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Comparative evaluation of fracture resistance of primary anterior teeth restored with long dentine posts and teeth restored with short fiber posts: An in vitro study

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ABSTRACT

Background: Badly broken primary teeth that require pulp therapy present a high-risk of biomechanical failure due to the loss of tooth substance resulting from pre-existing decay and endodontic therapy itself. The introduction of Biological dentine posts offered an excellent alternative for restoring such teeth. The ideal post material should have physical and mechanical properties that are similar to those of dentine. Accordingly there is no such material other than dentine itself. Another concern in restoring endodontically treated primary teeth is the need to find a material that can resorb in a similar way to natural tooth structure as a part of the exfoliation process allowing normal eruption of permanent successors. The difficulty of finding such a material had urged Pedodontists to only use short posts in restoring badly broken primary anterior teeth which adversely affected the retention of the posts and resulted in a less favorable stress distribution along the post. The aim of the current study was to assess the effect of using long dentine posts on the fracture resistance of endodontically treated primary anterior teeth in comparison to primary anterior teeth restored with short fiber posts.

Methods: A sample of thirty primary anterior teeth was collected from the outpatient clinic of Pediatric Dentistry and Dental Public Health Department. Ten extracted premolars were also collected from the outpatient clinic of Oral and Maxillofacial Department. Both departments are at the Faculty of Dentistry, Ain Shams University. The roots of the premolars were used to prepare twenty dentine posts of a standardized shape and dimensions, using CNC milling machine. After receiving proper filing and endodontic radicular preparation, the primary teeth were divided into two groups (fifteen teeth in each group). The first group was restored with dentine posts of 5 mm length, and the second group was restored with fiber posts 3 mm in length. For both groups, fracture resistance testing was performed using universal testing machine.

Results: Mann-Whitney U test was used to compare between the two post types. Long dentine posts showed statistically significantly lower mean fracture resistance than short fiber posts.

Conclusion: Short fiber posts offered better fracture resistance when compared to long dentine posts.

1. Introduction

Maintenance of primary dentition in a healthy condition is important for the well-being of children. It ensures proper mastication, esthetics, phonetics, space-maintenance, and prevention of aberrant habits [1].

The partial or complete loss of coronal tooth structure in the primary dentition may occur due to dental caries or physical trauma [2,3]. Severe early childhood caries is a devastating condition for both the child undergoing dental treatment and the concerned parents. It is also challenging for pediatric dentists to restore badly broken down teeth [4–6]. The goal of dental treatment is to restore the lost tooth structure. Its early loss may result in reduced masticatory efficiency and loss of vertical dimension. Furthermore, development of parafunctional habits such as tongue thrusting, speech problems and esthetic-functional problems such

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as malocclusion and space loss. Altogether, tooth loss may cause psychological burdens that can interfere in the personality and behavioral development of the child [7,8].

Several attempts have been made by clinicians to restore grossly decayed anterior primary teeth with innovative root canal retentive post and core systems so that the primary teeth are retained until they are replaced by permanent teeth. There are several types of root canal posts available for use in pediatric restorative dentistry, including pre-manufactured orthodontic wire in "α" or "γ" forms [4], omega forms [9], metallic posts with macro-retention [10],short posts with composite resin [11], and polyethylene ribbond posts [4].In addition, newer post systems such as carbon fiber, glass fiber, and zirconium oxide posts, offer excellent features including biocompatibility, fatigue, and corrosion resistance and have mechanical properties similar to dentin [6,12].Although these restorative methods aim at recovering the oral function, yet they do not allow subsequent smooth transition to permanent teeth, or physiological root resorption of primary teeth [13].

