

Traumatic Dental Injuries in Children: The Controversies of Managing Primary Tooth luxation Injuries

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One of the areas that are most contentious in the diagnosis and management of traumatic dental injuries in children are in the approach toward luxation injuries in the primary dentition. Although the majority of injuries to the primary anterior dentition are luxations, there appears to be little definitive evidence in the dental literature for the management of luxation injuries in primary dentition; namely, intrusive luxations and lateral luxations. Some of the controversies centre on whether particular management approaches are likely to increase likelihood of further damage to the permanent successor, whilst others centre on question of whether certain approaches are likely to increase likelihood of pulpal necrosis or periapical inflammation of the injured primary tooth. There is conflicting published evidence over whether intruded or luxated primary teeth are best extracted, positioned, or monitored for spontaneous repositioning. For intrusion injuries, factors considered in the literature include the degree of intrusion, presence of multiple injuries, and orientation. Many approaches to management of primary tooth luxation focus on the degree of injury or occlusal interference, and novel approaches are described. The controversies are described herein.

KEY WORDS: dental trauma, primary tooth, luxation, intrusion, extrusion

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INTRODUCTION

One of the topics that is most controversial in the diagnosis and management of traumatic dental injuries in children is about management of luxation injuries in the primary dentition. Although the majority of injuries to the primary anterior dentition are luxations^{1,2}, there appears to be conflicting evidence in the dental literature for its management, particularly intrusive luxations and lateral luxations. These controversies are described in the following sections. Some of the controversies centre on whether particular management approaches are likely to increase likelihood of further damage to the permanent successor, whilst others centre on question of whether certain approaches are likely to increase likelihood of pulpal necrosis or periapical inflammation of the injured primary tooth.

INTRUSION: EXTRACTION

An intrusive luxation is described as the displacement of a tooth into the alveolar bone. Extraction of the traumatised tooth is often recommended³, however, management of intrusive luxations in the primary dentition is not universally agreed upon in the dental literature. A recent study conducted

an impact analysis on the effect of trauma to primary teeth at different resorption stages, on the developing permanent tooth germ.⁴ The study used cross-sectional models using cone-beam tomography (CBCT) images of 3.5, 5 and 6 year old children to represent the various root resorption stages of a primary incisor. The study demonstrated that for all simulations, stress concentrations were found at the permanent tooth germ and surrounding hard and soft tissues regardless of the direction of impact and the primary tooth resorption stage, and that this increased the more the primary tooth was resorbed. More importantly, the stress concentrations were higher for incisal impact regardless of the root resorption stage of the primary tooth, and high stress concentrations were found at the root apex when there was no root resorption of the primary tooth. The study concluded that the stresses generated from impact during primary tooth trauma in the area of the dental follicle and surrounding tissues, were most significant for potential damage to the developing permanent tooth⁴, and this may lend support to the treatment option of extraction in intrusive luxation injuries. An older study, Selliseth (1970) proposed that leaving the primary tooth would lead to a higher chance of disturbance to the permanent successor as opposed to extracting the injured tooth at the time of injury. However, the findings in this study were limited to children older than three years of age, and the differences for other age groups was insignificant.⁵ However, a clinical and radiographic follow-up study by Andreasen and Ravn (1971) found that the younger the patient age, the

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more severe the injury was to the permanent successor.⁶

