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International Journal of Pedodontic Rehabilitation

Original Research

Clinical Evaluation of Zirconia and Stainless-Steel crowns in Primary Molars - A Randomized Control Trial

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How to cite: *Nikhil et al, Clinical evaluation of zirconia and stainless-steel crowns in primary molars - A randomized control trial, Int J Pedo Rehab 2022; 7(2):30-38.*

https://doi.org/10.56501/intjpedorehab.v7i2.571

Received : 26.10.2022 *Accepted:24.11.2022* *Web Published: 19.12.2022*

ABSTRACT

Background: Stainless steel crown are tooth shaped covering which are used universally with preference in primary teeth. With advancements in aesthetic restorative materials the demand of stainless-steel crown is at stake and esthetic alternatives to stainless steel crown for restoring primary molars are gaining more interest.

Aim: To evaluate clinically and radiographically the zirconia and stainless-steel crown in primary molars.

Methods: A randomized controlled study was conducted on children of age group of 5 to 8 years of age visiting, KVG Dental College and Hospital, Sullia and who were meet the inclusion criteria of the study. The study population was randomly divided into two groups of 24 each. Group I: stainless steel crown, Group II: zirconia crown. Post endodontic tooth preparation was done and selected stainless steel and zirconia crowns followed by cemented using type 1 glass ionomer cement. The subjects were be recalled after 3, 6 and 9 months to check gingival index, oral hygiene index and bone health of the tooth using intraoral periapical radiograph.

Results: There was significant increase in score of gingival indices and OHI score for both SSC and zirconia crowns after 3 months followed by reduction in score at 6 and 9 months. There was no statistically significant difference in alveolar bone height in both groups (zirconia and SSCs) 6 months.

Conclusion: Zirconia crowns presented to be an excellent choice for primary posterior teeth full coverage restorations. Zirconia crowns performed better than SSCs in the aspect of gingival response and prevention of plaque adhesion.

Keywords: Stainless steel crown, Zirconia crown, Esthetics, Early childhood caries.

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INTRODUCTION

Early childhood caries is the most devastating and prevalent disease in children which affects the primary teeth and result in problems in speech, mastication, maintaining arch length and cosmetic function. Pediatric dentistry plays a crucial role in the dental development of the young patient by rehabilitating the primary teeth until the permanent teeth erupts in to the oral cavity. As the treatment of primary and young permanent teeth with advanced carious lesion has been a constant and that might be a difficult problem for the dentist, the stainless-steel crowns have become an important in the restoration of the extensively carious lesion.[1]

Stainless steel crowns (SSCs) provide durable and reliable full coverage restorations and are retained for the life time of a primary tooth.[2] The stainless-steel crown has been shown to be the restoration of choice, or the "gold standard." Because it protects the tooth from fracture (full coronal coverage) and minimizes the possibility for leakage, and provides a biological seal.[3]

This results in technological advances in techniques and material science and led to the evolution of Zirconia crowns for primary teeth, thereby fulfill the esthetic demands. Also, patients and dentists have been looking for metal-free tooth-colored restorations. Therefore, the development of new high strength dental ceramics, which appear to be less brittle, less limited in their tensile strength, and less subject to time dependent stress failure.[4,5,6] Zirconia crowns are strongest dental ceramic restoration available as preformed posterior esthetic crowns for primary dentition and there is very limited literature is available with regard to its efficiency and clinical performance. Thus, this study was carried out to assess and compare the efficiency of zirconia crowns with stainless steel crowns used in posterior primary teeth.

