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CLINICAL PERFORMANCE OF COMPOSITE CORONAL BUILD – UP IN MUTILATED PRIMARY INCISORS: 3 YEARS RESULTS

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ABSTRACT

Purpose: To evaluate the clinical success and/ or failure of composite coronal build-up retained by macro-retentive grooves for restoring mutilated primary maxillary incisors after 36 months.

Design: Forty two primary incisors out of 14 children, privately treated under general anesthesia and presented for follow-ups after 6, 12, 18, 24 and 36 months. The parameters of retention, colour match, recurrent caries, chipping /fracture and loss of restoration (failure) were recorded at the baseline and follow-up intervals.

Methods: Fourteen 2-5 years old subjects, presented with mutilated primary incisors due to caries or trauma were treated comprehensively under general anesthesia from June 2016 to June 2017. Forty two incisors were restored with composite coronal build-up based on micromechanical adhesive concept and macro mechanical retentive grooves created on the lateral walls of cervical third of the roots. Patients were re-examined clinically at the follow-up intervals by using specific criteria for evaluation.

Results: Only 9.52% were rated as having lost some resin material; with overall 3 years follow up retention rate 92.86% of composite strip crowns. After 36 months, 6 restorations (14.29%) were totally lost, eight teeth (19.05%) had secondary caries and 33.33% demonstrated color change because of plaque accumulation. Higher failure rate was found in four- surfaces affected incisors than those presenting one or two carious surfaces, (P =0·3).

Conclusion: High success rate of composite strip crowns may suggest that such treatment option can be an aesthetic and satisfactory option for restoring carious primary incisors in young children.

KEY WORDS: Child, Esthetics, Dental caries, Primary incisors, Composite

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INTRODUCTION

In daily practice of pediatric dentistry, it is common to diagnose many patients with mutilated primary anterior teeth mainly due to problems such as bottle feeding caries, tooth anomalies, hypo plastic defects, crown fractures and some aggressive habits as bruxism.[1] The most common cause for mutilated primary anterior teeth is the nursing bottle caries. Early childhood caries remains major public health problem and the most common chronic infectious disease in children with a challenging approach to control.[2, 3, 4]

Primary maxillary anterior teeth are essential for physical appearance [4] and their destruction causes an esthetic problem and may also lead to development of para-functional habits such as tongue thrusting, speech defects, psychological burden, impaired masticatory efficiency, and loss of vertical dimension of occlusion.[1] Hence, it is mandatory to restore destructed crowns to preserve the integrity of primary dentition till its exfoliation and eruption of permanent teeth.[1]

The restoration of esthetics of severely mutilated primary anterior teeth has been a challenge for the pediatric dentists and one of the most difficult targets to achieve,[5] not only because of the limited available materials and techniques, but also because the children who require such restorations are usually among the youngest and least manageable group of pediatric patients.[1,2] Additionally, small sized teeth, the pulp proximity to the tooth surface, relatively thin enamel and small surface area for bonding increase the challenge.[6] However, insufficient coronal tooth structure endangers the retention and endurance the longevity of the restorations.

Previously, the most commonly followed treatment for such mutilated teeth was extraction.[4] Recently, with the advancements in materials and techniques coupled with growing awareness among the parents, it becomes reasonable concept to restore the carious teeth to their original forms and functions as soon as detected.[7]

Recent advances in restorative dentistry such as band reinforced composite restorations, composite strip crowns and biological restorations with natural teeth [1,7,8] along with recent placement techniques, preparation designs, and adhesive concepts have provided clinicians with alternatives to extraction and facilitated restoration of mutilated primary anterior teeth to a reasonable extent.[4] Meanwhile, the most popular type of preformed esthetic crowns for primary incisors is composite resin strip crown, first introduced by **Webber et al. 1979**.[9]

However, the outcome and durability for long lasting and successful management of these modalities to restore esthetics, form and function are lacking.[10] There is insufficient clinical data to suggest the use of one type of restoration and which one is more superior to another.[10] Therefore, it was beneficial to evaluate and compare the clinical performance and success of various options for esthetic restorations for primary anterior teeth.

Therefore, the present study aimed to evaluate the success and / or failure of coronal composite resin build-up restorations retained by macro-retentive grooves created on the lateral walls of the cervical one third of the roots of the treated primary anterior teeth after 6, 12, 18 , 24 and 36 months.

MATERIALS AND METHODS

Clinical Data were collected from (n= 14) children, 8 boys and 6 girls, aged from 2-5 years, who had received private dental treatment under general anesthesia, between June 2016 to June 2017. These children had minimum two carious maxillary incisors **Fig. (1)** but most frequently the four maxillary incisors were mutilated and restored with coronal composite build-up restorations (layering build-up) by using pre-formed celluloid crown (*3M ESPE, USA*) called as "strip crown technique".

Fig. (1) Teeth affected due to caries with one or two or three surfaces affected or more.

Inclusion criteria

- Apparently healthy children with age range from 2-5 years.
- Carious or traumatized with one or more surfaces affected.

Exclusion criteria

- Teeth nearing exfoliation or beyond restoration.
- Patients with systemic diseases which may interfere with general anesthesia.
- Teeth with excessive pathologic mobility.

Treatment Procedures:

All children were treated dentally under general anesthesia, and treatment was performed by the principal author (Saber, H.). The first step was removal of gross carious lesions using high speed hand piece and #330 round carbide steel bur of suitable size **Fig. (2)**. The pulp chamber was accessed and intraoral periapical radiograph was taken for recording canal length; pulp tissue was extirpated using barbed broaches under constant irrigation with 1.25% sodium hypochlorite diluted with saline. The canal was prepared till size #30 K files (*Mani Inc., Tochigi, Japan*) in case of Lateral incisors and size #40 in case of Central incisors under constant irrigation, dried with paper points of suitable size and filled with calcium hydroxide iodoform mix (*Metapex; Meta Biomed Co. Ltd, Korea*). **Fig (7)** Metapex paste was then condensed using a hand plugger of suitable size (*Mani Inc., Tochigi, Japan*) into the canal, **Fig. (3)**, isolation was performed using cotton rolls and high suction saliva ejectors as the teeth under treatment do not had enough crown structure for rubber dam application.

Fig. (2): Caries removal by using high speed hand piece and #330 round carbide steel bur.

About 3 mm of Metapex paste was removed from the coronal end of the root canal using # 330 round carbide steel bur of suitable size. For the creation of undercuts in the root lateral walls that will provide the macro-mechanical retention for the composite restoration, a small round bur size ½ was used. The undercuts were created at a level of 2-3mm below the Cemento-enamel junction all around the root surfaces (Mesial, Distal, labial &Palatal). The root canal walls were etched using 37% Ortho-phosphoric acid for 15s (*Meta Biomed Co. Ltd, Korea*), followed by application of the bonding agent (*3M-ESPE, Saint Paul, MN, USA*) and cured for 20s.

