

Dental Reimplantation: Indication, Conduct and Consequences

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ABSTRACT

The process of dental avulsion is characterized by the complete expulsion of the tooth from its socket. Its highest incidence is in male children and teenagers, largely due to the more aggressive nature of games, cases of violence and car accidents. Given the high incidence, dental reimplantation, which consists of reinserting the tooth into its socket, is the most common treatment. To this end, factors such as time, tooth storage and severity of the action must be considered. The study aimed to highlight the influence of factors on the prognosis of reimplantation, describing its forms of treatment and possible problems that may arise. The importance of this study lies in the principle of exposing data to dental surgeons and academics when faced with a case of avulsion, to decide on the best clinical conduct, deciding the main practices and care of the pre- and post-operative period and providing clarifications regarding possible doubts. The avulsion process involves not only the tooth coming out of its socket, but also the rupture of the gingival portion, damage to the periodontal ligament, cementum, alveolar bone and dental pulp. For reimplantation to be a reality, the extra-alveolar period and the way in which the dental element is stored must first be observed. To this end, the tooth must remain outside its socket for the shortest possible time and stored in a physiological environment that provides a reduction or at least minimization of the entry of microorganisms. Within these environments, the option for moist conservation media allows a greater chance of reimplantation even after a few hours/days have passed. Otherwise, half-dry teeth impair the preservation of the periodontal ligament and reduce the chances of a successful reimplantation. After the literature review, it was possible to understand that the management of an avulsed tooth should be done as carefully as possible and always guided by capable professionals with sufficient knowledge to evaluate each case with a view to preserving the function and aesthetics of the tooth.

Keywords: Tooth Avulsion, Tooth Injuries, Dental Reimplantation

Introduction

Dental trauma can be understood as damage to the tooth, gums, ligaments, soft tissues and bone, which cause aesthetic, functional and psychological changes to the patient. Among these traumas, dental avulsion is considered a serious dental emergency, since it consists of the complete displacement of the tooth from its socket, which can affect other structures such as the periodontal ligament, pulp, cementum, enamel and alveolar bone [1-4]. Affecting more the age group from 8 to 12 years old, given the greater activity at this age, currently, with a change in habits and customs, avulsion has also affected adults, mainly in car accidents and during sports practice. Furthermore, the

increase in urban and domestic violence rates has contributed to the increase in dental injuries [5-8].

To resolve this type of trauma, immediate dental reimplantation is recommended, aiming to reposition the tooth in its alveolus, since the first care together with the extra-alveolar period and the storage medium will define the success of the procedure. Despite an old and conservative approach within dentistry, there is maximum preservation of physical and aesthetic functions, thus avoiding the need for the use of prostheses and reducing the psychological impact resulting from the loss of the dental element [1-4].

In view of the above, the study aimed to perform a literature analysis of the concept of dental trauma, dental avulsion and

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the care protocols that directly influence the success of the prognosis, seeking to emphasize that in addition to emergency treatment, proper monitoring should be carried out to make the therapy more favorable, minimizing possible sequelae. Finally, this work is justified by the importance of knowledge of dentists when faced with dental avulsion, usually having better conduct and the necessary practice of post-trauma care.

Literature Review and Discussion

The so-called dental traumas are injuries that sensitize and impact, given the intensity of the force, the resistance of adjacent tissues, muscles and bones and that depend directly on the type of trauma, intensity and duration of the impact. Among all the types of existing traumas, there are tooth fractures, when only the tooth element is involved; fracture in enamel and dentin with or without pulp exposure; crown and root fracture with or without pulp exposure; dislocations when the tooth and periodontal tissue suffer injuries resulting in subluxation, lateral dislocation, intrusive dislocation, extrusive dislocation and avulsion; fracture of the alveolar process; fracture of the bone plate; segmental fracture; and maxillary and mandibular fracture [1,2,9-13].

Regardless of their classification, these traumas ultimately affect the behavior of individuals, whether by involving the aesthetic aspect, but also by compromising routine activities such as smiling, talking, chewing, which specifically influence interpersonal relationships [9-13].

