Enhanced CPD DO C

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Long-term Retention of Severely Luxated Teeth. Part 1: To Retain or to Replace

Abstract: Traumatic dental injuries are prevalent and may have long-lasting implications for affected individuals, with the management of severely traumatized teeth often being challenging.. This case series explores the long-term retention outcomes of severely traumatized teeth, considering whether to retain or replace the impacted teeth. Treatment strategies emphasize on preserving tooth structure and function while delaying or preventing tooth loss. Retaining traumatized teeth, even those with poor prognosis, can preserve alveolar bone and soft tissue, reducing future treatment complexity. The assessment of prognostic factors and prosthetic replacement options is essential to comprehensive trauma management strategies for improved patient quality of life.
CPD/Clinical Relevance: There is benefit in retaining traumatized teeth to support bone and optimize future treatment options.
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Traumatic dental injuries are common forms of injuries across the population, which can have long lasting implications on the affected individuals and present a major public health problem. Lateral luxations are the most common form of traumatic dental injury,[1] accounting for 23% of dental injuries.[2]

A lateral luxation injury is defined as an injury to the tooth resulting in the displacement of the tooth in any direction, other than axially. This form of injury, especially in cases of severe displacement, can disrupt the vasculature of the pulp and lead to the necrosis of the pulp.[3]

Other significant consequences of luxation injuries to the teeth include root surface resorption (inflammatory or replacement) that is related to damage to the periodontal ligament (PDL) and cementum layer.[4] In some cases, these teeth can also show signs of pulp canal obliteration.

The aim of the initial and long-term management of such traumatic dental injuries is to preserve the tooth structure, prevent or delay tooth loss, and restore the aesthetics and function of the patient's dentition.[5] Maintaining traumatized teeth, even if they have a poor long-term prognosis, enables preservation of bone and soft tissues around the traumatized teeth. This can minimize the need for complex treatment later on when the teeth are eventually lost.[6] It can also buy time to appropriately plan a long-term treatment strategy.

Luxation injuries

Luxation injuries include subluxations, lateral, intrusive and extrusive displacement of teeth, or avulsions. In many of these cases there can also be an associated alveolar fracture. These injuries can result in either crushing or separation injury to the PDL, with or without damage to the cementum. Crushing injuries (lateral luxations and intrusions) are worse, and often result in cell necrosis and more of

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an inflammatory healing process, whereas separation injuries (extrusive luxation or avulsions) generally cause less cell damage and may heal quicker, provided the acute management has been optimal. However, avulsion injury outcomes are compromised due to PDL desiccation, contamination and the extra-oral period.

Subluxation injuries involve injury to the tooth's supporting structures. The tooth remains undisplaced, however, with increased mobility and tenderness on percussion. The tooth may not respond to pulp sensibility testing, indicating transient pulpal damage. The radiographic appearance is normal, and a passive flexible splint can be placed for 2 weeks in cases of excessive mobility, as per the International Association of Dental Traumatology (IADT) guidelines.[7] Close pulpal monitoring is required with radiographic and clinical evaluations.[7]

Extrusive luxations involve displacement of a tooth out of its socket in an incisal/axial direction. The tooth appears elongated incisally with increased mobility. It is likely to have no response to pulp sensibility tests and, radiographically, shows increased apical and lateral periodontal space. Digital repositioning under local anaesthesia is indicated with a flexible passive splint for 2 weeks. In cases of breakdown of marginal bone, an additional 4 weeks of splinting is required.[7]

Lateral luxation refers to lateral displacement of the tooth, often associated with alveolar fracture of the cortical bone or alveolar socket wall. The tooth may be immobile if the root is engaged in the bone fracture, resulting in a metallic sound when percussed. This is best seen radiographically using a horizontal shift parallax showing a widened periodontal ligament space. Treatment involves digital repositioning and disengaging the alveolar bone, followed by stabilization with a 4-week passive flexible splint. After 2 weeks, endodontic evaluation is required.[5,7] Spontaneous revascularization may occur in teeth with incomplete root formation. Teeth with complete root formation are likely to become necrotic and root canal treatment should be started using a corticosteroid antibiotic or calcium hydroxide as an intra-canal medicament to prevent inflammatory external resorption.

