Case Reports in Dental Science

Case Report | Vol 3 Iss 1

Fragment Reattachment of Immature Permanent Incisors – Clinical Procedures and the Development of an Algorithm

Goyal A, Rathore M*, Devi P and Singh SK

Department of Pedodontics and Preventive Dentistry, Oral Health Sciences Centre, PGIMER, Chandigarh, India

Correspondence should be addressed to Mrinalini Rathore, rathoremrinalini@gmail.com

Received: June 16, 2021; Accepted: July 03, 2021; Published: July 10, 2021

ABSTRACT

Reattachment of fractured fragments provides the easiest and most esthetic rehabilitation of fractured teeth, wherever possible. In clinical practice, these cases may have a wide spectrum of presentation including different - dehydration times of the fractured fragments, methods of storage of the fragments, and reattachment techniques. However, no well defined protocol exists to guide the reattachment of fractured teeth in such different clinical scenarios. Using the reports of such cases treated at our center and reviewing the various fragment reattachment techniques mentioned in literature, an attempt has been made to develop an algorithm to guide the reattachment of fractured teeth in varied clinical scenarios. This report also describes, in detail, two cases of fractured immature permanent incisors with very different extra-oral dry time periods viz. 60 days and 18 hours, that were successfully treated by reattachment of fractured fragments. Fragment reattachment was found to serve as a functional and esthetically acceptable treatment option in restoring the integrity of fractured permanent incisors irrespective of the time elapsed since the fracture provided the dehydrated fragments were rehydrated before reattachment.

KEYWORDS

Algorithm; Dental trauma; Reattachment; Rehydration; Permanent incisor

1. INTRODUCTION

Traumatic dental injuries are usually common in young children between 6 years - 13 years and the degree of damage varies from a simple enamel fracture to avulsion. Most of the times, these injuries may be associated with pulpal involvement or bone fracture [1]. Dentists often try to treat dental trauma as an emergency to restore the aesthetic, functional, and emotional discomforts that tooth fractures normally cause. The restorative choice is based on the extent of the fracture, patient's age, tooth eruption, root formation, aesthetic expectations, amount and quality of remaining tooth, and pulpal and periodontal involvement. If pulp becomes exposed, the priority is to preserve vitality using a conservative approach (pulp capping or pulpotomy), depending on the degree of bacterial contamination, root formation, pulp status and bleeding. In case of immature young permanent teeth, the main objective of pulp therapy is to maintain the pulp integrity, so as to allow apexogenesis. Besides pulp therapy, the aesthetic and functional restoration of such fractured teeth also forms an essential part of the treatment. A perfect reproduction of the natural dental

Citation: Goyal A, Fragment Reattachment of Immature Permanent Incisors – Clinical Procedures and the Development of an Algorithm. Case Rep Dent Sci 3(1): 17-26.

color, optical properties, shape, and surface texture is a challenge and requires great skill and dexterity when performing the coronal reconstruction. Fragment reattachment, wherever possible, serves to be the most favorable treatment approach with various advantages like the conservative nature of the treatment, retaining the original tooth color and structure, and giving a positive attitude to the patient, both emotionally and economically. The procedure is reasonably simple with long term predictable clinical outcome. Most of the times, the fractured segment is brought immediately to the dental clinic by the patients for reattachment. However, in a few cases the fractured fragment is exposed to the extra-oral environment for a greater extent due to either the inability to locate and retrieve the fractured fragment or the ignorance among the patients and their parents regarding the possibility of reattachment. This prolonged extra-oral time results in dehydration of the fragment with impairment of the aesthetic and mechanical properties. To increase the durability, rehydration of the dehydrated fractured segment has been added as a step in the treatment protocol [1].

This report describes in detail the successful management of two cases that reported to the Pediatric Dental Clinic at the Oral Health Sciences Center, Post-graduate Institute of Medical Education and Research, Chandigarh, India with fractured immature permanent incisors wherein the fractured fragments had very different extra-oral dry time periods. The report also summarizes the methods of fragment reattachment in ten other similar cases done at our centre. Drawing from our clinical experience and the available literature an algorithm to aid in decision making in such clinical scenarios has been proposed.

2. CASE 1

A 9-years old male child presented with the chief complaint of broken upper front teeth due to trauma. A brief history revealed that the patient had suffered trauma to the upper front teeth by hitting against a steel rod, 2 hours prior to reporting. A thorough history and examination ruled out the possibility of other associated injuries.