Authors admit that the occurrence of dental traumas is increasing. The practice of certain types of sports, the greater speed involved in them and the incorporation of the sensation of adrenaline, lead to a continuous increase in the number of traumas. Of these, tooth avulsion accounts for almost 16% of all dental injury cases, occupying a prominent role due to the frequency with which they appear in dental offices or even due to the uncertainty of treatment, influenced by factors such as time, lack of information about the accident, few financial resources or even neglect [14].

In terms of incidence, these accidents are more frequent in young people still of school age, with the main causes being falls, run-overs, traffic accidents, assaults and sports practices. Regarding age, the 10 to 19 age group has a predominance of bicycle accidents and falls, while the age group over 20 years has a higher prevalence of accidents involving motorcycles and cars. Within this context, men show a certain prevalence over women, with an incidence between 30% and 16.1%, respectively [15].

Tooth avulsion

Tooth avulsion is one of the most common and serious injuries that can occur in dental elements. This problem is characterized by the abrupt exit of the tooth through the alveolus, with subsequent rupture of the pulp blood supply and possible exposure of the periodontal ligament. The process also causes damage to the periodontal fibers and apical vessels, where the injury is proportional to the intensity of the accident, duration of the trauma, stage of root development and evidence of necrosis, in addition to infection of the tissues involved, thus influencing the most appropriate treatment [1-3,6-8,11,13,15]. This type of injury varies from 1 to 16% in permanent dentition injuries and between 7 and 13% of traumatic injuries in deciduous dentition.

Regarding sex, avulsion is more frequent in men (3x more) than in women and between the ages of 7 and 11, mainly due to the eruption of permanent incisors [16].

Regardless of the type or form of avulsion, some structures are affected, such as: the innervation of the dental pulp, the enamel and cementum, and there is also rupture of the gingival epithelium and of the fibers of the periodontal ligament, with part of them remaining attached to the cementum of the tooth and the other part to the alveolar bone [1-4]. Therefore, the correct diagnosis must be obtained through a physical examination, which must observe pulp exposure, pain, mobility, pulp vitality, tooth displacement, soft tissue injuries, hemorrhage, edema, facial asymmetry and the presence of various types of fracture (alveolar, maxillary or mandibular) [14].

Dental reimplantation

The reimplantation was first described in the early days of civilization, when there was already a certain concern with repositioning the tooth in its original location immediately after the accident [13]. Following this line, authors observed that teeth were the first organs subject to transplantation or reimplantation, dating back to ancient times. Historical accounts show that in the 17th century it was common practice to extract teeth from the poorest people to relocate them to people from more privileged classes, a fact that was discarded after a few years due to the high risk of disease transmission. In his studies, conceptualized reimplantation as a term used to describe the procedure of replacing the tooth in its socket after its accidental or traumatic extraction [5-8].

Thus, dental reimplantation is an attempt to reintegrate the avulsed element into its normal anatomical position, representing one of the most conservative procedures in dentistry, since it allows the preservation of the aesthetic function, delays the need for fixed or removable prosthetic work overtime, thus reducing the psychological impact resulting from immediate loss [5-8].

With a success rate ranging from 4 to 50%, the process has an uncertain prognosis and should be performed whenever there is an indication, as an alternative way to enable the use of the tooth, favoring the functional, psychological and economic aspects of traumatized patients. The technique is contraindicated in cases of unsatisfactory patient conditions, in addition to insufficiency of the alveolar walls and inflammatory or infectious state caused by extensive lesions, fractured root, destroyed alveolar tissues, poor oral hygiene, bruxism, systemic diseases such as coronary artery disease and diabetes and psychological non-acceptance of the proposed therapy by the patient [5-8,12,14,15].

Some authors demonstrate that the success of dental reimplantations is closely linked to factors over which dentists have no control. Thus, the extent of the trauma, time of extra-alveolar permanence, means of conservation and storage, contamination, way the tooth is manipulated, and conditions of the avulsed tooth significantly influence the positive or negative prognosis of the process [13]. Furthermore, these factors are responsible for triggering problems such as periodontal inflammation, pulp obliteration, pulp necrosis, chromatic alteration, root resorption, alveolar-dental ankylosis and dental infraposition [2,4,9,11,13].

