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CLINICAL PERFORMANCE OF ENDOCROWNS VS. GLASS FIBER POST IN RESTORING ENDODONTICALLY TREATED FIRST PERMANENT MOLAR IN CHILDREN; A RANDOMIZED CONTROLLED TRIAL WITH 1 YEAR FOLLOW-UP

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ABSTRACT

Purpose: to compare the clinical performance of endocrowns versus the fiber posts with composite cores used in restoring endodontically treated 1st permanent molar in children using FDI criteria.

Materials& Methods: A single blind and parallel group study carried on 28 patients in the age group 10–13 years visiting endodontic clinic at MSA University seeking endodontic treatment of their decayed 1st lower molars. One week after completing endodontic treatment, patients were randomly divided into 2 groups: Group A (n=14): received lithium disilicate (IPS. emax-press) endocrowns & Group B (n=14): received glass fiber post with composite core. A clinical evaluation of debonding, fracture, caries and patient satisfaction was performed by a single examiner. Each was scored from 1 to 5 according to FDI where; 1 was clinically very good, and 5 was a clinically poor restoration that must be replaced. Patients were evaluated and recalled regularly at 3, 6, 9 and 12 months.

Results: Regarding the restoration debonding and fracture; group A(endocrowns) showed 100% survival throughout all periods of follow up while group B (glass fiber posts with composite cores) showed decrease in survival rate over time. As for evaluation of caries and patient satisfaction; both groups were not statistically significant different.

Conclusion: Endocrowns can be considered a clinically successful restoration for endodontically treated teeth in general and the concept can be adapted to the endodontically treated teeth in children.

Clinical significant: Although more studies with increased sample size and long term follow-up are still required, endocrowns can be a permanent restorative option for endodontically treated 1st permanent molar in young age with a high success rates.

KEYWORD Endocrowns, glass fiber post, composite restoration, ETT young permanent molar, cuspal coverage, randomized clinical trials, FDI criteria.

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INTRODUCTION

The first permanent molar is considered the key of occlusion. Its preservation is mandatory to maintain a proper inter-occlusal relationship[1]. It is early loss leads to decrease the chewing capacity of this side by 40-45%[2].

Caries incidence of first permanent molar is common in children. It is due to several factors. First, the morphology of its occlusal surface has deep pits and fissures. Second, its early eruption may be considered as a prime cause of its high caries incidence especially due to the fact that most of parents don not recognize its presence due to its early eruption date without a predecessor and the common misperception that eruption sequence of permanent teeth starts from anterior to posterior area. Furthermore, its posterior position in the oral cavity which may be adjacent to a carious primary molar. All these mentioned factors increase the incidence of many children seeking restorations, root canal treatment or even early extractions of first permanent molar to relieve pain[2,3].

Restoration of endodontically treated teeth is a clinical dilemma facing operators daily. The dilemma is much more complicated when related to young children with major loss of tooth structure as a result of caries and access cavity preparation. And as the first permanent molar is continued to erupt and increasing the crown length throughout teenage years All these factors increased the demand for a transient restoration that provides cuspal coverage following the completion of root canal treatment until the age of construction of permanent restoration[4,5].

Stainless steel crowns were developed to restore primary molars; they were also advocated as a transitional restoration of the endodontically treated first permanent molar until the recommended age of construction of full coverage crown was reached. Well adapted stainless steel crowns provide a healthy periodontium. However, the stainless steel crown is a metal pre-sized crown which may affects its esthetics and marginal adaptation, causing gingival inflammation, recurrent caries and adjacent tooth impaction[6]. Moreover, it requires additional tooth preparation and reduction with final poor esthetic results that not satisfying the patients and their parents[7].

With continuous progress in technologies, many trials were developed to overcome the limitations in stainless steel crowns such as open-face SSCS, pre-veneered SSCS, and zirconia pediatric crowns as NuSmile zirconia and kinder zirconia with their difficult in size selection and applications[8]. Furthermore, all these treatment options were mainly developed for deciduous teeth and none of these were tried for young permanent molars[9].