The introduction of dentin posts in few reported cases has shown promising outcomes [14–16]. These posts can be naturally resorbed as part of the process of exfoliation of the primary teeth and might be considered an alternative for rehabilitation in pediatric dentistry. This could be an advantage when compared to resin or metallic posts [17]. Dentin posts can also be expected to have physical properties similar to those of the teeth such as modulus of elasticity, compressive strength and thermal expansion [16]. However, there is deficiency of evidence in literature concerning the use of dentin posts in primary teeth, and in spite that it has been suggested that post length in permanent teeth must be at least equal to the crown height or two-thirds of the root length to facilitate stress distribution and provide resistance to occlusal forces. Yet there is no evidence of using long posts in primary teeth due to the physiological resorbtion that primary teeth undergo. Accordingly, the current study sought to investigate the fracture resistance of primary anterior teeth restored with long dentine posts that would undergo natural resorbtion, to investigate the effect of increasing the length of the posts on the strength of pulp treated primary anterior teeth.

2. Materials and methods

Thirty primary anterior teeth were collected from the outpatient clinic of Pediatric Dentistry and Dental Public Health Department, Faculty of Dentistry, Ain shams University. At least two thirds of the root length should be present, the roots were caries free and no previous endodontic treatment was performed in these teeth [18]. Ten extracted premolars were also collected from the outpatient clinic of Oral and Maxillofacial Department, Faculty of Dentistry, Ain shams University. They were freshly extracted for orthodontic reasons. The roots of the premolars were used to prepare twenty dentin posts of a standardized shape and dimensions, using Computer Numerical Control (CNC) milling machine (Centroid, USA) (Figs. 1 and 2) [16].The prepared dentin posts were all autoclaved at 121 °C for 20 min before use to insure all biosecurity standards for teeth disinfection and to simulate clinical condition [19]. The fiber posts used in this study were the red color-coded Easy posts (Dentsply, Maillefer, USA). They were silanized using silane (Ultradent Inc. USA) according to the manufacturer's instructions.

The thirty primary anterior teeth were cross-sectioned 1 mm above the cement-enamel junction (CEJ). Each root canal was filed with MANI Hedstrom endodontic Files up to size 40, irrigated with normal saline solution and then dried with paper points. Metapex (META-BIOMED Co. LTD, Korea) was then injected into the canal space. The teeth were divided into two groups: Group [1] for dentin posts and Group [2] for fiber posts. For group 1, a plugger with a stopper adjusted at 6 mm was used to condense the Metapex. This was done to confirm that 6 mm of the canal space coronally was left free from the Metapex. For group 2, 4 mm was left free from the Metapex. Glass ionomer lining cement (GC Equia, Tokyo, Japan) was then inserted into the canal space and adapted with the same plugger. Excess glass ionomer cement was removed so that the post space inside the root canal was 5 mm for the dentin posts and 3 mm for the fiber posts [20,21].

Fig. 1. Milling half of premolar root to generate biological dentine posts.

Fig. 2. Biological Dentine posts.

The dentin posts were cut so as to obtain the length of 8 mm for each post. Five millimeters of each post was inserted inside the root canal and cemented with self-adhesive resin cement (GC G-cem, Tokyo, Japan) leaving 3 mm coronally for crown build up. As for the second group, fiber posts were cut so as to obtain 6 mm. Only 3 mm of each fiber post was inserted inside the root canal and cemented, 3 mm were left coronally for crown building up. For both groups,

crown build up was performed using celluloid strip crowns and Flowable composite resin (Filtek Z350 XT) (Fig. 3) [20]. All the specimens were mounted in self-cured acrylic resin and thermocycled for 500 cycles; each cycle included immersion for 30 s into the hot bath at 55 ± 1 °C followed by immersion for same time into the cold bath at 5 ± 1 °C with 5 s delay between the hot and cold baths to simulate the temperature dynamics in the oral environment and hence increasing the accuracy of results [21,22].

The fracture resistance was measured using the Universal Testing Machine. Each specimen was held in a specially constructed attachment that was fixed to the lower compartment of the machine so that the specimen's inclination was 45°. A specially constructed load applicator in the form of metallic rod with a ball end 1 mm in diameter, was fixed to the upper compartment of the machine so that the dislodging force was at the junction between the incisal and middle thirds of the crown (Fig. 4). The specimens were loaded at a cross head speed of 1 mm/min. The values obtained at fracture were recorded in Newtons.