A study by von Arx found the highest prevalence of developmental disturbances of permanent teeth after intrusive injuries of primary teeth.⁷ An experimental study using an animal model demonstrated extraction of the intruded incisor results in less damage to the traumatised enamel epithelium of the permanent successors.⁸ The proposed explanation for these findings were that the subsequent intramedullary chronic inflammation is eliminated, thus reducing likelihood of damage to the permanent successor.⁹ However, it is difficult to extrapolate the findings of the histologic study to the clinical setting. The case for extraction of intruded teeth is also demonstrated in a case report which described the unforeseen sequelae of a subluxation injury to a primary tooth¹⁰, which is considered a far less traumatic injury than intrusive luxation. The permanent successor tooth subsequently exhibited grade III mobility on eruption, and exfoliated during daily activity. Thus, the case report demonstrated the significant consequences that even a relatively minor traumatic dental injury can have on the permanent successors.¹⁰ However, a recent retrospective study suggested that conservative measures may be acceptable for primary tooth intrusion.¹¹ Analysis of dental records showed that the prevalence of primary tooth intrusions in the cohort was 9.98%, and of those injuries, partial intrusion (57.3%) was more common compared to complete intrusion, with palatal orientation of the crown (61.8%) compared to buccal orientation.¹¹ Of these injuries, the most common management method involved conservative treatment (73.5%) as opposed to extraction. While the most common healing complication was mobility in 15.5% of cases, most cases exhibited no healing complications at three months (64.8%). In light of these findings, and notwithstanding the limitations of the follow-up period of the study, the authors supported the idea of conservative management of primary tooth intrusion if the permanent tooth germ is not clearly compromised, unless there are issues with patient cooperation.¹¹ The author's suggestion appears to be consistent with the philosophies underpinning the International Association of Dental Trauma (IADT) guidelines, which advocate extraction of the intruded primary tooth if there is clinical and/or radiographic evidence of displacement into the developing permanent tooth germ.¹²

Should the degree of intrusion dictate whether the primary tooth is extracted?

It is also argued that the degree of intrusion should dictate management. An intrusion injury can be classified into three types depending on the magnitude of intrusion.¹³ According to the classification, in type I intrusion, more than 50% of the crown is exposed; type II, less than 50% of the crown

is exposed and in type III, the entire crown is intruded.¹³ Others argue that regardless of the type of intrusion injury, the permanent successor is usually within 3mm of apex of the primary tooth and that this space may consist of connective tissue only, thus extraction should be the treatment of choice for an intrusive luxation in the primary dentition.¹⁴ This approach differs from the approach advocated by the IADT guidelines, in which management is dictated by the orientation of the primary tooth apex relative to the developing permanent tooth germ.¹²

INTRUSION WITH MULTIPLE INJURIES: REPOSITIONING OR EXTRACTION?

Many intrusive luxation injuries of primary incisors are associated with bone fractures.¹⁵ While leaving intruded primary teeth for re-eruption has been documented in the literature¹⁶, other approaches are discussed; the first is the repositioning of the fractured bone in the case of concomitant fracture using digital pressure and the use of a flexible splint for three to four weeks¹⁷ and to monitor any teeth in the fracture line with further splinting for another 2-3 weeks if further stability is required³ and the second is extraction of the injured tooth as an alternative to further splinting beyond the initial four weeks.³ It is noted however, that the latter recommendations for alveolar fracture in the 2001¹⁸ and 2002³ guidelines are absent from the latter paper by Flores and colleagues¹⁷ and the most recent IADT guidelines.¹² Interestingly, one study assessing the prognosis of luxation injuries found that intrusions had a decreased risk of necrosis when repositioned.¹⁹

INTRUSION: DEPENDS ON ORIENTATION OF TOOTH

Theoretically, it is argued that apex of primary maxillary central incisors is usually curved in a labial orientation and so in most cases, intrusion results in the apex being pushed labially away from permanent successor tooth germ.²⁰ This presents radiographically as a tooth with a foreshortened apex on maxillary occlusal film.³ An alternative method to confirm this radiographically is to expose a lateral film taped to the child's cheek extra orally and to double the exposure time. This approach appears to be used routinely in some earlier studies by Andreasen, but more recent guidelines recommend this only if there is 100% intrusion and one cannot palpate the apex buccally through alveolar bone. In this instance, the film would be used to determine whether the apex has been pushed into the tooth germ.³

One school of thought states that if the apex is displaced labially (foreshortened root on maxillary occlusal film), then

the tooth should be left for spontaneous eruption.^{15,21} If the apex is pushed into follicle of the permanent successor, it presents as an elongated root on maxillary occlusal film and the apex is not visible. In this case, it is thought that the tooth should be extracted due to risk of damaging the permanent successor¹⁹, and this philosophy and approach is described in the current IADT guidelines.¹² This view is supported by the findings of a retrospective study by Holan and Ram (1999) involving 172 intruded primary teeth. More than 80% of these teeth were intruded with the roots orientated buccally, and most of them erupted with no complications over a 36 month follow up period.²¹

