Effect of Stainless-Steel Crown and Preformed Zirconia Crown on the Periodontal Health of Endodontically Treated Primary Molars Correlating with IL-1β: An *In Vivo* Study

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Objective: *The purpose of this study was to evaluate the effect of different crown materials on the interleukin-one beta (IL-1β) content of the gingival crevicular fluid and to study which crown material causes the highest inflammation on the marginal gingiva on a biochemical basis in pediatric patients.* ***Study design:*** *Twenty patients in the age group of 4-8 years with endodontically treated primary molars indicated for crown placement were selected for the study which was further divided into 3 groups for sample consideration: group 1-stainless steel crown, group 2-preformed zirconia crown, and group 3- control group (primary second molar). All assay procedures were carried out and the results of the collected samples were calculated using the ELISA-AID TM technique.* ***Results:*** *On mean comparison among the groups using ANOVA one-way test, P-value turns out to be highly significant, on mean comparison using Tukey's HSD post–hoc test, The p-value was 0.000 ,0.000 ,0.193 on comparing group 1 with group 2, group 1 with group 3, group 2 with group 3 respectively.* ***Conclusion:*** *Preformed zirconia crown can be a relative replacement of SSC in primary molars as it causes comparatively less inflammation and with an advantage of esthetics.*

Keywords: *Preformed zirconia crown, stainless steel crown, esthetics, gingival health, interleukin.*

INTRODUCTION

For ages, it has been of utmost importance to preserve the health of primary dentition to facilitate the development of dentition in children. For pediatric dentists, there was always difficult to treat excessively damaged primary teeth because of challenges like children's cooperation and their parents' satisfaction. Also, the durability of restoration along with the maintenance of tooth structure is another important consideration. Over the years, various full coverage restorations have been introduced and incorporated in the pediatric dental practice where stainless-steel crowns (SSCs) have been the most acceptable and commonly used full coverage restoration for primary and permanent dentition in children. [1] Since the 1950s, pediatric dentists all over the world have preferred SSCs for their highly durable nature with a good cervical fit, comparatively low price, and minimally technique-sensitive restoration. [2]

Literature reports the success of SSCs to be as high as having a 97.2% success rate [3] although, the major drawback for SSCs is their metallic appearance which leads to their esthetic unacceptability for children and their parents.

With increasing concerns of esthetics in children, technological advancements over the years have been successful in introducing prefabricated zirconia crowns (ZCs). The use of zirconia crowns for primary dentition started in the year 2008 [4]. Though zirconia crowns have mechanical properties similar to metal, it requires more extensive tooth reduction. [5] Earlier, there were only in vitro studies of prefabricated zirconia crowns in the literature. [6] Recently, with

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evolution in pediatric dentistry, literature holds more clinical studies of ZCs with a success rate of almost 100% in primary dentition and also high acceptance of zirconia crowns by parents and children fulfilling their esthetic satisfaction. [7]

One of the main objectives of dental prostheses remains the maintenance of periodontal health. Since dental materials used in prosthesis come in close contact with the gingival tissues and oral mucosa for a long period can further lead to alterations in normal oral microbiota associated with plaque accumulation resulting in poor periodontal health of a child.

Till now, almost every study focused on evaluating plaque index or gingival index for determining the periodontal health status. But, one of the most reliable markers of periodontal disease activity is Gingival crevicular fluid (GCF) where periodontal disease can be assessed easily and non-invasively. It is an inflammatory exudate that can be collected at the gingival margin or gingival crevice. [8]

It is although widely accepted that the etiology of periodontal diseases is polymicrobial but P. gingivalis has been known to be a major factor responsible for the initiation and progression of the disease. [9] The interleukin one beta (IL-1b) is one of the most potent inflammatory cytokines which recruits neutrophils to the inflamed site activated by bacterial antigens like P. gingivalis.[10] Also, it is documented that interleukin-1-beta is one of the main markers of acute inflammation.

Thus, the present study was undertaken to evaluate the interleukin-1-beta marker in GCF obtained concerning two different primary molar crowns; stainless steel crown and zirconia crown, thereby assessing the resulting periodontal changes.

MATERIALS AND METHOD

The *in vivo* split-mouth study was done in the Department of Paediatric and Preventive Dentistry.

