**SURVIVAL OF REATTACHED TOOTH: A SYSTEMATIC REVIEW**

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**ABSTRACT**

**Background:** The use of tooth fragment reattachment as an alternative treatment for fractured anterior teeth has been widely reported. However, there is controversy about its longevity. This necessitates the review of studies on its survival rate.

**Aim and objectives:** To determine the reported survival rate of reattached tooth fragments and to assess the storage media, techniques and materials used for tooth reattachment as it affects the longevity of the restorations.

**Design of the study:** This is a systematic review of studies conducted on tooth fracture reattachment.

**Setting:** The review was carried out at the University College Hospital, Ibadan, a tertiary hospital in south-western region of Nigeria.

**Materials and Method:** A systematic search of PUBMED, Cochrane, Web of science, Scopus, Google scholar and Google was done three times for better outcome. Case reports, observational studies, in vivo studies, and cross sectional studies that were written in English language were included. Key words and phrases such as ‘tooth reattachment’, ‘fragment tooth reattachment’, ‘crown fragment reattachment’ as well as ‘AND’ ‘OR’ were employed to increase the field of search. Articles downloaded were critically appraised by the two authors for inclusion. Data including authors’ name, date, institution, age/gender of patient, teeth involved, medium of storage, technique of reattachment, materials used, and follow up period were extracted and entered into a data proforma.

**Results:** Search yielded 206 articles of which 61 relevant ones were downloaded and twenty five studies that met the selection criteria were analysed. A total of 29 teeth were treated in the studies. The majority, 20 (69.2%), of the patients were male and 15 (51.7%) of teeth treated were tooth-type 11. Ellis class III fracture constituted the major indication for reattachment, 21 (72.4%). Material mostly used for tooth reattachment was Light cured composite resin in 16 (55.2%) teeth followed by flowable composite in 8 (27.6%) and dual cure composite in 5 (17.2%) teeth. Follow-up period was between 3 months and 10 years with an average of 2-year-longevity and survival ~~rate~~.

**Conclusion:** Tooth reattachment as an alternative treatment for fractured anterior teeth is simple, conservative, cost effective and aesthetically pleasing with fair survival rate.

**Key words:** Fracture, Tooth reattachment, Aesthetics, Survival

**Introduction**

A common occurrence in children and adults in dental practice is injury to anterior teeth in which the maxillary incisors are mostly affected.[1,2] Tooth crown fracture has been reported to account for up to 92% of the traumatic injury to the permanent teeth.[3] These injuries often have physical, social and psychological impacts on the affected patients.[4] Traumatized anterior teeth, therefore, necessitate quick aesthetic and functional intervention.[5] There are many factors that influence the management options for such injured teeth; these include the degree of fracture, pattern of fracture, quality of fit between the segments, degree of tooth eruption and age of patient. Others are endodontic involvement, alveolar bone fracture, biological width violation, restorability of the fractured tooth, availability of the fractured segment, occlusion, aesthetics, finances and prognosis.[6,7,8,9]

Conventional method of using composite resin to restore traumatized teeth has been employed over the years.[5] However, fragment tooth reattachment which was previously used as a temporary treatment option has gradually become an established treatment modality for uncomplicated and complicated crown tooth fracture of anterior teeth so far as the fragment could be retrieved.[10] This is mainly due to the recent rapid improvement in adhesive dentistry.[4] This technique has been documented to be satisfactory by patients, parents and guardians.[11]

Tooth fragment reattachment treatment approach, apart from being the most conservative[12,13] provides many advantages when compared to conventional technique. These include the retention of natural tooth colour and surface texture, as well as the wear rate of the reattached incisal edge being similar to that of the adjacent natural teeth.[11] It also conserves tooth structure and provides positive emotional and social responses for patients. Treatment is relatively fast and is less burdensome economically.[1,5,14] Despite the various advantages of this biological method of restoration and the predictable outcome reported, there is still concern about the fracture strength of the restored tooth over time. It has, however, been reported that the primary cause of the loss of the reattached teeth fragment was new trauma or non-physiological use of the reattached portion.[15]

The longevity or survival of the reattached tooth has been a challenge. Several studies and case reports have put down different follow-up times which may be due to different techniques used for re-attachment, ability to recall patients, and peculiarities of different cases. This study, therefore, set out to review studies to determine the reported longevity and survival rate of reattached tooth fragments. It also assessed the storage media of tooth fragment, techniques used for reattachment and the materials used as all these may affect the longevity of the restorations.

