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Management of a Severe Traumatic Intrusion of a Permanent Incisor With Spontaneous Re-Eruption After Maxillary Expansion: A Surgical-Orthodontic Case Report

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Patient: Female, 7-year-old
Final Diagnosis: Traumatic intrusion of permanent incisor
Symptoms: Absence of permanent teeth
Clinical Procedure: —
Specialty: Dentistry

Objective: Unusual clinical course

Background: Traumatic intrusion of permanent incisors is one of the most severe forms of dental injury and is frequently associated with complications such as pulp necrosis, root resorption, and ankylosis. Although IADT guidelines provide structured recommendations based on the stage of root development and degree of intrusion, some clinical situations remain borderline, particularly cases presenting an open apex in an otherwise nearly mature root, making classification and treatment planning challenging.

Case Report: A 7-year-old girl presented with severe intrusive luxation (>10 mm) of the permanent right maxillary central incisor. Clinical and radiographic assessment revealed a wide apical foramen but near-complete root length, placing the case in a borderline category. A multidisciplinary plan was initiated, consisting of surgical repositioning and flexible splinting, followed by orthodontic extrusion. After 2 months of traction, undesirable intrusion of the adjacent incisors occurred, while the affected tooth failed to extrude, raising suspicion of ankylosis and leading to suspension of active orthodontic forces. Due to concurrent maxillary constriction, rapid palatal expansion was performed. Unexpectedly, spontaneous re-eruption of the intruded incisor occurred shortly after completing expansion, without further orthodontic intervention.

Conclusions: This case illustrates borderline presentations can require adaptive and individualized treatment strategies beyond standard guideline recommendations. The spontaneous re-eruption observed after expansion suggests orthopedic interventions modify local conditions, potentially facilitating natural repositioning, even in teeth initially suspected of ankylosis. Nevertheless, the relationship between expansion and eruptive recovery should be interpreted as hypothetical rather than causative. Further clinical reports are needed to elucidate the biological mechanisms underlying this phenomenon and define its potential therapeutic relevance.

Keywords: Case Reports • Child • Incisor • Orthodontics, Corrective • Tooth Injuries • Tooth, Impacted

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Introduction

Traumatic dental injuries are common events in childhood and adolescence that affect both the primary and permanent dentition, with an estimated prevalence of 15% in preschoolers and 20% to 25% in school-age children [1]. The maxillary region, particularly the central incisors, is the most frequently involved site [2,3]. Among these injuries, intrusive luxation of permanent teeth is a relatively rare but severe form of dental trauma. Epidemiological studies report a prevalence ranging between 0.5% and 2% of all dental trauma cases [3,4]. Despite its low incidence, intrusive luxation is considered the most complex and severe type of luxation injury, due to the extensive damage it causes to the periodontal ligament, alveolar socket, and apical neurovascular bundle, and it is often associated with an unfavorable prognosis [3,5].

According to the most recent guidelines of the International Association of Dental Traumatology (IADT), intrusive luxation in permanent teeth is classified based on the extent of displacement: mild (<3 mm), moderate (3-7 mm), and severe (>7 mm) [6].

The outcome depends on several factors, including the degree of intrusion, the root development stage, and the timeliness of intervention, which together determine the likelihood of pulp and periodontal healing. The long-term complications of intrusive luxation can include pulpal necrosis, inflammatory root resorption, ankylosis, and loss of marginal bone support [7]. The incidence of pulp necrosis is strongly influenced by the stage of root development. It occurs in approximately 50% to 60% of immature teeth and up to 80% to 100% of mature teeth after intrusive luxation [8,9]. Early management and the presence of an open apex are associated with a more favorable prognosis [10].

Management of intrusive luxation in permanent teeth includes different therapeutic approaches, such as allowing spontaneous re-eruption, orthodontic repositioning, or surgical repositioning, selected according to the degree of intrusion, the stage of root development, and the time elapsed since injury [6].

While the IADT guidelines categorize intrusive luxation primarily according to the degree of intrusion and the stage of root development, they do not specifically delineate management strategies for teeth presenting near-complete root length in association with a persistently wide apical foramen. Cases featuring a wide open apex in an otherwise nearly mature root do not fully conform to predefined categories and therefore remain clinically borderline, creating uncertainty in both classification and treatment planning.

In the present case, radiographic assessment revealed almost complete root formation, yet a still wide apical foramen, indicating incomplete apical closure and potential residual revascularization capacity. This biological presentation does not fully correspond to the conventional dichotomous classification of immature and mature teeth described in current recommendations.