Twenty patients in the age group of 4-8 years with endodontically treated primary molars (maxillary/mandibular) bilaterally were included in the study.

Sample size calculation

$$\text{Sample size} = \frac{2SD^2(Z_{\alpha/2}+Z_{\beta})^2}{d^2}$$

SD – Standard deviation = From previous studies or pilot study

$Z_{\alpha/2} = Z_{0.05/2} = Z_{0.025} = 1.96$ (From Z table) at type 1 error of 5%

$Z_{\beta} = Z_{0.20} = 0.842$ (From Z table) at 80% power

d = effect size = difference between mean values

$$\text{Sample size} = \frac{\mathbf{2}\,(2.35)^{\mathbf{2}}(1.96+0.842)^{\mathbf{2}}}{1.2\mathbf{0}^{\mathbf{2}}} = 60.219 = 60$$

For each Group 20 samples. For 3 groups 3x20 = 60 samples.

The subject's rights were protected by the institutional board and written informed consent was granted by all subjects. The endodontically treated primary molar teeth indicated for crown placement were selected for the study. Subjects whose parents gave consent for receiving both stainless-steel crowns (3M™ ESPE™) and preformed zirconia crowns (Kids-e-dental LLP, India) on contralateral teeth in the same arch were selected for the study. Patients were recalled after a year of crown placement for GCF collection.

The Twenty patients who received both the crowns were again divided into 3 groups for sample consideration: group 1-stainless steel crown, group 2-preformed zirconia crown, and group 3- control group (primary second molar) (Figure 1).

GCF was collected either from the buccal sulcular or lingual sulcular region for all three groups that are from stainless steel crown, preformed zirconia crown, and control group as well. Immediately after the sample collection, paper points were stored in Eppendorf tubes containing phosphate broth solution.

The patients with diabetes mellitus, hypertension, gingivitis, periodontal disease, or any other systemic problems which have an impact on the GCF levels were not included in the study.

Patients were instructed to use mouth rinse throughout the study period to maintain gingival health. Informed consent was obtained from the patients and all the procedures carried out were following the ethical standards.

Before the sample collection, the site was prepared by removing plaque and debris and isolating it with cotton rolls. Then, GCF was collected using prefabricated PerioPaper strips inserted into the gingival crevice until resistance felt avoiding mechanical trauma. The strips were left on site for 30 seconds and were then removed with the help of a tweezer and stored in Eppendorf tubes containing phosphate-broth solution. Samples contaminated with blood were discarded. The samples were stored at -70 degrees centigrade in sectioned plastic containers and placed in Ultra-low freezers.

The IL-1β- ELISA Kit is a solid-phase enzyme amplified sensitivity immunoassay which was used for the detection of IL- 1β. Samples and control were added on a microtitre plate.

The plate was incubated for 3 hours, 30 minutes, and 15 minutes consecutively at room temperature on a horizontal shaker set at 700 rpm, 50 µl of the stop solution (to stop the reaction) was pipetted into each well. The absorbencies were read at 450 nm and 490 nm within 3 hours. In between each incubation period, samples were washed thoroughly with distilled water. Color change was noticeable in the sample in which IL-1β was detected.

The results were calculated using the enzyme-linked immune sorbent assay–analysis in detail (ELISA-AIDTM) technique which processes the data. The plate was first to read at 450 nm and then at 490 nm against a reference filter set at 650 nm. The ELISA-AIDTM technique integrates both readings into a polychromatic model automatically.

Statistical analysis

Multiple comparisons were done using Tukey's HSD posthoc test and mean comparison among the groups was done using ANOVA one-way test. All Statistical analysis was performed using SPSS software (IBM Corp 2013; Version 22.0; Armonk, NY).

Figure 1:Three different groups, were assessed in the same mouth.

RESULTS

Table 1: Mean comparison among the groups.

Groups	Mean	Std. Deviation	F value	P value
GROUP 1 (Stainless steel crown)	27.30	3.78	17.689	0.000**
GROUP 2 (Preformed zirconia crown)	21.93	2.83		
GROUP 3 (Healthy tooth)	23.56	1.86		

Statistical Analysis: ANOVA one-way test.