**Materials and Methods**

This review was done by systematic search of the literature over a period of three months (August to October)in 2018 using various search engines including PUBMED, Cochrane, Web of science, Scopus, Google scholar and Google. Regarding the selection criteria, Case reports, observational studies, in vivo studies, cross sectional studies that were written in English language and that documented the follow-up of cases were included irrespective of the time or place of study. Reviews, letters, personal opinions, book chapters and abstracts were all excluded. Different key words and phrases were used for the search such as ‘tooth reattachment’, ‘fragment tooth reattachment’, ‘crown fragment reattachment’. Words such as ‘AND’ ‘OR’ were also used with the key words to increase the field of search or narrow down in certain cases. Search was done up to three times over a period of three months for better outcome. Studies were downloaded and two authors critically appraised them to know those that met the selection criteria. Data were then extracted and entered into a data proforma. Data obtained included author’s name, city and country, sex/age, teeth involved, diagnosis, media for rehydration, technique of reattachment, materials used, conclusion and follow-up.

**SUMMARY OF DATA FROM STUDIES USED IN ANALYSIS**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Authors** | **City and Country** | **Sex/Age (yrs) of patient** | **Teeth involved****(FDI Notation)** | **Diagnosis** | **Media for rehydration** | **Technique of reattachment** | **Material****used** | **Conclusion** | **Follow up** |
| Hegde RJ, (2003)**16** | Bagalkot, Karnataka, India | F/12 | 11, 12 | Ellis class II |  Not indicated | Tooth acid etchedFragment reattached with composite resin | Composite resin (not specified) | Tooth fragment reattachment procedure offers an ultra-conservative , safe, fast, and aesthetically pleasing results when the fractured fragment is available. Reattachment of the dental fragment as a restorative procedure becomes possible with the improvement of adhesive techniques and restorative materials | 1yr |
| Kumar et al, (2010)**17** | Tumkur, Karnataka,India | M/29 | 12 | Complicated crown fracture | Normal saline | Root canal treatment doneFibre post insertedFragment reattached with composite | Composite (not specified) | Reattachment of original tooth fragment with the improved adhesive protocol and reinforcement technique is a simple conservative approach to provide immediate natural aesthetics and functional rehabilitation. But long term follow up is needed to prove the predictable success | 1yr |
| Ajayi et al, (2011)**14**  | Ibadan,Nigeria | M/17 | 11 | ComplicatedCrown fracture | Normal saline | Single visit RCT doneParapost placedAcid etching doneFragment reattached with light cured composite | Light cured composite | Conservative approach to restoration of fractured teeth using reattachment is a Viable, inexpensive, efficient and feasible alternative that can restore aesthetic and function. However, longterm prognosis may be queried | 2yrs |
| Shetty et al, (2012)**1** | Udaipur, India | M/32 | 11 | Complicated crown fracture | Normalsaline | Single visit RCT followed by fibre post insertion and reattachment of fragment with dual cure composite | Dual cure composite | Reattaching a tooth fragment with newer adhesive materials may be successfully used to restore fractured teeth adequate strength but long term follow up is necessary | 3months |
| Ninawe et al, (2013)**18**  | Nagpur, Maharashtra, India | M/12 | 11 | Ellis and Davey class III at the cervical one third | Hank’s balanced solution | Single visit root canal treatmentFibre post placed and bonding of fragment done with composite | Flowable composite | Tooth fragment reattachment offers a conservative aesthetic and cost effective restoration that has been shown to be an acceptable alternative | 1.5yrs |
| Ramarkrishna et al, (2013)**19**  |  | M/18 | 11 | Complicated crown fracture | Normal saline | Root canal treatment doneAcid etching doneFragment of tooth reattached with composite | Composite (not specified) | Tooth fragment reattachment procedure offers ultra conservative, cost effective , safe , fast and aesthetic pleasing results when the fragment is available | 6months |
