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RESEARCH ARTICLE

EFFECT OF STORAGE MEDIA ON FRACTURE RESISTANCE OF REATTACHED TOOTH FRAGMENT: AN IN VITRO COMPARATIVE STUDY.

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Abstract

Children are the most common victims of anterior teeth trauma. An alternative treatment choice to composite treatment in uncomplicated crown fracture is fragment reattachment, when the fragment is retrieved and reusable. It is a conservative and minimally invasive approach. Storage of fragment plays a key role in improving strength of the reattachment. But only limited data is available on evaluation of storage media as a parameter in improving strength of fragment reattachment. Hence the present study was designed.

Material and Method: 48 extracted human central incisors were divided into 4 groups: group I milk, group II normal saline, group III tender coconut water and group IV dry (n=12). Teeth were sectioned at the junction of incisal and middle third with double sided diamond disc. Fragments were stored in respective storage media. After 24 hours of storage fragments were reattached by simple reattachment technique using same etchant and same bonding agent in all the groups. Reattached teeth were stored in distilled water and subjected to thermo cycling. Fracture strength testing was done using universal testing machine. Data was tabulated and subjected to statistical analysis.

Results: Group III demonstrated highest fracture resistance followed by group I and group II. Group IV achieved least fracture resistance.

Conclusion: Newly tested tender coconut water can be used as a storage medium for fragment reattachment based on its ability to increase fracture resistance.

Introduction:-

Coronal fracture is the most frequent form of dental injury, common type of injury being uncomplicated crown fractures that usually involve the maxillary incisors. Anterior teeth trauma of a young patient requires immediate

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attention not only because of damage to dentition but also because of psychological impact it may have on patients and parents [1].

The treatment of an uncomplicated coronal fracture is a considerable challenge for the dentist. Many parameters are implicated in the successful outcome, such as bringing back the original form and dimension of tooth, opacity, translucency, fluorescence and opalescence of original tooth. Several techniques have been proposed for restoring fractured crowns, including stainless steel crowns, orthodontic bands, pin retained resin restorations, crowns, composite resins with acid etch adhesive techniques, porcelain veneers and jacket crowns, each of which show diverse degree of success [2]. However, these types of treatment did not always guarantee an adequate long lasting esthetics and require sacrifice of healthy tooth structure.

Fragment reattachment is an excellent option when the fragment is available. It is a process of reattaching the traumatized fragment to the respective tooth using an adhesive material. It is simple, low cost method, provides better esthetics and increased wear resistance and thus improved function compared to other techniques [3,4.] The major drawback of fragment reattachment technique is that, the reattached fragment is highly prone to fracture whenever it is subjected to new trauma or excessive masticatory forces[5]. So improvement of this technique is still necessary to overcome unexpected traumatic situations .

Success of fragment reattachment technique depends on the time lapse between trauma and restoration and the patient's awareness of importance of the fragment storage, as the fractured part may lose its moisture after some time[6]. The restoration time can affect bond strength of these restorations because dentin moisture is essential for achieving high bond strength of composite resins with dentin[7].

Storing the fragment in storage media increases the bond strength and fracture resistance by preventing dehydration and dimensional changes[8,9,10]. It also improves esthetics[11]. This study is designed to look for a better storage media for preservation of fragment before reattachment and to know to how much extent the fracture resistance will be improved.

Material and method:-

A total of 48 extracted Permanent human maxillary central and lateral incisors were used in the study. Teeth that were freshly extracted for periodontal reasons were included and teeth having cracks, dental caries and other structural defects were excluded from the study.

Collected teeth were autoclaved for 40 minutes as infection control procedure. Tissue remnants on root surface were removed with ultrasonic tips and curettes. Then the teeth were stored in distilled water until experimentation.

The teeth were measured on the labial side from cervical to incisal edge with a digital calliper. The measured length in millimeters is divided by 3 and then teeth were marked at one third distance from the incisal edge. The root of each tooth was embedded in acrylic resin till the level of cervico enamel junction. This acrylic block was prepared according to zig size of universal strength testing machine. Specific numbering was given to each acrylic block.

All the 48 teeth with acrylic blocks were randomly divided into 4 groups, following lot method of sampling (n = 12). Group I milk, group II normal saline, group III coconut water and group IV dry. In group IV teeth were kept dry and this group is negative control. All the teeth with acrylic blocks were stored in distilled water until sectioning.

The teeth were cut on the marked line perpendicular to long axis of the tooth using low speed double sided diamond disk using saline as a coolant. Sectioned tooth fragments were stored in respective storage media according to numbering given on the acrylic block. All the teeth fragments were stored for 24 hours in respective storage media. Sectioned tooth fragments in the dry group were not stored in any of the storage media but were kept dry. Tooth remnants along with acrylic block were stored in distilled water until reattachment.

