copyright by
not for publication
Quintessenz

Management of Ankylotic Root Resorption Following Dental Trauma: A Short Review and Proposal of a Treatment Protocol

Shaul Lin[a] / Malka Ashkenazi[b] / Munir Karawani[c] / Sorin T. Teich[d] / Zvi Gutmacher[e]

Summary: Ankylotic root resorption is a serious complication following traumatic dental injuries. The aetiology of root resorption includes acute injury to the cementum and periodontal ligament, and subsequent biological processes that propagate the harm. The aim of the present paper is to present a structured treatment protocol for teeth that have experienced trauma and are at risk of developing ankylotic root resorption, followed by a decoronation protocol for situations in which ankylotic root resorption developed.

This protocol provides a structured road map from the primary dental trauma, through the initial development of ankylosis detected radiographically, to the clinical manifestation that results in significant infra-occlusion. The current protocol integrates the best available evidence from the literature and from published guidelines.

Ample contradictory data, which mainly consists of case reports related to the treatment of ankylotic root resorption, is available in the current literature. No accepted protocol or uniform guidelines for treatment in these cases exist, and many clinicians prefer avoiding replantation of an avulsed tooth that seems to have an uncertain long-term prognosis, or performing decoronation when infra-occlusion developed. As a result, young patients lose the benefits associated with replantation and decoronation procedures.

The option of re-implantation of the avulsed teeth should be considered irrespective of the negative long-term prognosis. Following ankylosis development, the goal of submerging the tooth root (decoronation) is to maintain the horizontal dimension of the alveolar ridge and also to gain vertical dimension, allowing implant placement in the future.

Key words: ankylotic resorption, avulsion, decoronation, luxation, protocol

Oral Health Prev Dent 2017; 15: 467–474.
doi: 10.3290/j.ohpd.a38736

Submitted for publication: 29.11.15; accepted for publication: 01.03.16

Traumatic dental injuries (TDI) are a common concern with an important impact, especially at young ages.[15,17,28] A recent study reported that the prevalence of TDI among 5- to 16-year-old schoolchildren in Bangalore City was 9.7%. In a large cohort study of 10,436 patients treated at the hospital emergency room as a result of a traumatic episode, 765 (7.3%) had sustained injuries to structures of the oral cavity. The leading cause of dental injury was falls, accounting for 55.8% of the injuries.[29] Data from hospitalised trauma patients in a level-1 trauma centre were analysed; of all 14,040 trauma patients, 1038 (7.4%) involved maxillofacial or dental injuries. Common causes of injury were motor vehicle crashes (41%), falls (27%) and intentional injuries (23%).[21] Prompt and appropriate management is necessary to significantly improve prognosis for many dento-alveolar injuries.[1,2,23] Treatment of oral and maxillofacial injuries requires expeditious diagnosis and coordination between all treating professionals from the moment of injury.[14,34] In a study by Murthy et al,[28] about 85% of the injuries occur redin maxillary anterior teeth and 89% in the permanent dentition with fractures in enamel as the most common type of TDI. Those authors concluded that an emergent problem such as TDI should be met by public health policies that emphasise the prevention of TDI based on the knowledge of the risk factors. Children,

[a] *Associate Professor, Endodontics and Dental Trauma Department, School of Graduate Dentistry, Rambam Medical Center, Haifa, Israel; School of Medicine at the Technion, Haifa. Israel. Designed the research, wrote the manuscript.*

[b] *Dentist in Private Practice, Petah-Tikva, Israel. Clinical consulting, data collection.*

[c] *Lecturer, Endodontics and Dental Trauma Department, School of Graduate Dentistry, Rambam Medical Center, Haifa, Israel. Clinical consulting, data collection.*

[d] *Associate Professor, Case Western Reserve University, School of Dental Medicine, Cleveland, OH, USA. Proofread the manuscript, compiled and reviewed data from the literature.*

[e] *Lecturer, Maxillofacial Rehabilitation Department and TMD Unit, School of Graduate Dentistry, Rambam Medical Center, Haifa, Israel. Clinical consulting, proofread manuscript.*

Correspondence: *Sorin T. Teich, Case Western Reserve University School of Dental Medicine, Department of Comprehensive Care, 2124 Cornell Rd, Cleveland, OH, USA 44106. Tel: +1-216-368-6161; Email: sorin@case.edu*

copyright by Quintessenz Not for publication

Table 1 Management of avulsed immature (open apex) and mature teeth (closed apex) that were kept in dry conditions for up to 60 minutes or were preserved in a suitable medium