For clinical decision-making purposes, the tooth was considered to present a transitional developmental pattern. Although current IADT guidelines recommend initial observation and spontaneous re-eruption in clearly immature teeth, the severity of intrusion (>10 mm) combined with the advanced root length in this case raised concern regarding the predictability of spontaneous recovery alone. Therefore, a combined approach was adopted, aiming to preserve pulp vitality while facilitating controlled repositioning. Cautious surgical repositioning was performed to reduce the extent of displacement and potential periodontal damage, followed by light orthodontic extrusion to support gradual realignment, rather than relying exclusively on passive spontaneous re-eruption or managing the case strictly as a fully mature tooth.

This case thus exemplifies the challenges encountered when anatomical maturity and apical development are not fully aligned, requiring individualized interpretation of existing guidelines.

Case Report

In August 2023, a 7-year-old female patient presented to the emergency department of a hospital following an orofacial trauma due to an accidental fall. After clinical evaluation, antibiotic therapy with amoxicillin-clavulanic acid was prescribed, and the patient was referred to the pediatric dentistry and orthodontics unit, where she presented 2 days later. The patient was in good general health, with no significant medical history or systemic diseases.

Clinical examination revealed the absence of the right maxillary central incisor, with the crown no longer visible intraorally. The surrounding soft tissues presented with mild bleeding and a small laceration of the vestibular gingiva in the area corresponding to the injured tooth (**Figure 1**), raising suspicion of either complete intrusion or avulsion.

Radiographic evaluation, performed through cone-beam computed tomography, confirmed complete intrusion of the tooth, with nearly fully developed root length and open apex, measuring 2.08 mm in apical foramen diameter. The total intrusion depth was approximately 10.23 mm. Fractures of the alveolar bone and the crown's incisal edge were noted, with no evidence of root fractures (**Figure 2A-2C**).

Considering the severity of the intrusion and the near-complete root formation, immediate surgical intervention was planned to

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Figure 1. Clinical examination showing absence of the right maxillary central incisor with mild bleeding and a small vestibular gingival laceration, suggestive of complete intrusion or avulsion.

reposition the tooth and minimize the risk of ankylosis. Under local anesthesia, gentle luxation and elevation were performed to partially reposition the tooth and expose the crown, allowing for splint placement. A 0.018-inch stainless steel wire was bonded from the upper right primary molar to the upper left primary canine, providing stabilization (**Figure 3**).

The splint was removed after 3 weeks (**Figure 4**). Orthodontic treatment was then initiated to promote controlled repositioning of the intruded tooth. A multibracket appliance was bonded from the upper right to the upper left primary canine, and a 0.012-inch nickel-titanium wire was used to deliver light, continuous forces (**Figure 5**).

After 2 months, a treatment complication was observed: the upper left central and lateral incisors showed mild intrusion, and the upper right central incisor failed to move, raising the suspicion of partial ankylosis (**Figure 6**). Clinical findings included reduced physiological mobility compared with adjacent teeth and a slightly high-pitched percussion sound. Radiographically, localized areas of reduced periodontal ligament space continuity were observed, further supporting this suspicion. Consequently, orthodontic traction was immediately suspended, the wire was removed to eliminate any active forces, and the patient was placed under monthly monitoring. Orthodontic traction was not resumed prior to rapid palatal expansion because the suspected ankylotic component could have rendered further traction ineffective and potentially increased the risk of root resorption or additional periodontal damage.

During the following 4 months, clinical assessment demonstrated that the right central incisor had partially regained physiological mobility, although radiographic findings suggested the presence of partial ankylosis.

Figure 2. Cone-beam computed tomography (**A**) confirms complete intrusion of the right maxillary central incisor with an associated incisal edge fracture. (**B**) Image shows a nearly fully developed root with an open apex (apical foramen diameter: 2.08 mm). (**C**) Image shows a total intrusion depth of approximately 10.23 mm.

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Figure 3. Partial surgical repositioning allowed crown exposure and splint placement using a 0.018-inch stainless steel wire.

Figure 4. Clinical appearance 3 weeks after surgical repositioning.

Figure 5. Multibracket orthodontic appliance bonded to initiate orthodontic traction.