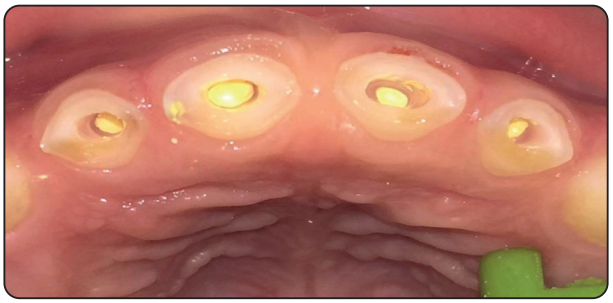

Fig. (3): Root canals were filled with calcium hydroxide iodoform mix (Metapex; Meta Biomed Co. Ltd, Korea)

The created 2-3 mm of the root canal space was filled using flowable composite Z350 Universal Restorative (*3M-ESPE, Saint Paul, MN, USA*), the composite was light-cured for 40 s. Crown was reconstructed using packable composite Z350 Universal Restorative by using strip crown former (*3M™ ESPE™ Pediatric Strip Crown Forms, USA*). Finishing and polishing were performed using Soflex tips (*3M-ESPE, Saint Paul, MN, USA*) after checking the occlusion.

The colour immediately after completion of the procedure was defined as acceptable when it was of a perfect match with neighboring restorations and/ or adjacent natural teeth or unacceptable when there was a slight difference.

Crowns were photographed and clinically assessed during the routine recall examination. The restorations were photographed to allow blind evaluation of their clinical appearance, color match, anatomic form, recurrent caries and chipping / fracture or total loss by the second author (Nasr, R.) without the presence of principle operator to avoid biasing. An evaluation rating system was derived from United States Public Health Service (USPHS) Alpha criteria rating system.[11]

The USPHS system was primarily designed for posterior teeth, so a new system was developed for anterior teeth. Definitions and criteria of rating system are detailed in ***Table (1)***. Briefly, it was a photographic record including evaluation of the color, anatomic shape and integrity of the strip crown.

All patients were re-called and restorations were re-evaluated for anatomic form, surface texture, recurrent caries, color match and retention in accordance with Modified Ryge's Direct Evaluation Criteria ***Table (1)*** [12, 13] at baseline time (immediately postoperative) **Fig. (4)**, and interval periods of 6, 12, 24, and 36 months. **Fig. (5 & 6)**.

The rate of failures of composite coronal build-up either due to trauma or failure of bonding was the highest percentage of 14.29 % at 36 months follow-up representing 6 out of 42 teeth. The failures rate increased by time at the follow- up periods with the least percentage 7.14% (n= 3) at the first

Fig. (4): Immediately postoperative (baseline)

TABLE (1): Modified Ryge's Direct Evaluation Criteria

Clinical Characteristics	Retention	Color match	Surface texture & Recurrent caries	Anatomic form (Chipping/ Fracture)
Alfa (A)	Restoration Present.	The restoration matches the adjacent tooth structure color and translucency.	Restoration surface is as smooth as the surrounding enamel.	Restoration is continuous with existing form.
Bravo (B)	Partial loss of restoration.	Slight mismatch in color or translucency between the restoration and the adjacent tooth.	Restoration surface is rougher than the surrounding enamel	Restoration is discontinuous with existing form, but missing material is insufficient to expose dentin.
Charlie (C)	Restoration Absent.	The color mismatch is outside the acceptable range of tooth color and translucency.	There is recurrent caries at the tooth/ restoration interface.	Sufficient restorative material is missing to partially or totally expose dentin.

month and percentage increased to be 9.52% (n = 4), 11.90% (n= 5) at 6 months, 12 months and 18 months follow-up respectively. The percentage was constant (14.29%) at the intervals of 24 months, 30 months and 36 months. Table (6) & Figure (11)

The composite crown was considered clinically successful, if surface appeared smooth, colour remained good and acceptable, no chipping/ fracture or recurrent caries at tooth/restoration interface and there is no loss of the restoration.

Data were analyzed using percentages, frequencies and cumulative frequencies. The Z-test was used for comparison between failure rates of the two types of failures (Failure due to trauma & failure of bonding), significance level was set at *P*< 0·05. The Chi square test was used for association between the number of affected surfaces and the total failures. *(P-value)* was set at P< 0·05.

RESULTS

Demographic data regarding the total number of children, number of treated teeth in boys and girls are summarized in ***Table (2)*** and ***Table (3)*** respectively. The numbers of carious surfaces present before treatment as well as the site of decayed surfaces were recorded: (only one) mesial, distal, buccal or palatal; (two) mesial or distal with buccal or palatal; (three) mesial, distal, and buccal or palatal and (Four surfaces) are shown in ***Table (4)***.

TABLE (2): Total Number of Children = 14

	N	Percentage
MALES	8	57.14%
FEMALES	6	42.86%

Fig. (5): Clinical appearance of four strip crowns at follow-up after one year.

Fig (6): Clinical appearance of four strip crowns at follow-up after 3 years.

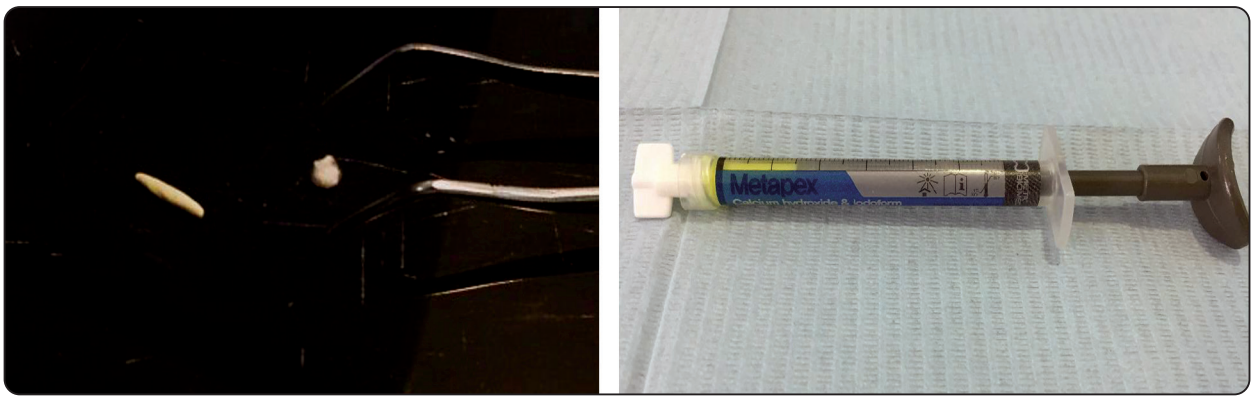

Fig (7): Calcium Hydroxide Iodoform Mix (Metapex; Meta Biomed Co. Ltd, Korea)