Emergency treatment at time of trauma	The tooth should be stored in a special medium such as saline solution or saliva (up to 2 h after injuries) or milk (up to 3 h after injuries) or dry (less than 60 mins) Holding the tooth by the crown, rinse gently with chlorhexidine, saline, water or milk. Gently clean injured area with water, saline or chlorhexidine and replant tooth in its position. Refer patient to dental clinic immediately.
Initial consultation	Informed consent: Parental consent is required after an explanation of the treatment, significance and possible complications. Without appropriate consent, the tooth is not to be replaced into the socket.
Emergency treatment at the dental clinic according to the clinical presentation	If contaminated, clean the root surface and apical foramen with saline. Hold the tooth by the crown only. Administer local anaesthesia without adrenaline and remove the blood clot in the alveolar socket with saline or chlorhexidine. If fractures of the bony socket are found, they are to be replaced and the tooth re-implanted with slight pressure. Make sure of tooth position with a radiograph. Mature teeth: The tooth can be treated with an intracanal corticosteroid medication (anti-inflammatory, anticlastic medication). If so, it should be placed immediately or shortly following replantation and left for at least 2 weeks. Open apex: soak the tooth in Doxycycline or Minocycline (1 mg/20 ml saline) for 5 min. Do not start any endodontic treatment unless there are signs of pulp necrosis (apical periodontitis). If pulp necrosis is detected, treatment should consist of apexification or revascularisation.
Treatment for all clinical presentations	Take a peri-apical radiograph to confirm the correct positioning of the tooth in the socket. Provide a semi-rigid splint for adjacent teeth (2 on each side) with the aid of composite and dental floss or thin passive orthodontic wire for 2 weeks. Suture gingival tears especially at the cervical area of the tooth. Perform occlusal adjustment so the tooth will not be in contact during lateral movment. Refer to the physician for an anti-tetanus vaccination if necessary.
Patient instructions	Soft diet for two weeks. Toothbrushing after every meal with a soft-bristled toothbrush. Chlorhexidine mouthrinse twice daily for 7 days (or use a swab with chlorhexidine in cases of poor compliance due to rinse's taste). Systemic antibiotics – Amoxicillin 1000 mg stat and 500 mg t.i.d for 7 days. If allergy to penicillin, Clarithromycin 500 mg stat and 250 mg b.d for 7 days. Children: 2- to 10-year olds: Amoxicillin: susp 250 mg/5 ml 125 mg x 3 10 years+: Susp 250 mg/5 ml 250 mg x 3 Azithromycin (Azenyl) susp. 200 mg/5 ml 1st day: 10 mg/kg 2nd to 5th day: 5 mg/kg A mouthguard for protection during contact sports is advisable.
Second consultation after 2 weeks	Mature teeth: If root canal therapy was not initiated at the emergency appointment, root canal treatment should be carried out 10–14 days post-replantation, with calcium hydroxide ($Ca(OH)_2$) dressing for up to 1 month, followed by a root canal filling. Splint removal.
Follow-up	Replanted teeth should be clinically and radiographically examined 3, 6 and 6 months post-replantation, and every year thereafter. Weight and height measurements should be recorded as a baseline for growth. This may become critical to determine the time of decoronation, if needed. Mature teeth: If the tooth shows signs of replacement resorption, the filling material should be removed and a long-term $Ca(OH)_2$ dressing should be placed. The tooth should undergo clinical follow-up until more than 1 mm occlusal difference between the ankylosed tooth and the subjacent teeth is evident. The frequency of follow-up depends on the child's age – more frequent during the growth spurt. A decoronation procedure should be scheduled and a temporary prosthesis should be fabricated to maintain pleasing aesthetics. Open apex: No root treatment unless there are signs of pulp necrosis.

parents and schoolteachers should be educated about the prevention and timely management of dental trauma in children. Prevention is obviously the first and best goal of TDI management,[18] however, knowledge and better practice of cases should be part of our overall efforts with TDI-related issues.[16,20,27]

Ankylotic root resorption (replacement root resorption) is a serious complication following traumatic dental injuries and often leads to loss of teeth.[12] The aetiology of root resorption includes acute injury to the cementum and periodontal ligament, and subsequent biological processes that propagate the harm.[11,38,39]

Bone apposition and resorption occur as part of the normal physiological process of remodeling. In a physiological situation, the bone remodeling process does not damage the root, because the dentin is protected by organic tissue (pre-cementum) and healthy periodontal ligament. However, when the periodontal apparatus (including the pre-cementum) is damaged during extensive traumatic injury, osteoclasts come into direct contact with the exposed root dentin and begin resorbing dental tissues during the remodeling process.[10,12]

After exposure of the mineralised tissue located beneath the pre-cementum, the inflammatory cascade 'recruits'

copyright by Quintessenz Not for publication

Table 2 Management of avulsed immature and mature teeth that were kept in dry conditions for more than 60 minutes or had been preserved in medium for longer than the recommended time – open apex and closed apex