| Rajeshet al, (2014)**20** |  Tamil Nadu, India | M/23M/19 | 2222 | Ellis class III fracture | Normal saline | Acid etching done with 37% phosphoric acid, fibre post is placed with.Dual cure composite Flowable composite was used to attach the fragment | Dual cure composite and flowablecomposite | It demonstrated the importance of multidisciplinary approach in successful management of complex crown fracture and its possible sequelae | 2yrs |
| Shubha et al, (2014)**21** | ,Nagpur, Maharashtra, India | F/16M/20 | 2211 | Ellis class III extending sub gingivally |  Not indicated | Single visit root canal treatment doneFibre post insertedFragment reattached with composite  | Composite resin type (not specified) | The remarkable advancement of adhesive systems and resin composite has made reattachment of the tooth fragment a positive treatment rather than provisional restoration, with favourable prognosis | 4yrs |
| Kim et al, (2014)**22** | Jeonju, Korea | M/16 | 23 | Complicated crown fracture | Milk | Endodontic treatment doneGlass fibre post insertedFragment reattached with composite | Composite type (not specified) | For post realigning, the indirect technique is more advantageous than the direct technique that is applied intraorally | 1yr |
| Martos et al, (2014)**23** | Pelotas, Brazil | M/15 | 11 | Uncomplicated crown fractureEllis class II | Water | Acid etched with 35% phosphoric acidLight cured conventional two -bottle composite was used to bond the fragment | Conventional two -bottle composite resin material. | The reattachment of the fractured crown fragment using the bonding technique offer several advantages such as function and aesthetics | 4 months |
| Saha et al, (2015)**7** | Guru Nanak, Kolkata | M/8 | 11 | Ellis class II fracture | Normal saline | Bevels placed on both tooth and fragmentTooth and fragment etched Fragment bonded with flowable composite | Flowable composite | The reattachment of a fractured fragment is a viable technique that restores function and aesthetics with a very conservative approach and the procedure should be especially considered while treating fracture of anterior teeth of younger children whenever the fractured fragments are available | 1 yr |
| Sadanandet al, (2015)**24** | Indore, MP, India | F/15 | 22 | Ellis class IIIfracture | Normal saline | Single visit Root canal treatment doneTooth and fragment etchedFragment reattached with fibre post and flowable composite | Flowable composite | The combined use of glass fibre Reinforced with Ribbond fibers as root canal post and reattachment of an original crown fragment is a simple and efficient procedure for the treatment of traumatized anterior teeth that appears to offer excellent aesthetic and functional results | 1 yr |
| Rai et al, (2016)**25** | Himachal Pradesh, India | F/30 | 12 | Ellis class III fractures | Distilled water | Single visit root canal treatment doneParapost cemented with parabondFragment bonded with composite | Composite (not specified) | Most of the reattachment procedures can be completed in single appointment even in case of complicated crown fracture. At 2yrs follow up the resultant appearance was acceptable to the patient. However before recommending a similar treatment on a regular basis, a longer follow up period is required | 2yrs |
| Chouldary et al, (2016)**26** | Jaipur, Rajasthan, India | F/22 | 22 | Ellis class IIIfracture | Normal saline | Root canal treatment was carried outPrefabricated metal post cemented with GICFragment reattached with flowable composite | Flowable composite | Tooth fragment reattachment along with post insertion is a viable technique that restores function and aesthetics with very conservative approach and should be considered when treating patients with gingival and even coronal fracture of the anterior teeth | 1yr 8month |
| Jyothi et al, (2016)**27** | Andhra Pradesh, India | F/27 | 11 | Chisel type complicated crown root fracture | Water | Single visit root canal treatment doneGlass post cementedBevel was placed on palatal surface of toothFragment reattached with flowable composite | Flowable composite | Reattachment technique is the most conservative and biological method of restoring a fractured anterior tooth. Reattaching a tooth fragment with newer adhesive materials may be used successfully to restore fractured tooth with adequate strength, but long term follow up is necessary | 2yr |