On the other side, fiber posts have a modulus of elasticity similar to root dentine which increases their flexibility and allowing the distribution of stress along the tooth more than metal post rendering the root highly resistant to fracture[10]. On the other hand, glass fiber posts with composite restorations provide protection of the obturating material and superior microleakage resistance. This can be considered as a conservative treatment in comparison to amalgam core or other alternatives[11].

With new concept of adhesive dentistry and its clinical applications in everyday practice, endo-crowns were introduced as an alternative restorative option of conventional post crown system. It eliminated the need for intra-canal retainer support as it uses the pulp chamber cavity for retention[12]. The technique was first described in 1995 by **Pissi** as a mono-block porcelain technique[13], while **Bindl** and **Mormann** in 1999 described the name endo-crown for the 1st time[14]. Endocrowns are indicated in many cases as excessive loss of coronal dental tissue and limited inter-occlusal space. This type of restoration mainly depends on macro-mechanical retention provided by the pulpal cavity and micro-retention by adhesive resin cement[15].

To date, the long term clinical performance data on endocrowns in general is required[16]. Furthermore, applying the endocrown concept as an option in restoring the endodontically treated 1st permanent molar in children needs to be evaluated and discussed.

The FDI (World Dental Federation Criteria) introduction in 2007 as a new clinical evaluation system for both direct and indirect restoration standardized the calibration of the clinical studies. These criteria can be individualized according to the clinical situation and the study objective[17].

The aim of the present study was to compare the clinical performance of endocrowns versus the fiber posts with composite cores used in restoring endodontically treated 1st permanent molar in children using FDI criteria.

The null hypothesis was that endocrown concept can be applied to permanent molars in children with satisfactory successful rate higher than post and core option.

MATERIALS AND METHODS

The present study was a randomized, single blind and parallel group study carried on 28 patients visiting endodontic clinic of faculty of Dentistry, Modern Sciences and Arts University, Cairo, Egypt. seeking endodontic treatment of their decayed first lower molars. A written consent was signed from the patient's parent after discussing all the treatment options and required follow-ups.

Patients were selected according to the following inclusion criteria:

1. Patient age ranging from 10-13 years old with closed apex.
2. Normal occlusion without any para-functional habits.
3. Decayed lower first molar.
4. Supra-gingival margin was required after preparation.
5. Absence of root fractures or cracks.

While the exclusion criteria:

1. Difficulty to apply rubber dam for proper endocrown bonding.
2. Lack of patient cooperation for post-operative recall and follow up.
3. Bad oral hygiene

28 patients ranging in the age group 10–13 years (taking into account 10% dropouts if present) were requiring endodontic treatment on asymptomatic permanent mandibular first molar with mature apex participated in the clinical trials. The procedure was explained to each patient's parents in his/her own language, and a written informed consent was obtained from.

Local anesthesia (2% lignocaine 1:80,000 adrenaline) was administered and rubber dam was applied (Hygienic, Coltene/Whaledent). Access cavity was prepared and canal patency was checked using #10 K-file. (Mani Inc., Japan). The working length was determined using DentaPort ZX (J. Morita Mfg. Corp., Kyoto, Japan) and confirmed with radiograph. Glide path was created by #15 K-file (Mani Inc., Tochigi, Japan).

Subsequently, root canal preparation was accomplished with full-sequence rotary = PTN files up to size X3 in mesial root canals (30/06) and distal roots X5 (50/06) according to the manufacturer's instructions.

Irrigation was performed with 3% NaOCl, 17% ethylenediaminetetraacetic acid, and 0.9% normal saline according to protocol suggested by Schafer et al.

Master cone radiograph was taken and both groups were obturated with single cone obturation technique with an epoxy resin based sealer (AH Plus ® Sealer (Dentsply DeTrey, Konstanz, Germany). Temporary restoration (Cavit G, 3M ESPE Dental-Medizin GmbH Co, Seafeld, Germany) was given

and postobturation intra-oral periapical radiograph was taken.