INTRUSION: LEAVE AND WAIT

Other studies in the literature support a "leave and wait" approach for intrusive luxation injuries in the primary dentition with no other concomitant injuries. A study conducted by Ravn involving 88 intruded teeth found that 72 of these intruded teeth re-erupted after the injury, four needed to be extracted immediately at the time of evaluation, and four were over-retained.²²

Ravn also conducted another study in 1976 which reported the outcomes of 100 intruded teeth. Of these teeth, 86 teeth re-erupted with 35 demonstrating calcific degeneration. Twenty-two teeth developed peri-apical pathology, and 29 teeth showed no post-traumatic sequelae. Eight teeth were removed immediately and six never re-erupted.²³

A study by Ravn and Andreasen 1971 study showed no difference in occurrence of damage to the permanent successor regardless of whether extraction or conservative management was adopted.⁶ Similarly, a study some years later by Thylstrup and Andreasen in 1977 found no differences in damage to the permanent successor with an extraction approach or watch and wait approach.²⁴ A more recent retrospective study involving 307 luxation injuries sustained by 222 patients found no significant association between the type of treatment rendered and secondary successor hypoplasia for intrusions ($P = 0.38$).¹⁹ These findings therefore imply that any damage would have been done at the time of injury and so a conservative management would therefore be appropriate. However, a recent controlled study examining the effect of traumatised primary teeth on its permanent successors had findings to the contrary. Of the injured primary teeth ($n=214$) in this study, only 44.1% ($n=19$) of intruded primary teeth had no sequelae in the permanent successor, with 20.9% ($n=9$) showing enamel discolouration and 18.6% ($n=8$) with enamel hypoplasia, with other injuries including crown dilaceration (4.6%; $n=2$), odontoma-like formation (2.3%; $n=1$), root dilaceration (2.3%; $n=1$), and sequestration

of tooth germ (2.3%; $n=1$) reported.²⁵ This study found a significant association between primary tooth intrusion and permanent tooth sequelae ($p=0.001$)²⁵ and therefore it appears to cast some doubt on the more conservative approach to primary tooth intrusion in general. While aesthetic concern over qualitative enamel defects would depend on the degree of enamel discolouration; the risk of other more serious permanent teeth sequelae must be weighed when considering available management options for primary tooth intrusions.

Severe intrusion

For proponents of the "watch and wait" approach, controversy exists also over whether severe intrusions should still be left for observation. This specifically relates to a third degree intrusion on the von Arx scale²⁶, as opposed to the treatment approaches described in the IADT guidelines according to apex orientation.¹² While one recommendation is extraction in this situation⁹, another approach is to still leave the tooth for observation.¹⁵ One case report successfully reported for conservative management for a complete intrusion of a primary incisor.²⁷ However, another case report on the permanent tooth sequelae of a primary tooth subluxation, outlines the albeit rare but serious consequences that a seemingly less traumatic dental injury can have on the permanent successor which subsequently sequestered some years later during routine daily activity, and the possibility of severe sequelae to permanent tooth need to be considered against the benefits of conservative approaches.¹⁰ Another author recommends to leave the tooth for spontaneous eruption unless the root tip has punctured the floor of the nasal cavity, in which case the tooth should be removed through the nares.²⁸ Proponents of this approach, again, would argue that any damage done to the permanent successor has been done already as shown in previous studies.^{6,22,23} It is also suggested that extraction of an intruded tooth itself can pose the risk of damaging the permanent successor.²⁹

If one adopts a conservative option of leaving an intruded primary tooth to observe for re-eruption, the clinician must follow up for signs of periapical infection or pulp necrosis. Its importance is highlighted by one study which shows that a significant relationship exists between necrosis and hypoplasia of the succedaneous tooth ($P = 0.80$)¹⁹, and the reported percentage of intruded primary teeth that subsequently develop pulpal necrosis varies. One source cites that 65% ($n=46$) of 68 intruded primary teeth had developmental disturbances in the permanent successor.³⁰ Such developmental disturbances may include enamel discolouration or hypoplasia, crown dilaceration, odontoma like formation, root duplication, vestibular root angulation, root dilaceration, arrestment of root formation, sequestration

of the permanent tooth germ, or disturbance in eruption.³⁰ Another source cites the ratio of pulp vitality to pulp necrosis as being almost 50% in patients aged 0-3 years.³