Emergency treatment at time of trauma	Holding the tooth by the crown, rinse gently with chlorhexidine, saline, water or milk. Gently clean injured area with water, saline or chlorhexidine and replant tooth in its position. Refer patient to dental clinic immediately.
Initial consultation	Informed consent: Parental consent is required after an explanation of the treatment, significance and possible complications. Without appropriate consent, the tooth is not to be replaced into the socket.
Emergency treatment: Treatment at the dental clinic according to the clinical presentation	Remove the attached non-viable soft tissue with the aid of sterile gauze and preserve the tooth in fluoride (topical fluoride, APF 1.2% F^-) for 5 minutes followed by meticulous saline rinse. Root canal treatment may carried out on the tooth prior to re-plantation. Administer local anesthesia without adrenalin and remove the blood clot in the alveolar socket with saline or chlorhexidine. If fractures of the bony socket are found, they are to be replaced and the tooth re-implanted with slight pressure.
Treatment for all clinical presentations	Take a peri-apical radiograph to confirm the correct positioning of the tooth in the socket. Provide a semi-rigid splint for adjacent teeth (2 on each side) with the aid of composite and dental floss or thin passive orthodontic wire for 4 weeks. Suture gingival tears especially at the cervical area of the tooth. Take tooth out of occlusion. Refer to the physician for an anti-tetanus vaccine if necessary.
Patient instructions	Soft diet for two weeks. Tooth brushing after every meal with a soft-bristled toothbrush. Rinse mouth with chlorhexidine twice daily for 7 days (or use a swab with chlorhexidine in cases of poor compliance with rinse taste). Systemic antibiotics – Amoxicillin 1000 mg stat and 500 mg t.i.d for 7 days. If allergy to penicillin, Clarithromycin 500 mg stat and 250 mg b.d for 7 days. Children: Amoxicillin 2-10 year: Susp 250 mg/5 ml 125 mg x 3 10 years+: Susp 250 mg/5 ml 250 mg x 3 Azithromycin (Azenyl) susp. 200 mg/5 ml 1st day: 10 mg/kg 2^{nd}–5th day: 5 mg/kg
Second consultation after 7–10 days	If root canal therapy was not initiated at the emergency appointment, root canal treatment should be carried out 10–14 days post-replantation, with calcium hydroxide ($Ca(OH)_2$) dressing for up to 1 month, followed by a root canal filling.
Second/third consultation after 4 weeks	Splint removal
Follow-up	Replanted teeth should be clinically and radiographically examined 3, 6 and 12 months post-replantation, and every 6 months thereafter. If the tooth shows signs of replacement resorption, the filling material should be removed and a long-term $Ca(OH)_2$ dressing should be placed. The tooth should undergo clinical follow-up until more than 1 mm occlusal difference between the ankylosed tooth and the subjacent teeth is evident. The frequency of follow-up depends on the child age – more frequent during the growth spurt. A decoronation procedure should be scheduled and a temporary prosthesis should be fabricated to maintain pleasing aesthetics.

multi-nucleated cells that initiate the resorptive process. In cases where the exposure site is small, the process can be self-limiting. In these instances, root resorption may not be clinically significant, and healing with cementum-like tissue will occur within 2 to 3 weeks.[12]

When the exposure of the mineralised tissue is accompanied by infection (from endodontic or periodontic origins) or pressure (orthodontic pressure applied to the roots during tooth movement or an impacted tooth), continued resorption will take place.[12] In these cases, the resorption will become evident clinically and/or radiographically. Furthermore, if the chronic stimulus (infection or pressure) is not addressed and treated, the tooth will inevitably require extraction.

In severe traumatic injuries (e.g. intrusion or an avulsed tooth), ankylotic root resorption usually takes place without a continued stimulus, i.e. without presence of inflammation or pressure.[39] In these cases, osteoclasts from the adjacent alveolar bone adhere to the damaged root surface before periodontal cell fibroblasts reach it. There is no known treatment that can obviate this type of ankylotic root resorption.[12] The sequel of this complication has significant functional and aesthetic clinical implications when it occurs in young, growing children, requiring a multidisciplinary ap-

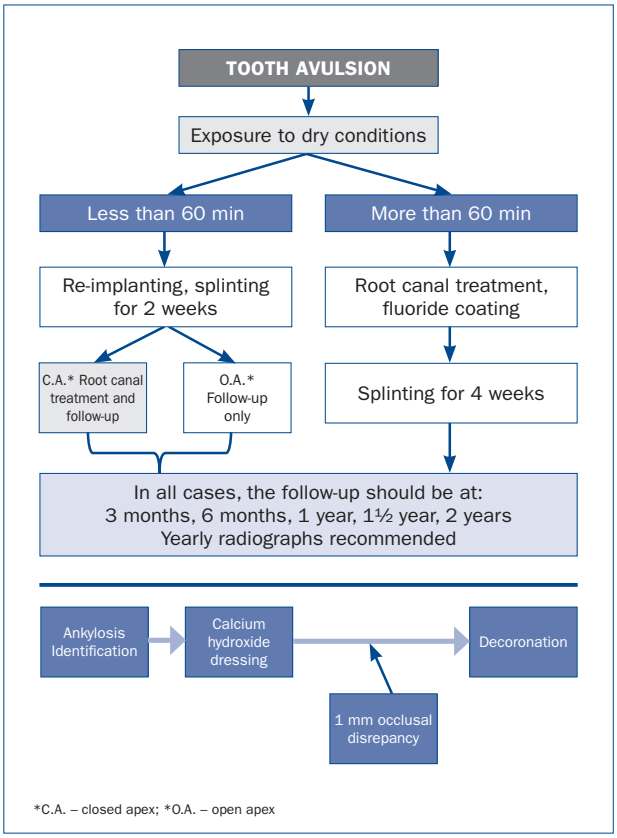


Fig 1 Flow chart for management of tooth avulsion.