** Highly significant at P < 0.01 & * Significant at P < 0.05

Table 1, mean comparison of IL-1β levels between three groups i.e. Group 1(stainless-steel crown), Group 2(Preformed zirconia crown), and Group 3(Healthy tooth).

The mean of Group 1, Group 2, and Group 3 are 27.30, 21.93, 23.56 respectively and the P-value comes out highly significant in comparison with all the groups. The mean of group 1 is the highest among all the groups elucidating that the interleukin levels are elevated in stainless steel crown indirectly associated with poor periodontal health. Additionally, when a healthy tooth (group 3) is compared to a preformed zirconia crown (group 2), group 3 exhibits higher IL-1β levels (Figure 2).

Figure 2: Mean comparison among the groups.

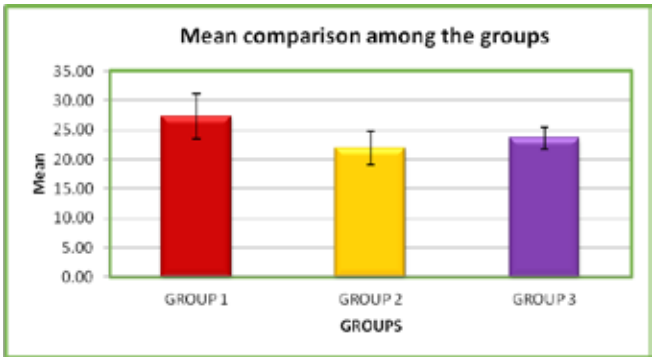


Table 2: Mean comparison between the groups.

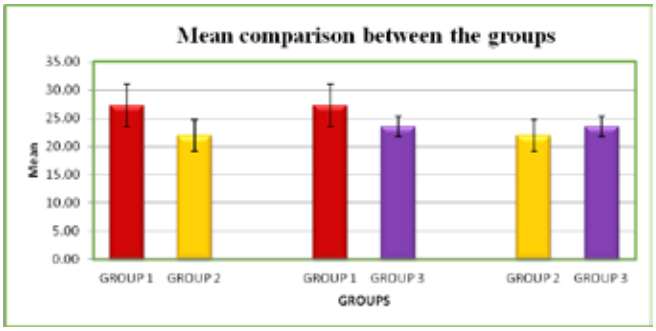
Groups	Mean	Std. Deviation	Mean difference	P value
GROUP 1	27.30	3.78	5.37	0.000**
GROUP 2	21.93	2.83		
GROUP 1	27.30	3.78	3.74	0.000**
GROUP 3	23.56	1.86		
GROUP 2	21.93	2.83	1.63	0.193
GROUP 3	23.56	1.86		

Statistical Analysis: Tukey's HSD post-hoc test.

** Highly significant at P < 0.01 & * Significant at P < 0.05

Table 2 marks the mean comparison between the groups. On comparing group 1 (stainless-steel crown) and group 2 (preformed zirconia crown), group 1 shows elevated levels of IL-1β with the p-value of 0.000. Moreover, in the comparison of group 1 (stainless-steel crown) to group 3 (healthy tooth), group 1 reveals higher levels of IL-1β with the p-value of 0.000. The results are statistically significant when comparing group 1 with group 2 (P-value 0.000) and group 1 with group 3 (P-value 0.000). Furthermore, in comparison of group 2 (preformed zirconia crown) to group 3 (healthy tooth), IL-1β level is higher in group 3 but is not statistically significant (P-value 0.193) (Figure 3). For this reason, it could be recognized that stainless steel crown manifests considerable poor periodontal health compared to PZC and healthy teeth.

Figure 3: Mean comparison between the groups



DISCUSSION

To maintain the integrity and function of endodontically treated primary molars, stainless steel crowns (SSCs) have been used as a full-coverage restoration in children for ages. Because of its high durability and strength along with minimal technique sensitivity, SSCs have been widely used in different treatment procedures including restoring class II cavities, developmental defects, and after endodontic treatment. But, with increased esthetic demand and consciousness among young ones, preformed zirconia crowns (ZCs) are overshadowing the conventional stainless-steel crowns with the advantage of durability, strength, and esthetics as well.

For optimum oral health of tissues, the periodontium should be maintained in a healthy state after a full-coverage restoration. To accomplish the same, Marcum (1967) found that placement of equi-gingival margins caused less inflammation and bleeding as compare to those below or above the gingival crest[11].

