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Comparison between Stainless-Steel, Zirconia and Fiberglass Crowns as Full Coverage Restoration for Deciduous Molars of Children

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Abstract

Introduction: Dental Caries is a widespread condition that requires attention however; its treatment remains a challenge in terms of child behavior management. **Aim:** To evaluate and compare fiberglass and zirconia crowns with stainless Steel crowns laboratory as full coverage restoration for deciduous molars of children. **Materials and Methods:** This study was conducted to evaluate and compare three types of crowns. It was carried out on 30 mandibular primary molars, 15 mandibular first primary molars for microleakage test and 15 mandibular second primary molars for crown fracture resistance test for three crown types. **Results:** In laboratory evaluation: the microleakage test results showed that there was a clear highly significant difference between the studied groups for the area ($p< 0.0001$). the fracture resistance test results showed that there was a clear significant difference between the studied groups for the Fracture Resistance test ($p< 0.001$). **Conclusion:** The accepted standard for posterior full coverage restorations in primary molars is still stainless steel crowns, followed by Zirconia crowns and fibreglass crowns come next.

Keywords: Stainless steel Crowns; Zirconia ; Fiber-Glass Crowns ; Molars ; Children

INTRODUCTION

Early Childhood Caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated lesions), missing or filled (due to caries) surfaces, in any primary tooth of a child under six years of age**.** Primary teeth can also be affected by conditions that disrupt the development of the dental hard tissues (i.e., hypoplasia, hypo-mineralization, dentinogenesis imperfecta, amelogenesis imperfect). That reduces the integrity and strength of the tooth and therefore, its longevity **(1)**.

Stainless steel crowns (SSCs) have been used for the restoration of primary dentition affected by caries, decalcification in the neck of the tooth, and developmental defects (e.g., hypoplasia, hypo-calcification). Moreover, SSC is used in the restoration of the primary teeth which will be exploited as an abutment to keep space or to use as interposed rehabilitation of severed teeth **(2)**.

Esthetic (cosmetic) dentistry is a discipline within dentistry in which the primary focus is the modification or alteration of the appearance of a patient's oral structures, in conjunction with the treatment and prevention of structural, functional, or organic oral disease. The smile of a child is the greatest gift of God which can be hampered mainly due to a lack of knowledge about oral hygiene procedures and negligence towards the maintenance of dental health [(3)].

Zirconia crowns are relatively in the practice of pediatric dentistry introduced in 2010. Ready‑made zirconia crowns are available for both primary incisors and molars [(4)].

Fiberglass crowns are recently introduced as esthetic full coronal crowns for primary teeth. The crown is made with a fiberglass or quartz fibers embedded with cosmetic resin composite. The crown has a similar structure seen on fiberglass dental posts already widely used in dentistry for endodontic/restorative purposes for decades. The strength and biocompatibility with a degree of flexibility are much closer to tooth structures than stainless steel and zirconia crowns [(5)].

Therefore, this study aimed to evaluate and compare fiberglass and zirconia crowns with stainless Steel crowns laboratory as full coverage restoration for deciduous molars of children.

Material and Methods

This study was conducted to evaluate and compare stainless-Steel, zirconia and fiberglass crowns laboratory after the approval of the Research Ethical Committee (REC) of the Faculty of Dentistry, Suez Canal University No.**(286/2020)**. The study design included two laboratory tests as Microleakage test and Crown fracture resistance test.

- ***Materials & Equipment:*** **(Figure 1)**

1- **Stainless steel crown**: Stainless steel alloy nickel-chromium-based crown, (3M.com/Dental, 3M Oral Care, USA).
2- **Zirconia crown**: Zirconia dioxide ZrO2 (Kids-e-dental. India).
3- **Fiberglass crown**: fiberglass embedded with a composite resin material (Figaro Crowns INC. USA).
4- ***The equipment***: including High-speed air turbine Handpiece (W&H Dentalwerk Burmoos Austria); Crown contouring plier (Stainless Steel, Pakistan); Caliper (Stainless Steel. Kynup. China); Double ended probe (Stainless Steel, India); Diamond stones (Medin, Czech Republic); Automated thermocycling machine (Robota, Turkey); Digital microscope (U500X Digital Microscope, China); Fracture resistance testing machine (Model 3345; Instron Industrial Products, US A).