One week after completing endodontic treatment, patients were randomly divided into 2 groups using randomized trial software program (Researcher Randomizer), random allocation was done by an investigator who was neither involved in the treatment nor outcome assessment, so as to make allocation concealment. The outcome assessment was performed by a single examiner who was not involved in the study. The examiner had been trained for assessment according to standardized steps.

Group A (n=14): received lithium disilicate (IPS. emax-press) endocrowns.

Group B (n=14): received glass fiber post with composite core

A single operator preformed the preparation in the same technique

Regarding group A, the endocrown group; a butt joint margin with average minimal 2mm axial reduction was prepared using a flat diamond bur (Mani, Japan). In order to ensure a flat surface, the bur was held parallel to the occlusal surface. A total occlusal convergence of (7º to 10º) was prepared. The floor of the pulp chamber was filled with flowable resin composite (Tetric Flow, Ivoclar Vivadent, Liechtenstein, Germany) to obstruct the undercuts.

Retraction paste was used and a putty wash technique was selected using polyvinyl siloxane impression material (Aquasil LV, Putty/Light Body, Dentsply, Germany) for all cases.

A temporary restoration was constructed from a bisacryl resin (ProTemp 4, 3M ESPE; Seefeld, Germany). All cases were restored using lithium disilicate-based ceramic (IPS e.max press, Ivoclar Vivadent, Liechtenstein, Germany) following manufacturer's instructions.

After endocrown try in was checked, the intaligo surface was etched with 10% hydrofluoric acid (Porcelain Etchant, FGM Produtos Odontol´ogicos; Joinville, Santa Catarina, Brazil) for 20 seconds and rinsed with running water before drying with an oil free air syringe. A silane coupling agent (Prosil FGM, Joinville, Santa Catarina, Brazil) was applied and air thinned with moisture-free air for 5 seconds according to the manufacturer's instructions then left for 60 seconds. One coat of resin (Adper Scotch Bond Multi-Purpose, 3M/ESPE, Seefeld, Germany) was applied and light-cured for 10 seconds. Finally, endocrown restorations were bonded with a dual cure resin-based luting agent (Rely X Unicem, 3M/ESPE; Seefeld, Germany). After excess cement removal, the restoration was light cured for 40 seconds at every aspect **(Figure 1a)**.

Regarding group B, the post space was prepared in the same manner following the manufacturer's instructions using the corresponding drill of the selected post size, the canals were irrigated then dried with paper points. After checking the post length and fit, a dual cure resin-based luting agent (Rely X Unicem, 3M/ESPE; Seefeld, Germany) was used for cementation. After excess cement removal, the restoration was light cured for 40 seconds at every margin.

After finishing of endocrowns and glass fiber posts, patients were evaluated and recalled regularly at 3 months (F1), 6 months (F2), 9 months (F3) and 12 months (F4) **(Figure 1b& c).**

According to FDI (World Dental Federation) clinical examination of direct and indirect restoration, a clinical form for evaluation was designed. Some functional properties of evaluation were selected as (debonding, fracture, radiographic evaluation of caries and patient satisfaction) and others were eliminated as (interproximal contact and wear) because it was not compatible with the nature of the study as the patients were in age of mixed dentition.

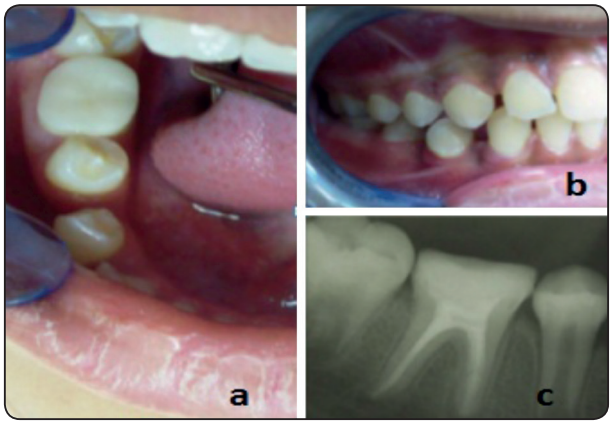

Fig. (1) (a) Endocrown immediately after cementation,(b) after 12 month follow-up (c) radiographic examination after 12 months.