Interleukin-1 beta (IL-1 beta) is a pro-inflammatory cytokine that participates in inflammation owing to gingivitis and immune regulation with bone resorption owing to periodontitis[12.] The most common periodontal pathogens, Porphyromonas gingivalis, and Aggregatibacter

Actinomycetemcomitans, initiate IL-1 beta production that can be effectively detected in saliva and GCF of patients[13.]Gafan GP *et al* (2004)[14]stated that the major three pathogens (P. Gingivalis and T. Forsythensis, A. actinomycetemcomitans,) can be detected in the dental plaque of healthy children and of those with gingivitis as well.Subjective to these findings, we have evaluated the level of IL-1 beta was evaluated from GCF collected with peri strips associated with 3 groups: group 1 (SSCs), group 2 (ZCs), and group 3 (Healthy tooth) to compare the periodontal inflammation between the groups using ELISA.

Previously, Saravanakumar *et al* (2017) [15]conducted a study on permanent molars evaluating IL-1 beta associated with metal crown, ceramic crown, and zirconia crown. They concluded that marginal gingiva in contact with metal crowns exhibited more inflammation than gingiva coming in contact with the other group of crowns. They attributed the increased gingival inflammation to distortion of the metal substructure in metal-ceramic crowns which is not present in all-ceramic crowns.[16.17.18] Further accounting the same to the leaching of metal ions coming in contact with marginal gingiva[19,20,21] The results of another study by Ozen, *et al* (2014)[22] proved that metal margins containing nickel-chromium-molybdenum (Ni-Co-Mo) alloy showed higher gingival inflammation compared to ceramic or zirconia crowns. Likewise, in the present study, the SSCs group demonstrated the highest IL-1 beta levels as compared to other groups (p-value 0.000). This could be related to the composition of SSC that contains nickel and chromium, which on leaching when in contact with gingival margin, produces immune response mediating molecules (cytokines) within 24 hours and trigger inflammation.[23.]

Another study done by Koleventi *et al* (2018)[24] demonstrated statistically increased P. gingivalis counts, increased gingival index and pocket depth in the permanent molars with preformed metal crowns from baseline to follow up in children. Taran (2018)[25]compared periodontal health indicators between primary molars restored with ZCs or SSCs and intact natural control teeth. Better PI and GI scores were obtained in molars treated with ZCs than those treated with SSCs. Belduz (2014)[26]compared periodontal health indicators among pre-veneered crowns, SSCs, and control teeth for up to 18 months; they reported that intact control teeth had better periodontal health scores than their crowned counterparts. Contrary to this, the results of the present study indicate that the IL-1 beta level was least in the ZC group as compared to healthy teeth and SSCs. This could be justified by quoting that the surface roughness of the crown material is also a significant factor. The rough surface may contribute to biofilm accumulation and its microbial content can significantly lead to poor periodontal health.[27] Marginal contacts, well-adapted seating, and the absence of cement remnants in the sulcus are some factors relating to plaque accumulation which further is directly proportional to long-term periodontal health around full coverage restorations.

Although, our study signifies that preformed zirconia crowns have better periodontal health-associated but, selecting acceptable-sized preformed crowns after tooth preparation is challenging. Because, unlike SSC, axial surfaces and marginal regions of PZC cannot be manipulated to adapt to tooth preparation, questioning their sealing ability.[28]

Therefore, both the pediatric crowns are sustainable wherein, SSC lapses in esthetics largely.

The periodontal health associated with both pediatric crowns are although comparable but are not causing any considerable periodontal difficulties in children.

CONCLUSION

Zirconia is a relatively new restorative material in pediatric dentistry, associated with comparable superior periodontal health due to its smooth surface and low affinity for plaque accumulation. Additionally, the adaption of Preformed Zirconia crown (PZC) is solely based on tooth preparation and cannot be modified questioning its sealing ability as compared to Stainless-steel crown (SSC). In consequence, preformed zirconia crown can be a relative replacement of SSC in primary molars with an advantage of esthetics at most.

Disclosure of potential conflicts of interest:

No potential conflicts of Interest

Research involving human participants and/or animals:

Research Involves human participants.

Informed consent:

Informed consent was taken from all the participants

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