Intra-oral examination revealed a complicated crown fracture with pinpoint pulpal exposure in maxillary right central incisor and an uncomplicated (Ellis class II) fracture in maxillary left central incisor (Figure 1A and Figure 1B). The patient was in acute pain with severe tenderness on percussion. No mobility was evident, and the surrounding intra-oral soft tissues appeared normal. The IOPAR of the traumatized teeth revealed the root development to be at Nolla’s stage 9 in both (Figure 2A).

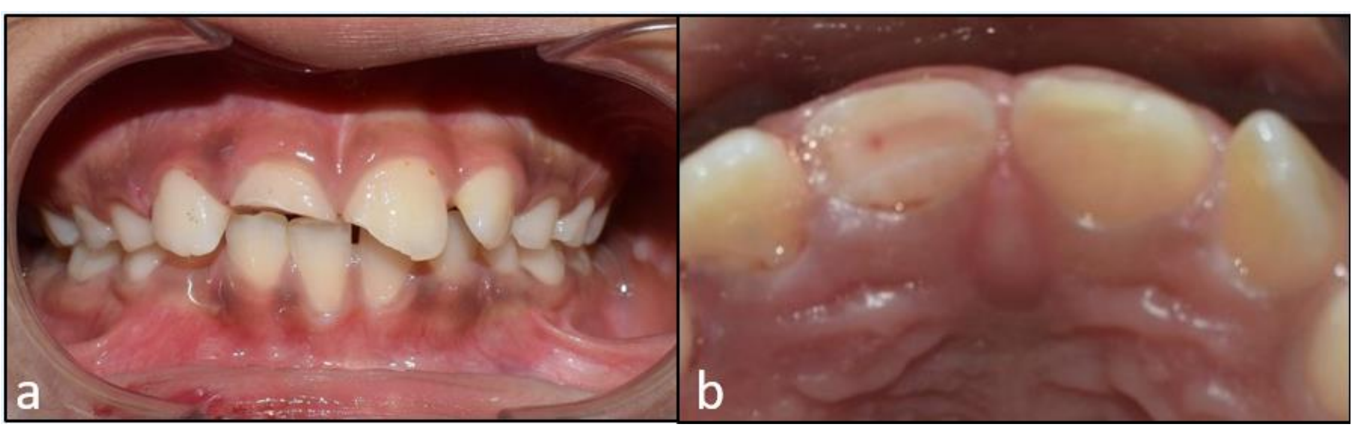

Figure 1: A) Ellis Class III fracture in 11 and Ellis Class II fracture in 21; **B)** Pinpoint pulpal exposure evident in 11.

On considering the factors such as type of trauma, status of the pulp and stage of root development, MTA pulpotomy to induce apexogenesis in the maxillary right central incisor followed by coronal reconstruction using direct resin composite in both the teeth was initially planned.

MTA Pulpotomy was carried out for maxillary right central incisor and radiographs were recorded to ascertain the adequacy of the MTA plug (Figure 2B). The access cavity was sealed with GIC and an appointment scheduled for coronal reconstruction of the tooth. However, due to personal reasons, the patient missed his appointment. Two months later the patient's mother returned with the fractured tooth fragment of the maxillary right central incisor wrapped in a piece of paper. On evaluation the fractured fragment was fully dehydrated with chalky white color showing complete loss of lustre on both enamel and dentinal surfaces, though no cracks were evident.

Figure 2: A) Pre-operative IOPAR of 11 and 21, showing Nolla's stage 9 root development; **B)** Placement of MTA plug in 11 to induce apexogenesis.

Preparation of the fragment

The dehydrated fragment was immediately placed into saline solution and subjected to topical fluoride varnish application (Fluoritop SR Varnish, ICPA Health Products Ltd.; 22.6mg F/22,600ppm) for 30 minutes and again placed into saline for rehydration until reattachment (Figure 1C). The patient then reported for treatment after 3 days. The rehydrating fractured fragment which remained in saline for 72 hours was then reattached.