Each item was scored from 1 to 5 according to FDI where, score 1 was clinically very good, score 2 clinically good, score 3 was satisfactory restoration, score 4 was a restoration can be repaired and score 5 was a clinically poor restoration that must be replaced. All patients were analyzed, scores were recorded for each property and finally total scores were calculated in each follow up period.

Kaplan-Meier test used to estimate the survival analysis for different tested groups. Chi square test used to compare between tested groups for patient satisfaction. The significance level was set at $P \leq 0.05$. Statistical analysis was done by using IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 25 for Windows.

RESULTS

In this study 28 children were recruited at the start of the study, two cases were not reported during follow up period (one in each group) due to child school time, this was 7.14% dropout which was well within our estimated dropout percentage. The children were involved in this study aged between 10-13 years with mean 11.5.

Restoration fracture, debonding, radiographic evaluation of caries and patient satisfaction were scored from 1 to 5 according to FDI (World Dental Federation) clinical examination of direct and indirect restorations. score4 and 5 were considered as a failure.

Regarding the restoration debonding, group A (endocrowns group) showed 100% survival throughout all periods of follow up. Group B (glass fiber posts with composite cores) showed decrease in survival rate over time 100% survival at 3 months follow up, 97% survival at 6 months, 86% survival at 9 months and 66% survival at 12 months follow up. There were three failed restorations, one at 6 months follow up which was taken score 4 due to a small partial debonding of composite at interproximal area damaging the margins and it was repaired and two restorations were failed at 9 months follow up, one was taken score 4 also and the other one was taken score 5 due to total debonding of composite at axial lingual wall looseness of the restoration that required a new restoration **(Figure 2).**

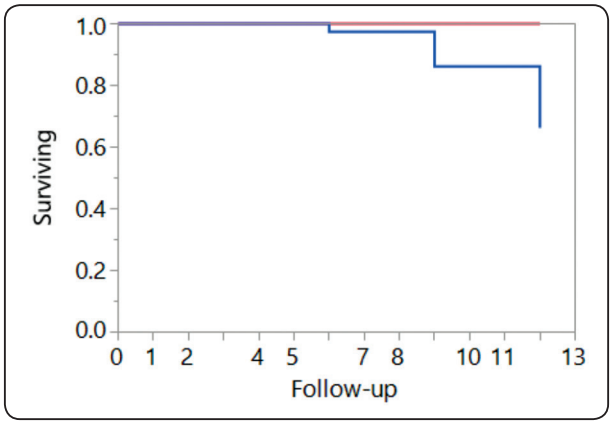

Fig. (2) Kaplan-Meier survival curve showing the debonding survival.

As for the restoration fracture, group A showed 100% survival throughout all periods of follow up. Group B showed decrease in survival rate over time 100% survival at 3 months follow up, 97% survival at 6 months, 86% survival at 9 months and 66% survival at 12 months follow up. There were three failed restorations, one at 6 months follow up which was taken score 4 due to small chipping and was repaired and two restorations were failed at 9 one taken score 4 due to chipping and it was repaired and one was taken score 5 due to cuspal fracture and it was replaced **(Figure 3).**

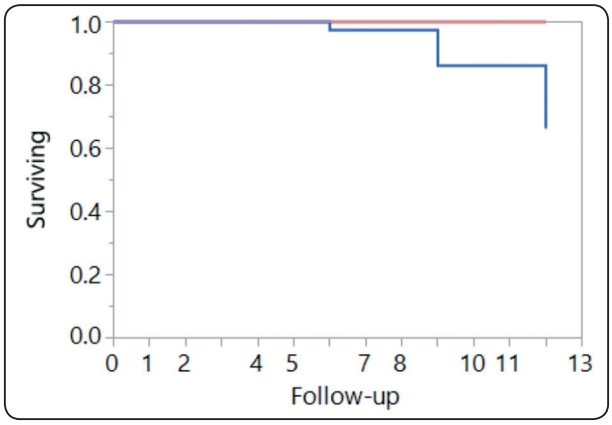

Fig. (3) Kaplan-Meier survival curve showing the Fracture survival.

