillary photograph. (B) Preoperative mandibular photograph. (C) 1st month follow-up showing stainless steel crown IRT 75 and zirconia crown IRT 85. (D) 3rd month follow-up showing attrition IRT 55 opposite to zirconia crown.

However, at 3rd month follow-up, SSCs showed 100% retention of crown, followed by 86.67% zirconia crown appearing normal with no cracks, chips, or fractures and 6.67% had small but noticeable area of loss of material and complete loss of zirconia crown , respectively.

TMJ Problem

Both the crowns showed 100% results with no TMJ problems at 1st and 3rd month follow-up.

Gingival Response

Twenty percent of the subjects in both groups showed mild marginal gingivitis at 1st month follow-up, in the third month follow-up 6.67% of the zirconia crown showed mild marginal gingivitis, whereas SSC had healthy gingiva. So, they were 100% accepted by the patients.

Wilcoxon signed ranks test showed statistically significant difference for both the groups as SSCs came out to be better than zirconia crown ($p = 0.046$) (Table 2).

Plaque Accumulation

After 1 month follow-up 60% of SSC and 80% of zirconia crown showed no plaque accumulation. At third month follow up, SSC showed no plaque accumulation while 13.33% of zirconia crowns showed plaque accumulation; therefore, SSC showed better results than zirconia crown. Wilcoxon signed ranks test showed statistically significant difference for both the groups as SSCs came out to be better than zirconia crown ($p = 0.005$) (Table 2).

Tooth Wear in Opposing Teeth

After first month follow-up, 26.67% of zirconia crowns and 10% of SSC showed tooth wear and loss of enamel surface in the opposing teeth. However, at 3rd month follow up 80% zirconia crowns showed tooth wear in the opposing teeth while there were no changes recorded for SSC. Mann–Whitney *U* test and Wilcoxon signed ranks test showed statistically significant difference for both the groups, in which stainless steel crowns was better than zirconia crown ($p = 0.005$) (Tables 1 and 2).

Discussion

One of the techniques which is becoming increasingly common to resolve early childhood caries is full coronal restoration. There are other alternatives as well; however, there are tradeoffs involved in each with variations in clinical performance.

Zirconia crowns have become popular in this trend. However, the lack of literature validating performance is a genuine concern. Therefore, the present study was conceptualized and conducted to evaluate and compare the clinical performance of pediatric zirconia crowns and stainless steel crowns which are currently prevalent, for posterior primary teeth.

Preformed Kids-e-Dental zirconia crowns were used in this study due to factors such as range of available sizes, occlusal flat surface, superior retention, and uniform axial thickness. Preformed SSCs (3M ESPE) were used as they are easily available and less costly. Both the crowns were luted by using type 1 GIC (GC Gold Label).

Table 1: Mann–Whitney U test after 1st and 3rd month follow-up

	Groups	*N*	*Mean rank*	*Z*	*p value*
Retentivity of crown	Stainless steel crown	20	17.50	−1.155	0.248
	Zirconia crown	15	18.67		
TMJ problem	Stainless steel crown	20	18.00	0.000	1.000
	Zirconia crown	15	18.00		
Gingival response	Stainless steel crown	20	17.50	−1.155	0.248
	Zirconia crown	15	18.67		
Plaque accumulation	Stainless steel crown	20	17.00	−1.658	0.097
	Zirconia crown	15	19.33		
Tooth wear in opposing teeth	Stainless steel crown	20	12.75	−4.123	0.000
	Zirconia crown	15	25.00		

Table 2: Wilcoxon signed ranks test for stainless steel crown after 1st and 3rd month follow-up

	Month	*Z*	*p value*
Retentivity of crown	1st month follow-up and 3rd month follow-up	−1.000	0.317
TMJ problem	1st month follow-up and 3rd month follow-up	0.000	1.000
Gingival response	1st month follow-up and 3rd month follow-up	−2.000	0.046
Plaque accumulation	1st month follow-up and 3rd month follow-up	−2.828	0.005
Tooth wear in opposing teeth	1st month follow-up and 3rd month follow-up	−2.828	0.005

Stainless steel crown showed better results regarding retentivity of crown than zirconia crown at 3rd month follow-up. Complete loss of SSC was driven by poor adaptation of luting cement. Set cement evidently has voids and porosity, and this over time leads to propagation of cracks with the aid of occlusal forces. As a result, cement loss is observed as time progresses.