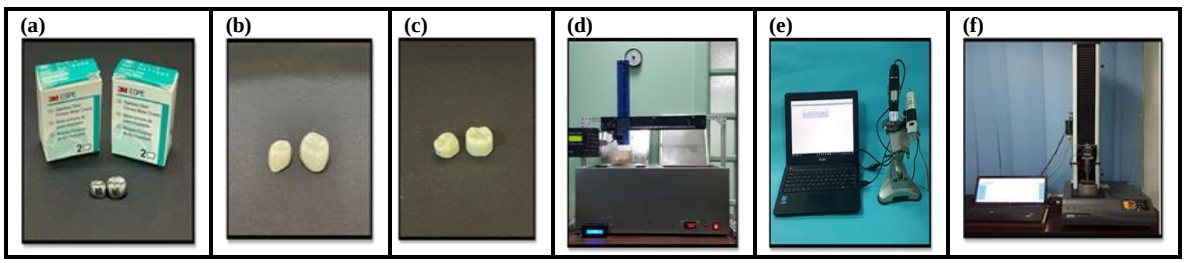

Figure (1): **(a)** Stainless steel crown; **(b)** Zirconia crown; **(c)** Fiberglass crown; **(d)** Automated thermocycling machine; **(e)** Digital microscope ; **(f)** Fracture resistance testing machine (Instron Machine).

- **Sample Size Calculation for Microleakage Test:**

The sample size was calculated with a power of 80% and confidence of 95%. The sample was calculated to be 15 primary molars, 5 primary molars for each group, by using www.clincalc.com [(6)].

$$K=\frac{n_2}{n_1}=1 \qquad n_1=\frac{(\sigma_1^2+\sigma_2^2/k)\left(z_1-\frac{\alpha}{2}+z_1-\beta\right)^2}{\Delta^2} \qquad n_1=\frac{(0.15^2+0.15^2/1)(1.96+0.84)^2}{0.26^2}$$

(n_1= 5; n_2 = k * n_1 = 5; Δ= $[\mu_2-\mu_1]$ = absolute difference between two means ; σ_1,σ_2, = variance pf means # 1 and #2 ; n1= sample size for group # 1 ; n2= sample size for group # 2 ; α= probability of type I error (usually 0.05) ; β= probability of type II error (usually 0.2) ; Z= critical z value for a given α *or* β; K=ration of sample size for group # 2 to group #1).

- **Sample Size Calculation for Crown Fracture Resistance Test:**

The sample size was calculated according to the following evaluation of Fracture Resistance with a power of 80% and confidence of 95%. The sample was calculated to be 15 primary molars, 5 primary molars for each group, by using www.clincalc.com **[(6)].**

$$K=\frac{n_2}{n_1}=1 \qquad n_1=\frac{(\sigma_1^2+\sigma_2^2/k)\left(z_1-\frac{\alpha}{2}+z_1-\beta\right)^2}{\Delta^2} \qquad n_1=\frac{(0.15^2+0.15^2/1)(1.96+0.84)^2}{0.26^2}$$

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- **Inclusion criteria:**

The presence of enamel on the crown margins, have at least three of its axial walls intact or have tiny carious lesions with a minimum of 1 mm of remaining tooth structure. Adequate root length of at least 1/3rd of root**.** The collected primary molars were disinfected with 10% thymol and stored in saline at room temperature until usage [(7)].

Sample grouping:

This study included 30 mandibular primary molars divided into two main groups according to the type of evaluation tests:

- **Group I:** included 15 mandibular first primary molars for the microleakage evaluation test.
- **Group II:** included 15 mandibular second primary molars for crown fracture resistance evaluation test.

I. Groups for Micro-leakage test:

The selected 15 mandibular first primary molars for microleakage evaluation were numbered from 1 to 15 and then randomly divided (using the website http://WWW.randomizer.org.) [(8)] into 3 groups according to crown types **(Figure 2)**:

- **Group Ia:** included 5 mandibular first primary molars restored by stainless steel crowns.
- **Group Ib:** included 5 mandibular first primary molars restored by zirconia crowns.
- **Group Ic:** included 5 mandibular first primary molars restored by Fiberglass crowns.