Intrusive luxation is displacement of the tooth in an apical direction, crushing the PDL. Radiographically the PDL may not be visible, and the cemento-enamel junction is located more apically than adjacent teeth. Spontaneous re-eruption may occur in immature teeth; however, if this does not occur within 4 weeks, orthodontic repositioning is indicated. While revascularization may occur, close pulpal monitoring is required upon signs of infection or inflammatory resorption. In mature teeth that are displaced <3 mm allow spontaneous eruption to take place. If this has not occurred within 8 weeks, surgical or orthodontic repositioning is required, followed by provision of a 4-week flexible splint. If a mature tooth is intruded 3–7 mm, surgical or orthodontic repositioning is advised. If the intrusion is >7 mm, surgical repositioning is advised. The tooth usually becomes necrotic, so initiation of root canal treatment is advised at 2 weeks.[5,7]

Avulsion injuries are the complete displacement of the tooth from the alveolar socket. These contribute to 0.5–16% of all adult dental injuries.[8,9] The prognosis of the tooth is highly dependent on the timing of clinical intervention. Ideally the tooth should be replanted with digital pressure at the emergency site. Prompt management is vital as the viability of the PDL cells is dependent on the length of extra-oral time. After 30 minutes of extra-oral dry time, most PDL cells are not viable.[10] If the tooth has a closed apex, the tooth should be rinsed and re-inserted, followed by 2-week splint stabilization. Root canal treatment should be initiated within 2-weeks of replantation. The patient's tetanus status should be checked, and antibiotics administered. If the tooth has an immature apex, pulp revascularization may be achieved following repositioning and close pulpal monitoring is indicated.

Domains	Generic outcomes
Injury activity	Periodontal healing (to include bone loss, gingival recession, mobility, ankylosis and resorption)
	Pulpal healing (to include infection)
Physical consequences of disease	Pain
	Discolouration
Functional status	Tooth loss (to include premature loss for primary teeth)
Social outcomes and quality of life	Quality of life (to include days off work, school, or sport)
	Aesthetics (patient perception)
Side effects of therapy	Trauma-related dental anxiety
Health resource use	Number of clinic visits

Table 1. A summary of the generic core outcome sets for traumatic dental injuries.

Outcomes of dental trauma

Dental traumatic injuries can have a long-standing impact on the dentition, with many significant sequelae that can occur as a result of the injury. The IADT recently developed a core outcome set (COS) for traumatic dental injuries (TDIs), which are applicable to both deciduous and permanent dentitions.[11] These core outcomes were developed following a robust consensus methodology and underpinned by a systematic review of the outcomes in the trauma literature.[12]

The outcomes within the COS were identified as either 'generic' (Table 1), referring to outcomes associated with all TDIs or as 'injury specific' (Table 2), which represents outcomes related only to one or more specific types of TDI.[11] The outcomes, as highlighted in Table 1 and Table 2, are divided into domains including injury activity, physical consequences of disease, functional status, social outcomes and quality of life, side effects of therapy and health source use.

Prognosis of the affected teeth

Determining the prognosis of teeth following dental trauma allows clinicians to establish appropriate strategies for patient management and to ensure predictable and optimal outcomes. However, as dental trauma is unpredictable, it is difficult to accurately determine the prognosis of injuries. Success rates can vary, and outcomes of some injuries can be more favourable than others.[12] Prognosis of traumatized teeth can vary depending on factors such as treatment delay, affected region, and extent and type of trauma.[13]

DOMAINS	INJURY							
	Uncomplicated crown fracture	**Complicated crown fracture**	**Crown root fracture**	**Root fracture**	**Extrusion, lateral luxation, alveolar fracture**	**Intrusion, avulsion**	**Immature non-vital permanent teeth**	**Primary teeth**
Injury activity				Root fracture site repair			Late-stage crown fracture	
Physical consequences of disease			Mobility	Mobility	Infra-occlusion	Re-alignment	Root length	Re-alignment
							Root width	Impact on permanent successor
Functional status	Quality of restoration	Quality of restoration	Quality of restoration					
Side effects of treatment	Loss of restoration	Loss of restoration	Loss of restoration					

Table 2. Summary of injury-specific core outcomes for traumatic dental injuries.