The rehabilitation of children with early childhood caries now frequently includes full coronal restorations. Each option tested has demonstrated a different clinical performance. Children are exposed to the idea of ideal beauty at a very young age due to changes in lifestyle, more socialisation possibilities, and the involvement of the media. This has shown an impact on their concerns about esthetic which are similar to that of adults.[7] Regarding the restorations that will be put on their teeth, the same idea holds true.[8]

SSCs have been suggested as an alternative to big multi-surface amalgam restorations for the restoration of severely fractured teeth. Although stainless steel crowns are considered the best treatment modality for teeth with extensive caries lesions or pulpotomies teeth, their use fails to meet the esthetic demands of the patient and the parents because of their unsightly metallic appearance.[9]

Preformed zirconia crowns were becoming considerably more common as the idea of aesthetics gained traction with both parents and kids.[10,11] But very limited literature is available regarding their performance. The current study was carried out to evaluate the clinical performance of paediatric zirconia crowns with that of stainless-steel crowns, which were the most frequently utilised crowns for posterior primary teeth.

MATERIALS AND METHODS

A randomized clinical study was conducted in children of 5-8 years of age reporting to the Department of Pedodontics and Preventive Dentistry, KVG Dental College and Hospital, Sullia and who was meets the inclusion and exclusion criteria. The study population was randomly divided into two groups of 24 each. Group I was stainless steel crowns and Group II was zirconia crowns. Thorough oral prophylaxis was done before the tooth preparation and in Group 1: post endodontic tooth preparation was done and selected stainless steel crown was cemented using type 1 glass ionomer cement after crimping and contouring. In Group 2: post endodontic tooth preparation was done and selected zirconia crown was cemented using type 1 glass ionomer cement. In the Figure 1 the subjects were recalled after 3, 6 and 9 months to check gingival index, OHI index and bone health of the tooth using IOPA radiograph.

SAMPLE SIZE ESTIMATION

Sample size was calculated based on the formula

$$N = \frac{[\, Z1-\alpha/2 \sqrt{(2P-Q-)} + Z1-\beta \sqrt{(P1Q1 + P2Q2)}\,]^2}{(P1 - P2)^2}$$

Estimated sample size = 48

INCLUSION CRITERIA:
Tooth which needs full coverage restoration.
Children who are cooperative in behaviour and willing for follow up visit
Children of 5 to 8 years of age.

EXCLUSION CRITERIA:
Tooth with poor prognosis (mobility, resorption)
Children who are differentially abled.
Children who are not willing for regular follow up.

Scoring Criteria for Oral hygiene index. Fig (2,3)
0 – No debris
1 – Soft tissue debris covering less than one third of the tooth surface
2 – Soft tissue debris covering more than one third, but not more than two third of tooth surface.
3 – Soft tissue debris covering more than two third of tooth surface

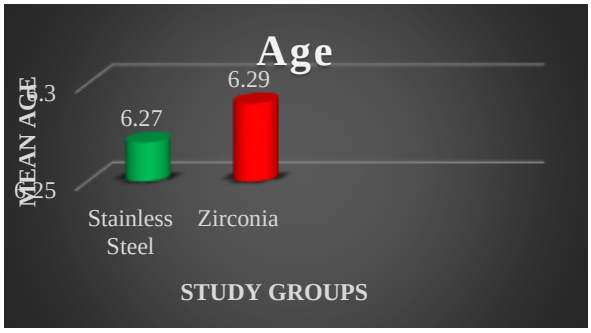
Scoring criteria for Gingival index. fig (4,5)
0 – Healthy gingiva
1 – Mild inflamed gingiva
2 – Moderately inflamed gingiva
3 – Severely inflamed gingiva

RADIOGRAPHIC CRITERIA: Interdental bone level 2mm or less than from the crest of the interdental bone and the cementoenamel junction was considered normal or non-resorbed, If the distance was greater than 2mm, it was considered as resorbed. Fig (6,7)