| Sanyantan et al, (2016)**8**  | Panihati, Kolkata | F/16 | 11 | Complicated crown fracture |  Not indicated | Root canal treatment doneFibre post insertedFragment reattached with composite | Light cured composite | Fracture reattachment is a viable conservative and aesthetic alternative treatment of the complicated crown fracture. The long term prognosis is still obscure but it is an immediate technique of aesthetic rehabilitation in the management of traumatized tooth  | 1yr |
| Dali M (2016)**28** | BIRATNAGAR, Nepal | M/10 | 11 | Complicated crown fracture | Normal saline | Root canal treatment doneComposite was inserted as postTooth acid etched,fragment reattached with conventional composite | Composite resin (not specified) | Reattachment of tooth fragment is a viable technique that restores function and aesthetics with a very conservative approach, could be done in a single visit and considered when treating patients with coronal fractures of the anterior teeth especially in younger patients. | 1yr |
| Pathan et al, (2017)**2** | Latur, Maharashtra, India | M/34 | 11 | Ellis class IIIExtending from incisal edge to the middle |  Not indicated | Single visit Root canal treatment doneFragment and tooth bevelled and attachment done with flowable composite | Flowable composite | Tooth fragment reattachment procedure offers ultra conservative cost effective pleasing results when fragment is available | 1yr |
| Tonini, (2017)**4**  | Brescia, BS, Italy | F/19 |  22 | Complicated crown fracture | Normal saline | Root canal treatment was done, Fibre post was attached to fragment first and dual cure used to cement the post and the fragment | Dual cure composite | This study confirmed the long term efficacy of the reattachment procedure using fibre posts which serve as alternative treatment method | 4yrs |
| Mendes et al, (2017)**29** | Nova Friburgo, Brazil | F/9 | 11 | Enamel dentine with pulpal exposure | Milk | Direct pulp capping was doneTooth Acid etchedFragment bonded with dual cure composite | Dual cure composite | Techniques for tooth fragment reattachment are not temporary procedure but require functional and aesthetic adjustment over time to maintain the biomimetic characteristics of traumatized anterior teeth with a very conservative approach and predictable outcomes | 10yrs |
| Lise et al, (2017)**9** | Florianopolis, Brazil | M/13 | 11 | Enamel dentine fracture extending subgingivally | Distilled water | Gingival flap raised to expose fractureAcid etching doneFragment bonded with composite | Two-step adhesive composite | Considering the high incidence of dental fracture due to trauma, the working knowledge of dentist regarding treatment possibility is essential. Tooth reattachment should be performed whenever possible because it is a simple, fast and affordable procedure and presents a predictable aesthetic result | 1 yr |
| Martos et al, (2018)**30**  | Pelotas, Brazil | F/17 | 11, 12 and 21 | Complicated crown fracture | Dry empty bottle | Root canal treatment done Fragment cleaned with chlorhexidine diglucoseAcid etched with 35% phosphoric acidComposite use to bond the fragment | Composite (not specified) | The type of storage medium in which the tooth is stored has no influence on the survival, colour and bonding strength of the restored tooth after fragment reattachment | 14 months |
| Martins et al, (2018)**31**  | Belo Horizonte, Brazil | M/23 | 21 | Ellis class III fracturePart of the fragment was lost | Normal saline | Root canal treatment institutedFibre post was cemented with auto adhesive cementFragment reattached with composite | Composite resin (not specified) | The combined use of adhesive materials and fragment is a simple, low cost and efficient procedure for the treatment of traumatized anterior teeth | 2yrs |
| Karre et al, (2018)**32**  | Vikarabad, India | M/12 | 22 | Enamel dentine fracture | Water | Acid etched with 37% phosphoric acidFibre post was placed extra corona vertical grooves made in the fragment and toothReattachment was done with flowable composite  | Flowable composite | Tooth fragment reattached is an aesthetically acceptable and a conservative approach in the management of traumatic dental injury | 2yrs |