One of the main advantages of reimplantation is the maintenance of dental aesthetics, which is directly related to the patient's self-esteem and social acceptance after the premature loss of a tooth. The main, and perhaps only, disadvantage is the need for additional treatments such as retention of the reimplanted tooth, endodontic therapy and several radiographic examinations for monitoring. During the healing process, there is a possibility of abscesses, root resorption and ankylosis [17]. Having understood the concept of reimplantation, it is worth noting that the recommended situation is when reimplantation is performed immediately. If this is not possible, it is recommended to preserve the dental element in milk, saliva, saline solution and tissue culture media such as Hank's and Viaspan solutions [1-4]. Amorós observed after 5 years of monitoring the integrity of the root surface of tooth 11 and the occurrence of root resorption by replacement in the cervical region of tooth 21 [18]. The resorption progression in tooth 21, after 6 years and eight months, led to the replacement of the root of this tooth by bone. The avulsed teeth were kept outside their respective alveoli for approximately 1 hour.

Junior was able to observe good integrity of avulsed teeth after a 32-month follow-up, without the teeth presenting dental mobility or displacement [19]. The avulsed teeth (11, 12, 21 and 22) were kept in a cup with saline solution for approximately 30 minutes before reimplantation. According to Sousa; Westphalen; Santos, a patient was admitted 20 minutes after the trauma with an avulsed tooth stored in pasteurized milk [20]. After 24 months of reimplantation, the tooth is free from abnormalities and reabsorption.

Authors define late reimplantation as one in which there are no minimum conditions for cell survival due to the tooth being stored in an environment that does not meet cellular nutritional needs. Even so, reimplantation continues to be indicated only for masticatory and aesthetic purposes for as long as possible. Furthermore, it maintains the alveolar bone volume and delays prosthetic rehabilitation [1-4].

According to Uchoa, the patient sought care approximately 2 hours after the accident, with the tooth stored in water [21]. After reimplantation, the presence of root resorption and incomplete root formation of element 11 was noted. Definitive endodontic filling was performed after 150 days, when two changes of calcium hydroxide were made over a period of 4 months, and were evaluated by radiographic images taken at 30, 60, 90 and 120 days. The last radiograph suggested stabilization of the replacement root resorption.

In the late reimplantation procedure, time is no longer a crucial factor, since the periodontal ligament fibers attached to the tooth are no longer viable. Therefore, the periodontal fibers must be removed when necrotic and the tooth must be fixed in the original alveolus, directly connected to the alveolar bone, resulting in dentoalveolar ankylosis [1-4].

A six-year and eight-month follow-up showed radiographically and clinically that the replacement of dental tissue by bone has occurred successfully and, as a result, the necessary space for the placement of a dental implant has been preserved. The avulsed element is kept in a dry environment (pocket) until seeking

care. One year after tooth reimplantation, periapical radiographs show some areas of root resorption that were replaced by bone tissue, characterizing ankylosis associated with replacement resorption [19]. Moura and Costa reported, through radiographic examination, the reabsorption of the interdental septa, without major infections or worsening of apical reabsorption, after a period of 12 months following reimplantation [22]. Semi-rigid retention was used for a period of 15 days, since reimplantation occurred after 5 days with the avulsed element stored in a dry environment.

Handling of Avulsed Teeth and Storage Media

Ensuring successful reimplantation mainly involves the viability of the periodontal ligament fibers. To preserve them, it is essential to avoid any type of contact with the tooth root during manipulation, and only the crown should be handled [1-4].

Storing teeth in saline solution, blood, tissue culture media, milk and saliva aims to cure the pulp and periodontal tissue. Moist media are ideal for storage, as they hydrate the periodontal ligament and help reinsert the teeth with minimal inflammation. Otherwise, dry media are unfavorable to the vitality and viability of the connective tissue attached to the root surface, compromising the success of the reimplantation process [5-8]. In view of these prerogatives, it was concluded that the most appropriate storage medium should have the correct osmolality and pH (isotonic solutions), since hypotonic conditions result in cell lysis in the same way as dry media. Cell permeability is high and thus, in a hypotonic solution, cells will expand and rupture. Therefore, water does not contribute to and should not be used to preserve the tooth, since hypotony causes the cells of the periodontal ligament to break [5-8]. Therefore, dry storage media, such as tissues, paper, gauze, and cotton, are considered inappropriate media because they induce a quicky and dangerous inflammatory response, since they dehydrate the tooth cells when in direct contact with the connective tissue of the root [9-13].