The coronal tooth fragment was initially secured by a piece of sticky wax in order to facilitate proper fragment handling. After achieving adequate moisture control, using rubber dam, enamel beveling was done on the tooth and vertical grooves of about 1 mm were placed on both the fractured segment as well as the tooth surface. Both the surfaces were then treated with 37% phosphoric acid gel for 30 seconds, followed by adequate rinsing. The bonding adhesive system was then applied to the etched surfaces and light cured for 20 seconds. Flowable Composite resin was applied to both fragment and tooth surface. The fractured segment was then accurately placed on the tooth, ensuring a perfect fit between the segments. After establishing the proper position of the fragments, excess resin was removed, tooth was light cured for 20 seconds on each surface and finally subjected to finishing and polishing. The rubber dam was removed, and the occlusion was checked and adjusted.

Post-operative instructions were given to the patient, and he was periodically reviewed at 1, 3, 6, 9, 12 and 18 months and it was observed that the tooth was asymptomatic, clinically sound and functionally stable. Aesthetically, the reattached segment was comparable to that of the sound tooth structure despite prolonged extra-oral dry time of the fragment (Figure 1D). The radiographic evaluation at the periodic follow-up visits showed continued root development with apical closure evident at 12 months (Figure 2C).

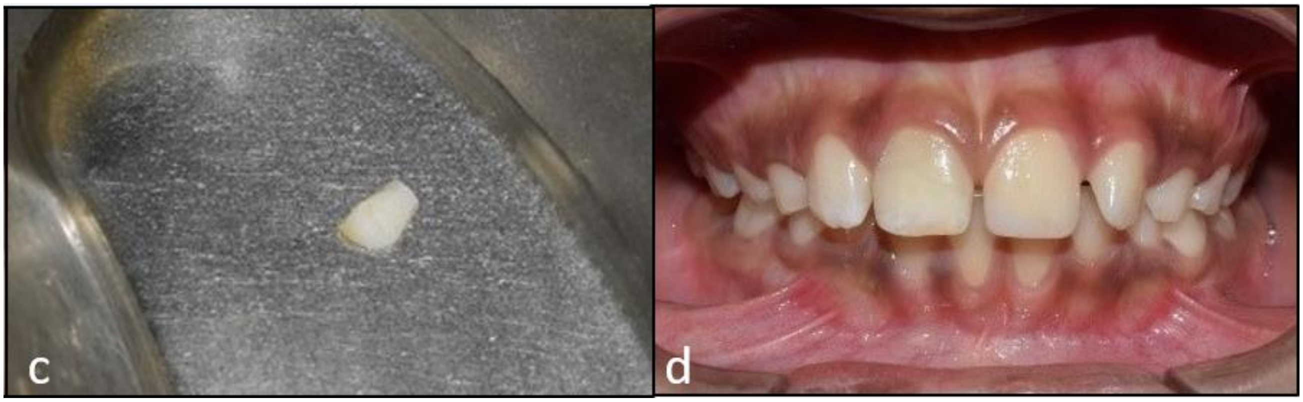

Figure 1: C) Fragment received after 2 months, placed in saline for rehydration; **D)** At 12 months follow-up post-operatively.

Figure 2C: 12 months follow-up showing continued root development and apex closure.

3. CASE 2

An 8-years old male child presented with the complaint of a fractured upper front tooth following a fall while playing at home the previous day. The patient had recovered the fractured fragments (2 fragments) at the site of injury and secured them in a plastic bag under dry conditions. A thorough clinical examination ruling out any associated injuries, revealed a complicated crown fracture in relation to the maxillary right central incisor with a pin-point pulpal exposure (Figure 3A). The radiographic evaluation did not show any subgingival fracture and revealed an immature fractured incisor at about Nolla's stage 8 of development (Figure 4A).

Owing to the immature stage of the root development and the pin-point exposure of the pulp, it was decided to carry out MTA Pulpotomy similar to the previous case (Figure 4B).

The fractured fragments had been retrieved and evaluated for their fit with the fractured tooth surface at the time of initial clinical evaluation (Figure 3B). The fractured dentinal surfaces of the fragments appeared chalky white while some lustre was evident on the enamel surface. A careful inspection of fragments for cracks or craze lines did not reveal any. Owing to their dehydrated appearance and a dry storage time of approximately 18 hours, the retrieved fragments were placed in normal saline for rehydration for 30 minutes (duration of the procedure). The two fractured fragments were first reattached to each other extra-orally using flowable composite resin. The fractured surfaces of the tooth and the fractured segments were then prepared to form internal dentinal grooves with a round bur. Following this, both the fractured surfaces were etched with 37% phosphoric acid for 15 seconds, washed with a gentle stream of water, dried and a thin layer of the dental adhesive was applied and cured for 30 seconds. The two fragments were then approximated using flowable composite resin on the interface and cured for 40 seconds after removing the excess with a microbrush. Final finishing was done (Figure 3C) and a post-operative radiograph was taken to ensure adequate approximation of the reattached fragments (Figure 4B).

