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COMPARATIVE EVALUATION OF THE EFFECT OF VARIOUS STORAGE MEDIA ON THE FRACTURE RESISTANCE OF RE ATTACHED TOOTH FRAGMENTS WITH FLOWABLE COMPOSITE -AN IN VITRO STUDY

Endodontics

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ABSTRACT

INTRODUCTION: Fracture of an anterior tooth due to trauma is a common occurrence, with an incidence of 18-22% of all injuries to the dental hard tissues. About 28-44% of these cases are uncomplicated fractures, i.e. they do not involve the dental pulp. Fragment reattachment can be considered as a valid treatment option in such situations. However, the ideal storage medium for fragments before reattachment needs to be explored.

AIM: - To compare the fracture resistance of Incisor tooth fragments stored in five storage media i.e. Milk, contact lens solution, Hanks Balanced Salt Solution, Control group (Open Air), Coconut Water before reattaching them with flowable composite.

MATERIALS AND METHODS: - Sixty freshly extracted Maxillary Incisors were divided into five groups. Teeth were mounted in acrylic block till cervical margin ,exposing only the crown portions and were intentionally fractured at incisal third using Universal Testing Machine, fractured fragments were stored in Milk (Group I), Contact lens solution (Group II), and Hanks Balanced Salt solution (Group III), Open air (Group IV), Coconut water (Group V) for 2 hours. The fractured fragments were re-attached using simple reattachment technique with flowable composite and tested on the Universal Testing Machine for fracture resistance,

STATISTICALANALYSIS: Statistical analysis was performed using one-way analysis of variance and post hoc Tukey's test.

RESULTS: There was a statistically significant difference ($P < 0.05$) in fracture resistance values between the groups. The highest fracture resistance value was demonstrated by Group III (Hanks balanced salt solution), whereas the least fracture resistance values were observed in Group IV (open air).

CONCLUSION: Along with HBSS, Coconut water can be considered a viable alternative.

KEYWORDS

Fracture Resistance; Fragment Reattachment; Hbss; Coconut Water; Storage Medium

INTRODUCTION

The trauma of the oral & maxillofacial region occurs frequently & comprises 5% of all injuries for which people seek dental treatment. among all facial injuries, dental injuries are the most common, of which crown fractures and luxation occurs most frequently, children and adolescents are most susceptible to these injuries. The Coronal fracture of permanent incisors represents 18-22% of all trauma to dental hard tissues; of these, 96% involve maxillary incisors (80% central incisors & 16% lateral incisors). Traumatic dental injuries not only cause damage to the dentition but also have a psychological impact on the child and his parents as well[1].

The different techniques for the reconstruction of injured teeth are prosthodontic replacement by resin crowns, steel crowns, ceramic crowns, and resin composite restorations[2] These are not conservative techniques as it requires wear off of sound dental structure. There are technical difficulties also like tooth contouring, color shade matching, and translucence. It is also a time-consuming method. Composite restorations have primary disadvantage of color mismatch and variable wear, disadvantage of poor abrasion resistance in comparison to tooth enamel, marginal staining, discoloration, and lack of marginal integrity.[3] The use of acid etch technique for the reattachment of fractured fragment was first reported by Tennery, the fragment reattachment procedure has several advantages over above-mentioned procedures and conventional acid etch composite restorations.

Compared to conventional techniques, fragment reattachment offers several advantages, the most predominant one being-aesthetics, since it preserves the original shape, color, brightness, and surface texture of enamel and also fragment re-attachment procedure gives a positive emotional and social response from the patient to the preservation of natural tooth structure, and it is also an economical and a conservative procedure.[3]

Therefore, if a broken fragment is available, the restoration of the tooth using its own fragment has been suggested as an alternative. The important factor in success of fragment reattachment is the mode of storage of fragment in media before it is re attached, Storage medium acts as one of the key determinants since hydration aids to maintain the vitality, aesthetic appearance, and the bond strength.[4]

Hence present study was planned to compare the fracture resistance of incisor tooth fragments stored in five storage media i.e. Milk, Contact Lens Solution, Hanks Balanced Salt Solution, Control Group (Open Air), Coconut Water before reattaching them with flowable composite.

2.METHODS AND MATERIALS: -

2.1 SAMPLE PREPARATION: -

Sixty freshly extracted permanent Maxillary Incisors extracted due to therapeutic reasons with intact crown structures were collected. Teeth

with defects such as fractures, decalcification, or caries were excluded from the study. Cleaning and removal of tissue remnants on the root surfaces were carried out using ultrasonic tips. The teeth were disinfected using 0.2% thymol and stored in distilled water until the time they were intentionally fractured (Figure-1). The selected teeth were randomly divided into five groups of 12 each based on the storage medium used.