proach involving specialists in the fields of endodontics, periodontics, orthodontics, oral surgery, prosthodontics, aesthetic dentistry and paedodontics.[23]

According to the International Association of Dental Traumatology (IADT) and the American Association of Endodontics (AAE), the recommended treatment for avulsed permanent teeth[1,2] is replantation, with no concerns regarding time of exposure to dry conditions or type of storage medium. This recommendation does not consider evidence that teeth stored dry for more than 60 min, or in other non-optimal conditions after the traumatic event, have an uncertain prognosis due to ankylosis and root resorption.[1] As stated by Andersson et al,[2] the goal in delayed replantation, in addition to restoring the dentition for aesthetic, functional and psychological reasons, is to maintain alveolar bone contour. In children and adolescents, before or during the growth spurt, tooth ankylosis is frequently associated with infraposition, and decoronation of these teeth may be necessary when the infraposition becomes clinically significant, i.e. > 1 mm.[1,2,23] Decoronation includes surgical removal of the ankylosed tooth crown below the cemento-enamel junction, enhancement of the internal-replacement root resorption process by removing the root canal obturation, grinding of the inner wall of the pulp chamber, and flooding it with blood to create a coagulum.[5,23]

Several authors[9,19,22,23] indicated that decoronation of ankylosed permanent incisors in children and adolescents enables maintenance of the alveolar bone ridge width and continuity. This in turn will facilitate future implant placement and rehabilitation with minimal, if any, ridge augmentation procedures.

The aim of the present paper is to present a structured treatment protocol for teeth that have experienced trauma and are at risk of developing ankylotic root resorption, followed by a decoronation protocol for situations in which ankylotic root resorption has already developed.

PROTOCOL DESCRIPTION

The treatment protocol for teeth that have experienced trauma and are at risk of developing ankylotic resorption is described in Tables 1 and 2. An abbreviated flow chart is described in Fig 1. If an avulsed immature (open apex) or mature (closed apex) tooth is not immediately replanted at the site of the accident and is kept dry for more than 60 min or has been preserved in non-ideal medium for a prolonged period, parents should provide informed consent regarding the prognosis and possible complications that may require further treatments. After acquiring parental consent, the tooth should be held by the crown, and attached non-viable soft tissue should be removed using sterile gauze.[2] The tooth should be preserved in fluoride (2% sodium fluoride solution) for 20 min while rinsing the socket with saline to remove the blood clot prior to replantation.[2,30,35,40] If fractures of the bony socket are found, the bone should be repositioned and the tooth should be replanted applying slight pressure.

A radiograph of the tooth should be taken immediately after replantation to ensure correct positioning, followed by application of a semi-rigid splint extended to at least 2 teeth on each side of the avulsed tooth (Fig 2). This splint can be directly placed with composite material reinforced by thin passive orthodontic wire for 4 weeks.[1,2] Gingival lacerations should be sutured with special emphasis on the cervical area of the tooth, and the patient should be referred to a physician for an anti-tetanus vaccination.

Patient take-home instructions include a soft diet for two weeks, twice-daily rinsing with chlorhexidine for 1 week, and systemic antibiotic coverage.[2] Although the value of systemic administration of antibiotics after replantation is still a debated topic,[2,7,13] some experimental studies have shown positive effects.[31, 32] Considering also that the patient's medical status or concomitant injuries may warrant antibiotic coverage, and taking into account the current guidelines, we submit that antibiotics are recommended after replantation.[2,13] According to the IADT and AAE,[1,2] endodontic treatment of avulsed teeth with closed apices should be carried out either prior to replantation or 7–10 days post-replantation. Initially, a calcium hydroxide ($Ca(OH)_2$) dressing should be inserted in the root canal for up to 1 month, followed by permanent root canal filling.

Replanted teeth should be followed clinically and radiographically at 1, 3, 6 and 12 months post-replantation, and yearly thereafter.[2] If an ankylosis and replacement resorp-

copyright quintessence

copyright by Quintessenz not for publication



Fig 2 Fixation of tooth 21 to adjacent teeth.



Fig 3 Calcium hydroxide ($Ca(OH)_2$) inserted into the root after ankylosis was detected.