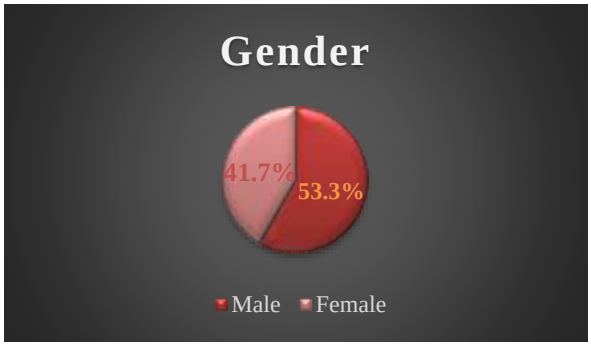
RESULTS
A total of 48 children with a mean age of 6.2 years were included in this study. Analysis of gender representation among the study participants at baseline revealed a slight male predominance in the Stainless-Steel group and a female predominance in the Zirconia group. Statistically, a significant difference was not observed at baseline for both demographic and clinical parameters included in the study as depicted in Table No.1

Characteristics	Stainless steel group(n=24)	Zirconia (n=24)	P value
Mean age	6.27±0.9	6.29±0.7	0.936
Gender **Male** **Female**	 14(53.3%) 10(41.7%)	 10(41.7%) 14(53.3%)	0.564
Oral hygiene index score	0.25±0.1	0.23±0.1	0.49
Gingival index score	0.084±0.01	0.087±0.01	0.3
Interproximal bone loss **Present** **Absent**	 0 24	 0 24	NA

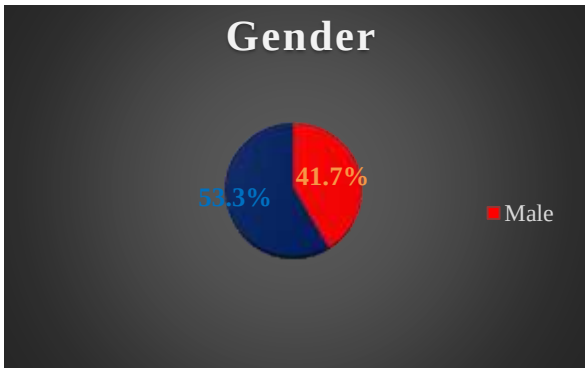
Table No.1: Characteristics of the study population at baseline



Graph No. 1: Distribution of study population in relation to age



Graph 2: Distribution of study population in relation to gender in Stainless Steel group



Graph No. 3: Distribution of study population in relation to gender in Zirconia group

There was a sudden increase in the mean OHIs score among the Stainless-Steel group at the 3rd-month follow-up (0.59±0.2) followed by a steady reduction in mean scores at 6th month (0.3± 0.1) and 9th month (0.13± 0.01) follow up respectively. Similarly, an abrupt increase in the mean OHIs score was reported among the Zirconia group at 3rdmonth follow-up (0.57±0.27) followed by an increase in the mean scores at 6thmonth (0.26± 0.1) and 9th month (0.05±0.02). Intragroup comparison of OHIs scores at different periods yielded a statistically significant result (p-value <0.001) in both the study groups. Additionally, a statistically significant difference was reported in mean OHIs scores [(0.13± 0.01 v/s 0.05±0.02) p<0.001] among the Stainless Steel and Zirconia groups at the 9th month follow up as shown in Table No.2.

Table No.2: Comparison of Oral Hygiene index(s) score among Stainless Steel group and Zirconia groups

Group	Baseline	Third month	Sixth month	Ninth month	P value
Stainless steel	0.25±0.1	0.59±0.2	0.3±0.1	0.13±0.01	<0.001*
Zirconia	0,23±0.1	0.57±0.27	0.26±0.1	0.05±0.02	<0.001*
P value	0.49	0.73	0.17	0.001*	

OHIs scores expressed as Mean ± SD, * denotes statistical significance (p value<0.05)

Further analysis revealed a steep increase in the mean gingival index scores among the Stainless-Steel group at the 3rd-month follow-up (0.30±0.1) followed by a gradual reduction in the mean scores at 6th month (0.18±0.08) and 9th-month (0.06± 0.02) respectively. Similarly, a sudden increase in the mean gingival index score was noticed in the Zirconia group at 3rdmonth follow-up (0.24±0.1) followed by an increase in the mean scores at 6thmonth (0.14± 0.01) and 9th month (0.03±0.01). Intragroup comparison of gingival index scores at different periods yielded a statistically significant result (p-value <0.001) in both the study groups. Moreover, a statistically significant difference was observed in mean gingival index scores [(0.06± 0.02v/s 0.03±0.01) p<0.001] among the Stainless Steel and Zirconia groups at 9th month follow-up as described in Table No.3.