Fourteen pediatric patients (age=2-4years) are participating in the study, 57.14% of them are boys (n=8) and the girls participating represent 42.86% (n=6). All are treated under general anesthesia. **Table (2)** and **Figure (8)**. Within the total number of the treated teeth (n= 42), fifteen central incisors and eleven lateral incisors were treated in boys. However, nine central incisors and seven lateral incisors were treated in girls of the study **Table (3).** Such distribution is shown in **Figure (9).**

TABLE (3): Number of Treated Teeth in Boys and Girls

Gender distribution	Central incisors	Lateral incisors	Total incisors	Total Percentage
MALES	15	11	26	61.90%
FEMALES	9	7	16	28.09%

The rate of success of composite coronal build-up was the highest percentage of 92.86% at the first month follow-up representing 39 out of 42 teeth. The success rate decreased by time to 90.48% , 88.10% , 85.71% at 6 months, 18 months,36 months respectively. However, the rate of failure due to trauma showed less percentage than failure due to debonding at the first month, 6 months, 12 months and 18 months and equal percentages of failure (7.14%) due to trauma and debonding at 24 months, 30 months and 36 months. **Table (5)**

Thus, the data of 42 resin-bonded composite strip crowns placed in 26 maxillary central incisors and 16 maxillary lateral incisors belonging to 14 children, followed up between 1 and 36 months after treatment, are presented in this preliminary report **Table (5)**. More than 85% of the restorations were successful at the final follow-up examination.

The rate of failures of composite coronal build-up either due to trauma or failure of bonding was the highest percentage of 14.29 % at 36 months follow-up representing 6 out of 42 teeth. The failures rate increased by time at the follow- up periods with the least percentage 7.14% (n= 3) at the first month and percentage increased to be 9.52% (n = 4), 11.90% (n= 5) at 6 months, 12 months and 18 months follow-up respectively. The percentage was constant (14.29%) at the intervals of 24 months, 30 months and 36 months. **Table (6) & Figure (11)**

As regarding the comparison between the rates of the two types of failure, the percentages of failure due to trauma showed less value than rates of failure of bonding along the follow up intervals except at the 24 months, 30 months and 36 months showed the same percentage (7.14%) for both types. **Table (7).**

For comparison of the failure rates of the two types of failures (Failure due to trauma & failure of bonding), Z test is applied. Significance level is considered at $P < 0.05$ (S); while for $P < 0.01$ is considered highly significant (HS). There is statistically non-significant difference between the two failure types *($P > 0.05$)* at any month. **Table (8)** & **Table (9).**

As regarding the cumulative frequency of

TABLE (4): Treated incisors by site and number of caries surfaces

Site of Caries	Central Incisor	Lateral Incisor	Total Incisors	Total Percentage
	(n=24)	(n=18)	(n=42)	
One surface M or D or P or B	3	4	7	16.70%
Two surfaces	5	3	8	19%
Three Surfaces	6	3	9	21.40%
Four Surfaces	10	8	18	42.80%

TABLE (5): Rates of success and failures at follow-up periods till 36 months:

		Frequency	Percent
1month	**Success**	39	92.86%
	Failure due to Trauma	1	2.38%
	Failure of bonding	2	4.76%
	Total Failure	3	7.14%
	Total	42	100.00%
6 months	**Success**	38	90.48%
	Failure due to Trauma	1	2.38%
	Failure of bonding	3	7.14%
	Total Failure	4	9.52%
	Total	42	100.00%
12 months	**Success**	38	90.48%
	Failure due to Trauma	1	2.38%
	Failure of bonding	3	7.14%
	Total Failure	4	9.52%
	Total	42	100.00%
18 months	**Success**	37	88.10%
	Failure due to Trauma	2	4.76%
	Failure of bonding	3	7.14%
	Total Failure	5	11.90%
	Total	42	100.00%
24 months	**Success**	36	85.71%
	Failure due to Trauma	3	7.14%
	Failure of bonding	3	7.14%
	Total Failure	6	14.29%
	Total	42	100.00%
30 months	**Success**	36	85.71%
	Failure due to Trauma	3	7.14%
	Failure of bonding	3	7.14%
	Total Failure	6	14.29%
	Total	42	100.00%
36 months	**Success**	36	85.71%
	Failure due to Trauma	3	7.14%
	Failure of bonding	3	7.14%
	Total Failure	6	14.29%
	Total	42	100.00%

TABLE (6): Total Rate of Failure:

Time	Frequency of Failure	Percent
1month	3	7.14%
6 months	4	9.52%
12 months	4	9.52%
18 months	5	11.90%
24 months	6	14.29%
30 months	6	14.29%
36 months	6	14.29%

TABLE (7): Comparison of the types of failure rates:

	Failure due to Trauma	**Failure of bonding**
1month	2.38%	4.76%
6 months	2.38%	7.14%
12 months	2.38%	7.14%
18 months	4.65%	7.14%
24 months	7.14%	7.14%
30 months	7.14%	7.14%
36 months	7.14%	7.14%

TABLE (8): Comparison of the failure rates after 36 Months to Month 1:

	Z value	P value	
Difference of failure rate at Month 1 and at End	1.06	0.28992	**P > 0.05 NS**

There is statistically non-significant difference between the two failure rates (P > 0.05)

TABLE (9) : Comparison of the failure rates of the two types of failures

Difference between the two types of failure rates			
	Z value	P value	
At Month 1	0.59	0.55657	**P > 0.05 NS**
At Month 12	1.02	0.55551	**P > 0.05 NS**
At Month 18	0.46	0.64469	**P > 0.05 NS**

There is statistically non-significant difference between the two failure types (P > 0.05) at any Month

discoloration along the follow up intervals, the minimum percentage 0.00% was found in the first month follow up. While the maximum percentage (33.33%) of cumulative frequency of discoloration occurred in the 36 months follow up interval. **Table (10)** & **Figure (13)**

TABLE (10): Cumulative frequencies of DISCOLORATION:

Time	Frequency	Percent	Cumulative frequency	Percent
1month	0	0.00%	0	0.00%
6 months	2	4.76%	2	4.76%
12 months	6	14.29%	8	19.05%
18 months	1	2.38%	9	21.43%
24 months	2	4.76%	11	26.19%
30 months	3	7.14%	14	33.33%
36 months	0	0.00%	14	33.33%