**Results**

The search from the various sites yielded 206 articles of which 61 relevant ones were downloaded. Twenty five studies from different countries that met the selection criteria were included; most of them (24) were case reports while the remaining was an article34 that reported hydration and dehydration periods of crown fragment. The year of the studies ranged from 2003 to 2018. All the patients were children and young adults with ages between eight (8) years to thirty four (34) years. The majority of patients (69.2%) were male. Altogether, twenty nine (29) teeth were treated in the studies reviewed. Fifteen (51.7%) out of the 29 teeth were upper right maxillary centrals, followed by upper left lateral incisors which were seven (24.1%); the rest were upper right lateral incisors 4(13.9%), upper left central 2(6.9%) and upper left canine 1(3.4%). Ellis class III fracture constituted the major indication for the tooth fragment reattachment in 23(79.3%) while others were Ellis class II. Only 19 studies indicated the storage medium used, with normal saline utilized in 11 (57.9%) studies for rehydration of tooth fragment; one study (5.3%) used Hank’s balanced solution[18], 5(26.3%) studies used water and 2 (10.5%) used milk. However, in one ~~of the~~ study, the tooth fragment was put in an empty container. Materials that were used for reattachment included Light cure composite in 13(54%), Flowable composite in 7(29%) and Dual cure composite in 4(17%) studies. Fibre posts were the most commonly used for core retention 13(54%). Follow up period was between three months and ten years with an average of approximately two years.

Generally, the studies reviewed concluded that, with newer adhesive composite materials, alongside post insertion, fragment tooth reattachment offers a viable ultra conservative, cost effective, safe, fast, aesthetic and alternative treatment with pleasing results. However, long term follow up is needed to confirm the long term efficacy. Storage medium used has no influence on the survival colour and bonding strength of reattached tooth.

**Discussion**

Traumatized anterior teeth is a relatively common reason for patients presenting in the dental clinic; it most times affects function, aesthetics and psychological well-being of the patient, thus, requires quick and simple restorative treatment. Tooth fragment reattachment which was once used as a provisional restoration has now gained ground as an established option for restoring fractured teeth when the fragment is available.[10] It is the most conservative, aesthetic, less expensive and well pleasing to the patient.

Improvement in longevity of tooth reattachment is not unconnected with the advancement in the adhesive dentistry and the use of fibre post. This recent advancement in restorative materials alongside the placement techniques, and preparation designs have enabled restorative dentists to restore fractured teeth predictably.[11] Survival rate of this method of restoration has been reported to be good while further studies have been recommended.[4,18,24]

All the patients treated in the case reports included in this present study were children and young adults with ages between 8 and 34 years. It has been reported in other studies[18,25] that injury to anterior teeth is relatively common and mainly affects children and adolescents with majority of the cases being male. This could be due to the fact that boys are more active in sports, fights and other traumatic injury-associated activities than their girl counterparts.

Rehydration of the tooth fragment in a storage medium has been reported to be a factor in the survival of reattached tooth. Duration of rehydration has been controversial as different authors have suggested different duration of storage in a medium before reattachment is done. Shirani et al[34] in their study conducted on one hundred and eight traumatized mandibular incisors to evaluate the effect of different rehydration periods concluded that twenty-four hour rehydrated specimen of dehydrated tooth fragment exhibited stronger bonds in comparison with the 30-minute rehydrated specimen. Different rehydration media have been reported by various authors which include Normal Saline, Distilled water, Water, Saliva, Milk and Hanks balanced Solution.[18] However, in this present review, normal saline was the most commonly used rehydration medium for the tooth fragment which may be due to its ready availability. Martos et al in 2014[23] reported that the type of medium in which the tooth is stored prior to reattachment has no effect on the survival, colour and bonding strength of the restored tooth after fragment reattachment.

Several case reports that used different techniques and materials to reattach fractured teeth segments have been published.[1,11,14,18,23] Materials that have been used in the case reports reviewed in this present study include Light cured composite (54%), Flowable Composite (29%) and Dual Cure composite (17%). Adequate knowledge of these materials and their bonding capacity is essential for good results.[35] Composite resin was introduced in 1955 when Buonocore used orthophosphoric acid to improve the adhesion of acrylic resins to the surface of the enamel and Bowen developed the Bis-GMA in an attempt to improve the physical properties in 1962.[36,37] Conventionally, Composite resins are composed of the organic phase, inorganic phase (filler or disperse phase) and organosilane as coupling agent that bond the components together. Composite resin has indubitably acquired an important place among the filling materials due to its considerable aesthetic properties, ability to micromechanically bond to etched tooth tissue, conservation of tooth structure and great versatility that give rise to a variety of therapeutic indications. However, they are highly technique sensitive which requires proper isolation and good nimbleness in handling, for a better success.[36] The era of Nanotechnology has led to the development of a newer composite resin containing nanoparticles and nano-aggregates of approximately 25nm and 75nm respectively. Since the particle size is small, resin made with this type of particles gives the restoration a better finish and wear resistance, less curing shrinkage, less cusp wall deflection and reduces the presence of microfissures in the enamel edges [36]