Given the presence of maxillary constriction and the need to create adequate space within the arch, a second phase of treatment was initiated using a rapid palatal expander. The appliance was used to correct the transverse deficiency and improve space distribution, while also providing a more stable anchorage system for any subsequent orthodontic movements. The appliance was activated once daily for 20 consecutive days. An auxiliary extension was incorporated in the retroincisal area to allow the application of light extrusive

Figure 6. Two months after treatment, intrusion of the upper left central and lateral incisors and lack of movement of the right maxillary central incisor, suggestive of partial ankylosis.

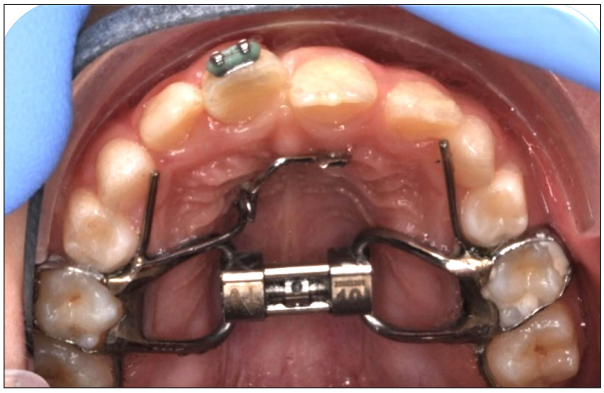

Figure 7. Rapid palatal expander with extension arm designed for traction of the right maxillary central incisor, prepared but not activated.

Figure 8. Spontaneous re-eruption of the right maxillary central incisor following completion of maxillary expansion, without additional orthodontic traction.

forces on the impacted tooth (**Figure 7**). Although the extrusion arm was incorporated into the appliance, it was never activated. Remarkably, spontaneous re-eruption of the right maxillary central incisor was observed shortly after completion of the maxillary expansion phase, without the need for further orthodontic traction (**Figure 8**).

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Figure 9. Orthopantomography 8 months after treatment showing correct alignment, persistence of an open apex with physiological root development, and no signs of pulp necrosis.

After 8 months, the rapid palatal expander appliance was removed, and orthopantomography confirmed correct alignment of the tooth, persistency of an open apex but with evidence of physiological root development, and no radiographic signs suggestive of pulp necrosis (**Figure 9**). Pulp sensitivity was assessed at baseline and during follow-up using cold testing. At the initial post-trauma evaluation, the tooth did not provide a reliable response, which was considered consistent with transient pulpal shock commonly observed after intrusive luxation. Cold testing was subsequently repeated at 3-month intervals throughout treatment and follow-up. During follow-up visits, the tooth demonstrated consistent and reproducible positive responses to cold stimulation, supporting maintenance of pulp vitality. At the 3-month follow-up after appliance removal, the tooth remained responsive to cold testing, clinically stable, and functionally integrated.

Discussion

According to the most recent IADT guidelines (2020), the management of intrusive luxation in permanent teeth is primarily determined by the stage of root development and the severity of intrusion. In immature teeth, in which root formation is incomplete, a conservative approach prioritizing the preservation of pulp vitality is recommended, and spontaneous re-eruption is advised regardless of the intrusion depth. Orthodontic extrusion should be initiated if no spontaneous movement is observed within 4 weeks. In contrast, in mature teeth, spontaneous re-eruption is recommended only for mild intrusions (<3 mm), with surgical or orthodontic repositioning indicated if no movement occurs within 8 weeks. Moderate intrusions (3-7 mm) are preferably managed surgically, although orthodontic extrusion remains an option, while severe intrusions (>7 mm) generally require surgical repositioning [6].

In the present case, the intrusion was severe (>10 mm), but the root-development pattern was borderline, characterized by an almost fully formed root length combined with a still immature apex. For this reason, a combined approach was selected, consisting of partial surgical repositioning followed by orthodontic extrusion. This strategy aimed to achieve controlled repositioning while maximizing the likelihood of maintaining pulp vitality and supporting periodontal healing.

The timing of intervention is known to influence prognosis [11,12]. In the present case, surgical repositioning was performed approximately 2 days after the injury; nevertheless, no radiographic signs of root resorption were observed during follow-up, indicating a favorable healing outcome despite the delayed management. Intrusive luxation is often associated with alveolar fractures; however, in younger patients the bone tends to be more resilient, favoring displacement of the tooth rather than fracture [12-14]. In the present case, an alveolar fracture was observed in the absence of root fracture.