Regarding to radiographic evaluation of caries, both groups showed 100% survival throughout all periods of follow up.

Patient satisfaction was not statistically significant different between the tested groups **(Table 1, Figure 4).**

TABLE (1) Frequency and percentage of patient satisfaction score.

Patient satisfaction	Score	Groups				p-value
		Group A		Group B		
		N	%	N	%	
3 Months	1	9	69.2%	10	76.9%	0.8813 NS
	2	3	23.1%	2	15.4%	
	3	1	7.7%	1	7.7%	
	4	0	0.0%	0	0.0%	
	5	0	0.0%	0	0.0%	
6 Months	1	10	76.9%	8	61.5%	0.7003 NS
	2	2	15.4%	3	23.1%	
	3	1	7.7%	1	7.7%	
	4	0	0.0%	1	7.7%	
	5	0	0.0%	0	0.0%	
9 Months	1	10	76.9%	8	61.5%	0.3310 NS
	2	3	23.1%	2	15.4%	
	3	0	0.0%	0	0.0%	
	4	0	0.0%	2	15.4%	
	5	0	0.0%	1	7.7%	
12 Months	1	9	69.2%	8	61.5%	0.2927 NS
	2	4	30.8%	2	15.4%	
	3	0	0.0%	0	0.0%	
	4	0	0.0%	2	15.4%	
	5	0	0.0%	1	7.7%	

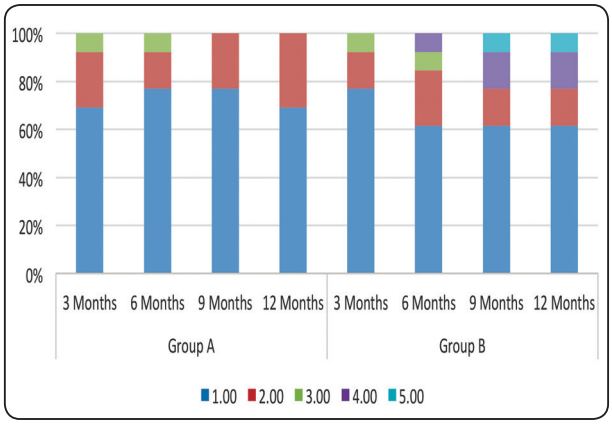

Fig. (4) Stacked bar chart showing percentage of satisfaction score.

DISCUSSION

Carious lesions can be aggressive, rendering teeth structurally weak after extensive carious dentin removal, endodontic treatment and traditional restorative care. Consequently, these teeth are at a greater risk of fracture due to unsupported enamel, large pulps and thin radicular walls[18].

Loss of structural integrity associated with the access preparation may be resulted in increased cuspal deflection during function, which increases the risk of fractures[19]. Considering that in most endodontically treated teeth have missing tooth structure due to caries or existing restorations associated to endodontic access preparation, higher occurrence of fractures may be due to the structural changes in the dentin, missing of tooth structure or both[20].

It's well-known that dentists are inconsistent in making the restorative decision regarding treatment of endodontically treated teeth especially in young permanent patients[18,21]. The evidence mentioned that the endodontically treated posterior teeth should be protected with complete cusp coverage and this will affect long term success[21]. Another issue related to the endodontically treated teeth is the coronal microleakage and bacterial contamination that occurs when they are not immediately restored, causing endodontic failure and requesting retreatment. So, the use of bonded restorations should be considered to avoid the microleakage[22].