Fig 4 Tooth 21 diagnosed with replacement resorption with significant occlusal discrepancy between the ankylosed tooth and the adjacent teeth.

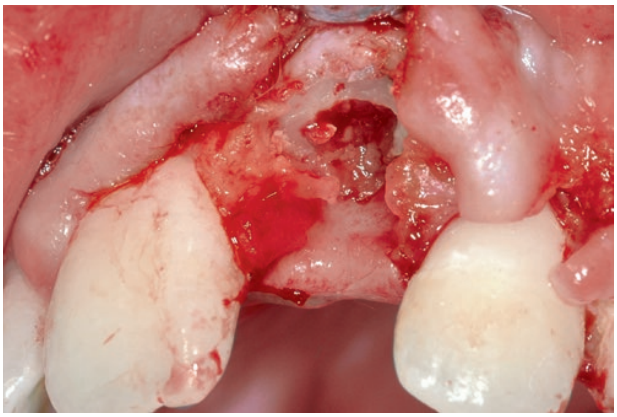


Fig 5 The ankylosed tooth's crown is sectioned and removed.

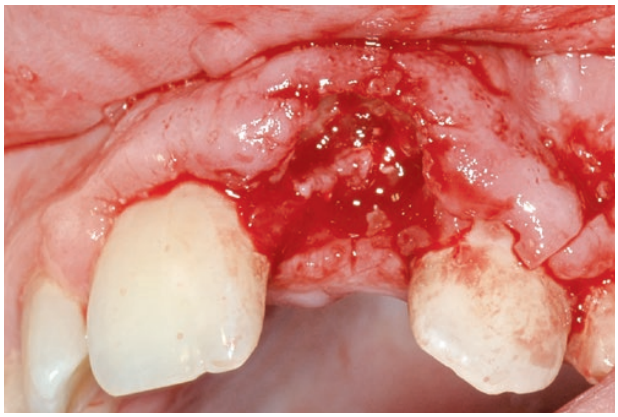


Fig 6 Bleeding initiated into the root canal.

tion process is diagnosed, long-term $Ca(OH)_2$ dressing should be placed in the canal space.[26] In the case of previously endodontically treated teeth, the filling material should be removed and a long-term $Ca(OH)_2$ dressing should be applied (Figs 3 and 4).

The protocol for the decoronation procedure described in Table 3 includes the following sequence: a mucoperiosteal flap is raised, the ankylosed tooth's crown is sectioned and removed, the remnant root is reduced to 2 mm below the alveolar crest to enable the bone to grow vertically and apically, and the root canal is rinsed with saline solution to remove the dressing from the canal space (Fig 5). A sterile rotatory instrument or file is used to remove dressing remnants and dentin from the root canal. In younger patients, it is recommended to remove only a minimal amount of dentin from the internal root surface to postpone complete root resorption, thereby maintaining the horizontal dimension of the alveolar ridge for a longer period.[33] In older patients (16–17 years old), the removal of a substantial amount from the internal root surface may be recommended when possible to ensure complete resorption of the remnant root at the time of the implantation.[33] A sterile file is used to penetrate the apical tissues past the apical foramen to initiate bleeding into the root canal, allowing the ingress of osteoclasts and osteoblasts that will help root resorption and inducing bone formation (Fig 6).[9] Finally, the flap is sutured over the submerged root to achieve primary closure and separation from the oral cavity.

DISCUSSION

The development of ankylotic resorption is a common complication after the replantation of an avulsed tooth, especially when it has been kept in non-physiological or non-os-

copyright by
not for publication
Quintessenz

Table 3 Decoronation protocol for teeth diagnosed with ankylotic root resorption (ankylosis)

Teeth diagnosed with replacement resorption without submerging (occlusal discrepency)	Tooth with root canal treatment	Tooth with NO root canal treatment
	The gutta percha should be removed and a long-term calcium hydroxide dressing placed. Three monthly follow-up visits are required.	A calcium hydroxide dressing needs to be placed. Do not perform a root canal filling with gutta percha.
Teeth diagnosed with replacement resorption with 1 mm occlusal discrepancy between the ankylosed tooth and the adjacent teeth	Decoronation procedure: A temporary prosthesis needs to be planned prior to the decoronation procedure Rinse with chlohexidine 0.2% prior to anaesthesia Anaesthesia Endodontic dressing: remove the dressing from the canals Flap: raise a mucoperiosteal flap Crown sectioning and removal: section the tooth's crown and reduce the root to 2 mm below the alveolar crest. Induce bleeding: use a sterile file to traverse the apex to induce bleeding into the canal Sutures: suture the flap over the submerged root in order to achieve primary closure Post-operative instructions: Mouthrinse: rinse twice daily with 0.2% chlorhexidine Follow-up at 3, 6 and 12 months and every 6 months thereafter	
Final restoration	Auto-transplantations should be considered when possible Implant placement can be performed following the completion of skeletal growth	

molality-balanced storage medium and/or stored dry more than 60 min.[2] Therefore, this study presents a protocol to guide the clinician in treating avulsed teeth and address the sequelae following ankylosis.

