

## DENTAL SPLINTS: TYPES AND TIME OF IMMOBILIZATION POST TOOTH AVULSION

### Dental Splint Tipleri ve Diş Avülsiyonu Sonrasında İmmobilizasyon Zamanı

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#### ABSTRACT

Avulsion is defined as the complete displacement of the tooth out of its socket with disruption of the fibers of periodontal ligament, remaining some of them adhered to the cementum and the rest to the alveolar bone. This condition is more frequent in young permanent teeth, because the root development is still incomplete. Splints are used to immobilize traumatized teeth that suffered damage in their structures of support, preventing their constant movement. The literature has shown that after replantation, it is necessary to use splints in order to immobilize the teeth during the initial period, which is essential for the repair of periodontal ligament; the use of semi-rigid splint is more indicated than the rigid one, and long periods of splinting showed that substitutive resorption or ankylosis is an expected complication. Thus, the aim of this review is to describe the different types of splints; their time of permanency, and its influence on the process of healing and reparation on the occurrence of substitutive resorption or ankylosis. It is very important to keep gathering knowledge about this content, since it has been proved that the approaches and the protocols keep changing over time.

**Keywords:** Tooth replantation; Tooth avulsion; ankylosis; substitutive resorption; splinting

#### ÖZ

Avülsiyon dişin doketten tamamen çıkması, periodontal ligament liflerinin bazılarının alveolar kemik bazılarının da sementte yapışık kalacak şekilde kopması olarak tanımlanır. Bu durum kök gelişimi tamamlanmadığı için genç sürekli dişlerde daha sık görülür. Splintler travmatize olan dişin immobilizasyonu ve sürekli hareketten zarar gören destek yapıları korumak amacıyla kullanılır. Literatürler bilgilerine göre replantasyon sonrası hemen immobilizasyonu sağlamak için splint yapımı gereklidir; bu periodontal ligamentonarımı için zorunludur. Semi-rijit splintlerin kullanımı rejitelere göre daha çok endikedir. Uzun süre splintleme sonucu yer değiştirme rezorpsiyonu veya ankiloz beklenen bir komplikasyondur. Bu derlemenin amacı farklı splint tiplerini, kullanım zamanlarını ve bunların iyileşme ve onarım süreçlerine, yer değiştirme veya ankiloz meydana gelme olasılıklarına etkilerini anlatmaktır. Tedavi yöntemleri zamanla gelişip değişeceği için, bu konuda bilgileri yenilemek önemlidir.

**Anahtar kelimeler:** Diş replantasyonu; diş avülsiyonu; ankiloz; rezorpsiyon; splintleme

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## **Introduction**

Traumatic dental injuries compromise the patient, in both functional and psychological aspects (1). Among dental traumas tooth avulsion has a prevalence from 0.5 to 16% in permanent dentition (2-5), and it is defined as the complete displacement of the tooth out of its socket with disruption of the fibers of periodontal ligament, remaining some of them adhered to the cementum and the rest to the alveolar bone (6).

Avulsion is more frequent in young permanent teeth, because the root development is still incomplete and periodontium is in formation as well. Consequently, light horizontal impacts may result in the total displacement of the tooth. Among the teeth, the upper central incisors are most involved while among children from seven to eleven years old, boys are more susceptible to this type of trauma than girls (7).

Etiologically, it is associated with car accidents and practice of sports (8), protrusion of the anterior teeth; malocclusion class II, division 1; anterior open bite and mouth breathing as well. In such cases the severity of injury is higher as more pronounced is the dental protrusion (9, 10).

Immediate treatment for avulsion is replantation (1), and splint is the device used to support, protect or immobilize in order to avoid possible damage to the pulp and periodontal tissue, which retards the repair of neurovascular bundle and reintegration of periodontal fibers broken by trauma (8). The goal of this study is to do a narrative review of the literature, describing the different types of dental splints used in replantation, as well as the immobilization time and its relation to substitutive resorption.

### *Historic progress of dental splints*

The first experimental research regarding this content, according to Chelotti and Valentine (11) began with Wilkinson in 1918, who used monkeys to perform teeth replantation and subsequent histological evaluation, which led him to conclude that it was necessary the presence of the periodontal membrane so that fixation could happen. Chelotti and Valentine (11) also affirmed that years after that, in 1983, Tiley Bodecker confirmed Wilkinson's thesis, stating that the replanted teeth should be treated and sealed, and once replanted they should be completely immobilized.