The patient was discharged with relevant instructions. At the one-month recall, the pulp sensibility status of the tooth was recorded with an electric pulp tester, and found to be similar to the adjacent sound teeth. The tooth was clinically sound, and the appearance of the reattached fragment appeared to match with the adjacent tooth structure. A radiograph recorded to rule out any periodontal changes secondary to trauma revealed a healthy periapical area.

The patient was recalled every 3 months for clinical and radiographic evaluations. After about 18 months, complete apical closure was noted in the treated tooth (Nolla 10) with a sound peri-apical area (Figure 4D). At 30 months the patient remained clinically asymptomatic with the reattached fragments remaining functionally and aesthetically adequate.

To further aid in the development of a step-by-step algorithm for dealing with cases of tooth fragment reattachment in permanent incisors, a list of clinical cases of fractured incisors wherein the fractured fragments were reattached at our institute has been summarized (Table 1). The summary is solely based on the clinical practice followed by us at our centre and compiled for the purpose of reviewing the common clinical practice in such cases.

Figure 3: A) Complicated crown fracture of 11; **B)** Fractured fragment retrieved as two units; **C)** Reattached fragment after final finishing.

Figure 4: A) Pre-operative IOPAR of fractured 11 revealing Nolla's stage 8 of root development in 11; **B)** Post-operative IOPAR after MTA pulpotomy and fragment reattachment in 11; **C)** At 9 months follow-up, IOPAR revealed continued root development; **D)** At 18 months follow-up, IOPAR revealed completed root development.

SNo.	Age/ Gender	Fractured Teeth	Fracture Type	Extra Oral Dry Time	Rehydration Solution	Rehydration Time	Treatment	Outcome
1	9 years/M	11	Ellis III	30 Minutes	Saline	15 minutes	Direct Pulp Capping followed by Fracture Reattachment	Follow up: 30 Months Fragment Intact
2	14 years/M	21,22	Ellis III	7 Days	Saline	24 hours	Simple Reattachment followed by Pulpectomy	Follow up: 18 Months Fragment Fractured Again and was Reattached
3	10 years/M	11,21	Ellis II - 11 Ellis III - 21	13 Hours	Saline	24 Hours	Reattachment (Dentinal Grooves) followed by MTA Pulpotomy	Follow up: 24 Months Fragment Intact
4	9 years/M	11,21	Ellis II - 11 Ellis III - 21	4 Hours	Saline	30 Minutes	Enamel Bevel followed by Reattachment MTA Pulpotomy in 21	Follow up: Intact till 7 Months Lost to Follow up
5	8 years/M	11, 21	Ellis III - 11 21	13 Days	Saline	>24 Hours	MTA Apexification - 21 Revascularization -11 Fracture Reattached with Simple Procedure	Follow up: 18 Months Fragment Intact
1.	3 years/M	51	Ellis IX	1 Day (Fragment Loosely Attached with the Tooth)	Saliva	Intra Oral	Simple Reattachment Procedure	Follow up: 15 Months Fragment Intact
2.	9 years/M	21	Ellis II	>24 Hours	Saline	24 Hours	MTA Pulpotomy with Simple Reattachment Procedure	Follow up: 20 Months Fragment Intact
3.	8 years/M	21	Ellis III	>2 Hours	Saline	30 Minutes	MTA Pulpotomy with Simple Reattachment Procedure	Follow up: 18 Months Fragment Intact
4.	8 years/F	11	Ellis II - 11	27 Days	Milk	Washed with Saline	Enamel Bevel Followed by Reattachment	Follow up: 24 months → Discoloration at Reattachment Interface Removed with Polishing Fragment Intact
5.	12 years/M	11	Complicated Crown Root Fracture	2 Days (Fragment Loosely Attached with the Tooth)	Saliva	Intra Oral	Conventional Endodontic Treatment Followed by Simple Reattachment Procedure	Follow up: 12 Months Fragment Intact

Table 1: Summary of cases with different extra-oral dry times of fractured fragments.