The aim of dental management following a traumatic injury is to preserve pulp vitality, prevent endodontic infection developing and prevent root resorption taking place.[12,14,15]

The rate of complications can be minimized by adherence to the recommended IADT treatment strategies and a regular follow-up period.[16]

Tooth replacement options

Dental trauma can result in tooth loss, despite the best attempts made by clinicians to preserve the tooth structure and maintain the tooth.[17] Upper anterior teeth are the most common traumatically impacted teeth. The replacement of these teeth can pose significant aesthetic and functional difficulties and can be tricky to manage.[18,19] Furthermore, traumatic injuries often also damage the supporting soft and hard tissues, which can have further repercussions on the restorative rehabilitative options.[20] Table 3 outlines the various options available to replace traumatized teeth and the associated advantages and disadvantages.

Ideally, restoration of the edentate space in a traumatized dentition should be minimally invasive.[20] The options for restoration of edentate spaces include implant-retained restorations, removable partial dentures and fixed bridge restorations (conventional and resin retained). In the developing dentitions, implants may not be considered until growth is completed.[21]

Implant-retained prosthesis are predictable long-term restorative options following tooth loss, with a 10-year survival rate of 94.6%.[27,28] However, implant placement planning in traumatic dental injuries can be challenging. There should be careful consideration of the bone levels and soft tissue contours. Dental trauma can often be associated with ankylosis, endodontic infection and resorptive processes (of the bone or root), resulting in an aggressive, rapid loss of bone and soft tissue contour.[29] In cases of horizontal root fractures, the impact and timing of the extraction of the apical fragment must be considered, as retrieval of apical root fragments may result in further bone loss. Atraumatic exodontia techniques are often implemented, in combination with adjunctive tissue regeneration to preserve bundle bone and maintain hard and soft tissue topography.[30]

The aesthetic impact of tooth loss

A traumatic dental injury itself can result in soft and hard tissue loss.[31] This can be further complicated by physiological changes that take place to the bundle bone around teeth following tooth loss.

The bundle bone is the bone that makes up the socket of a tooth with a thickness of 0.2–0.4 mm. It relies on a blood supply from the adjacent periodontal ligament of the tooth. Resorption of the bundle bone occurs post extraction, and this process cannot be stopped. This leads to further horizontal and vertical bone loss, especially when multiple adjacent teeth are lost.[32] A systematic review showed a loss of 2.6–4.5 mm in width and 0.4–3.9 mm in the height of healed sockets.[33] Further bone loss can take place through overzealous extraction techniques resulting in crushing of the interdental bone through the use of elevators, removal of buccal bone and fracture of the buccal plate.[34] It is essential that minimally invasive extraction techniques, including sectioning of teeth, are adopted to help preserve the surrounding bone.

Soft tissue texture, colour and appearance is pivotal for achievement of an aesthetic prosthetic tooth replacement and hence, immense consideration needs to be placed on soft tissue healing post exodontia.[20] Following tooth extraction, the socket defect heals by secondary intention and cell proliferation, which results in an increased soft tissue volume and changes in mucosal contours. The changes that occur are dependent on the external profile of the alveolar bone and soft tissue profiles. The increased soft tissue thickness can mask the extent of the hard tissue resorption and impact reconstructive efforts, especially regarding aesthetics.[35]

Although inevitable to some extent, the degree of dimensional alterations that occur to the edentulous ridge post-extraction can be reduced by alveolar ridge preservation techniques and socket grafting with biomaterials, and the use of barrier membranes.[36]