Much contradictory data, which mainly consists of case reports related to the treatment of ankylotic root resorption, is available in the current literature. No accepted protocol or uniform guidelines exist for treatment in these cases and many clinicians prefer avoiding replantation of an avulsed tooth that seems to have an uncertain long-term prognosis, or performing decoronation when infraocclusion developed. As a result, young patients lose the benefits associated with replantation and decoronation procedures.[22] Dental traumatic injuries occur mostly in the early stages of puberty when anterior teeth are in the final stages of development or have just completed root development, and adjacent teeth have not yet fully erupted.[8] At this stage, a permanent prosthesis for the anterior missing tooth cannot be provided, even though this is the stage that children are most sensitive to their facial appearance. Providing a removable temporary prosthesis is likely to affect the child's self-confidence and may even result in psychological effects. Maintenance of the replanted tooth in the mouth even for a limited period will mitigate the negative psychological and aesthetic effects on the child.[22,23] In addition, if the tooth is not replanted at an early stage, bone resorption will lead to changes in the bucco-palatal dimension of the alveolar ridge, which may lead to the necessity of bone grafting at a later stage.[19]

An alternative treatment option for the replantation of an avulsed tooth, reported to have a predictable success rate, is the extraction and replantation of a premolar into the area of the injured tooth (autotransplantation procedure).[6] This treatment alternative is advantageous in young patients, because the autotransplanted tooth will promote vertical growth of the surrounding alveolar bone. However, this treatment alternative is possible only when there is an indication for premolar extraction due to crowding. Furthermore, the premolar's root should have reached at least three-fourths root formation to achieve predictable pulp and periodontal ligament healing.[6]

Therefore, the option of re-implantation of the avulsed teeth should be considered, irrespective of the negative long-term prognosis. The most common complication in these cases is the development of dento-alveolar ankylosis involving direct apposition of the bone to the root surface, as a result of the extensive damage to the periodontal apparatus.[12] This process may be temporary and reversible only when less than 20% of the root surface area has been injured.[6] The term 'ankylotic resorption' denotes that the process of bone apposed directly onto dentin is not self-limiting. The rate of tooth resorption is primarily related to the patient's basal metabolic rate (BMR), which is increased in younger children.[4] Radiographic analysis of ankylosed and infra-occluded teeth reveals resorptive lacunae filled with bone and indiscernible periodontal ligament; this process progresses until the entire tooth is replaced with bone.[4]

Clinically, ankylosed teeth do not exhibit physiological mobility and generate a characteristic metallic sound upon percussion.[2,3] In addition, during the growth spurt, these teeth do not erupt simultaneously with the alveolar bone, which in the maxilla grows downwards and anteriorly.[22,23] The discrepancy between the growth of the alveolar bone process around normal teeth and ankylosed teeth results in a clinical appearance of infra-occlusion.[22,23]

If the patient has passed the pubertal growth spurt and the infraposition is minimal, buildup of the infra-occlused tooth may be a treatment option. However, before and during pubertal growth, the infraposition process is progres-

copyright by Quintessenz

sive, and therefore, buildups will need to be repeatedly replaced, resulting in a long clinical crown with limited aesthetic predictability.[23]

Currently, in spite of the poor prognosis of replantation of immature and mature teeth that have been kept in improper storage media or stored dry for more than 60 min, replantation is still recommended for aesthetic, functional, and physiological reasons, as well as to maintain the alveolar bone contour.[2] It should be emphasised that the determination of storage media and the effect of the duration of storage in these media following avulsion is not conclusive. For instance, it has been suggested that the effectiveness of milk can last from 3 to 48 h and that milk with a lower fat content might be more appropriate in maintaining PDL cell viability than milk with a higher fat content.[37]

According to the IADT,[2] replanted teeth should be clinically and radiographically examined 3, 6 and 12 months post-replantation, and then on a yearly basis. The decision on the frequency of follow-ups is affected by the timing of the patient's growth spurt. Andersson et al[4] reported that in children and adolescents, the rate of root resorption was significantly higher compared with adults.They also concluded that a tooth replanted without removing the necrotic periodontal membrane will become ankylosed and resorbed within 3 to 7 years in young patients, whereas a tooth replanted under similar conditions in older patients may remain in function for a considerably longer period.

If the tooth shows clinical signs of infraocclusion of more than 1 mm relative to the adjacent teeth in a growing child, a decoronation procedure should be scheduled and a temporary prosthesis should be fabricated.[1,2,23] Several temporary prostheses may be considered, including a removable appliance, attachment of the decoronated crown to the adjacent teeth by orthodontic wire or a polyethylene ribbon fiber, attachment at the palatal surfaces of the anterior teeth, composite buildup of the missing tooth, etc.