Fragments were reattached by simple reattachment procedure without any additional preparation. 37% phosphoric acid was applied to the tooth remnant and fragment for 15 seconds and rinsed with water for 10 seconds, this was followed by air drying for 5 seconds to remove excess water.

Bonding agent (ADPER SINGLE BOND 2, 3M ESPE, st. Paul, MN, USA) was applied in 2 consecutive coats. Then surfaces were dried for 5 seconds using an air syringe to allow solvent evaporation. The bonding agent was cured for 20 seconds in fractured fragment and 20 seconds in tooth remnant.

The flowable composite (FILTEK FLOWABLE Z 350, 3M ESPE, USA) was applied on the fractured surface of fragment and tooth remnant. Fractured fragment was carried to the tooth remnant by means of sticky wax. After repositioning, light curing was done in 4 stages: 20 seconds in mesio buccal half, 20 seconds in mesio lingual half, 20 seconds in disto buccal half, 20 seconds in disto lingual half. After reattachment, specimens were stored again in distilled water until thermo cycling.

All the restored teeth were kept in distilled water at 37 degree centigrade and subjected to 100 cycles of thermo cycling. The temperature range is 5-55 degree centigrade with a dwell time of 15 seconds and transfer time of 10 seconds. After thermo cycling, the specimens were again stored in distilled water until testing.
All the samples were then subjected to fracture strength test using universal testing machine (AUTOGRAPH) in CIPET Hyderabad, at a cross head speed of 0.6 mm per minute. The force application was always at 90 degrees with respect to buccal surface. Force required to fracture each tooth was recorded in Newtons (N). The data was represented in the form of tables and then subjected to statistical analysis. In this study p value < 0.05 was considered as level of significance**.**

Results:-

The results were expressed as mean values along with their standard deviations. Mean comparison among groups was done with ANOVA test. Mean comparison between groups was done with Tukey post hoc test.

Results showed that Coconut water group obtained highest fracture resistance of 129.95Newtons (N). Fragments stored in Milk demonstrated a fracture resistance of 121.53 N. Normal saline group demonstrated a fracture resistance of 95.23 N. Dry group demonstrated least fracture resistance of 64.71 N. One way ANOVA indicated differences in the amount of force required for fracturing at the reattachment site. (p value <0.001).

Tukey post hoc test was performed for group wise comparison, results showed that there was statistically significant difference between groups I and IV(P value < 0.001), and groups II and IV (p value 0.003) and groups I and II (0.027). Comparison between groups II and III (p value< 0.002) revealed statistically significant difference. There was no statistically significant difference between group I and III (p value 0.465).

Discussion:-

Even though fragment reattachment is simple, easy, minimally invasive, fast, economical and and effective procedure, the prognosis may not be good at all times. Fragment de-bonding happens because of repeated trauma, non physiological use of the tooth, or horizontal pulling of the tooth[12]. The risk of de-bonding is higher for children since they have more exposure to traumatic situations because of more physical activity.

Fracture resistance of a material is a measure of its ability to retard crack initiation and propagation. High fracture resistance is required in clinical situations where high impact stresses are experienced[13] . Incisal edge reattachment of anterior teeth is one such demanding situation.

A plethora of studies reported that fracture resistance of reattached tooth fragment can be improved with use of new adhesive agents, bonding materials and tooth preparation techniques techniques[14,15,16,17,18,19,20,21]. Apart from all these improvements, hydration of fragment also plays an important role in improving fracture resistance[9]. Storage medium acts as one of the key determinants since hydration aids in maintaining the vitality, esthetic appearance, and improving the bond strength. This is based on the fact that ability of storage media to retain the collagen framework and intertubular porosity patent for subsequent infiltration of monomers[22.] Bond strength may increase as the resin penetrates into the intact dentinal tubules.

There is paucity of literature demonstrating the role of hydration or storage media in improving success of fragment reattachment. There are gold standard storage media like HBSS that demonstrate good amount of hydration and stability of collagen structure, but their availability is limited and expensive. So, this present study was undertaken to know the effect of commonly available storage media in improving fracture resistance of reattached teeth fragments.

Intact sound dentin which was stored in a dry environment for 24 hours retains only about 25% of the total amount of its moisture. It seems that this partial loss of dentin moisture and its shrinkage results in the reduction of the composite surface contact with dentin[23]. In this study bond strength of the fragments which were kept in a dry environment before reattachment had the lowest bond strength.

Bond strength of fragments stored in milk was greater than that of fragments which were kept dry. This may be due to the fact that storage of fragments in moist environment prevents the collapse of collage fibers in dentin leading to better bond strength.

Bond strength of fragments which were left dry was less than that of fragments stored in saline. This can be attributed to the following effect: if the fragment is dry there will be collapse of collagen net in the dentin, this will prevent the penetration of bonding agent into partly demineralized zone. This will result in relatively low bond strength.