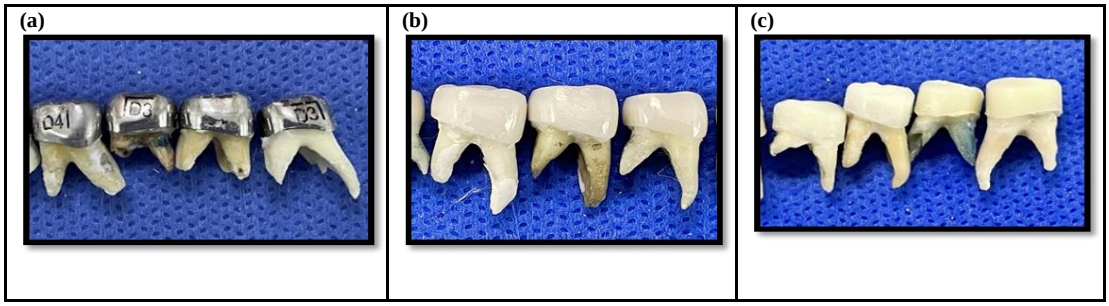

Figure (2): Showed (a) stainless steel crowns in group Ia, (b) zirconia crowns in group Ib and (c) Fiberglass crowns in group Ic.

I. Groups for Crown Fracture Resistance test:

The selected 15 mandibular second primary molars for crown fracture resistance evaluation were numbered from 1 to 15 and then randomly divided (using the website http://WWW.randomizer.org.) into three groups according to crown restoration types **(Figure 3)**. All restored molars for crown fracture resistance test were embedded in an acrylic resin block for easy handling [7]:

- **Group IIa:** included 5 mandibular second primary molars restored by stainless steel crowns.
- **Group IIb:** included 5 mandibular second primary molars restored by zirconia crowns.
- **Group IIc:** included 5 mandibular second primary molars restored by Fiberglass crowns.

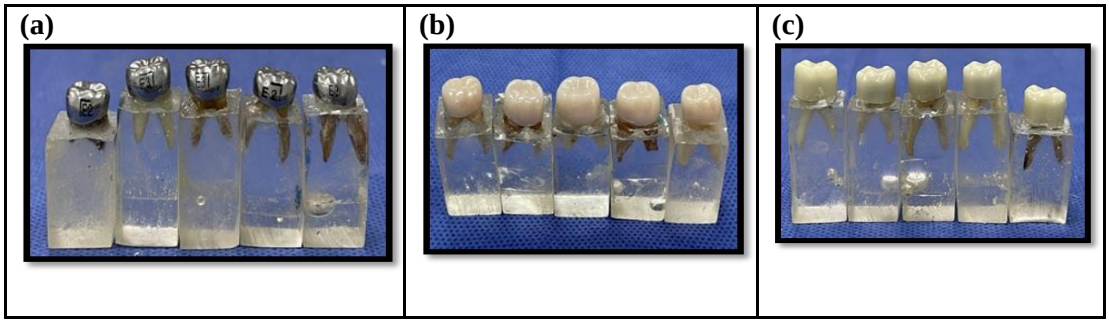

Figure (3): showed (a): Group IIa., (b) Group IIb. and (c): Group IIc.

Statistical analysis:

Data analyzed using Microsoft Excel software, then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. Differences between quantitative independent multiple by ANOVA. P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

This study included 30 mandibular primary molars divided into two main groups according to the type of evaluation tests.

Regarding microleakage test results, there was a clear highly significant difference between the studied groups for the area ($p< 0.0001$). The high value was recorded in group Ib (62003.5 ±3822.5) followed by group Ic (47167.2±3655.5) while group Ia (35233.1±4337.4) was the lowest one. For the percentage between the leakage area according to the total area, the statistical analysis showed a significant difference between groups Ia & Ib and Ib & Ic while there was a non-significant difference between Ia&Ic ($p= 0.20$), the high percent was recorded in Group Ib (45.08%) followed by Group Ic (31.22%) while the group Ia (25.22 %) was the lowest one **(Table 1; Figure 4).**

Table (1): Comparison between groups for the microleakage test (area and percentage):

Groups	Area	Percentage (%)	Pair-wise Comparisons		
	Mean ±SD	Mean ±SD	Bonferroni's post hoc test		
				Area	Percentage
Group Ia	35233.1^{c}±4337.4	25.22^{b} ±6.5	***Ia Vs Ib***	**0.00000224****	**0.0000013****
Group Ib	62003.5^{a}±3822.5	45.08^{a} ±15.1	***Ia Vs Ic***	**0.00000120****	**0.20^{ns}**
Group Ic	47167.2 ^{b}±3655.	31.22^{b} ±5.62	***Ib Vs Ic***	**0.000000227****	**0.00000022****
P value	**0.00000005****	**0.002****			