Replacement option	Advantages	Disadvantages	Indications	Contraindications	Design considerations
Implant prosthesis	Predictable long-term outcomes (10-year survival rate of 94.6%)[28]	Complex planning Requires sufficient bone and soft tissue[29] High cost	Suitable for adults with complete bone growth[21] Single or multiple tooth loss Sufficient bone volume	Growing patients, insufficient bone Systemic health issues affecting healing	Requires atraumatic extraction[30] Possible need for a bone graft Careful planning of bone levels and soft tissue contours[29]
Conventional fixed bridge	Good aesthetics and function, relatively quick procedure	Invasive, requires significant reduction of natural tooth structure Risk of abutment tooth vitality loss	Multiple adjacent tooth loss Stable dentition	High caries risk Poor periodontal health Abutment teeth not suitable	Requires preparation of abutment teeth Careful occlusal design to distribute forces
Resin-bonded bridge (RBB)	Minimally invasive, requires minimal tooth preparation[24] Predictable 10-year survival rates of 80.4%[26]	Risk of decementation[27] Potential aesthetic issues with metal retainer wings[24] Limited in cases of multiple tooth loss[20]	Developing dentition where alveolar growth and changes in tooth position are anticipated[25] Single tooth loss Suitable abutment teeth	Multiple adjacent tooth loss[20] Poor occlusal control Unsuitable abutment teeth	Requires minimal tooth preparation Options for opaque cement or zirconia retainer to improve aesthetics[24]
Removable partial denture	Non-invasive Cost effective Easy to modify Simpler to add further teeth	Plaque accumulation Can be perceived as less socially acceptable, especially for single anterior teeth[22,23]	Temporary or interim solution Patients with multiple tooth loss Insufficient bone for implants	Poor oral hygiene Young patients with high aesthetic demands	Requires careful design for stability and retention Maintenance of hygiene is crucial

Table 3. Summary of the advantages, disadvantages, indications and design considerations for the different tooth replacement options.[20,22–30]

Aesthetic assessment

One of the challenges following the loss of teeth is to recreate papilla around prosthetic replacements. Predictable outcomes can be achieved for anterior single-tooth replacement in cases without hard tissue loss, because tissue support is provided by the bone on the adjacent teeth. In traumatic injuries involving loss of multiple adjacent teeth, there is likely to be increased bone loss, especially in the interdental regions[37] and therefore, there is a real challenge to recreate interdental papilla and an aesthetic outcome.

Restoratively driven prosthetic planning is essential to achieve good pink and white aesthetic outcomes and achieve harmony with the peri-oral facial structures. This includes harmony of height, volume, colours and contours of teeth to imitate the natural surrounding dentition.[38]

As outlined in the International Team for Implantology (ITI) aesthetic risk assessment (Table 4), patient factors to consider when carrying out an aesthetic risk assessment include medical status, with patients with immunocompromise being at higher risk for suboptimal aesthetic outcomes. Smoking and vaping also compromise aesthetic outcomes and it is important to discuss this with patients prior to planning complex treatment. Patient's aesthetic expectations also affect the aesthetic outcome. Patients who have higher expectations will have a higher risk of achieving a suboptimal outcome from their perspective.[38]

Extra-oral soft tissue parameters to consider include the lip line. A lower lip line will have a lower aesthetic risk. Intra-oral soft tissue parameters include the gingival biotype, with low scallop and thick biotypes having a lower aesthetic risk. Hard tissue considerations include the shape of the tooth crowns, with rectangular-shaped teeth being easier to restore aesthetically than triangular-shaped teeth because achieving a good emergence profile becomes more difficult. Furthermore, a reduced edentulous span and high bone level at adjacent teeth, and an alveolar crest without bone deficiency also indicate favourable outcomes. Areas of vertical bone deficiency are at higher risk than horizontal bone deficiencies.[38,39]

To optimize aesthetic outcomes, provisional restorations play a useful diagnostic role in restoration in the aesthetic zone. They can be placed to restore spaces in the short term and allow definition of the correct emergence profiles, tooth height and tooth contour.[40]

Restorative cycle for patients and benefits of retention of teeth post trauma

Tooth retention post trauma offers numerous benefits, significantly enhancing both functional and aesthetic outcomes