Among the media recommended by the Brazilian Society of Alveolar-Dental Trauma (SBTD) are saliva and milk. Saliva, an efficient and easily accessible medium, preserves the vitality of the cells of the periodontal ligament for a period of up to 2 hours. Sharing the same extra-alveolar space, milk has one of the best osmolalities when compared to water and saliva, in addition to having bacteriostatic action [14]. Souza observed satisfactory dental stability and periodontal health for 3 years, as well as the absence of abnormalities in control radiographs [23]. After the avulsion of teeth 11 and 21, where they remained in the oral environment through orthodontic brackets. On the 7th day after reimplantation, good tissue healing and dental stability were observed, releasing the patient to start endodontic treatment.

Other studies have shown the success of the Hanks balanced solution (HBBS) and ViaSpan as methods capable of maintaining the viability of periodontal ligament cells for longer. Although their success is guaranteed, these methods are difficult to access and often cost a lot. HBBS is a saline solution that contains all the essential metabolites and carbohydrates for cell maintenance. ViaSpan is a solution used in organ transplant procedures and is a very effective storage method for avulsed teeth, as it maintains intact cell morphology and promotes cell multiplication.

Compared to HBBS, ViaSpan was considered better over long periods, but there are no significant differences over short periods. More recent research indicates that Dentosafe, made of amino acids, vitamins, and glucose, can keep cells viable and capable of proliferating for over 48 hours [24].

Treatment of Avulsed Teeth

Initially, assessment and treatment should be performed only by professionals with clinical skills and knowledge of the problem, aiming at excellent emergency conduct and appropriate medium to long-term control [9-13]. Authors such as Vasconcelos highlight a logical sequence of clinical conducts that should be followed to ensure the reimplantation of avulsed teeth: Anamnesis (consists of obtaining the patient's medical and dental history); Clinical examination (visual inspection, antisepsis, observation of other injuries, hemorrhage, edema, hematomas); Palpation to analyze possible fractures; Gentle percussion to test pain sensitivity; Radiographic examination (combination of several radiographs where possible fractures, degree of root resorption, stage of root development, size of the pulp chamber, among others, must be observed) [13,14].

After washing the avulsion region, reimplantation must occur in three phases: the preliminary phase, the surgical phase and the post-surgical phase. The preliminary phase consists of preparing the mouth, asepsis of the site and anesthesia of the area to be worked on; the surgical phase encompasses 4 stages: treatment of the alveolus, preparation of the tooth, reimplantation and retention through light digital pressure and finally, the post-surgical phase, which consists of endodontic treatment and clinical monitoring of the patient [16].

The time that the tooth spends outside the alveolus is one of the main factors that influence the success of reimplantation. When the tooth is not reimplanted at the time of avulsion, the patient should store it in an appropriate liquid and, as soon as possible, seek a dentist [9-13].

Several studies demonstrate the maximum time that a tooth can remain outside its socket and still maintain the vitality of its cells and tissues. Bhambhani, for example, concluded that a period of up to 30 minutes outside the socket is a key factor for successful treatment [25]. On the other hand, some authors argue that the time that an element can remain outside the socket should be a maximum of 2 hours, regardless of the storage medium. Another author recommends reimplantation of the avulsed element regardless of the extra-alveolar time, where it is proven that when the element is reimplanted immediately after the avulsion or kept in a dry environment for a short time (less than 15 minutes), excellent healing and an excellent prognosis are demonstrated [24].

For cases with teeth that remained for at least 2 hours in a dry environment or were preserved in a non-physiological and effective liquid environment, immersion in saline solution is recommended. In teeth that remained for more than 2 hours in a dry environment, it is recommended to remove the periodontal ligament and dental pulp and leave the tooth in a sodium fluoride solution for 20 minutes. According to Trope M, when the element spends less than 1 hour in a dry extra-alveolar environment, the root should be rinsed with water or saline solution and

reimplanted [11]. If the root formation is not complete (with an open apex), it is recommended to place the tooth in doxycycline for 5 minutes before reimplantation. In cases of dryness for more than 1 hour, in teeth with complete root formation, the periodontal ligament should be removed, and the element should be immersed in an acid solution for 5 minutes, submerged in fluoride for another 5 minutes or covered with Emdogain before reimplantation. With an open apex, the procedure should be the same, differing only in the endodontic treatment, which should be performed extraorally [24].