***; a,b,c: means the significant difference between groups*

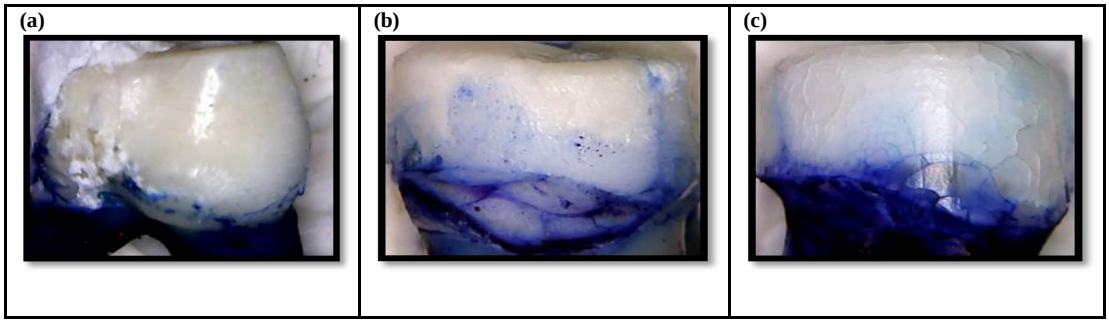

Figure (2): showed Microleakage test results: (a) the leaked area in group Ia., (b) the leaked area in group Ib. and (c) the leaked area in group Ic.

Regarding crown fracture resistance test results, there was a clear significant difference between the studied groups for the Fracture Resistance test ($p< 0.001$). The high value was recorded in group IIa (2857.93±47.55) N followed by group IIb (2245.39±40.04) N while group IIc was (2156.02±62.67$^{)\ N}$ the lowest one **(Table 2; Figure 5)**.

Table (1): Comparison between groups for fracture resistance test:

Groups	Fracture (N)	Pair-wise Comparisons	
	Mean ±SD	Bonferroni's post-hoc test	
Group IIa.	2857.93 ±47.55^{a}	IIa Vs IIb	**0.0000153****
Group IIb.	2156.02±62.67^{c}	IIaVs IIc	**0.0000149****

Group IIc.	2245.39±40.04[b]	IIb Vs IIc	**0.0000127****
P value	**0.00000191****		

***; a,b,c: means the significant difference between groups*

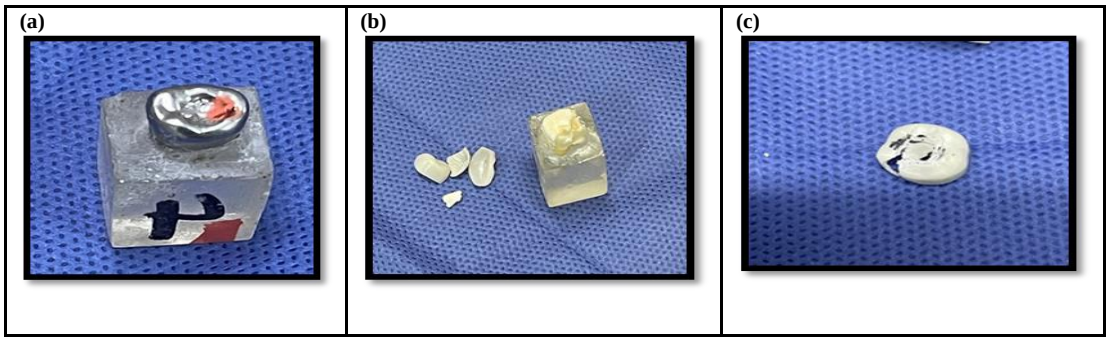

Figure (3): Crown Fracture Resistance test (a): fractured crown in Group IIa, (b) fractured crown in Group IIb and (c): fractured crown in Group IIc.

DISCUSSION:

Today there are many solutions available for aesthetic problems in Pediatric Dentistry. But the biggest dilemma is choosing the best treatment modality for a patient and situation which depends on various factors like the age of the patient, the motivation of the parents, the child's behaviour in the dental clinic and the socioeconomic status of the patient **(9)**.