2.1. Statistical analysis

Numerical data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed non-parametric (non-normal) distribution. Data were represented as mean, standard deviation (SD), median, range and 95% Confidence interval (95% CI) values.

Mann-Whitney *U* test was used to compare between the two post types (Table 1, Fig. 5).

The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM[1] SPSS[2] Statistics Version 20 for Windows.

Fig. 3. Specimens after crown building-up.

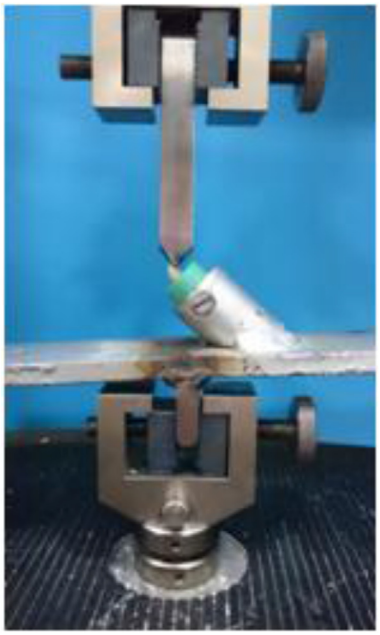

Fig. 4. Fracture resistance testing.

3. Results

Biological long post showed statistically significantly lower mean fracture resistance than fiber post.

4. Discussion

Dental caries and trauma are the most common causes of crown destruction in primary anterior teeth [23]. For many years, extraction was the treatment of choice for these badly broken teeth. However, early loss can cause a number of disturbances as loss of space, phonetic alterations, impaired mastication and psychological problems affecting the self-esteem of the child [10,14]. Satisfactory rehabilitation treatment is still a challenge [18]. Gaining intra-canal retention using posts in primary anterior teeth is more complicated than in permanent teeth because the primary teeth have to exfoliate normally giving a way to their permanent successors to erupt in undeflected positions [24].Accordingly, the standard practice in pediatric dentistry was to use short posts that never exceeded 3 mm length inside the canal [4,8,21]. Other much needed requirements of intra-canal posts for primary anterior teeth are biocompatibility, availability, ease of application, esthetics and ability to withstand masticatory forces [24].

Dentin posts turned the scale as they can be resorbed as a part of the shedding process. They also have all the desired characteristics discussed above and an additional advantage of being inexpensive [24]. Previously, the dentin posts have been prepared using primary root dentin [14,25,26] yet the limited availability and difficulty of finding primary root dentin free from resorption, urged pedodontists to use premolar root dentin that is widely available, being the most common tooth extracted for orthodontic reasons. Another advantage of using the premolar root is the ease of finding them in sound form [24]. One of the limitations of using biologic restorations is preoperative preparation, such as sterilization and preparation of natural tooth to make dentin post/post and core/shell crown. But, these steps can be performed by dental auxiliaries as well, and the dentist does not need to waste time for this. Some parents may find this technique unacceptable. However, it is the pedodontist role to reassure them and inform them about the harmless nature of this restorative modality [24].

An ideal post system should exhibit fracture resistance higher than the average masticatory forces [27]. It has been suggested that post length in permanent teeth must be at least equal to the crown height or two-thirds of the root length to facilitate stress distribution and provide resistance to occlusal forces leaving at least 4 mm of gutta-percha. In contrast, increasing post length could decrease the root strength [28].

As for primary teeth, no consensus exists concerning the proper length for posts, the influence of long posts in primary teeth needs to be determined. Accordingly, the current study assessed the effect of using long dentin posts on the fracture resistance of endodontically treated primary anterior teeth in comparison to primary anterior teeth restored with short fiber posts.