TABLE (11): Cumulative frequencies of FRACTURE/ CHIPPING

Time	Frequency	Percent	Cumulative frequency	Percent
1month	0	0.00%	0	0.00%
6 months	0	0.00%	0	0.00%
12 months	0	0.00%	0	0.00%
18 months	1	2.38%	1	2.38%
24 months	1	2.38%	2	4.76%
30 months	2	4.76%	4	9.52%
36 months	0	0.00%	4	9.52%

TABLE (12): Cumulative frequencies of RECURRENT CARIES:

Time	Frequency	Percent	Cumulative frequency	Percent
1month	0	0.00%	0	0.00%
6 months	0	0.00%	0	0.00%
12 months	0	0.00%	0	0.00%
18 months	3	7.14%	3	7.14%
24 months	3	7.14%	6	14.29%
30 months	1	2.38%	7	16.67%
36 months	1	2.38%	8	19.05%

As regarding the cumulative frequency of fracture and/or chipping of composite build up along the follow up intervals, the minimum percentage 0.00% was found in the first month follow up. While the maximum percentage (9.52%) of cumulative frequency of fracture/chipping occurred in the 36 months follow up interval. **Table (11) & Figure (14).**

As regarding the cumulative frequency of recurrent caries at composite/ tooth interface along the follow up intervals, the minimum percentage 0.00% was found in the first month follow up. While the maximum percentage (19.05%) of cumulative frequency of composite/tooth recurrent caries occurred in the 36 months follow up interval. **Table (12) & Figure (15)**

Out of Forty-two treated incisors, (9.52%) presented chipping (n = 4) at the end of 3 years follow up, and recurrent caries was found in (n =8) incisors presenting (19.05%) of the treated incisors, discoloration 33.33% (n = 14) while failure found in 14.29% (n= 6) at the end of 36 months follow up. **Table (13) & Figure (16)**

Relation between the number of affected tooth surfaces and the type and rate of failures:

No failure occurs in 20% of the teeth with two surfaces affected; however 35% of five affected surfaces teeth showed no failures. Ten teeth showed discoloration at the end of follow-up time with 50% in teeth with 4 affected surfaces. One 4-surfaces tooth showed chipping in the composite and another one with 2 affected surfaces showed discoloration and recurrent caries. Regardless the number of decayed tooth surfaces, 28.5% of the teeth showed recurrent caries at follow-up. **Table (14)**

Of all the parameters evaluated, only the number of carious surfaces of the tooth at baseline influenced the treatment outcome. Thus, the failure rate was higher in incisors, with four affected surfaces, than in those presenting with one or two carious surfaces, both in the central and lateral incisors (P =0·3). **Table (15)**

TABLE (13): Change of Rates of Failure and Other Events With Time:

	FAILURE		DISCOLORATION		FRACTURE/CHIPPING		RECURRENT CARIES	
Time	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1month	3	7.14%	0	0.00%	0	0.00%	0	0.00%
6 months	1	2.38%	2	4.76%	0	0.00%	0	0.00%
12 months	0	0.00%	6	14.29%	0	0.00%	0	0.00%
18 months	1	2.38%	1	2.38%	1	2.38%	3	7.14%
24 months	1	2.38%	2	4.76%	1	2.38%	3	7.14%
30 months	0	0.00%	3	7.14%	2	4.76%	1	2.38%
36 months	0	0.00%	0	0.00%	0	0.00%	1	2.38%
Total	6	14.29%	14	33.33%	4	9.52%	8	19.05%

FAILURE	14.29%	FRACTURE/CHIPPING	9.52%
DISCOLORATION	33.33%	RECURRENT CARIES	19.05%

TABLE (14) Relation between the number of affected tooth surfaces and the type and rate of failures:

	Number of decayed surfaces				
	Two	**Three**	**Four**	**Five**	**Total**
None	n= 4	n=3	n=6	n=7	20
	20.0%	15.0%	30.0%	35.0%	
Chipping	0	0	1	0	1
	0.0%	0.0%	100.0%	0.0%	
Discoloration	0	2	5	3	10
	0.0%	20.0%	50.0%	30.0%	
Discoloration / Chipping	0	1	2	0	3
	0.0%	33.3%	66.7%	0.0%	
Discoloration/ Recurrent Caries	1	0	0	0	1
	100.0%	0.0%	0.0%	0.0%	
Recurrent Caries	1	2	2	2	7
	14.3%	28.6%	28.6%	28.6%	

TABLE (15)

No. of Affected Surfaces	**Without Failure**		**Total Failure**		**Total Number**	**Chi-Squared**	**P-Value**
	Frequency	Percent	Frequency	Percent			
2	5	83.33%	1	16.67%	6	3.56	0.31363
3	8	100.00%	0	0.00%	8		
4	12	75.00%	4	25.00%	16		
5	11	91.67%	1	8.33%	12		

TABLE (16)

No. of Affected Surfaces	Without Failure		Total Failure		Total Number	Fisher Exact test Probability
	Frequency	Percent	Frequency	Percent		
2 & 3	13	92.86%	1	7.14%	14	0.64480

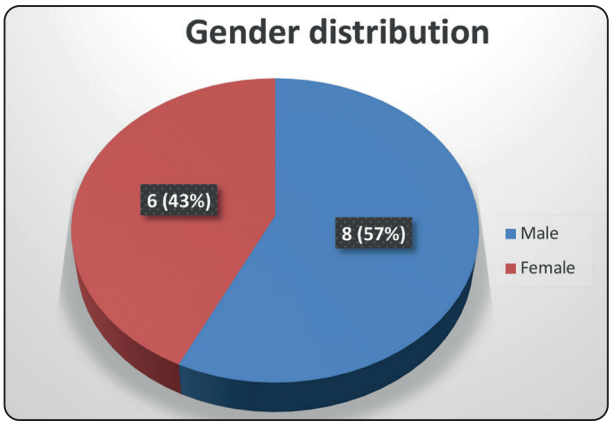

Fig. (8): Showing gender distribution of the participants.