In considering this, however, younger children seem less likely to develop pulp necrosis as a result of traumatic injury to the primary dentition. A study by Holan and Ram showed that young children less than 1.5 years of age were less likely to develop pulpal necrosis in spite of the fact they had the highest frequency of intrusion. On the other hand, the eldest children greater than 5.5 years of age had a ten-fold greater risk of pulpal necrosis even though the most common injury was subluxation. The authors proposed that an explanation for these findings were that a young child's tooth has a high vascular supply and wide open and short pulp.²¹

Intrusion- leave and wait - how long for?

The proposed follow-up time to observe for re-eruption of intruded primary teeth varies in the dental literature. Schreiber (1959) suggested that an intruded tooth with the root displaced buccally would usually be expected to re-erupt within six weeks.³¹ Similarly, Andreassen and Ravn (1973) proposed that in the same scenario that this period was three to four weeks.³² On the other hand, Crespi (1992) stated that this period was three months.³³ Ravn (1968) proposed that intruded primary teeth would usually re-erupt after six months.²²

LATERAL LUXATION

Some controversial/alternative management options exist for lateral luxation injuries in the primary dentition. There is limited evidence in the dental literature on the prognosis of primary teeth with lateral luxation injuries in the primary dentition. A study by Ravn (1968) showed that of the six luxated teeth evaluated, four were extracted immediately, and two that were repositioned later needed extraction.²² Sequelae to the permanent successor following primary tooth lateral luxation is documented in a recent study investigating the sequelae to permanent teeth from primary tooth injury. It found that of the injured primary teeth (n=214), 68.1% (n=15) of primary tooth lateral luxation injuries had no sequelae in the permanent dentition, with 18.1% (n=4) having enamel hypoplasia, one case observed for enamel discolouration (4.5%; n=1), partial arrest of root formation (4.5%; n=1), and eruption disturbance (4.5%; n=1). The exact type of emergency treatment administered was not clear in these cases.²⁵

In general, most guidelines, including those proposed by the IADT¹², suggest that management of laterally luxated teeth is determined in part by whether there is occlusal

interference.³ It is suggested that if there is no occlusal interference, that the tooth be left to reposition spontaneously.^{15,19} One study that supports this recommendation reports that out of 104 laterally luxated teeth, 99% repositioned spontaneously within one year.¹⁵ Another retrospective study involved 331 primary teeth with lateral luxation left without treatment.³⁴ It found that the estimated risks after three years for pulpal canal obliteration (PCO) were 41.3%, pulpal necrosis (PN) 19.8%, infection related resorption (IRR) 7.0%, ankylosis related resorption (ARR) 1.4% and premature tooth loss as 24.8%.³⁵ This study concluded that conservative management was associated with a relatively high healing potential.³⁴ On the other hand, in laterally luxated teeth with severe occlusal interferences, leaving the tooth to spontaneously reposition may further compromise its prognosis.³⁶

If there is minor occlusal interference as a result of lateral luxation, slight odontoplasty is advocated, as per the IADT guidelines.¹² However, it is suggested that care must be taken as severe grinding may cause exposure of dentinal tubules, pulp exposure and lead to loss of pulp vitality of the tooth.³⁷ In such a case, topical fluoride may be applied to minimise the risk of sensitivity.

It is also suggested that if there is occlusal interference, that the primary tooth be actively repositioned and splinted to the adjacent teeth for two to three weeks^{15,38} and this is consistent with that of the IADT guidelines.¹² While success with this approach has been documented in one case report involving repositioning, splinting with composite resin and pulpectomy of the injured tooth³⁸, an observational study found that while 60% of 52 teeth left for spontaneous repositioning did not show complications, active repositioning of lateral luxations was associated with an increased risk of developing pulpal necrosis.¹⁹ Another recent retrospective study assessing the outcomes of splinting in primary teeth with root fractures, lateral and extrusive luxations, found that splinting in lateral or extrusive luxations were not associated with a good prognosis.³⁹ In addition, active repositioning cannot be performed when there is delayed presentation of the injury.