Fracture resistance is one of the main desirable characteristics of

[1] IBM Corporation, NY, USA.
[2] SPSS, Inc., an IBM Company.

Table 1
Descriptive statistics and results of Mann-Whitney *U* test for comparison between fracture resistance values (N) of the two post types.

Post type	Mean	SD	Median	Minimum	Maximum	95% CI		P-value
						Lower bound	Upper bound	
Biological	145.8	112.3	101.9	52.5	425.9	70.4	221.2	0.029[a]
Fiber	239.4	130.8	203.3	112.4	559.3	145.8	333.0	

[a] Significant at $P \leq 0.05$.

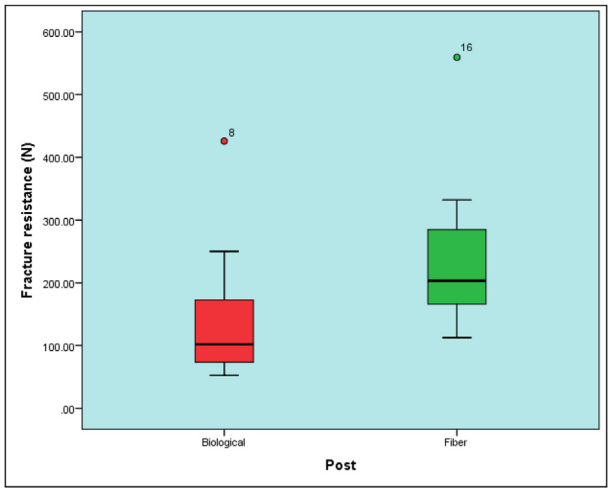

Fig. 5. Box plot representing fracture resistance of the two post types (Circles represent outliers.

restoration materials, especially during mastication and the most important factor in achieving a durable restoration [29]. In addition, post placement has a significant influence on the final fracture resistance of the restored teeth [30]. Unfortunately, there is scarcity in studies measuring the fracture resistance of posts in primary teeth specially dentin posts. In 2014, Baghalian et al. [20] tested the fracture resistance of four different posts used in the restoration of severely decayed primary incisors (Intact glass fiber posts, split-ended glass fiber posts, composite resin posts, and orthodontic "γ" wire posts). They found out that there was no significant difference between any of the groups. Seraj et al. (2015) [21] compared the fracture resistance of three types of posts in restoration of severely damaged primary anterior teeth. Group 1: Customized quartz fiber post, Group 2: Composite resin post and Group 3: Prefabricated glass fiber posts. It was concluded that all three types of studied posts could be successfully used to restore badly broken down primary anterior teeth.

In spite of being biocompatible and having similar physical properties to those of the teeth, surprisingly in the current study the long biological dentin posts showed statistically significant lower mean fracture resistance than fiber posts. These results disagreed with a number of studies that assessed the fracture resistance of biological dentin posts. Unfortunately, most of these studies were carried out on permanent anterior teeth and there is a deficiency in literature regarding primary teeth. Kathuria et al. (2011) [16] and Ambica et al. (2013) [31] found that permanent teeth restored with dentin posts exhibited better fracture resistance than those restored with fiber posts. The results in the current study may be attributed to the histological difference between primary and permanent teeth which needs further investigations. As well as, the vast variations that could be present between the premolars from which the posts were milled, and this explains the diversity in the fracture resistance readings of the dentin post specimens. Besides the limitation of the small sample size that was due to the difficulty in finding primary anterior teeth with at least two thirds of the root present.

5. Conclusion

From the above discussion, it becomes clear that, there is a continuous need for evaluation of various post systems for primary teeth to make evidence-based decision. Currently, the evidence is lacking to provide any recommendation about the possibility of using long dentin posts alternatively to other short posts systems for primary teeth. Yet, the present study might provide a strong base for further trials in this field advocating larger sample size and a well-defined and standardized methodology to eliminate variations and diversities in the prepared biological dentin posts.

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