A prolonged period of extraoral in a dry environment is not an absolute contraindication to reimplantation, since the surface can be chemically treated, thereby delaying the reabsorption process in the case of teeth with complete root formation. In these cases, the teeth should be immersed in a 2.4% acidified sodium fluoride-phosphate solution with a pH of 5.5 for 20 minutes before reimplantation. With the result in these cases, the longer the time, the greater the chances of necrosis of the periodontal ligament cells attached to the tooth, thus reducing the success of the treatment [13].

When immediate reimplantation is impossible, the root should be treated as the first step. To do this, it is necessary to remove all the periodontal ligament that is in a state of necrosis, since its presence results in inflammatory processes. This removal can be done mechanically or chemically, always preserving the cementum to avoid or at least reduce root resorption [9-13].

The positioning and maintenance of the tooth in its original location is performed through the process called splinting. This technique consists of rigid (fixed) and semi-rigid (flexible) retainers, where each indication is made according to the type of trauma [1,2,6,8,26].

If only soft tissues were injured, suturing and the use of semi-rigid retainers are recommended, using 0.5 mm flexible orthodontic wire or nylon wire, adapted to the tooth with composite resin. This material allows the tooth to move without putting pressure on the gums for a period of 7 to 14 days, which is considered enough time for the periodontal ligament cells to create enough stability to keep the tooth in position within its socket. In cases of fracture of the adjacent alveolar bone, fixed retention using multifilament orthodontic wire is recommended for a period of 4 to 8 weeks. Regardless of the type of retention, a light diet is recommended for two weeks and local hygiene with soft toothbrushes and 0.12% chlorhexidine mouthwash for one week [1,2,6,8,26].

Another recommendation for late reimplantation is endodontic treatment. For teeth with an open apex, immediate endodontic treatment should be performed, and for teeth with a closed apex, 7 to 10 days after reimplantation. Permanent teeth with complete root formation should undergo pulpectomy, regardless of the time the tooth was out of the alveolus [19]. When reimplantation is performed immediately in teeth with incomplete root formation, possible revascularization of the pulp is expected. If revascularization does not occur, endodontic treatment should be indicated. Thus, adequate endodontic treatment can eliminate or even reduce root resorption, since the presence of pulp remains in teeth reimplanted late can trigger inflammatory resorption [9-13].

The splinting or retention method consists of retaining the tooth until it is fully consolidated. This process also allows for the stimulation of forces used during chewing, thus increasing the functional area of the periodontal membrane. Splinting can be performed with 3mm orthodontic wire or even with nylon wire, which is considered the most suitable because it allows for better movement. The time required to maintain the retention varies. In cases considered simple, it takes 7 to 10 days; in alveolar fractures, approximately 14 to 21 days; and in more severe cases, the method can take up to 12 weeks for complete root regeneration [16].

Medication administration and clinical monitoring

The administration of antibiotics during the first week of reimplantation combats and prevents pulp bacterial invasion. Furthermore, it prevents infection of the traumatized and necrotic periodontal tissues. In cases where the tooth has been in contact with soil, it is essential that the patient receives a tetanus vaccine [16]. After this, monitoring should be carried out through clinical and radiographic examinations, still in the first week, to evaluate healing, fixation, infections and oral hygiene. During the healing process, the patient should avoid resistant and hard foods for up to 3 weeks after reimplantation [14].

After consolidation of the reimplantation, clinical and radiographic monitoring should be maintained, initially for a period defined by the professional and then annually until 5 years have elapsed since the trauma. During follow-up, the splinting should be removed [1-4].

Reimplantation complications

The sequelae observed after reimplantation depends on factors such as the stage of root development, extraoral time, storage medium, and the type and duration of the retainers [1-3,6-8,11,13,15].

Storage or even drying of the avulsed element before reimplantation damages the cells of the periodontal ligament, causing intense and severe inflammation throughout the root surface area. This leads to the process in which the bone joins the root surface in a process called bone replacement or replacement resorption [11]. Some authors define this process as one of the main conditions for the loss of the reimplanted element. The same authors also carried out several studies on dental trauma, where it was found that root resorption was found in 63% of avulsed teeth, while ankylosis was observed in 41% of all cases of resorption. Other clinical situations that may appear as a result of trauma are chromatic changes in the crown, which may become darkened. The presence of infra-occlusion and fistula may also be present [1-3,6-8,11,13,15].