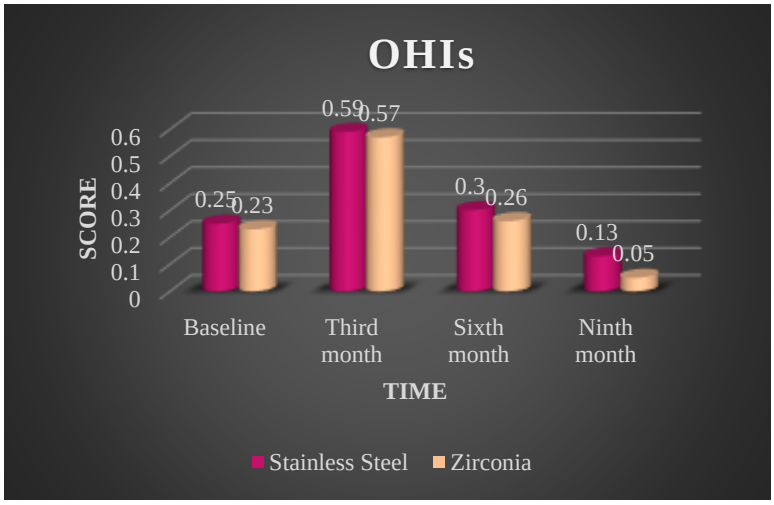
Group	Baseline	Third month	Sixth month	Ninth month	P value
Stainless steel	0.084±0.01	0.30±0.1	0.18±0.08	0.06±0.02	<0.001*
Zirconia	0.087±0.01	0.24±0.1	0.14±0.01	0.03±0.01	< 0.001*
P value	0.3	0.04*	0.01*	<0.001*	

Gingival index scores expressed as Mean ± SD, * denotes statistical significance (p-value<0.05)

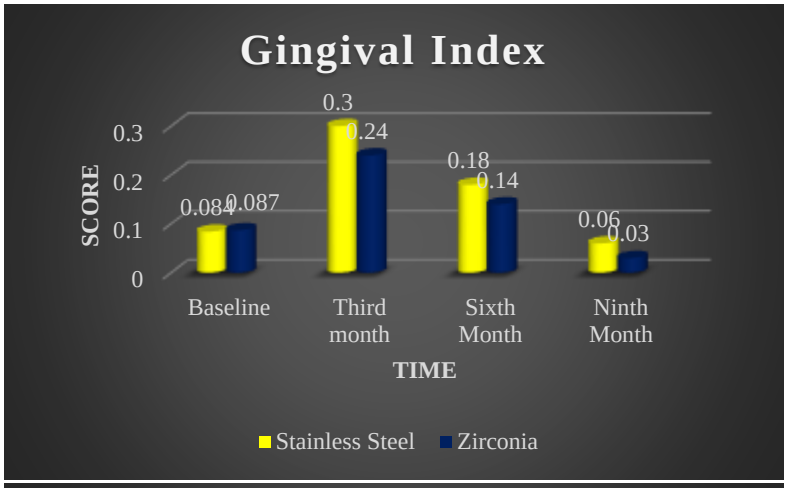
Table No.3: Comparison of Gingival index score among Stainless Steel group and Zirconia group

Group	Baseline	Third month	Sixth month	Ninth month
Stainless steel	NP	NP	NP	NP
Zirconia	NP	NP	NP	NP
P value	NA	NA	NA	NA