In this consideration, the appearance of different techniques, devices and materials helps in creating beautiful restorations which help children and adolescents to improve their self-image. However, restoring primary teeth can be a hard task because of the difficulty to isolate properly and the uncooperative behaviour of the child **(9)**.

The present study evaluated the microleakage test and the crown fracture resistance test as both tests were useful to guide the practice protocols for a variety of clinical approaches **(10)**. The microleakage test was performed as one of the reasons for a full coverage crown clinical failure. Minimizing the seepage of oral fluids by identifying the affecting clinical factors may improve their success rate **(11)**.

In this study, unidentified extracted 15 mandibular first primary molars were collected and divided into three groups according to crown restoration types for the microleakage test in this study, this may be due to easy to obtained due to caries rate and easy extraction of them when compared to second molars .which corresponded with **Ramazani and Ranjbar (8)** and **Seraj et al. (11)** who applied the same criteria selection of their samples and concluded that the primary first molars were selected.

Our results for the microleakage test revealed that the ZRCs had high microleakage followed by FIGCs and the lower one was the SSCs with a highly significant difference between the different studied groups. This may be due to more tooth reduction in zirconia crown preparation and no crimping possibility for the zirconia crowns whereas the SSCs required less tooth reduction, easily to crimp and

has snap-fit as, also the FIGCs based on the flex fit technology which provided tight margins and thus a reduction in marginal leakage. This finding is in agreement with **Subramanian et al.** [12] who compared the degree of microleakage of zirconia crowns with stainless steel crowns in primary molars. They found that microleakage was noticed in all the specimens irrespective of the crowns used, however, the degree or extent of microleakage was more with zirconia crowns and this difference was statistically significant. Also, our results agreed with **Subramanian et al.** [13] who found that all the samples included in the study showed marginal leakage. 55% of SSCs and 40% of Figaro crowns showed marginal leakage at the margins of the crown only.

The current findings disagreed with those studies **Ali** [14] and **Akila** [15] who found that zirconia crowns had the lowest marginal and internal gap width. These discrepancies in results may have been due to methodological differences in terms of measuring microleakage. Also, they reported a lack the presence of a standardized method to measure the marginal and internal fit of cemented crowns, in general.

The crown fracture resistance test was performed as the restorative materials in the oral cavity are subjected to excessive forces, biting on a hard object and uncontrolled contact between opposing teeth. These restorative materials should have the ability to withstand these forces and fracture, especially in the stress-bearing area. this is in agreement with **Omer et al.** [16] . Unidentified extracted 15 mandibular second primary molars were collected and divided into three groups according to crown types for the crown fracture resistance test in this study which can be available. This is agreed with **El Makawi and Khattab** [7] who applied the same criteria selection of their samples.

Our results for the fracture resistance test revealed that the SSCs showed the highest fracture resistance followed by FIGCs while group ZRCs were the lowest one, there was a clear significant difference between the studied groups. this may be attributed to the high ductility of stainless-steel crowns and the brittleness of ZRCs. This was in accordance with other studies done by **Akila** [15] and **Townsend et al.** [17] who reported that Stainless steel crowns exhibited better compressive strength and a lesser amount of tooth reduction required compared to Zirconia crowns**.** also, our results agreed with **Çiftçi et al.** [10] who recorded mean fracture resistance values and demonstrated higher fracture resistance for FIGCs than the ZRCs groups and that this difference was statistically significant**.**

Causes of fiberglass crown failure; this may be due to occulsal wear which can be the result of the thin thickness of the fiberglss crown and it has low microhardness as it can not withstand the mastication forces. Excessive occusal wear led to the loss of cementation thus complete loss of the crown. Over time, fiberglass crown surfaces become rough and less polished which allows crown staining (color chang).

CONCLUSION:

The accepted standard for posterior full coverage restorations in primary molars is still stainless steel crowns, followed by Zirconia crowns and fibreglass crowns come next.

Based on laboratory results achieved in the current stud recommended that:

1. The current most popular choice for the restoration of primary molars stays the SSCs.
2. Zirconia crowns are a good choice as aesthetics full coverage restoration for primary molars.
3. Fiber-glass crowns cannot be recommended for clinical use for periods greater than 6 months.