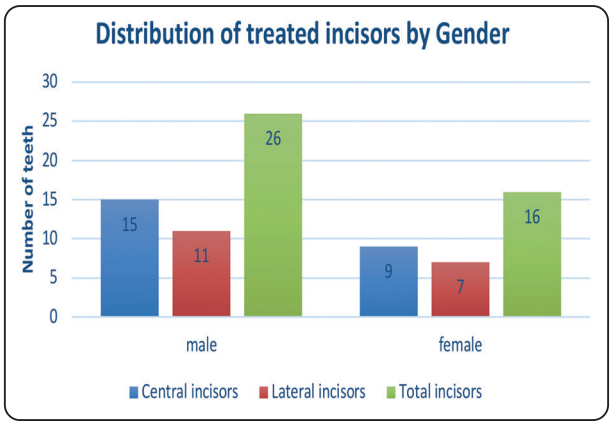

Fig. (9): Showing distribution of the treated teeth.

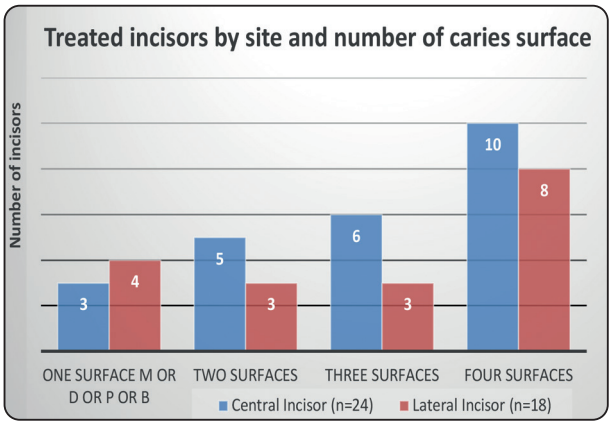

Fig. (10): Showing distribution of treated incisors by the site and the number of affected surfaces.

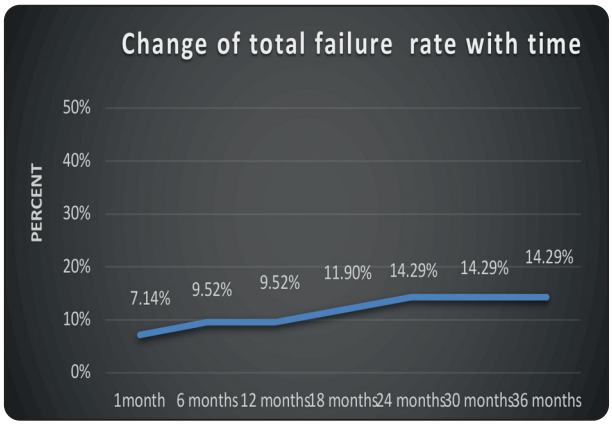

Fig. (11): Showing total rate of failure by time.

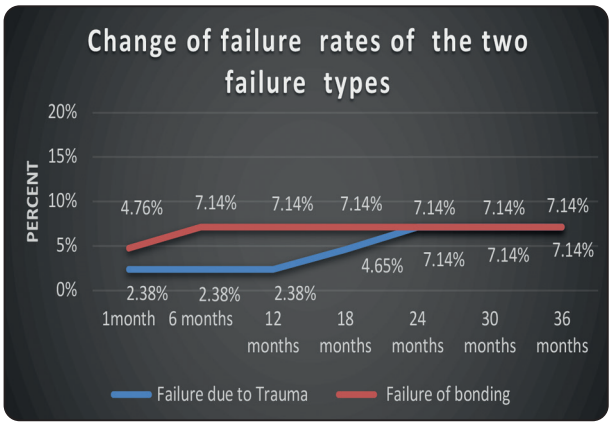

Fig. (12): Showing comparison of the two types of failures.

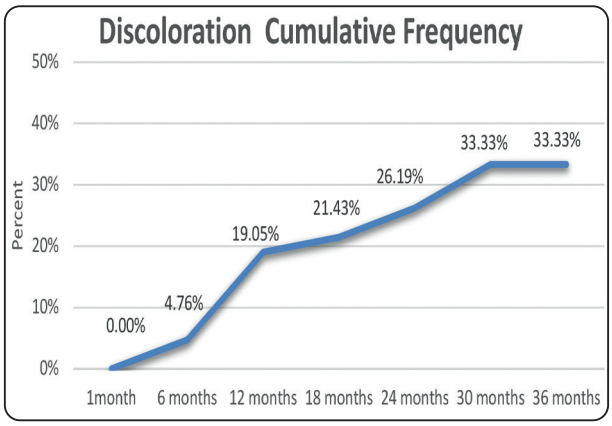

Fig. (13): Showing cumulative frequency of discoloration.

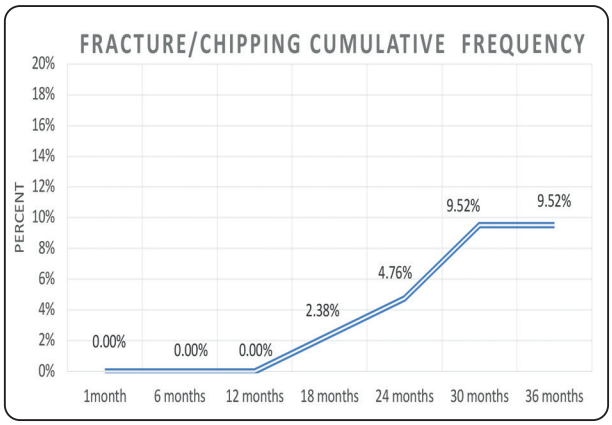

Fig. (14): Showing cumulative frequency of Fracture/ Chipping.

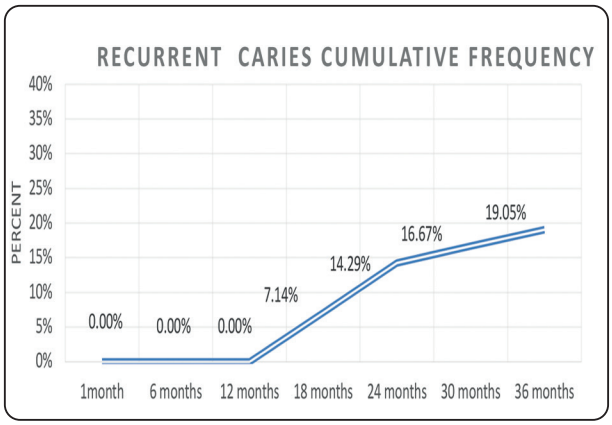

Fig. (15): Showing cumulative frequency of recurrent caries.