1. Group I: Milk as a storage media
2. Group II: Contact Lens Solution
3. Group III: Hanks Balanced Salt Solution
4. Group IV: Dry Air
5. Group V: Coconut Water

FIGURE :-1

2.2 THE PROCEDURAL STEPS WERE AS FOLLOWS:

2.2.1. INTENTIONAL FRACTURE OF FRESHLY EXTRACTED SOUND TEETH: -

Each sample was embedded in a self-cure acrylic resin block such that only the coronal portion of the tooth was exposed (Figure-2). Then cervico incisal distance was measured for each of the tooth on the labial surface. One-third of this distance was calculated and then marked on the labial surface from the incisal edge. An enamel notch was made on the mesial and distal section of the traced line using a slow speed contra angled hand piece then tooth was subjected to a constant load from universal testing machine (UTM) perpendicular to the long axis of tooth till it fractured (FIGURE-3). The teeth that were showing any fracture pattern other than along the predetermined line were discarded at this stage

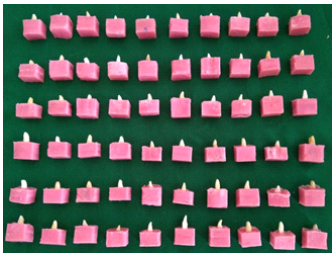

FIGURE 2

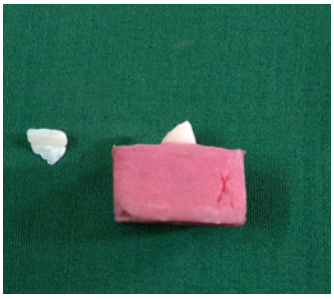

FIGURE :-3

2.2.2 STORAGE OF THE FRACTURED FRAGMENTS IN APPROPRIATE STORAGE MEDIA FOR 2hr:

Immediately after fracturing, the fragments were stored in separate marked containers with appropriate storage media (Milk, contact lens solution, Hanks balanced salt solution, dry air, coconut water) for 2 hr and the remaining tooth structure was stored in artificial saliva until reattachment.

2.2.3 REATTACHMENT OF FRACTURED TEETH USING FLOWABLE COMPOSITE RESIN:

The fragments and the remaining tooth structure were rinsed in distilled water. Fragments were reattached after 2 h by means of simple reattachment technique. About 37% phosphoric acid was applied to the fragment and the tooth for 15 s, rinsed for 10 s followed by air drying for 5 s. The bonding agent was applied in two consecutive coats and surfaces were dried for 5 s using an air syringe to allow solvent evaporation. The bonding agent was then light cured for 20 s in the fractured fragment and 20 s in the tooth remnant. Nanohybrid flowable composite (TETRIC N FLOW) was applied on the surface of the fragment and tooth remnant. The fragment was then positioned back to the tooth remnant by means of a sticky wax (to carry the fractured fragment). After ascertaining the correct position, light curing was carried out for 40 s both labial half, lingual half.

2.2.4. **INCUBATION OF PREPARED SAMPLES AT 37°C IN ARTIFICIAL SALIVA: -**

After reattachment, all the samples were kept in artificial saliva and incubated at 37°C for 48–72 h.

2.2.5. **FRACTURING THE SAMPLES USING UNIVERSAL TESTING MACHINE**:

All the samples were then subjected to testing using Universal Testing Machine (Hounsfield). The rod of universal testing machine was held perpendicular to the long axis of the tooth at the incisal third of the crown near the bonding line on the labial surface (FIGURE-4). The load was applied at a crosshead speed of 1 mm/min. The load was increased progressively and the value at which the reattached fragment debonded was recorded in Newton (N). This load represented the fracture resistance of the reattached tooth. The fracture resistance of all the samples was recorded similarly. The data were compiled and put to statistical analysis using the software Statistical Package for the Social Sciences for Windows SPSS Version 16 (SPSS Inc., Chicago, IL, USA). Wherein one-way analysis of variance and post hoc Tukey's test were performed. $P \leq 0.05$ was considered statistically significant.

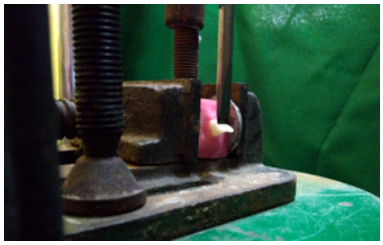

FIGURE: -4

RESULTS: -

The values for each group were tabulated, and the mean and standard deviation were calculated for each of the groups [Table 1]. Statistical tests were then applied. The highest fracture resistance value was demonstrated by Group III, followed by Group V, followed by Group I and Group II, least fracture resistance values were observed in Group IV [Table 1]. For group-wise comparison, post hoc Tukey's test was applied and it was seen that there was a statistically significant difference in fracture resistance values between Group I and Group II ($P = 0.000 P < 0.05$); Group II and Group IV ($P = 0.000 P < 0.05$); Group III and Group IV ($P = 0.000 P < 0.05$) Group IV and Group v ($p = 0.000 P < 0.O5$) .

Table 1 : Mean and S.D values of the fracture resistances for the the Five Groups

	N	Mean	Std. Deviation
Group 1 (Milk)	12	223.228	24.700
Group II (Contact Lens Solutions)	12	179.673	13.552
Group III (Hanks Balanced Salt Solutions)	12	292.019	29.380
Group IV (Control Group Dry Air)	12	130.358	28.503
Coconut Water	12	257.067	22.482
Total	60	216.469	61.997

DISCUSSION: -

Fracture of anterior teeth after trauma is not only painful to the patient but also affects the psychological well-being of the patient. It is advisable that whenever the fracture fragment is available reatta

chment should be the first choice of treatment, the use of natural tooth fragment to restore the fractured tooth offers conservative, esthetic, and economic advantages. It ensures long-lasting esthetics and is a simple procedure.