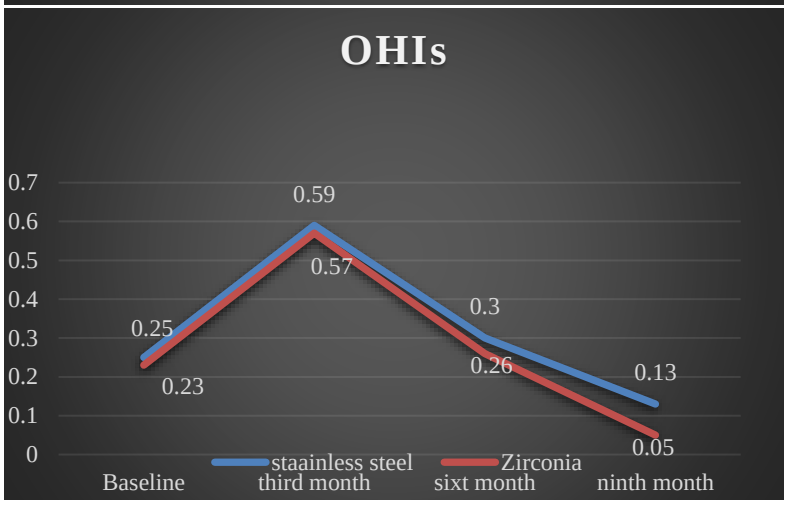
Table No.4: Comparison of presence of interproximal bone loss among Stainless Steel group and Zirconia groups



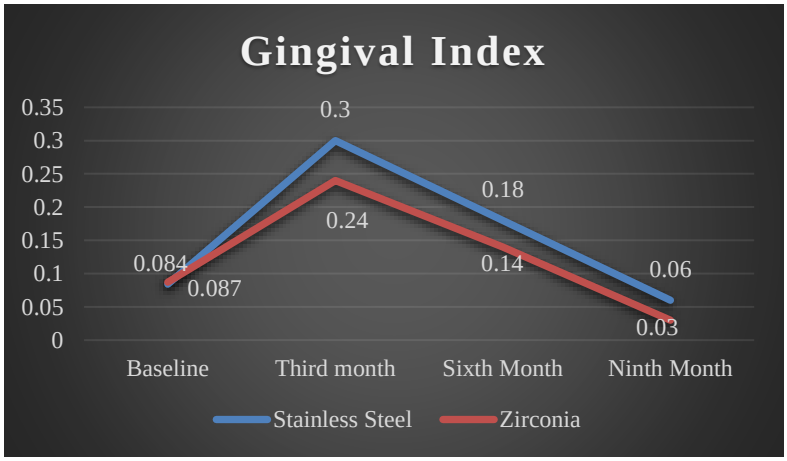
Graph No .4: Distribution of Oral Hygiene index(S) score among Stainless Steel group and Zirconia group



Graph No. 5: Distribution of Gingival index score among Stainless Steel group and Zirconia group



Graph No .6: Comparison of Oral Hygiene index(S) score among Stainless Steel group and Zirconia group



Graph No .7: Comparison of Gingival index score among Stainless Steel group and Zirconia group

DISCUSSION

This study demonstrated a time-dependent comparison of undamaged primary molars and teeth treated with SSC and zirconia crowns. At 3, 6, and 9 months, both groups' oral hygiene, gingival health, and radiographic bone health was evaluated.

In the current study, gingival health was shown to be better in teeth treated with Zirconia crowns than those treated with the stainless-steel crowns at 3 and 6 months, but after 9 months, both groups still had healthy gingiva. The mean gingival index scores in both groups experience a sharp rise at the third month of follow-up, which is followed by a progressive decline in the mean scores at the sixth and ninth months, respectively. The stainless-steel group has higher gingival scores than the zirconia groups, according to an intragroup comparison of gingival index scores. These outcomes may be attributed to Zirconia utilised for tooth components having exceptional biocompatibility and having a smooth and polished exterior, which reduces the propensity of plaque build-up and, consequently, the risk of gingival irritation. The current study's findings were in line with those of Taran et al., who discovered that zirconia crowns performed better in