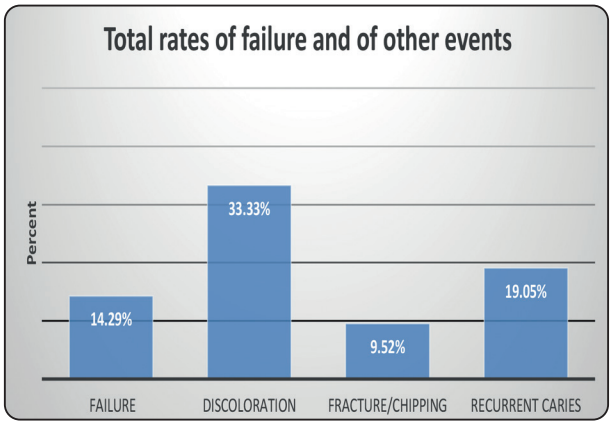

Fig. (16): Showing Change of failure rates and other events with time.

No statistically significant association between number of affected surfaces and total failures.

The use of Chi squared test is not appropriate as the frequency per cell is small less than 5.

Hence the data will be rearranged as 2X2 tale to apply Fisher exact test.

Although it is clear that at greater number of affected surfaces more failures occur. Due to small numbers

No statistically significant association between number of affected surfaces and total failures.

DISCUSSION

The success rate of strip crowns in the present study was (85.71%), after 36 months, which was better than that described by ***Tate et al.*** [14]**,** and almost similar to that (88%) reported by ***Kupietzky et al. 2003***, if we take the larger study sample into consideration[15].

This finding might also be related to the type of practice and to the socioeconomic level of the participating parents. Most of these parents were highly motivated, and were willing to bring their children for check-ups after 6 months, 12, 24 and 36 months as well as for periodical fluoride applications. These factors might have influenced both the decrease in the number of children who continued with the nocturnal nursing habit and the decline in the number of new carious lesions found in the follow-up examinations.

This high success rate might be attributed to the fact that the operator is a well experienced pediatric dentist with very good skills, and not just due to the use of general anesthesia.

Eidelman et al., 2000 compared the durability of restorations placed in children under sedation to those placed under a general anesthetic [16]. In a sample of 34 children treated under general anesthesia and followed between 6 and 24 months,

successful marginal adaptation and good anatomic form were found in 90% and 86%, respectively [16]. In comparison, out of 31 children who were treated with sedation, marginal adaptation and anatomic form were considered successful in 63% and 65%, after 6 and 24 months respectively [16]. This difference between successful treatment under general anesthesia and conscious sedation was statistically significant. These results suggested that strip crowns placed under general anesthesia may exhibit superior longevity [16].

A few authors have also completely eliminated patient cooperation as a variable affecting treatment outcome by evaluating the treatment success rate in patients having received anterior crown restorations under general anesthesia [16, 17]. Overall data suggest that treatment under general anesthesia may result in better quality of treatment due to the elimination of patient cooperation, which invariably affects the clinical conditions at the time of restoration. This is especially true for fearful young children where poor cooperation and lack of good moisture control may interfere with the successful placement of composite resin strip crowns.

The longevity of the crown is likely to be jeopardized if a considerable amount of tooth structure is missing, since the composite crown relies on dentin and enamel adhesion for retention[18]. **Nor *et al.1997*** found that the dentine of primary teeth is more reactive to acid than that of the permanent teeth. These authors also reported lower bond strength in the primary teeth, and attributed this finding to a thicker hybrid layer formation that is not completely penetrated by the bonding agent during composite build-up procedure[19].

This might explain using a shorter etching time (15 s.) for primary dentine in the present study to reproduce the hybrid layer seen in etched permanent dentine to maximize the bonding mechanism. This comes in agreement with **Araujo *et al.*** [20], used Scanning Electron Microscopy and reported the formation of a resin-reinforced hybrid layer in primary teeth when utilizing a 15-s etching time. Although these were *in vitro* findings, it might be worth by using a 15-s etching time when placing composite strip crowns in multi-surface decayed primary incisors.

Retention:

Failure of bonding at the end of 36 months follow-up was 7.14%, which is considered low percentage. In other terms, the overall 3 years retention rate of composite strip crown in this study was 92.86%, higher than that reported by ***Kupietzky et al. 2003*** in their 18 months retrospective study, and they found that full retention rate of the strip crown to be 88% [15]. Similar results were shown by ***Ram and Fuks 2006*** [21]. According to ***Anderson***, the retention or survival rate of reattached tooth fragment was lower in relation to the survival rate of composites [22] which was explained by adhesive, micromechanical bonding concept between composite and tooth structure.

Furthermore, in addition to the adhesive concept of composite to the tooth structure, additional macro-mechanical retentive undercuts were created to improve retention. Similarly, ***Kenny et al. (1986)*** introduced the composite resin short post, or "mushroom undercut" into the dentin, to aid in the retention of the crown [23]. They retrospectively evaluated the clinical performance of 243 patients with 625 composite resin strip crowns with short post technique. They found that with proper case selection and mechanical design of the short post, as well as adequate crown-root ratio, these composite resin strip crowns could be retained till normal exfoliation. The authors did not report on the details of the retrospective study and the lack of a controlled study design was a major limitation [23] similar to the present study.

Judd and colleagues (1990) in a prospective clinical study with one year follow-up reported a

100% retention rate of composite resin strip crown retained by short composite post in a sample of 92 teeth [24]. ***Grosso et al. (1987)*** and ***Mendes et al. (2004)*** case report also described and suggested the use of a composite resin short post in the pulp chamber of an anterior tooth that had received a pulpectomy to improve the retention of final coronal restoration [25, 26].

However, the use of different techniques to obtain retention in pulpectomized teeth can increase the survival rate of the restoration. On the contrary, physiologic root resorption of primary teeth is the main limiting factor for placement of intra-canal posts in the primary dentition [27.] ***Metha et al. 2012*** precluded the use of the entire root canal length; therefore, the coronal third of the canal was commonly used for gaining retention in such circumstances through different approaches[27,28,29.], similar to the clinical study conducted by ***El Shahawy OI, O'Connell AC, 2016*** in which Fuji IX was condensed into the intra-canal space created to a depth of 3mm, to provide a core which also extended 3mm supra-gingivally. Crown preparations were completed upon these cores. Different to the present study, Zirconia crowns (Nusmile, Houston Texas USA) were fitted and cemented over the prepared cores to achieve a long-term stable esthetic restoration for primary anterior teeth [30].

Color match

When assessed color match in the present study, restoration showed some degree of discoloration over a period of time. At the base line and the first follow –up 0.00% cumulative frequency of discoloration, increased gradually by time to be 33.33% at the end of 36 months follow.

Color changes could be attributed to changes in composite restoration itself, which may be caused by the formation of colored degradation products, changes in surface morphology because of wear and by extrinsic staining and pigments. In agreement with both ***Ernst et al. 2006*** and ***Kupietzky et al. 2003*** and ***Kupietzky et al. 2005*** [31, 15,32].