DISCUSSION

The simple and complex coronal fractures occur in children with prevalence of 28% - 44% and 11% - 15% respectively [1]. For the coronal reconstruction of such teeth, reattachment of the fractured fragment presents one of the most conservative techniques to restore tooth integrity while recovering approximately 37% - 50% of the tooth fracture resistance [2,3]. This recovery may increase to up to 89 % with the placement of retentive features like internal dentinal grooves [4].

Numerous factors viz. the duration and media used to store the tooth fragment, type of material used for adhesion, use of materials to protect the dentin-pulp complex and technique used for the reattachment procedure play an important role in determining the longevity of the reattached tooth fragment.

Hydration of the fractured fragment has a considerable effect on the fracture strength and appearance of the restoration [5,6], with the dry fragments exhibiting less than half of the fracture resistance of those rehydrated in saline [7]. Thus, rehydrating the dehydrated tooth fragment is considered to be important in the treatment of fractured teeth and can help prevent bonding failures.

Poubel et al. (2017) reported the effects of different dry and wet storage times on reattached fragments and found that rehydrating a tooth fragment for 15 minutes before bonding with a multimode adhesive appears to maintain sufficient moisture to increase reattachment strength even when the dry time was upto 24 hours [6]. Capp et al. (2009) in their invitro study found that fragment dehydration for 48 hours causes a reduction in fracture strength, which gets recovered by a 30 minutes rehydration [8]. In an in vitro study, Shirani et al. (2012) concluded that 24 hours rehydrated specimens of dehydrated tooth fragments exhibited stronger bonds in comparison to a 30 minutes rehydration schedule and that the dehydration seemed to plateau at 6 hours of dry storage beyond which no significant effect of dehydration was noted on the fracture resistance [5]. Madhubala et al. (2019) designed a humidification chamber and assessed its efficacy in improving the rehydration of tooth fragments and subsequent fracture resistance after reattachment. The authors found that fragment reattachment after rehydration for 15 minutes in the humidification chamber showed better fracture resistance than the composite restorations [9].

Thus, drawing from the available reports of rehydration of dehydrated tooth fragments, it seems reasonable to propose that for a dry storage period of up to 6 hours, rehydration of the fragment for 15 minutes - 30 minutes should suffice. However, when dealing with a tooth fragment with longer periods of dry storage, deferring the reattachment till a next appointment, usually after 24 hours, seems prudent to allow maximum recovery of fracture strength.

In the first case, the fragment had an abnormally extended dehydration time of 2 months, which is unexplored in the available literature, and thus was subjected to a prolonged rehydration time of >72 hours. While in the second case, the fragment was rehydrated for 30 minutes, after a dry time of about 18 hours, which has been the most frequently reported period for rehydration in clinical reports. However, in both the cases the restorations appeared functionally and aesthetically adequate at subsequent follow up periods of 18 months and 30 months respectively. Thus, from this case report, it can be suggested that even if the fragment remains dehydrated for long periods of time and presents a contrasting color to the natural shade, reattachment remains a viable treatment option after sufficient rehydration of the fragments.

The next most important factor that plays an important role in the success of fragment reattachment is the storage media. Unlike the well-established protocols on storage of avulsed teeth before treatment, guidelines do not mention about the storage of a tooth fragment, even though most reports support the idea that the fragment should be kept hydrated. Various storage media such as milk [7,10,11], normal saline [7,10], coconut water [11], egg white and 50% dextrose [11,12], have been used and it has been suggested that all these tested storage media in particular hypertonic solutions have positively influenced the bond strength of the fragment resulting in higher fracture resistance when compared to storage in tap water or dry conditions [12].