In 1990, Chelotti and Valentine (11) reported that splints are used to immobilize the injured teeth, which by immobilization have better repair conditions. They stated that the most used splinting devices are: mouth guards, dental braces and splints made with composite resin.

In 1993, after studying dental trauma and its consequences, Alvarez and Alvarez (12) concluded that once the tooth is positioned correctly, it should be splinted in order to be kept in place and to prevent constant movements, which would damage the organization of periodontal tissue. In situations when no bone or tooth fracture is detected, they suggested splinting for 2 to 3 weeks, on the contrary, the splint should be maintained for 6 to 8 weeks.

In 2000, Trope *et al.* (13) indicated for avulsed teeth a semi-rigid splint for 7 to 10 days fixed with composite resin and steel wire with a diameter from 0.015 to 0.030. They recommended this type of splint and amount of time, because it allows physiological movements of the teeth during the healing process and it also results in a reduction of the incidence of ankylosis. In 2001, Vasconcelos *et al.* (10) also recommended this type of splint, in addition, they said that when a rigid fixation is placed, there is a higher degree of bone growth over the periodontal space with consequent ankylosis and replacement resorption.

Also in 2001, a literature review made by Pereira *et al.* (14) reported a case that the avulsed teeth were replanted and fixed with a rigid wire (0.9) and composite resin for 2 weeks, and then the endodontic treatment was performed. One year and three months after the accident, by analyzing the radiographies, no evidence of resorption was found, thus they decided for root canal obturation. Two years later, a control radiography was taken, it was observed a suggestive image of external resorption. The authors concluded that maintaining the vitality of the cells and periodontal ligament fibers is an important factor that might affect the success, so does not matter how great is the splint technique if periodontal ligament cells became necrotic.

In 2002, Castro *et al.* (15) reported a clinical case about the consequences of dental replantation after avulsion. In an emergency care, the teeth were replanted, but was not placed any kind of splint. Two days later, the patient went to the Dental School of Araçatuba – UNESP - Brazil where was placed a splint with orthodontic wire and composite resin, then the patient was referred to endodontic treatment. The authors stated that the proper repositioning of the

tooth in its socket can be compromised by factors such as: the organization of the blood clot, the presence of bone or tooth fragments, bone plate fracture or displacement of the socket wall (16, 17).

Studying dental trauma, in 2004, Oliveira *et al.* (18) conducted a research and reported that an efficient splint is essential for the maintenance of the avulsed tooth; there are several forms and materials for splinting, such as: resin, by itself or with a flexible arch of nylon or metal wire, orthodontic brackets with malleable arch, and vestibular arches or bars. They reported that flexible and short-term splints allow the physiological mobility of the teeth, which has been proven to be in favor of periodontal healing and reduce the risk of ankylosis and external resorption. However, they highlighted that in cases of fractured bone plate, a rigid contention is necessary and suggests the use of Erich bars and braces.

It was reported by Cobankara and Ungor (19), in 2007, a case of late replantation (1 week) of two incisors after a cycling accident. The teeth had their roots debrided, the root canals were treated endodontically and filled with calcium hydroxide, and then immediately were replanted and splinted with rigid contention for 5 weeks, ankylosis was observed after 10 months. They concluded that although the risk of substitutive root resorption and subsequent tooth loss is high, the technique appears to be advantageous not only for aesthetic, postponing a prosthetic treatment, but also for maintaining the height of the alveolar bone (19, 20).

In the same year, Westphalen *et al.* (21) conducted a study involving 250 general dentists in order to find the degree of knowledge regarding the treatment of dental avulsion. The results showed that the level of knowledge on the subject was sufficient; and that in relation to dental splints 73% of respondents used semi-rigid splint with nylon, 10% steel wire and 10% use restorative material. Regarding the amount of time, 36% use for 15 days, 38% for 3 days, 24% for 60 days, only 2% would use for 24 hours. Only 7% said they did not use any kind of splint, and could not explain their decision; only one respondent justified the decision of not placing the splint in case of a satisfactory stability after replantation of the tooth, but not mentioned which type of splint it would use if necessary.

In 2009, Granville-Garcia *et al.* (22) also assessed the knowledge of dental avulsion among dentists in a Program of Family Health Care, and the influence of professional experience, by interviewing 30

professionals. The results were similar to other studies (23) concluding that most dentists have adequate knowledge of dental avulsion, not being influenced by the time of experience. In this evaluation saline solution was the most appropriate media for storage (56.7%), the ideal extra-alveolar period of time was less than 30 minutes (60%), and 61.1% of respondents used Semi-rigid contention for up to 15 days (23).