REFERENCES:

1- Pitts, N. B., Baez, R. J., Diaz-Guillory, C., Donly, K. J., Feldens, C. A., Mcgrath, C., Phantumvanit, P., Seow, W. K., Sharkov, N. & Songpaisan, Y. 2019. Early childhood caries: IAPD Bangkok declaration. Journal of dentistry for children (Chicago, Ill.), 86**,** 72.

2- Holsinger, D. M., Wells, M. H., Scarbecz, M. & Donaldson, M. 2016. Clinical evaluation and parental satisfaction with pediatric zirconia anterior crowns. Pediatric dentistry, 38**,** 192-197.

3- Aindrila G., P. J., Shabnam Z., And Gautam K 2019. Figaro Crowns - A promising Alternative for Esthetics and Functional Rehabilitation of Decayed Primary Incisors: A case Report. . International Development Association, World Bank group, 35**,** 33-35.

4- Abdulhadi, B., Abdullah, M., Alaki, S., Alamoudi, N. & Attar, M. 2017. Clinical evaluation between zirconia crowns and stainless steel crowns in primary molars teeth. Journal of Pediatric Dentistry, 5**,** 21.

5- Chakraborty, S., Das, A., Agarwala, P., Zahir, S., Lahiri, P. K. & Kundu, G. K. 2019. Esthetic rehabilitation of decayed primary incisors using Figaro crowns and strip crowns. IJDSIR, 2**,** 490-4.

6- Rosner, B. 2011. Fundamentals of Biostatistics (The 7th edition). Boston, MA: Brooks/Cole.

7- El Makawi, Y. & Khattab, N. 2019. In Vitro comparative analysis of fracture resistance of lithium disilicate endocrown and prefabricated zirconium crown in pulpotomized primary molars. Open Access Macedonian Journal of Medical Sciences, 7**,** 4094.

8- Ramazani, N. & Ranjbar, M. 2015. Effect of tooth preparation on microleakage of stainless steel crowns placed on primary mandibular first molars with reduced mesiodistal dimension. J of Dentistry (Tehran, Iran), 12**,** 18.

9- Nerkar, R. 2017. Recent esthetic revolutions in pediatric dentistry: A review. Int J Oral Health Med Res, 4**,** 80-82.

10- Çiftçi, Z. Z., Şahin, İ. & Karayılmaz, H. 2022. Comparative evaluation of the fracture resistance of newly developed prefabricated fibreglass crowns and zirconium crowns. Int.j. of paed. dentistry.

11- Seraj, B., Shahrabi, M., Motahari, P., Ahmadi, R., Ghadimi, S., Mosharafian, S., Mohammadi, K. & Javad Kharazifard, M. 2011. Seraj Pediatric Dentistry, 33**,** 525-528.

12- Subramanian, E., Kumar, A. & Lavanya, G. 2021. Comparative Evaluation Of Marginal Leakage Of Ssc And Zirco-nia Crowns In Primary Teeth. Nveo-Natural Volatiles & Essential Oils Journal| NVEO**,** 7063-7068.

13- Subramanian, E., Lavanya, G., Jeevanandan, G. & Kumar, A. 2022. Comparative Evaluation Of Marginal Leakage Of Stainless-Steel Crowns And Figaro Crowns In Primary Teeth-An In-Vitro Study. European Chemical Bulletin, 11**,** 1-1.

14- Ali, S. N. A.-H. 2019. In vitro comparison of marginal and internal fit between stainless steel crowns and esthetic crowns of primary molars using different luting cements. Dental Research Journal, 16**,** 366.

15- Akila V., J. M., Poornima V., Deebiga K .,Swathika M. C. L., Aarthi V. 2021. Evaluation of compressive strength, microleakage and amount of primary tooth reduction required for posterior zirconia and stainless steel crowns-an invitro study. International Journal of Scientific and Research Publications (IJSRP), 11**,** 544-547.

16- Omer, H., Hammouda, H., Shalan, H. & Abdellatif, A. 2019. Fracture resistance of puplotomized primary molars restored with various restorative materials. Acta Scientific Dental Sciences, 3**,** 98-104.

17- Townsend, J. A., Knoell, P., Yu, Q., Zhang, J.-F., Wang, Y., Zhu, H., Beattie, S. & Xu, X. 2014. In vitro fracture resistance of three commercially available zirconia crowns for primary molars. Pediatric dentistry, 36**,** 125E-129E.