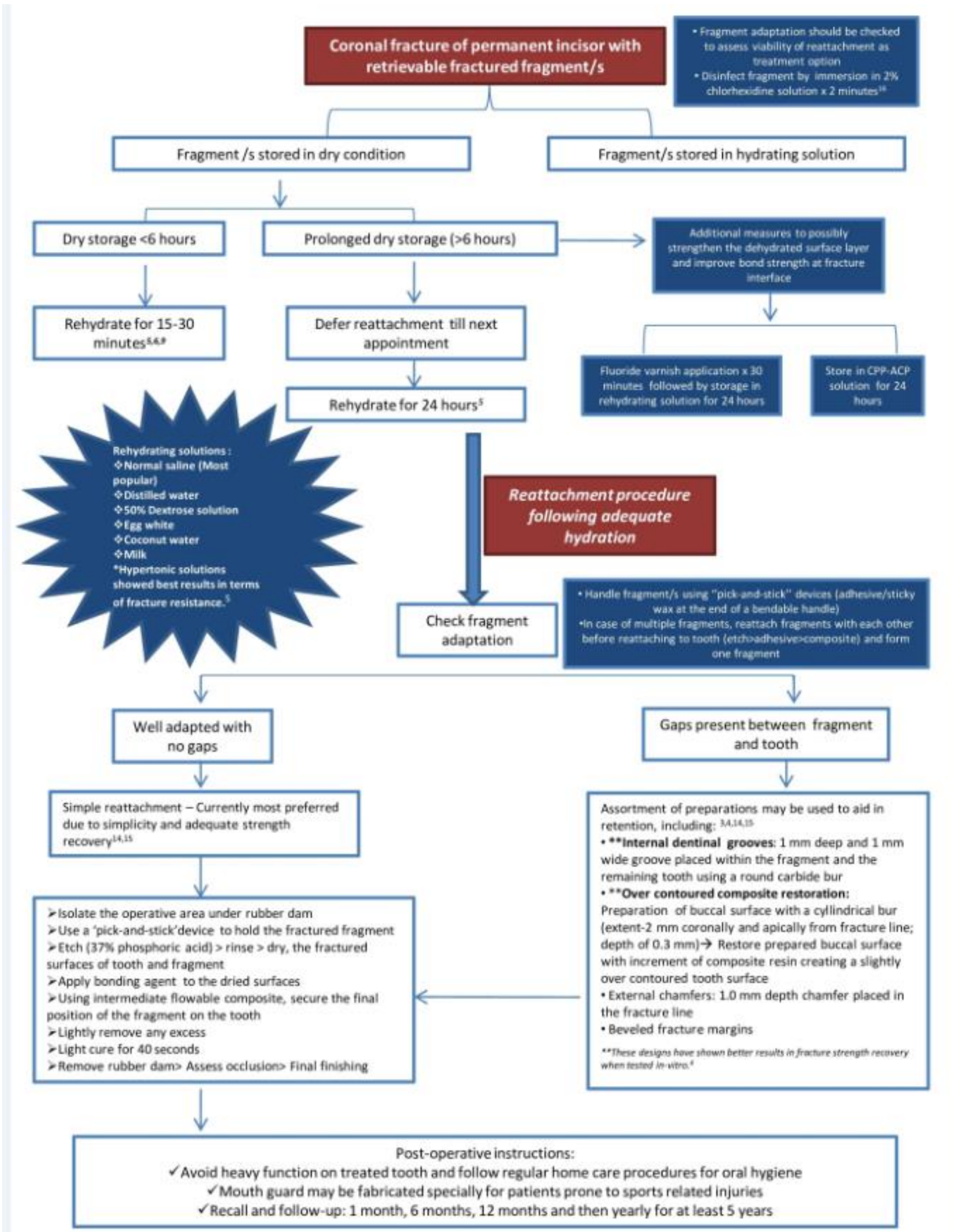

Figure 5: Step-by-step algorithm to aid in decision making when reattaching a fragment to a fractured permanent incisor.

The use of storage medium for a fractured fragment also depends on its availability. Considering the Indian scenario, there is a greater probability of Coconut water and Milk being readily available at the site of trauma, thereby making them potential storage mediums for the fractured fragment. In the present cases, in a clinical setting, 0.9% Normal Saline being readily available, was used as an effective storage medium for rehydration of the fractured fragment which has been suggested as a superior storage media in terms of recovery of fracture resistance [7].

Apart from the hydration time, storage media and material used, the design of preparation also governs the fracture strength of the reattached tooth [13]. In the present case, the reattachment was performed with additional surface modifications using enamel bevel and vertical grooves of 1 mm on both the tooth and the fragments. A systematic review of clinical reports and observational studies on fragment reattachment techniques has concluded that simple reattachment can be considered a preferred technique wherever there is complete fragment adaptation, compared with other reattachment techniques using over-contouring and dentinal groove preparation [14]. However, internal grooves and outer bevels have shown significantly higher fracture strength recoveries than simple reattachments in in-vitro investigations [4].