Risk factor	Low risk	Moderate risk	High risk
Medical status	Healthy, cooperative patient with an intact immune system		Reduced immune system
Smoking habit	Non-smoker	Light smoker (<10 cigs/day)	Heavy smoker (>10 cigs/day)
Patient's aesthetic expectations	Low	Medium	High
Lip line	Low	Medium	High
Gingival biotype	Low scalloped, thick	Medium scalloped, medium thick	High scalloped, thin
Shape of tooth crowns	Rectangular		Triangular
Infection at implant site	None	Chronic	Acute
Bone level at adjacent teeth	<5 mm to contact point	5.5–6.5 mm to contact point	>7 mm to contact point
Restorative status of neighbouring teeth	Virgin		Restored
Width of edentulous span	One tooth (>7 mm)	One tooth (<7 mm)	Two teeth or more
Soft-tissue anatomy	Intact soft tissue		Soft-tissue defects
Bone anatomy of alveolar crest	Alveolar crest without bone deficiency	Horizontal bone deficiency	Vertical bone deficiency
Facial bone-wall phenotype*	Thick-wall phenotype ≥1 mm thickness		Thick-wall phenotype <1 mm thickness

Table 4. ITI aesthetic risk analysis for implant dentistry.[39] *If three-dimensional imaging is available with tooth in place.

for patients. Preserving natural teeth helps maintain proper alignment and occlusion, which is crucial for effective function and withstanding masticatory forces.[41] Tooth retention also supports the integrity of the alveolar tissue, preventing bone loss that occurs with tooth extractions.[31]

Keeping the natural teeth reduces the need for prosthetic solutions such as implants or bridges, which can be costly and have a high treatment burden. As a patient has more treatment, teeth enter the 'restorative cycle'. This refers to the lifelong upkeep and maintenance of restoratively treated teeth owing to the finite nature of restorations.[42] A minimal intervention approach offers more treatment options if conservative methods fail, enabling healthcare providers to have the option for more complex restorations.[43] This approach is particularly important for children who are more susceptible dental trauma owing to their developing motor coordination and active lifestyle.[44] Adopting a minimally invasive approach where complex treatment is avoided not only helps to reduce dental anxiety, but also fosters more positive attitudes towards dental care.[45] In children, it is also especially important to preserve the natural dentition and supporting structures as much as possible as their dentition will need to remain functional for a longer period and it can delay the need for complex treatment, such as implants, which are not a viable option until growth is complete.[46]

Considering the long-term prognosis of the teeth and potential need for implants in the future is important when managing trauma patients. Traumatized teeth, in particular intrusions and avulsions, are at a higher risk of ankylosis and inflammatory resorption.[47] Where teeth are severely displaced, multidisciplinary care with orthodontic teams is valuable not only to realign teeth, aiding direct and indirect restorations such as composite build ups and bridges, but also to move roots into a favourable position, should the teeth require extraction in the future.[48]

Aesthetically, retained teeth contribute to a natural smile, boosting confidence and psychological wellbeing. Consequently, maintaining natural teeth after trauma is a vital aspect of comprehensive dental care, promoting long-term oral health and quality of life.

Summary

Traumatic dental injuries, particularly lateral luxations, are prevalent and pose significant long-term consequences for affected individuals, including pulp necrosis, root resorption and tooth loss.

Effective initial and long-term management of such injuries focuses on preserving tooth structure, aesthetics, and function, often requiring a multidisciplinary approach involving maxillofacial surgeons, orthodontists and restorative dentists. Different types of dental trauma necessitate specific treatments, such as splinting, endodontic therapies and radiographic monitoring.

Prognosis varies based on the severity and type of injury, with many complications arising within the first 6 months post-trauma. Despite best efforts, tooth loss may occur, necessitating prosthetic replacements, such as implants, bridges, or removable partial dentures, each with unique benefits and challenges.

Preserving natural teeth post-trauma offers substantial functional and aesthetic advantages, supporting proper alignment, occlusion and the integrity of alveolar bone. Multidisciplinary care and adherence to guidelines from bodies such as the International Association of Dental Traumatology are crucial for optimizing outcomes and ensuring long-term oral health and quality of life.

Part 2 of this two-part series will demonstrate the clinical application of these principles through a complex dental trauma case managed restoratively over the long term.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

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