The philosophy behind this approach dates back to the early 1960s. However, the interest in this concept got renewed after it was found that the mode of fragment storage following trauma was a key prognostic determinant[7]

A study by Farik et al. showed that additional drying of fractured fragment beyond 1 hr decreases the fracture resistance significantly, thus emphasizing the importance of keeping the fragment moist [5]. Toshihiro et al in their study hypothesized that fractured part should be stored in wet moisture. They observed that fractured fragments were discolored on losing its moisture. Some studies recommended keeping the fractured fragments in moisture to prevent dehydration as it helps in ensuring the minimal collapse of collagen fibers in dentin, which increases the bond strength. However, the present study is one of the very few interventions which has solely evaluated the effectiveness of the storage media.

Permanent maxillary incisors were selected for this study because of their greater involvement in traumatic episodes.[6] Previous studies have stated that HBSS was better in enhancing the fracture resistance of the reattached tooth fragment than dry air. Hence, dry air was taken up as a negative control in the present intervention while HBSS served as the positive control.

Lee et al. reported that residual chlorine from saline and sodium hypochlorite can negatively influence the bond strengths when used as a storage medium. Hence, distilled water was chosen as the storage medium for freshly extracted teeth in the present intervention[8]

In this study, the teeth were fractured in a standardized manner using a universal testing machine (cervico incisal distance was measured for each of the teeth on the labial surface. One-third of this distance was calculated and then marked on the labial surface from the incisal edge. An enamel notch was made on the mesial and distal section of the traced line using a slow speed contra angled hand piece, then tooth was broken on the marked line perpendicular to its long axis with universal testing machine the teeth that were showing any fracture pattern other than along the predetermined line were discarded at this stage) as the aim was to evaluate the storage media.

The adaptation between the fragment and the tooth was not always perfect. However, fracturing a tooth in vitro has its own disadvantages as the fractured fragments produced could be of uneven dimensions. As a result, the amount of material required for reattachment will vary and give inconclusive results. Hence, with this limitation to simulate the natural fracture forces, in this procedure fracturing the teeth using a universal testing machine was followed as it allows the standardization of the fragment size.

The storage time was taken as 2 h to simulate a clinical scenario wherein the reattachment procedure is carried out in the same appointment. In our study, the storage media used were Milk, Contact Lens Solution,Hbss,Dry Air, Coconut Water, Hanks Balanced Salt Solution is an effective medium for avulsed tooth conservation because it helps in preservation of the periodontal ligament cells and ability to reconstitute the same, as it does not require any refrigeration, neutral pH; also, it does not contain any contaminants.

The technique of simple reattachment was followed as the point of contention here was the hydration media. Dehydration of human dentin has demonstrated a brittle behavior. Hence, at no point in the entire study was the samples allowed to dry except for the fragments of Group IV. The tooth remnants, as well as the samples after reattachment, were kept in artificial saliva to simulate the natural condition in the oral cavity [9]

All of the samples were tested within 48–72 h of their storage period to prevent any major variation from occurring in the values between the samples. The direction of load application for fracturing the reattached teeth simulated a clinical scenario wherein a tooth restored using fragment reattachment encounters the second episode of trauma. However, one potential drawback of this study was the amount of load which was applied using the universal testing machine at a crosshead speed of 1 mm/min did not simulate a natural traumatic scenario. [10]

In our study, the fracture resistance value for Group III (Hanks balanced salt solution) was recorded as the highest being statistically significant compared to other Groups (Graph -1). It can be attributed to the osmolality of HBSS and ideal PH 7.2, and high-water content, which allowed adequate rewetting of the dentinal tubules [11]. Group V (coconut water), Group I (milk) gave the highest fracture resistance values. Coconut water has higher osmolality than milk [1311].

Furthermore, in previous studies, media with greater osmolality have given better results [10]. It can also be hypothesized that the water content of coconut water being greater than milk might have allowed better wetting of the dentin preventing the collapse of the collagen fibers which play a role in resin tag formation[14 12] Among all five groups ,Group IV (dry air) got least fracture resistance , because dry air can dehydrate the tooth fragments[13]

Group II (contact lens solution) demonstrated second least fracture resistance values having a statistically significant difference with respect to Group I, III, V. It is due to least osmolality compared to other media and it is essentially a saline solution containing cationic monoester as a preservative, which negatively influences the bond strength and vitality of cell. This particular aspect of our study is in contrast to a previous intervention by Shirani et al. [10]

Hence, this study has the potential to be the eye-opener to the fact that the mode of storage of a fragment before its reattachment significantly affects the prognosis. Though In this study coconut water got second highest mean, coconut water being readily available at the site of trauma such as a typical school playground's, there is a need to catalyze public awareness about the manner of preservation of such fragments much economically, with better prognosis. Though HBSS is proved to be the best storage media, it is not available universally and is not economical.

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