terms of plaque build-up and gingival health than stainless steel crowns and controls.[12] Our findings was in line with those of Mathew et al., who discovered that at the conclusion of a 12-month follow-up, gingival inflammation and plaque index scores were significantly higher around stainless steel crowns than they the zirconia crowns. They also came to the conclusion that Streptococcus mutans adhered to stainless steel crowns more strongly than they did zirconia, and that there was little accumulation of gingival inflammation and plaque in the tooth.[13] Mild bleeding (8%) was observed in the zirconia group, but no similar complaints were observed in the stainless steel group throughout the 12-month follow-up, according to Gayathri et al.[14] According to Maclean et al., incorrectly shaped metal borders and adhesive residues left in the sulcus in the case of SSCs are the two main factors that irritate the gingiva, causing plaque build-up and subsequent gingival inflammation.[15] Gihan Abuelniel* and Sheriff Eltawil's study, on the other hand, revealed no statistically significant difference in the GI and OHI scores in the two groups at baseline, 3, 6, or 12 months. At nine and twelve months, the Stainless-Steel crown group had statistically substantially higher mean GI and OHI scores than the Zirconia crown group.[16]

This result was in contrast to a study by Mathew et al. who discovered that both SSC and zirconia crowns had 100% clinical success throughout the study period in terms of crown retention, modified gingival index, stain resistance, gingival marginal extension, occlusion, and proximal contact at placement. The only difference was observed in case of plaque index, where zirconia crowns (100%) did not demonstrate any plaque accumulation throughout the study period, and they came to the conclusion.[13] similarly, Donly et al. conducted a study contrasting zirconia and SSC and came to the conclusion that zirconia primary molar crowns perform similarly to an established stainless-steel crown for the restoration of primary molar teeth in the 24-month period. They also discovered that the only significant difference in the parameters assessed was in the preference of the parents for the zirconia crown.[16]

According to Abduhadi et al research's zirconia crowns (100%) had better gingival health than stainless steel crowns (75%) did. Our results corroborated their findings. In contrast, the glazed and polished surface of zirconia crowns led to less plaque accumulation and good gingival health, according to him. He claimed that improper shaping of metal borders as well as adhesive residues in the sulcus are the causes of gingival problems in the case of stainless-steel crowns. Comparing strip crowns and pre-veneered SSCs to zirconia crowns on primary anterior teeth, Walia et al found that zirconia crowns had better gingival health overall. These findings were attributed to zirconia's high biocompatibility and polished, smooth surface, which reduce plaque build-up and, in turn, gingival sensitivity.[17]

Raslan N. et al. claimed that gingival health surrounding SSCs was better than that around the esthetic veneered crowns, although the findings of the present investigation contradict this claim. The commercial aesthetic crowns bulbous composite veneer was blamed for this discrepancy.[18]
Additionally, Fuks et al findings that the aesthetic pre-veneered crowns caused poor gingival health and ascribed these findings to the bulk of the veneer on the aesthetic crown, resulting in a thicker margin, complement these findings.[19] Similarly Sharaf A. et al.[20] concluded that stainless steel crowns had no harmful effect on gingival health provided that good oral hygiene level was maintained.