Bond strength of fragments stored in coconut water was greater than that of strength of fragments that were kept dry. This was because hydration of surfaces restores approximately 50% of the fracture strength of the original tooth [7]. A dried fragment has a lower bond strength compared to a fractured part which is kept in a moist environment or is rehydrated before reattachment.

Bond strength of fragments stored in milk group was greater than that of fragments stored in normal saline. Calcium and phosphate are the main elements found in milk and these can stiffen and harden both demineralized and healthy dentin. This may be the reason behind enhancement of bond strength of fragments stored in milk[8].

In the present study, there is no statistically significant difference between the bond strengths obtained by the fragments stored in milk and coconut water. Coconut water has higher osmolality than milk. 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[24].

Fragments stored in normal saline obtained lower bond strengths than fragments stored in coconut water. Previous studies have compared the effectiveness of coconut water and normal saline as storage media for avulsed teeth, the authors found that normal saline was superior to pure coconut water as storage media[25]. The reason might be that factors required for PDL cell viability are different from that of fragment reattachment. The pH of normal saline is 5.9 and sufficiently acidic for some demineralization to occur. On the other hand it lacks calcium and phosphate ions for remineralization. It has been shown that the hardness and young's modulus of elasticity of dentin decreased when specimens were stored in normal saline. This is presumably due to loss of surface calcium resulting in hydrolysis of unprotected collagen fibrils.

Table 1:- Mean comparison among Groups using one way ANOVA

GROUP	**MEAN**	**SD**	**P VALUE**
I (MILK)	121.53 N	20.96	<0.001 Significant
II (COCONUT WATER)	129.95 N	30.52	
III (NORMAL SALINE)	95.23 N	23.38	
IV (DRY)	64.71 N	24.67	

Table 2:- Mean comparison between group I and group II.

GROUP	MEAN	SD	MEAN±SD difference	P VALUE
I (MILK)	121.53	30.52	8.42±5.85	0.465
II (COCONUT WATER)	129.95	24.67		Not Significant

Table 3:- Mean comparison between group I and group III

GROUP	MEAN	SD	MEAN±SD difference	P VALUE
I (MILK)	121.53	30.52	26.30±7.14	0.027
III (NORMAL SALINE)	95.23	23.38		Significant

Table 4:- Mean comparison between group I and group IV

GROUP	MEAN	SD	MEAN±SD	P VALUE
I (MILK)	121.53	30.52	56.82±9.56	<0.001 Significant
IV (DRY)	64.71	20.96		

Table 5:- Mean comparison between group II and group III

GROUP	MEAN	SD	MEAN±SD difference	P VALUE
II (COCONUT WATER	129.95	24.67	34.72±1.29	0.002 Significant
III (NORMAL SALINE)	95.23	23.38		

Table 6: Mean comparison between group II and group IV

GROUP	MEAN	SD	MEAN±SD	P VALUE
II (COCONUT WATER)	129.95	24.67	65.24±3.71	<0.001 Significant
IV (DRY)	64.71	20.96		

Table 7: Mean comparison between group III and group IV

GROUP	MEAN	SD	MEAN±SD	P VALUE
III (NORMAL SALINE)	95.23	23.38	30.52±2.42	0.003 Significant
IV (DRY)	64.71	20.96		

Limitations of the study and further research:-

In this study maxillary central and lateral incisors were selected for the study, because these teeth were more prone to fracture. There will be difference in the cross sectional areas of central and lateral incisors. So the area of bonding differs for central and lateral incisors, this will have impact on bond strength values.

The uncomplicated crown fracture occurs more commonly among young patients. Obtaining sound young permanent incisors is highly difficult as their extraction is unethical. In this study incisors extracted for periodontal reasons, which are usually teeth of older people were selected. Aging can cause alterations, especially in dentin, which will have negative influence on bond strength. This is one limitation of the present study.

The extracted teeth were sectioned with double sided diamond disc to obtain fragments. The fractured surfaces obtained by this method may differ from the surfaces of natural fractures. Cutting with disc may also produce smear layer and there will be minute loss of tooth structure so the fragment may not fit well over the remaining tooth structure. This is a limitation of the present study.

Long term clinical trials and in-vitro studies on larger number of samples and at larger scale need to be undertaken in this area of research to elucidate the effect of storage media on fracture resistance of reattached tooth fragment.

Conclusion:-

The effectiveness of coconut water as storage media was superior to that of normal saline and milk. Within the limits of study, it can be concluded that coconut water can be used as storage media for fragment reattachment of teeth. Conclusions drawn from the present study should be further evaluated by long term clinical studies. More research in this direction is needed in future as the role of storage media in fragment reattachment has been proved critical for the success of restoration.

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