Furthermore, due to the transparent characteristic of resin composites used; the brown hue (affected dentin) of the excavated lesion could be seen through the restoration. This comes in accordance of other study [33].

Another cause for discoloration and unacceptable aesthetic results, as described by **Kupietzky *et al.*** [15], was found in teeth which had been endodontically treated. The colour was acceptable when the teeth were vital. But Endoflas (*Sanlor Laboratories, Bogota, Colombia*), an iodoform containing paste extensively used by pediatric dentists as a resorbable root canal filling material in primary teeth, has the disadvantage of badly discoloring pulpectomized teeth. This might be another explanation for color change occurring in the current study as: pulpectomy was performed in all teeth and filled with calcium hydroxide iodoform mix (Metapex; Meta Biomed Co. Ltd, Korea).

Recurrent Caries

Children presenting with ECC are high caries risk group and possible failure to follow proper preventive regimen can result in caries recurrence. Lack of compliance with the preventive instructions resulting in caries recurrence even in treated cases of ECC has also been reported previously by several authors; ***Eidelman et al 2000*** [16] and ***Almeida et al 2000.*** [34]

The percentage of patients reporting with recurrent caries in this study at the end of follow up period, 19.05% (cumulative frequency of recurrent caries) which is much lower than in the above said studies, and can be attributed to the restrict preventive measures instituted along with parental counseling regarding diet and oral hygiene given by the authors.

Fracture/ Chipping:

Composite resins can be successfully used for reinforcement of weakened tooth structure

[35.] Mechanical and physical properties of direct composite resin restorations such as fracture toughness, hardness and polymerization shrinkage are variables which always affect the functional longevity of restorations.

For restoring such teeth, restorative material used must have adequate fracture resistance to withstand masticatory forces [36]. This is especially important in restoration of severely damaged primary teeth because the remaining tooth structure in such teeth is limited and compromised as they have higher risk of trauma and fracture [37, 38].

Similarly, according to the ***X X Chen et al. 2020*** changes seen in anatomic form seemed to be due to loss of material caused by disintegration or fracture [39].

In the present finding, the frequency of four teeth out of the total number with a percentage of 9.52% showed fracture/ chipping at the end of the follow-up period which is considered a very acceptable finding and comes in coincide with ***Kupietzky et al. 2003*** [15] in which, none of the restorations were totally lost, and only 12% were rated as having lost some resin material (cracked, chipped or fractured).

Loss of Restoration (Failure)

There is a statistically non-significant ($P > 0.05$) difference between the two failure types whether due to trauma or failure of bonding at any month of the follow up period. There is a statistically non-significant difference between the two failure rates ($P > 0.05$) at first month and month 36 with Z- value =1.06

Relation between the number of affected tooth surfaces and type and rate of failures

No failure occurs in 20% of the teeth with two surfaces affected; however 35% of five affected surfaces teeth showed no failures. Ten teeth showed discoloration at the end of follow-up time with percentage of 50% in the teeth with four affected surfaces. One 4-surfaces tooth showed chipping in the composite and another one with 2 affected surfaces showed discoloration and recurrent caries. This can be explained by the fact that the number of carious surfaces of the tooth at baseline was the only parameter that influenced the treatment outcome. Thus, the failure rate was higher in incisors, with four affected surfaces, than in those presenting with one or two carious surfaces, both in the central and lateral incisors (P =0·3). No statistically significant association between number of affected surfaces and total failures.

CONCLUSIONS

- Resin-bonded composite strip crowns can be a durable and aesthetic restoration for mutilated carious primary incisors.
- In this clinical study, composite resin strip crowns performed well to restore primary incisors with large or multi-surface caries. They provide an esthetic and durable restoration for carious primary incisors.
- The retention rate is lower in teeth with decay in three or more surfaces, particularly in children with a high caries risk.
- Because of high technical sensitivity and its requirement of child cooperation, strip crowns are more suitable for older and cooperative children as well as children receiving dental treatment under sedation or general anesthesia.

RECOMMENDATIONS

Thus, composite strip crowns have a great potential to be used as esthetic restorative option in primary anterior. However, further long-term research is required to validate their use in primary anterior teeth.

Substantial improvement is required in clinical practice by introducing realistic approaches for easy management of challenges faced in the pediatric dentistry.

LIMITATIONS OF STUDY

Some of the limitations of this study may be considered. The absence of a proper preventive strategy could result in caries recurrence in this group of teeth. As oral hygiene and diet are critical factors in developing caries, one of the limitations of this study was absence of control over the oral hygiene and diet of the children; thus, these factors could influence caries recurrence rates in our study.

Another limitation was that no comparison was carried out between the type of teeth (central or lateral incisors), which may affect post retention because of differences in tooth morphology and tooth position in the dental arch; therefore, further investigational studies are recommended in this regard.

Additionally, a radiographic evaluation similar to the photographic one would have been useful to provide a 3-dimensional evaluation to supplement the 2-dimensional photographic evaluation. In spite of these limitations, the photographs did provide an avenue to closely evaluate the real esthetics and contours of these crowns.