The current investigation about these OHIs revealed a substantial rise in score for SSC at 3 months, followed by a consistent drop in mean scores at 6, and 9 months, as well as a significant increase in score for zirconia crowns at 3 months, followed by a reduction at 6 and 9 months. The stainless-steel group had higher intragroup comparison OHIs values than the zirconia groups. These outcomes may be related to zirconia crowns' greater levels of polish and smoothness compared to SSC, which results in a lesser propensity for debris build-up on zirconia surfaces. These findings concur with those of Kara N. et al., who compared oral hygiene and gingival health between three types of crowns (SSCS, veneered SSCS, and Nusmile zirconia crowns) and found that the amount of plaque that accumulated on NS crown-restored teeth was less than that found on SSC-restored teeth at the conclusion of the study. The OHI-S levels at the follow-ups, however, were not altered, which was in contrast to the finding of Tara et al. in 12 monthly investigations.[12] According to Abdulhadi B. et al., the zirconia crowns group had fewer plaque accumulations over the course of the follow-up periods and also improved. On the other hand,[21] SSCs showed more plaque accumulations consistent with our study.
This study found no statistically significant difference in alveolar bone height between the two groups when measuring the distance between the edges of the crowns and the crest of the alveolar bone (immediately after cementation) and (up to 9 months) (zirconia and SSCs). These outcomes could be a result of the crowns' effective marginal adaptation, strong crown extensions, and preservation of the teeth's undamaged contact. There is, however, little research on the impact of crown edges on interproximal bone resorption in primary molars. These outcomes were comparable to those described by Raslan N. et al[18] and Ram. et al[19], who found no resorption in either SSCs or cosmetic pre-veneered crowns. The findings of the American Academy of Periodontology, which hypothesised that alveolar bone resorption in the primary dentition is unusual and can be brought on by other causes such some systemic disorders, are in agreement with these findings. However, according to Sharaf A. et al.[20], stainless steel crowns that were deemed radiographically unsatisfactory

were linked to alveolar bone loss Additionally, severe periodontitis in children and teenagers may be a precursor to a systemic illness.[22]

After a 9-month follow-up, zirconia crowns performed comparably better in terms of OHI and gingival index than stainless steel crowns did. Interproximal bone resorption was not substantially impacted by either crown marginal extension or adaptation for either SSCs or zirconia crowns, however. This outcome is in line with the findings of a research by Mohamed A. Wakwak, et al., who found that Zirconia crowns outperformed SSCs in terms of aesthetics, gingival response, and plaque retention prevention. While neither the crown marginal extension nor adaptation, which applied to both SSCs and zirconia crowns, had a substantial impact on interproximal bone resorption. Zirconia crowns demonstrated better gingival health than the SSC group, according to research by Gihan Abuelniel et al and Sherif Eltawil et al. Additionally, when compared to stainless steel crowns, the Zirconia group demonstrated respectable clinical and radiological results with the benefit of enhanced aesthetics.[24] Additionally, Elqousy A. et al.[23] observed that when pre-formed SSCs were used for pulpotomied primary molars, there was no interproximal bone loss. However, when SSCs were utilised to restore a pulpectomies primary molar, there was a large amount of bone resorption; this outcome was related to causes other than the insertion of SSCs.

The short-term follow-up, reduced sample number, and inability to implement a split-mouth design were the primary drawbacks of this study. Most inter-patient variability, including that related to oral hygiene, food, and brushing behaviours, may be reduced using split mouth research designs. Long-term follow-up and a bigger sample size are necessary. To gather more useful data on the clinical performance of preformed zirconia crowns, additional studies using a split-mouth design are advised. These studies should test various brands of commercially available zirconia crowns with different levels of polish, gloss, and morphological variations for a longer period of time. It is advised that more research be done to determine the crown's effectiveness in a variety of clinical situations, including crowded teeth, teeth with occlusal variation, and the use of numerous crowns.[24,25]

CONCLUSION

Within the limitation of this study following conclusions can be drawn:

1. The clinical success rate for paediatric stainless steel and zirconia crowns was high, and there was a significant difference between the two groups ($p<0.001$).
2. When compared with both groups, the teeth with zirconia crowns had reduced debris build-up after three, six, and nine months.
3. At nine months' teeth restored with zirconia shows less gingival inflammation when compared to stainless steel crowns.
4. Comparing both groups there was no statistically significant difference in alveolar bone height in both groups, interproximal bone resorption was not significantly affected by either crown marginal extension or adaptation for both SSCs and zirconia crowns

Zirconia and stainless-steel crowns were both demonstrated to be superior options for posterior tooth full coverage restorations. Despite their high price, zirconia crowns outperformed other types of crowns in terms of aesthetics, gingival response, and plaque retention.

FINANCIAL SUPPORT AND SPONSORSHIP – Nil

CONFLICTS OF INTEREST - There are no conflicts of interest

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https://doi.org/10.56501/intjpedorehab.v7i2.571