Various techniques are employed depending on the case scenario; there is no technique for reattachment that has been tagged the best, though different preparation methods of the fragments and the remaining tooth surface are important.[38] Clinicians who want to master the technique and provide favourable long term aesthetic and functional results for their patients must possess a working knowledge of the varieties of the techniques.[9] Some cases may even require multidisciplinary approach especially from Oral surgery, Periodontology or Endodontic specialists. Mechanical preparation of the fragment and the tooth surface may be performed by placing dentin groove, bevel, chamfer or over-contour. Fractured enamel prisms that are not in a favourable position may also be removed for better etching.[8,39] It has been reported that simple reattachment without any other preparation can only restore 37.1% of the intact tooth’s fracture resistance, while buccal chamfer recovered about 60.65%; bonding with an over-contour and placement of an internal groove nearly restores the intact tooth fracture strength to 97.2% and 90.5% respectively.[40]

Reattachment of a tooth with more than 50% of the tooth fragmented requires insertion of post to ensure stability.[18,25] In about 54% of the cases reviewed fibre posts were either cemented with dual cure composite or glass ionomer cement. The use of fibre post is dated as far back as 1989 though the first published article on it was in 1990.[41] The initial fibre posts contained pre-stretched carbon or silica bonded by a matrix of polymer resin which had some drawbacks with their aesthetic usage as they were radiolucent and difficult to conceal under all-ceramic or composite restoration.[42] More aesthetic and radio-opaque quartz and glass fibre posts were introduced to overcome this shortcoming.[42] Fibre posts are more favourable for situations with aesthetic demands such as in the upper anterior region. It also possesses high tensile strength, low electrical conductivity, resistance to solubility, resistance to biochemical degradation and modulus of elasticity (about 20Gpa) which is similar to that of dentine (18Gpa).[43] This similarity in modulus of elasticity of fibre post to that of natural tooth and its ability to form monobloc with the cement and dentin qualifies it to be used and favoured by many clinicians in the reattachment of tooth fragment.[6,25] This is corroborated by Dhanalexmi et al[32] who concluded in their own study that careful tooth and fragment preparation and fibre post reinforcement gave excellent stability and aesthetics with no colour change even after 2-year review.

Longevity of tooth fragment reattachment was initially questionable and unpredictable before the recent advances in adhesive materials. It is of note that several authors have attempted follow-up of cases of tooth fragment reattachment which ranged from 3 months to ten years in order to monitor the colour stability, fracture resistance and survival rate. However, the average follow up period analysed from the case reports reviewed in this study was 2 years. The majority of the follow-up were between one and two years, this may be due to the fact that many patients are lost to follow up and only come back when they have issues with their restorations. Most of the clinical follow-up of the reattached teeth showed positive outcomes regarding retention and aesthetics,[29,31,32,43,44] Andreasen et al45in their clinical follow-up of 334 reattached fractured incisors reported 50% and 25% retention after five and seven years respectively. Another study by Vijayakuman et al[46] that investigated 50 reattached incisor fragments over 5 years showed 80% survival rate. The survival rate in patients treated with biological method of tooth reattachment was reported by Sarapultseva and Sarapultseva[44] to be 88.9%. Longevity of tooth fragment reattached is also comparable to the direct composite restoration; this was confirmed by pairwise comparison in a study in which it was concluded that both methods provide similar results over the 60-month observation.[44]

Tooth fragment reattachment is, therefore, a viable and valid treatment option for management of coronal tooth fracture especially in the anterior region whether uncomplicated or complicated, when the fractured segment is available. It is also recommended that in future, a standardized long term period study be conducted to further evaluate the survival rate of this treatment approach.

**Conclusion**

It can be concluded that fragment tooth reattachment as an alternative treatment for fractured anterior teeth is simple, conservative, cost effective, aesthetically pleasing and acceptable with fair survival rate. However, longer-term follow-up is recommended in future studies.

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