First permanent molar is the most important tooth as it's considered the cornerstone of function and occlusion[1]. Unfortunately, its early eruption makes it highly susceptible to caries and pulp involvement in a very early time. Restoration of endodontically treated first permanent molar is required for maintenance of arch integrity, normal masticatory function, protection from microleakage and fracture[2,18].

Subsequently, a full coverage restoration is considered an ideal restoration for endodontically treated molar, but in young age, a continuous eruption of first permanent molar makes it a difficult choice[5].

Stainless steel crowns were 1st used to restore deciduous dentition with acceptable results. Stainless steel crowns were a good recommendation for permanent molars in children as a transitional restoration for almost 50 years but the limitations of their use were many including the pre-sized with poor marginal adaptation, high risk of recurrent caries, periodontal inflammation and impaction of erupting teeth[7,8]. The evidence recommended a routine use of it in primary dentition but regarding to permanent dentition in children there were no clear data supporting this[23].

The development of adhesive dentistry provides restorative options that preserve the tooth structure and allow a normal function[12,24]. Bonded composite restorations was a good conservative approach as when compared to amalgam restoration showed a high survival rate[25].

Combining the use of glass fiber post with composite foundation was a main choice for long time. Glass fiber post was mainly used to retain the coronal restoration but not for root reinforcement as mentioned in many researches but the composite core is not providing the required cuspal protection with increased the rate of fracture[26].

Endocrowns when compared to other restorative options are more simple technique with short chair time, less preparation steps and fewer difficulties if compared to traditional post and core system[27]. Many studies had reported the problems associated with post space preparation such as over-weakening of the tooth with radicular dentin removal and possible root fracture[18].

Endocrowns showed 100% survival rate regarding both fracture and debonding. These could be attributed to the increased thickness and amount of ceramic used in case of endocrown covering the entire margins and pulp extensions which subjecting the ceramic to compressive load that will increase the tensile strength of endocrowns if compared to conventional crowns[20,27,28]. Moreover, Biacchi and Basting in 2012 reported a high resistance to compressive load of lithium disilicate endocrowns than traditional crowns supported on fiber post[29,30]. More recently, finite element analysis highlighted the role of endocrowns in stress distribution[31].

Endocrowns are anchored to the wall of the pulp chamber and marginal area providing macro and micro retention depending on pulpal walls and adhesive cement that allowing dissipation of forces along the whole tooth structure[32].

A recent systematic review in 2016 conducted to examine endocrowns clinical success and fracture strength (in-vitro) versus intra-radicular posts, direct composite and inlay/ onlay indirect restorations

reported that the performance of endocrowns were superior or similar to other restorative options. The same study suggested more clinical trials to confirm their results[16].

Furthermore, the lithium disilicate ceramics offered a high bond quality to tooth structures and also the number of interfaces decreased if compared to traditional glass fiber post and composite core[13,27], thus reducing the degradation of hybrid layer. Rocca& Serge mentioned that the bonding surface of the endocrown is equal or higher than that obtained from the bonding of radicular post of 8 mm depth[25].

Both groups reported no recurrent caries and accurate marginal adaptation which could be referred to the short clinical evaluation time. At the same way, both groups showed same patient satisfaction level with no difference. Finally, the limitations of the present study were the small sample size and the small follow-up period.

According to the present results, he null hypothesis of the study was accepted and endocrown concept can be applied to permanent molars in children with satisfactory successful rate higher than post and core option.

CONCLUSION

Within the limitations of the current study the following conclusions can be recommended: Endocrowns can be considered a clinically successful restoration for endodontically treated teeth in general and the concept can be adapted to the endodontically treated teeth in children. Subsequently, this sparing the dilemma of endodontically treated teeth restoration in children especially the 1st permanent molar.

There are insufficient randomized clinical trials about restorative options of endodontically treated 1st permanent molar in children. Further studies are required with increased sample size and follow-up period to evaluate the long term clinical success.

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