In cases of severe luxation injury of the primary tooth in a labial direction, the IADT guidelines stipulate that extraction is the treatment of choice.¹² However, it is suggested that extraction of anterior teeth in young children can lead to poor aesthetics, phonetics and loss of function and may cause psychological and social problems.^{17,36}

Alternative methods of managing primary tooth luxations were documented in two case reports which involved a novel approach to achieve gradual repositioning of a primary tooth in cross bite caused by lateral luxation.^{36,37} An incisal plane fabricated with composite resin was created by placing

additional composite over the opposing teeth.^{36,37} Other novel approaches to management include the use of a wooden tongue blade to reposition a primary tooth displaced by lateral luxation. However, this approach is thought to be spurious as the success of this technique depends heavily on the cooperation of both the parents and the child.^{19,36} Another technique involves the placement of a reversed stainless steel crown over the opposing tooth as an inclined plane to allow gradual repositioning of the laterally luxated tooth. While this method has been successful, the reversed stainless steel crown affords poor adaptation to the tooth.^{36,40} The use of a removable acrylic appliance with a Z-spring has also been reported in the literature as the proposed management to move the displaced incisor forward.³⁶ However, the success of these treatment approaches depend on the age (at the time of the injury) and compliance of the child.

The evidence in the literature is unclear about the definite approach for lateral luxation injuries in primary teeth in terms of prognostic outcomes according to treatment type. A study previously described in this review suggested splinting of lateral luxations was associated with a poor prognosis.³⁹ A retrospective study involving 307 teeth found that there was no significant association between the type of treatment rendered and the occurrence of hypoplasia in the permanent successor in instances of lateral luxation injuries ($p=0.13$).¹⁹ With the exception of extraction, current guidelines suggest that all luxation injuries should be afforded adequate clinical and radiographic follow-up, as per the recommended schedule, until the eruption of the permanent successor, to detect signs of infection, or dark discolouration.¹²

PRIMARY TOOTH EXTRUSION MANAGEMENT

There is little evidence to support current guidelines for management of extrusive luxation injuries in the primary dentition. Various guidelines, including the IADT guidelines, propose that for minor extrusion injuries of less than 3 mm, the management should be to either leave the tooth for spontaneous alignment or to reposition and splint the tooth.^{3,12,17} There was no published literature on the approach involving repositioning with splinting at the time the IADT guidelines were published on the management of primary tooth extrusion injury.³ One recent retrospective study reported the treatment outcomes of splinting in the primary teeth of 137 children with root fractures and lateral and extrusive luxation injuries. Of 183 teeth examined, semi-rigid splints were placed on 80 teeth, and it was found that splinting for extrusive luxations was not associated with favourable prognosis ($p<0.05$), and this differs from the

splinting recommendation in the IADT guideline.³⁹ An earlier retrospective study followed 26 primary tooth extrusion injuries in 24 patients, where these teeth were repositioned without splinting. Follow-up examinations were performed periodically up to one-year post-injury and also when the patients were six years old. The study found that after three years, estimated risks were reported as PCO being 39.8%, PN as 15.6%, IRR as 3.8%, and PTL as 43.3%. The IADT and other previously published guidelines recommend that cases involving severe extrusive luxation greater than 3 mm in the primary dentition should be extracted.^{3,12,17}

CONCLUSION

In conclusion, the evidence for the clinical approach toward luxation injuries in the primary dentition is controversial. The evidence is conflicting and that there is relatively little substantive scientific evidence to discredit one approach over another. Many factors including patient age, presence of concomitant injuries, orientation of the teeth, patient and parent factors and consent also have a bearing on the clinical approach in paediatric patients. When treating such injuries, it is important that clinicians should also be aware of such factors in addition to the various management options available for that injury. All these factors can help clinicians in making the most informed decision regarding the best approach that is tailored for the individual child.

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POTENTIAL CONFLICTS OF INTEREST

None declared.

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