REFERENCES

1. Sahana S., Vasa A.A., Shekhar R. Esthetic crown for primary teeth: A review. Ann Essences Dent. 2010;II:87–93.
2. Himanshu Duhan, Inder Kumar Pandit, Nikhil Srivastava, Neeraj Gugnani, Monika Gupta, Gulsheen Kaur Kochhar . Clinical comparison of various esthetic restorative options for coronal build-up of primary anterior teeth. Dental Research Journal / November 2015 / Vol 12 / Issue 6: 574-580 PP
3. Tiwari E., Kulkarni V.K., Sharma D.S., Bhusari C.P. Esthetic and functional rehabilitation of primary teeth in an emotionally immature child under general anesthesia. Natl J Dent Speciality Res. 2014; 2:35–7.
4. Grewal N., Seth R. Comparative *in vivo* evaluation of restoring severely mutilated primary anterior teeth with biological post and crown preparation and reinforced composite restoration. J Indian Soc Pedod Prev Dent. 2008; 26:141–8. [PubMed: 19008621]
5. Reynoso A.R., Argueta A.R. Hybrid nano-resin esthetic crowns in primary teeth: Case report. Rev Odontol Mex. 2014; 18:255–8.
6. Mathew R.A. Esthetics in primary teeth. Int Res J Pharm. 2013; 4:80–2.
7. Das U.K., Maiti N. Nature's own alternative — Restoration with biological crowns. Pediatr Dent 2014; 3:144-9.
8. Waggoner WF. Restoring primary anterior teeth: updated for 2014. Pediatr Dent. 2015; 37(2):163–170. [PubMed] [Google Scholar]
9. Webber, D. L., Epstein, N. B., Wong, J. W., & Tsamtsouris, A. . A method of restoring primary anterior teeth with the aid of a celluloid crown form and composite resins. Pediatr Dent1979, 1(4), 244-246.
10. Waggoner W.F. Anterior crowns for primary anterior teeth: An evidence based assessment of the literature. Eur Arch Paediatr Dent. 2006;7:53–7. [PubMed: 17140528]
11. Ryge G. Clinical Criteria. *Int Dent J*. 1980; 30:34-58.
12. Grewal N., Seth R. Comparative *in vivo* evaluation of restoring severely mutilated primary anterior teeth with biological post and crown preparation and reinforced composite restoration. Indian Soc Pedod Prev Dent 2008; 26:141-8.
13. Schirrmeister J.F, Huber K., Hellwig E., Hahn P. Two-year evaluation of a new nano-ceramic restorative material. Clin Oral Investig 2006; 10:181-6.
14. Tate A.R., Ng M.W., Needleman H.L., Acs G. Failure rates of restorative procedures following dental rehabilitation under general anesthesia.*Pediatric Dentistry* 2002; 24 : 69–71.
15. Kupietzky A., Waggoner W.F., Galea J. The clinical and radiographic success of bonded resin composite strip crowns for primary incisors. *Pediatric Dentistry* 2003; 23: 577–581.
16. Eidelman E., Faibis S., Peretz B. A comparison of restorations for children with early childhood caries treated under general anesthesia or conscious sedation. Pediatr Dent 2000; 22 (1), 33-7.
17. Al-Eheideb, A. A., & Herman, N. G. Outcomes of dental procedures performed on children under general anesthesia. J Clin Pediatr Dent 2003, 27(2), 181-183

18. Lee J.K. Restoration of primary anterior teeth: review of the literature. *Pediatric Dentistry*2002; 24: 506–511.

19. Nor J.E., Feigal R.J., Dennison JB, Edwards CA. Dentin bonding: SEM comparison of the dentin surface in primary and permanent teeth. *Pediatric Dentistry* 1997; 19: 246–252.

20. Araujo F.B., Garcia-Godoy F., Issao M. A comparison of three resin bonding agents to primary tooth dentin. *Pediatric Dentistry,* 1997; 19: 253–257.

21. Ram D., Fuks A.B. Clinical performance of resin-bonded composite strip crowns in primary incisors: A retrospective study. Int J Paediatr Dent 2006; 16:49-54.

22. Andreasen F.M., Norén J.G., Andreasen J.O., Engelhardtsen S., Lindh-Strömberg U. Long-term survival of fragment bonding in the treatment of fractured crowns: A multicenter clinical study. Quintessence Int 1995; 26:669-81.

23. Kenny, D. J., Johnston, D. H., & Bamba, S. The composite resin short-post: a review of 625 teeth. Ont Dent1986, 63(5), 12, 14, 17-18.

24. Judd, P. L., Kenny, D. J., Johnston, D. H., & Yacobi, R. (1990). Composite resin short-post technique for primary anterior teeth. J Am Dent Assoc, 120(5), 553-555

25. Grosso, F. C. Primary anterior strip crowns: a new technique for severely decayed anterior primary teeth. J Pedod1987, 11(4), 375-384.

26. Mendes, F. M., De Benedetto, M. S., del Conte Zardetto, C. G., Wanderley, M. T., & Correa, M. S. Resin composite restoration in primary anterior teeth using short-post technique and strip crowns: a case report. Quintessence Int 2004, 35(9), 689-92.

27. Metha D., Gulati A., Basappa N., Raju O.S. Esthetic rehabilitation of severely decayed primary incisors using glass fiber reinforced composite: a case report. J Dent Child (Chic) 2012 Jan-Apr; 79(1):22-25.

28. Eshghi A., Esfahan R.K., Khoroushi M. A simple method for reconstruction of severely damaged primary anterior teeth. Dent Res J (Isfahan) 2011 Oct; 8(4):221-225.

29. Rachana B., Suleman A., Tapan S. Custom-made polyethylene fiber reinforced composite resin used as a short post for pediatric anterior teeth. Asian J Oral Health Allied Sci 2011 Jan-Mar; 1(1):31-35.

30. El Shahawy OI, O'Connell AC. Successful restoration of severely mutilated primary incisors using a novel method to retain zirconia crowns-two year results. J Clin Pediatr Dent. 2016;40(6):425–430. doi: 10.17796/1053-4628-40.6.425.

31. Ernst C.P., Brandenbusch M., Meyer G., Canbek K., Gottschalk F., Willershausen B. Two-year clinical performance of a nanofi ller vs a fi ne-particle hybrid resin composite. Clin Oral Investig 2006; 10:119-25.

32. Kupietzky A, Waggoner WE, Galea J. Long-term photographic and radiographic assessment of bonded resin composite strip crowns for primary incisors: results after 3 years. Pediatr Dent. 2005; 27(3):221–225. [PubMed] [Google Scholar]

33. Schirrmeister J.F., Huber K., Hellwig E., Hahn P. Two-year evaluation of a new nano-ceramic restorative material. Clin Oral Investig 2006; 10:181-6.

34. Almeida A.G., Roseman M.M., Sheff M., Huntington N., Hughes C.V. Future caries susceptibility in children with early childhood caries following treatment under general anesthesia. Pediatr Dent 2000;22:302-6.

35. Magne P., Belser U.C. Porcelain versus composite inlays/onlays: effects of mechanical loads on stress distribution, adhesion, and crown flexure. Int J Periodontics Restorative Dent. 2003 Dec;23(6):543-55.

36. Fathi B., Bahcall J, Maki J.S. An in vitro comparison of bacterial leakage of three common restorative materials used as an intracoronal barrier. J Endod. 2007 Jul; 33(7):872-4.

37. Memarpour M., Shafiei F., Abbaszadeh M. Retentive strength of different intracanal posts in restorations of anterior primary teeth: an in vitro study. Restor Dent Endod. 2013 Nov; 38(4):215-21.

38. Pithan S., de Sousa Vieira R., Chain M.C. Tensile bond strength of intracanal posts in primary anterior teeth: an in vitro study. J Clin Pediatr Dent. 2002 Fall; 27(1):35-9.

39. X X Chen , J Zhong , W J Yan, H M Zhang, X Jiang , Q Huang, S H Xue, X G Liu. Clinical performance of resin-bonded composite strip crowns in primary incisors. Journal of Peking University. Health Sciences 2020 Oct 18; 52(5):907-912. doi: 10.19723/j.issn.1671-167X.2020.05.019.