Pulp necrosis is a common complication after intrusive luxation and is strongly influenced by the degree of root maturity and apical foramen size. Evidence suggests that teeth with smaller apical foramina have poorer outcomes [15]. In this case, the wide apical diameter (2.08 mm) represented a favorable prognostic factor for pulp vitality, which remained positive throughout follow-up.

It is well documented that intruded teeth can develop ankylosis and that unintended tooth movements can occur in anchorage units during fixed orthodontic therapy [16]. After 2 months of traction with a multibracket appliance, undesirable intrusion of the adjacent incisors was observed, while the affected tooth remained immobile. This pattern suggested that extrusive forces were not adequately transmitted to the traumatized tooth, likely due to early ankylosis, resulting instead in intrusive displacement of the anchorage teeth.

Given this unfavorable response, orthodontic forces were discontinued to avoid further complications. Attention then shifted to addressing the maxillary constriction identified in the upper arch. Rapid palatal expansion was initiated to improve

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transverse dimensions and redistribute space. Remarkably, spontaneous re-eruption of the previously intruded incisor occurred shortly after completion of the expansion phase, without any additional traction. This unexpected outcome suggests that reducing occlusal and spatial constraints through maxillary expansion may have facilitated natural eruptive recovery and periodontal remodeling. This temporal association should be interpreted with caution and does not allow a direct causal inference. However, it is plausible that expansion improved transverse spatial conditions and reduced mechanical constraints, thereby allowing biological recovery processes within the periodontal ligament to resume eruptive activity.

Similar observations have been rarely reported in the literature. In the review by Omar et al [17], 3 cases of traumatically intruded permanent incisors were managed using different strategies, including monitored spontaneous re-eruption, orthodontic extrusion, and delayed surgical repositioning. In immature teeth, spontaneous re-eruption was observed in some cases, although the timing was variable and, in 1 instance, lack of eruption led to surgical intervention due to suspected ankylosis. Compared with those reports, the present case differed in that spontaneous re-eruption occurred after a period of failed orthodontic traction and following rapid palatal expansion, without additional surgical manipulation. While orthodontic space regaining was described by Omar et al as potentially facilitating delayed eruption, our case involved transverse skeletal expansion, which may have improved spatial and biomechanical conditions within the maxillary arch. Nevertheless, the temporal association between expansion and re-eruption does not establish causality, and the favorable outcome may reflect progressive periodontal ligament recovery over time.

Although the underlying biological mechanism remains uncertain, it has been suggested that maxillary expansion may alter the local biomechanical environment, modulate occlusal forces, and enhance vascular and periodontal conditions, collectively supporting the resumption of eruptive activity, even in teeth initially suspected of ankylosis.

In retrospect, the initial therapeutic approach can be viewed as a reasonable attempt to balance the severity of intrusion with the need to preserve periodontal and pulpal healing in a biologically borderline situation. Although the presence of a nearly complete root with a still wide apex might also have supported an initial period of observation, the chosen strategy reflected a cautious effort to promote controlled repositioning. The subsequent clinical course suggests that, in cases with uncertain apical activity, the timing and magnitude of active traction should be carefully modulated. The spontaneous re-eruption observed later cannot be clearly attributed to rapid palatal expansion alone, and a contributory role of biological recovery over time cannot be excluded. Accordingly, in borderline situations, a flexible approach that allows for delayed or adjusted intervention may represent a reasonable clinical option.

This report describes a single case, and the observations made may not be representative of all patients with similar injuries. Furthermore, the follow-up period is limited, and longer-term observation would be necessary to assess potential late complications. Additional clinical reports may help clarify the consistency and clinical significance of this phenomenon.

Conclusions

This case highlights that borderline presentations, such as an intruded permanent incisor with an almost complete root and a still wide apex, can fall outside strict guideline categories and therefore require individualized clinical judgment. In addition, the time elapsed between the traumatic event and the orthodontic-surgical repositioning may have negatively influenced the overall outcome. Although the spontaneous re-eruption observed cannot be definitively attributed to rapid palatal expansion alone, the favorable clinical evolution following expansion suggests that this orthopedic approach may be considered a potential contributing factor in selected cases. These observations support the need for flexible and timely treatment strategies in complex dental trauma scenarios and encourage further investigation into the potential role of maxillary expansion in facilitating eruptive recovery.

Department and Institution Where Work Was Done

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Patient consent

Written informed consent for publication was obtained from the patient's parents. The patient was treated according to national and international guidelines and the principles of good clinical practice.

Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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