It was postulated that the goal of submerging the tooth root (decoronation) is to maintain the horizontal dimension of the alveolar ridge and also to gain vertical dimension.[23,26] Lin et al[22] described that decoronation of ankylosed young permanent incisors resulted in a decrease in the bucco-palatal dimension limited to 1.67 mm over 50 ± 24 months. The authors concluded that although decoronation resulted in a decrease in the bucco-palatal dimension, it did not prevent vertical alveolar growth, and thus decoronation procedures may help maintain the alveolar bone ridge width, height, and continuity, and assist in future rehabilitation while minimising the need for ridge augmentation procedures required for implant placement.[22] Other authors concluded that patient's age at the time of decoronation is an important factor for favorable development of the alveolar ridge and that the procedure should be performed earlier in girls than in boys.[26] It was suggested that in children with early mixed dentition up to 10 years of age, decoronation should be performed within 2 years of diagnosis or prior to a growth spurt. In late mixed dentition (~10–12 years), discretion should be applied, with early intervention being preferred. If ankylosis and infraposition occur during the growth spurt, decoronation should be performed as soon as the problem is diagnosed. It has been shown that when this protocol is followed, vertical and horizontal dimensions of the alveolar ridge are maintained and develop harmonically with adjacent structures through adulthood.[24,25,36]

Following decoronation, by the time implants are inserted for permanent rehabilitation, root remnants are usually located apically as a result of the vertical growth of the alveolar process.[33] It is presumed that these will not interfere with future implant placement,[26] although future consequences of the dentin remnants in the bone remain to be elucidated.[33]

CONCLUSION

Severe dental traumatic injuries may lead to ankylosis, resorption and replacement of the root by bone. Furthermore, in children and adolescents, ankylosis is frequently associated with the infraposition of the tooth. In instances when the infraposition is significant, decoronation may be necessary to preserve the integrity of the alveolar process. Following a well-structured protocol from the initial traumatic event to the end of alveolar development creates the opportunity for a predictable future rehabilitation with implant-supported prostheses.

REFERENCES

1. American Association of Endodontists. The recommended guidelines of the American Association of Endodontists for the treatment of traumatic dental injuries. AAE Publication, 2013.
2. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, Diangelis AJ, Kenny DJ, Sigurdsson A, Bourguignon C, Flores MT, Hicks ML, Lenzi AR, Malmgren B, Moule AJ, Tsukiboshi M. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dent Traumatol 2012;28:88–96.
3. Andersson L, Blomlof L, Lindskog S, Feiglin B, Hammarstrom L. Tooth ankylosis. Clinical, radiographic and histological assessments. Int J Oral Surg 1984;13:423–431.
4. Andersson L, Bodin I, Sörensen S. Progression of root resorption following replantation of human teeth after extended extraoral storage. Dent Traumatol 1989;5:38–47.
5. Andreasen JO, Andreasen FM, Andersson L. Textbook and color atlas of traumatic injuries to the teeth. Copenhagen: John Wiley & Sons, 2013.
6. Andreasen JO, Schwartz O, Kofoed T, Daugaard-Jensen J. Transplantation of premolars as an approach for replacing avulsed teeth. Pediatr Dent 2009;31:129–132.
7. Andreasen JO, Storgård Jensen S, Sae-Lim V. The role of antibiotics in preventing healing complications after traumatic dental injuries: a literature review. Endodontic Topics 2006;14:80–92.
8. Andreasen JQ, Ravn JJ. Epidemiology of traumatic dental injuries to primary and permanent teeth in a Danish population sample. Int J Oral Surg197;1:235–239.
9. Cohenca N, Stabholz A. Decoronation – a conservative method to treat ankylosed teeth for preservation of alveolar ridge prior to permanent prosthetic reconstruction: literature review and case presentation. Dent Traumatol 2007;23:87–94.
10. Emslie RD. Some considerations on the role of cementum in periodontal disease. J Clin Periodontol 1978;5:1–12.
11. Friedman S, Rotstein I, Libfeld H, Stabholz A, Heling I. Incidence of external root resorption and esthetic results in 58 bleached pulpless teeth. Dent Traumatol 1988;4:23–26.