Another consequence commonly associated with dental trauma is pulp necrosis, responsible for pulp and periodontal damage, and depending on the intensity, this damage may even be irreversible. The combination of bacteria in the root canal and damage to the cementum on the outer surface of the root results in external inflammatory resorption that can be very serious and lead to rapid tooth loss, which is why endodontic treatment becomes essential in these cases [1,2,7,8,11,13].

The major complications after reimplantation could be list: [9-13]

- **Replacement resorption:** resulting from damage to the periodontal ligament, leading to the replacement of dental tissue by bone tissue and culminating in tooth loss in a short period of time.
- **Inflammatory resorption:** results from necrotic remains and contamination of the dentinal tubules and can be controlled by good cleaning and disinfection of the root canals.
- **Root resorption:** loss of root tissues such as dentin and cementum under physiological or pathological conditions. For Panzarini, root resorptions can be superficial (resulting from small lesions in the innermost layer of the periodontal ligament and cementum, which causes osteoclastic activity in the tooth root), by replacement also called ankylosis and inflammatory, which can be active, ceased or repaired (caused by necrosis or removal of the periodontal ligament [19]. It can manifest itself in two ways: permanent, where the entire root is gradually reabsorbed, or transient, in which the ankylosis, once established, later disappears. Radiographically, it can be observed 3 to 4 weeks after reimplantation).

Treatment of complications

One of the main causes of root resorption is the intense activity of bacteria in the periodontal ligament, dentinal tubules, and pulp during endodontic treatment at the time of its execution. Bacterial proliferation contributes to the formation of an inflammatory process, resulting in tooth resorption. When resorption reaches the level of the dentinal tubules, two distinct repair processes occur. The first occurs when the root canal has infected necrotic tissue, resulting in inflammatory resorption of the root; the second occurs if the root canal has inflamed tissue, resulting in repair of the cavity with deposition of new cementum [27].

To reduce the root resorption process, Andreassen JO6 reports that calcium hydroxide is an element capable of controlling this problem, thanks to its restorative properties and bactericidal effects. Its action is aimed at increasing the pH of the root surface, thus inhibiting inflammatory resorption by altering the bacterial environment. For more effective action, it is recommended to use a paste prepared with calcium hydroxide for a period of 30 days or more. Choosing the correct endodontic therapy also contributes to the interruption of root resorption, due to the reduction of the inflammation process [27].

In cases of ankylosis, the extraction of the element and radiographic and clinical follow-up are necessary, where the degree of dental infraocclusion, the patient's age, the compromised occlusion, the presence and location of the permanent successor, the severity of the damage caused by the anomaly, the stage of development of the successor and the systemic condition of the patient must be observed [27].

Pulp necrosis occurs mainly in teeth with an open apex. Periodontal repair occurs more easily when compared to teeth with a closed apex. The wider the apical foramen, the better the prognosis, since pulp revascularization is facilitated. However, bacterial contamination of the periodontal ligament and pulp reduces the chance of revascularization. Therefore, the most unfavorable situation occurs in children and adolescents with

teeth with complete root formation, since pulp revascularization rarely occurs and ankylosis is established, followed quickly by replacement reabsorption. Furthermore, the association of bacteria inside the root canal causes damage to the cementum, resulting in external inflammatory reabsorption, which can reach a certain severity and lead to rapid tooth loss [27].

Conclusion

With high recurrence and often without a correct approach, dental avulsions are a public health problem due to the large number of cases and the impact that this problem has on the aesthetic, psychological and financial functions of each patient. Therefore, it is inferred that the professional must have sufficient knowledge to provide the necessary emergency care with the simple objective of preserving the vitality of the tooth, minimizing possible sequelae that may evolve into complications even after years.

After reimplantation of the tooth, the patient must undergo root surface treatment and endodontic treatment, starting on average 7 to 14 days after reimplantation. These procedures aim at the appearance of pulp necrosis and root resorption. Another possible recurring complication is dental ankylosis followed by replacement resorption, whose progression is not stopped even with the use of intracanal medications.

That said, the case reports were essential to prove the entire literature review, being able to provide an assertive view of the most different cases, presenting the possible approaches to cases of avulsion.

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