Considering the lack of well-defined recommendations for performing tooth fragment reattachments to restored fractured incisors, we propose a step-by-step algorithm (Figure 5) to aid in decision making in various clinical scenarios requiring tooth fragment reattachment based on the limited evidence available on the topic and our clinical experience with such cases. We hope this would inspire more research in the field and eventually lead to the development of evidence based, meticulous, step-by-step guide in addressing tooth fragment reattachments.

CLINICAL SIGNIFICANCE

1) Two of the cases presented with fractured fragments exposed to highly varying dry time periods viz. 60 days and 18 hours and were thus subjected to different rehydration regimes. In both the cases the reattached fragments appeared esthetically and functionally stable at subsequent examinations.
2) A concise, step-by-step algorithm has been proposed based on available literature and the authors' clinical experience, to aid dental practitioners in managing fractured permanent incisors with retrievable fragments.

REFERENCES

1) Zuhal K, Semra ÖEM, Hüseyin K (2005) Traumatic injuries of the permanent incisors in children in southern Turkey: A retrospective study. Dental Traumatology 21(1): 20-25.
2) Farik B, Munksgaard EC (1999) Fracture strength of intact and fragment-bonded teeth at various velocities of the applied force. European Journal of Oral Sciences 107(1): 70-73.
3) Reis A, Kraul A, Francci C, et al. (2002) Re-attachment of anterior fractured teeth: Fracture strength using different materials. Operative Dentistry 27(6): 621-627.
4) Abdulkhayum A, Munjal S, Babaji P, et al. (2014) In-vitro evaluation of fracture strength recovery of reattached anterior fractured tooth fragment using different re-attachment techniques. Journal of Clinical and Diagnostic Research: JCDR 8(3): 208.
5) Shirani F, Malekipour MR, Manesh VS, et al. (2012) Hydration and dehydration periods of crown fragments prior to reattachment. Operative Dentistry 37(5): 501-508.

6) Poubel DL, Almeida JCF, Dias Ribeiro AP, et al. (2017) Effect of dehydration and rehydration intervals on fracture resistance of reattached tooth fragments using a multimode adhesive. Dental Traumatology 33(6): 451-457.
7) Sharmin DD, Thomas E (2013) Evaluation of the effect of storage medium on fragment reattachment. Dental Traumatology 29(2): 99-102.
8) Capp CI, Roda MI, Tamaki R, et al. (2009) Reattachment of rehydrated dental fragment using two techniques. Dental Traumatology 25(1): 95-99.
9) Madhubala A, Tewari N, Mathur VP, et al. (2019) Comparative evaluation of fracture resistance using two rehydration protocols for fragment reattachment in uncomplicated crown fractures. Dental Traumatology 35(3): 199-203.
10) Hegde RJ, Kale SJ (2017) Comparison of the effect of various storage media on the fracture resistance of the reattached incisor tooth fragments: An in vitro study. Indian Journal of Dental Sciences 9(4): 233.
11) Prabhakar AR, Yavagal CM, Limaye NS, et al. (2016) Effect of storage media on fracture resistance of reattached tooth fragments using G-aenial Universal Flo. Journal of Conservative Dentistry: JCD 19(3): 250-253.
12) Shirani F, Sakhaei Manesh V, Malekipour MR (2013) Preservation of coronal tooth fragments prior to reattachment. Australian Dental Journal 58(3): 321-325.
13) Lise DP, Vieira LC, Araújo É, et al. (2012) Tooth fragment reattachment: The natural restoration. Operative Dentistry 37(6): 584-590.
14) De Sousa APBR, França K, de Lucas Rezende LVM, et al. (2018) In vitro tooth reattachment techniques: A systematic review. Dental Traumatology 34(5): 297-310.
15) Garcia FCP, Poubel DL, Almeida JCF, et al. (2018) Tooth fragment reattachment techniques - A systematic review. Dental Traumatology 34(3): 135-143.
16) Bozkurt FÖ, Demir B, Erkan E (2015) Reattachment of dehydrated tooth fragments: Two case reports. Nigerian Journal of Clinical Practice 18(1): 140-143.
17) Andreasen FM, Norèn JG, Andreasen JO, et al. (1995) Long-term survival of fragment bonding in the treatment of fractured crowns: A multicenter clinical study. Quintessence International 26(10): 669-681.