In 2012, de Jesus Soares *et al.* (24) described the use of multidisciplinary approaches to deal with an unsuccessful replantation. Both upper incisors of a 14-year-old female patient were replanted and splinted with a semi-rigid splint for 3 months. The patient reported that the extraalveolar period before first care lasted about 3 hours and 10 minutes, with the teeth being in dry storage for 10 minutes after being stored in saline solution. Due to presence of severe inflammatory root resorption, showing communication with periodontal tissue associated with enhanced tooth mobility, authors opted for extraction, use of a temporary prosthesis made by patient's own crowns followed by adhesive prosthesis, and after 3 years follow up, implant surgery associated with porcelain crowns. Autotransplantation also has been pointed as an alternative to replace missing incisors (25-29). However, it has limitations as the root of the donor tooth has to be two thirds to three quarters formed, besides of anatomic concerns once about 60% of autotransplanted teeth were dissimilar in appearance with regard to an asymmetric gingival width or a color mismatch (26, 28).

In 2014, Sardana *et al.* (30) performed a replantation of avulsed maxillary central incisor with 15-hours extra-oral time. A 3-year follow-up was made in order to observe the consequences of delayed replantation. As expected, ankylosis and inflammatory resorption did happen, but clinically the tooth was asymptomatic. In addition, the authors concluded that it is very important perform a delayed replantation even after prolonged extra-oral time because it maintains the esthetics of the individual. It also works as a good alternative to prosthesis (implant or fixed partial denture) till the growth is completed due to preservation of the alveolar bone and psychological benefit to the patient.

In 2015, Nagata *et al.* (31) described a case involving an immature maxillary left lateral incisor that was replanted and successfully treated with pulp revascularization technique. The same approach was also described by Lucisano *et al.* in the follow year to manage a similar case (32): in both cases a 8-year-

old boy had his teeth replanted after 30min and 1 day of avulsion, respectively. Besides dental splint, revascularization therapy was performed by irrigating the root canal and applying a calcium hydroxide paste and 2% chlorhexidine gel for 21 days. After that, the canal was cleaned and a blood clot was stimulated up to the cervical third of the root canal. Mineral trioxide aggregate (MTA) was placed at the entrance of the root canal and the crown was restored. In both cases, it was possible to notice periapical repair and apical closure (31, 32).

Pulp and periodontal regeneration were reported for mature teeth as well (33-35). In 2016, a study from Tambakad *et al.* (34), the use of Platelet-rich plasma (PRP) was evaluated for pulpal regeneration in an 11-year-old's avulsed mature incisor after more than 8 hours extraoral dry time and delayed replantation. After disinfection and extraoral pulp extirpation, the tooth had its apex enlarged, and was placed in doxycycline solution for 20 minutes. After tooth replantation and splinting, PRP was injected up to the level of the cements/enamel junction and sealed with glass ionomer cement. Passed 6 months, it was noticed internal and external root resorption with periapical radiolucency and an apparent periodontal ligament space, which were treated by inserting antibiotics (minocycline and metronidazole) into the canal.

Twelve months later, radiographs suggested resolution of periapical radiolucency as well as stagnation of internal resorption and positive response to thermal and electric pulp tests (34).

#### *Usage of splinting*

Several factors might influence in the success of replantation, such as: extension of the trauma, extra-alveolar permanence period, means of preservation, contamination, manipulation and conditions of the avulsed tooth (36). Also, relevant factors such as type of splint used and time of permanence. Currently, it has been suggested to make a slight splint and immediately to establish an occlusal function that will generate physiological stimulus in the metabolism of periodontal tissues (8). A consensus among authors is that after replantation, it is necessary to use a splint. This device is used to immobilize the injured teeth when necessary. They believe that this stabilization helps the periodontal ligament to have better repair conditions, however those devices should be the least traumatic as possible (2, 7, 9-15, 17, 18, 36-46). Several types of splints are available, depending on

the mobility degree, they are classified as: flexible, semi-rigid and rigid. The authors ideally recommend the use of semi-rigid splint in cases of dental avulsions when no bone fracture is detected (2, 7, 10, 13, 15, 17, 18, 37, 39, 40, 42, 45, 46). Non-rigid immobilization is the ideal device due to its passive, atraumatic and flexible features, which allows a certain functional movement, and thus a functional arrangement of the periodontal ligament fibers, reducing the risk of external resorption and ankyloses (2, 10, 17, 37, 44, 47-49). Some authors also advocate the use of flexible splint in avulsions (4, 36, 38, 43). Even though Pereira *et al.* used the rigid contention in their clinical case (14), this contention produces a higher degree of external bone growth along the periodontal space with consequent ankylosis or substitutive resorption (2, 10). However, the rigid splint is necessary in cases of fracture of the bone plate and late replantation (7, 9, 19, 46).