12. Fuss Z, Tsesis I, Lin S. Root resorption–diagnosis, classification and treatment choices based on stimulation factors. Dent Traumatol 2003;19:175–182.
13. Hinckfuss SE, Messer LB. An evidence-based assessment of the clinical guidelines for replanted avulsed teeth. Part II: prescription of systemic antibiotics. Dent Traumatol 2009;25:158–164.
14. Levin I, Ashkenazi M, Schwartz-Arad D. [Preservation of alveolar bone of unrestorable traumatized maxillary incisors for future]. Refuʾat ha-peh veha-shinayim (1993) 2004;21:54–59, 101–102.
15. Levin L, Friedlander LD, Geiger SB. Dental and oral trauma and mouthguard use during sport activities in Israel. Dent Traumatol 2003;19: 237–242.
16. Levin L, Jeffet U, Zadik Y. The effect of short dental trauma lecture on knowledge of high-risk population: an intervention study of 336 young adults. Dent Traumatol 2010;26:86–89.
17. Levin L, Samorodnitzky GR, Schwartz-Arad D, Geiger SB. Dental and oral trauma during childhood and adolescence in Israel: occurrence, causes, and outcomes. Dent Traumatol 2007;23:356–359.
18. Levin L, Zadik Y. Education on and prevention of dental trauma: it's time to act! Dent Traumatol 2012;28:49–54.
19. Lin S, Fuss Z, Wigler R, Karawani M, Ashkenazi M. Decoronation: treatment protocol for ankylotic root resorption as a consequence of dental trauma. Refuat Hapeh Vehashinayim 2013;30:32–40.
20. Lin S, Levin L, Emodi O, Fuss Z, Peled M. Physician and emergency medical technicians' knowledge and experience regarding dental trauma. Dent Traumatol 2006;22:124–126.
21. Lin S, Levin L, Goldman S, Peled M. Dento-alveolar and maxillofacial injuries–a retrospective study from a level 1 trauma center in Israel. Dent Traumatol 2007;23:155–157.
22. Lin S, Schwarz-Arad D, Ashkenazi M. Alveolar bone width preservation after decoronation of ankylosed anterior incisors. J Endodont 2013;39: 1542–1544.
23. Malmgren B. Ridge preservation/decoronation. J Endodont 2013;39: S67–S72.
24. Malmgren B, Cvek M, Lundberg M, Frykholm A. Surgical treatment of ankylosed and infrapositioned reimplanted incisors in adolescents. Eur J Oral Sci 1984;92:391–399.
25. Malmgren B, Malmgren O. Rate of infraposition of reimplanted ankylosed incisors related to age and growth in children and adolescents. Dent Traumatol 2002;18:28–36.
26. Malmgren B, Tsilingaridis G, Malmgren O. Long-term follow up of 103 ankylosed permanent incisors surgically treated with decoronation–a retrospective cohort study. Dent Traumatol 2015;31:184–189.
27. Menezes M, Carvalho R, Accorsi-Mendonça T, De-Deus G, Moreira E, Silva E. Knowledge of dentists on the management of tooth avulsion injuries in Rio de Janeiro, Brazil. OHPD 2015;13:457.
28. Murthy AK, Mallaiah P, Sanga R. Prevalence and associated factors of traumatic dental injuries among 5- to 16-year-old schoolchildren in Bangalore City, India. Oral Health Prev Dent 2014;12:37–43.
29. O'Neil DW, Clark MV, Lowe JW, Harrington MS. Oral trauma in children: a hospital survey. Oral surgery, oral medicine, oral pathology 1989;68: 691–696.
30. Panzarini SR, Gulinelli JL, Poi WR, Sonoda CK, Pedrini D, Brandini DA. Treatment of root surface in delayed tooth replantation: a review of literature. Dent Traumatol 2008;24:277–282.
31. Sae-Lim V, Wang CY, Choi GW, Trope M. The effect of systemic tetracycline on resorption of dried replanted dogs' teeth. Dent Traumatol 1998;14:127–132.
32. Sae-Lim V, Wang CY, Trope M. Effect of systemic tetracycline and amoxicillin on inflammatory root resorption of replanted dogs' teeth. Dent Traumatol 1998;14:216–220.
33. Schwartz-Arad D, Levin L, Ashkenazi M. Treatment options of untreatable traumatized anterior maxillary teeth for future use of dental implantation. Implant Dent 2004;13:11–19.
34. Schwartz-Arad D, Levin L. Post-traumatic use of dental implants to rehabilitate anterior maxillary teeth. Dent Traumatol 2004;20:344–347.
35. Shulman LB, Gedalia I, Feingold RM. Fluoride concentration in root surfaces and alveolar bone of fluoride-immersed monkey incisors three weeks after replantation. J Dent Res 1973;52:1314–1316.
36. Sigurdsson A. Decoronation as an approach to treat ankylosis in growing children. Pediatr Dent 2009;31:123–128.
37. Souza BD, Luckemeyer DD, Reyes-Carmona JF, Felippe WT, Simoes CM, Felippe MC. Viability of human periodontal ligament fibroblasts in milk, Hank's balanced salt solution and coconut water as storage media. Int Endod J 2011;44:111–115.
38. Tronstad L. Root resorption – etiology, terminology and clinical manifestations. Dent Traumatol 1988;4:241–252.
39. Trope M. Root resorption of dental and traumatic origin: classification based on etiology. Pract Periodont Aesthet Dent 1998;10:515–522.
40. Trope M. Avulsion of permanent teeth: theory to practice. Dent Traumatol 2011;27:281–294.

copyright by author publication intended

View publication stats