On the contrary, occlusal forces present during the seating of the zirconia crown can potentially lead to its chipping. Lack of proper trimming of the cuspal patterns also results in occlusal issues, thereby causing some chipping. Since zirconia crowns have passive fit so they largely depend on cements for retention. Therefore, a regular luting GIC may not be effective cement in cases of zirconia crowns, resin-based cement would perform better.

This findings do not conform to findings of Abdulhadi et al.[7] who relied on luting with resin cement or resin-modified glass ionomer cement and delivered 100% retention of zirconia crowns.

In this study effect on TMJ has been considered since monolithic zirconia crowns cause more TMJ disorders as said by Michael Behr et al.[8] But in our study we found no significant changes in TMJ after 3rd month follow-up. This finding may be due to that TMJ in children's is very flexible. Also TMJ disorders sign and symptoms may be present at an early age even in the absence of pain as said by Tallents and Catania.[9]

Zirconia crowns evaluated for gingival response showed mild marginal gingivitis at 1st month follow-up, which got reduced at 3rd month follow-up, which may be due to the fact that its preparation is traumatic and painful to the child so patient would have to avoid touching that area even with the toothbrush for first few weeks following its placement.

Stainless steel crowns showed better results regarding plaque accumulation when compared to zirconia crowns which is contrary to the studies of Sailer et al.[10] and Abdulhadi et al.[7] Their results showed decreased plaque accumulation owing to the fine smooth surface of zirconia crowns.

In our study, we observed statistically significant results for both the groups which is similar to the studies of Henderson et al,[11] who reported lower plaque index for stainless steel crowns when compared to remaining oral cavity.

Stainless steel crowns showed better results regarding tooth wear in opposing teeth which was 10% only at the end of 3rd month follow-up, which was very similar to the studies of Walia et al.[12] who also reported only 10% tooth wear in opposing teeth. Zirconia crowns showed 80% tooth wear in opposing teeth at the end of 3rd month follow-up, our results were similar to the studies of Aly et al.[13] who too concluded that more severe wear in primary teeth is caused by mechanical mismatching between zirconia crown and natural enamel. The mechanical properties of zirconia crown having flexural strength >1,000 MPa, elastic modulus 210 GPa, and hardness 10 GPa, are far above than that of human enamel with flexural strength 280 GPa, elastic modulus 94 GPa, and hardness 3.2 GPa.

Zirconia crowns are the best choice in terms of esthetic concern, high flexure strength, biocompatibility, smooth and glossy surface, superior corrosion resistance, unique ability to resist crack propagation, and better mechanical properties. But from a clinical performance, SSCs remain better option for posterior teeth full coverage rehabilitation. The performance for the SSCs was best in terms of retention, gingival response, plaque accumulation, and tooth wear in opposing teeth than zirconia crowns.

Limitations of the study is that a greater follow-up is needed to see intricate factors like retention and TMJ disorders. Also proximal contacts of all teeth restored with zirconia crowns and SSC should have been evaluated.

Conclusion

Stainless steel crowns remains "Gold Standard" for posterior full coverage restorations in primary molars as it has more simplified crown preparation and is less costly as compared to zirconia crowns.

Zirconia crown although being "Esthetic" have very traumatic crown preparation, cannot be given without local anesthesia, and is time consuming so not accepted much by the parents and patients.

Clinical Significance

Stainless steel crowns remains "Gold Standard" for posterior full coverage restorations in primary molars as compared to zirconia crowns.

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