Most authors believe that the ideal semi-rigid splint type is the one made with composite resin and orthodontic wire or nylon thread. The variation regards the type of thread and material used. Ruellas *et al.* (44) and Prokopowitsch *et al.* (7), used a 0.018 inch wire twistflex; The orthodontic wire is utilized by McDonald and Avery (42), Castro *et al.* (16), Manfrim *et al.* (41) with smaller diameter than or equal to 0.5 mm; Prokopowitsch *et al.* (7) use the 0.20 mm to 0.40 mm in diameter; Andreassen *et al.* (37) the one with 0.3mm in diameter; Trope *et al.* (13) 0.015 to 0,030mm diameter. The nylon thread recommended by Andreassen *et al.* (37) is the fishing line type; McDonald and Avery (42), Soares and Goldberg (45), and Manfrim *et al.* (41) recommended the use of nylon monofilament 20 to 30 pounds (Figure 1).



**Figure 1.** Semi-rigid splint, placed after tooth avulsion of the central incisors.



Authors like Prokopowitsch *et al.* (7), Isolan *et al.* (50) and Manfrin *et al.* (41) considered the splint with nylon composite resin as flexible and not as semi-rigid. On the other hand, Cortes and Bastos (39) used as flexible splint the steel wire for osteosynthesis 0.12 or 0.25mm fixed with composite resin. Rigid immobilization can be made with composite and rigid wire 0.9 (14). On the other hand, Oliveira *et al.* (18) recommend Erich bars and orthodontic appliances. Prokopowitsch *et al.* (7) used steel wire 0.5mm and photo-polymerized resin, although Manfrin *et al.* (41) consider the wire of 0.5 mm as flexible (Figure 2).



**Figure 2.** Rigid Splint placed after tooth intrusion of an upper left central incisor. At the moment of the consult, the patient reported to be using this splint for 2 months. It was revived immediately. After CBCT, it was possible to confirm the substitutive resorption on the root of the tooth.

There are other types of alternative splints, such as the ones made with orthodontic brackets associated with a passive wire, sutures or vestibular bars (18, 40, 45, 47, 51). Regarding the time of immobilization, authors such as Isolan *et al.* (50), Trope *et al.* (13) and Baldissera *et al.* (38) agreed that long periods of splinting are factors that may contribute to the occurrence of substitutive resorption, therefore, over the years, it has been used in shorter periods of time.

In cases of avulsion with no fracture in the bone plate, some authors advocate the use of splinting for just one week (2, 5, 36, 48, 49). Others, on the other hand, believe that 2 weeks are sufficient (14, 40, 41), however, Trope *et al.* (13) indicate for 7 to 10 days. McDonald and Avary (42) suggest for 7 to 14 days and Soares and Goldberg (45), for 7 to 15 days. According to Souza Neto *et al.* (46) and Prokopowitsch *et al.* (7) the ideal period should be 10 to 14 days and to Alvarez and Alvarez (12) would be 2 to 3 weeks. In cases of avulsion associated with fracture of the bone plate Alvarez and Alvarez (12) suggest the use of splints

for 6 to 8 weeks. Ruellas *et al.* (44) recommended for 5 weeks. Trope *et al.* (13) use splints for 4 to 8 weeks and Prokopowitsch *et al.* (7) for 25 to 30 days. In late replantation, Prokopowitsch *et al.* (7) advocate the use of splints for a period of 45 days and Cobankara and Ungor (19) believe that it should be used for 5 weeks.

### Conclusion

Based on the literature, it can be concluded that after replantation the use of splint is compulsory for allowing immobilization of the teeth during the initial period, which is essential for the repair of periodontal ligament; the use of semi-rigid splint is more indicated than the rigid one, and that long periods of splinting showed that substitutive resorption or ankylosis is an expected complication.

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### Conflict of interest

None declared.

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