

## The changing role of endodontics and orthodontics in the management of traumatically intruded permanent incisors

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### Abstract

*Disagreement remains regarding the optimal treatment for intrusive luxation injuries to permanent teeth. Three problems often present themselves following intrusive luxation: improper tooth position, pulpal necrosis, and internal or external root resorption. In the recent past, the accepted treatment was to allow the permanent teeth to reerupt spontaneously for 6-8 weeks. If this did not occur, orthodontic traction was applied. The pulpal status of the teeth was monitored and either calcium hydroxide therapy or conventional endodontics was instituted following pulpal necrosis depending on the maturity of the root end. Pulpectomy and a calcium hydroxide filling material were also the treatment of choice if there was evidence of internal or external root resorption.*

*Recent evidence suggests that orthodontic repositioning should commence as soon as possible following the trauma regardless of the stage of root development. Teeth with open apices can be monitored. Those with closed apices should be opened, the pulp extirpated, and the canal filled with a calcium hydroxide material. This will reduce the chance of root resorption and provide a period of monitoring prior to a definitive root canal filling. Two cases are presented that demonstrate these contrasting treatment techniques and possible complications.*

**E**ffective endodontic and orthodontic management of traumatic intrusive luxation of the permanent teeth in children and adolescents continues to challenge the dental profession. Management should include an accurate diagnosis and treatment that will result in the best prognosis. The purpose of this paper is to present two instances of intrusive luxation

and discuss the treatment and complications in view of the changing and contrasting literature regarding these injuries.

### Literature Review

Traumatic intrusion is a form of luxation that displaces the tooth in an apical direction. This injury is characterized by comminution of the alveolar socket and expansion of the alveolus to permit the new position of the tooth.<sup>1</sup> Upon percussion, the intruded tooth elicits a metallic sound similar to an ankylosed tooth — distinguishing it from an unerupted tooth. The intrusion may be so severe that the affected tooth appears to be missing upon clinical examination. Radiographic examination may reveal partial or total obliteration of the periodontal ligament space.

Intrusive luxation of permanent teeth occurs less frequently than other types of luxation and is associated far more often with maxillary teeth than mandibular teeth.<sup>1,2</sup> Although it is the less common form of luxation, it is reported to be the type which has the poorest prognosis.<sup>2,3</sup> However, few systematic studies have appeared in the literature. A variety of therapeutic measures have been reported, but the optimal method of returning the tooth to its normal position remains to be determined.<sup>4,5</sup>

In the past, surgical repositioning and splinting have been recommended. This type of repositioning has serious pulpal and periodontal consequences. A significantly higher percentage of marginal bone loss, ankylosis, and pulpal inflammatory response have been demonstrated following surgical repositioning of intruded teeth in comparison to permitting spontaneous reeruption or orthodontic repositioning.<sup>5</sup>

It has been suggested that intruded permanent teeth

with incomplete root formation be permitted to re-erupt spontaneously since there is significant eruption potential of such teeth.<sup>4</sup> If no eruption occurred within 2 months or root formation was complete, orthodontic repositioning was advised.<sup>6,7</sup>

Although Andreasen conducted a retrospective investigation of 189 luxated permanent teeth and found that the 23 intruded teeth ultimately demonstrated 96% incidence of pulpal necrosis, pulpectomy was not recommended initially unless pulpal necrosis was diagnosed.<sup>1</sup> In teeth with complete root formation, pulpal necrosis was treated with conventional endodontics. In those with incomplete root formation, pulpal necrosis was treated with either pulpotomy or pulp extirpation followed by procedures to close the open apex.<sup>5</sup>

Another complication of intrusive luxation is root resorption. In Andreasen's study, 52% of the intruded teeth were affected by either external replacement or inflammatory resorption.<sup>1</sup> External root resorption was treated by either pulpectomy and a calcium hydroxide fill or conventional endodontics.

A final problem frequently associated with traumatically intruded permanent teeth is loss of marginal bone support. Andreasen found this complication with 48% of the intruded teeth and attributed such a high incidence to the severity of the periodontal injury and the delay in treatment.<sup>1</sup>

It now appears that the appropriate treatment for intruded teeth with or without complete root formation is immediate application of orthodontic forces to reposition the teeth in 3-4 weeks in order to avoid ankylosis and permit monitoring or early access for endodontic treatment.<sup>5,8</sup> For teeth with complete apices, extirpation of the pulp followed by a calcium hydroxide fill is indicated within 14 days of the injury. This has been advised due to the certainty of

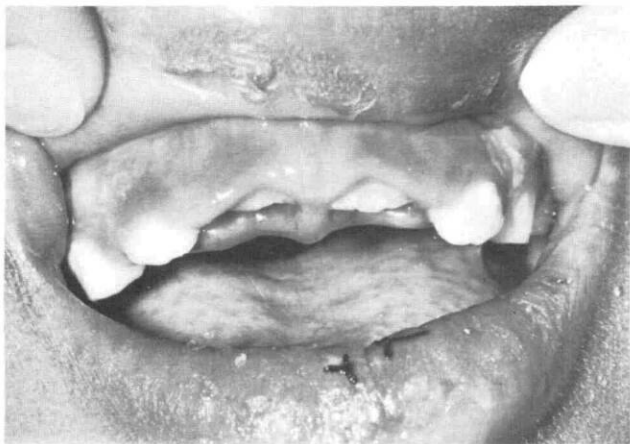


FIG 1. Patient 1 (initial visit), showing 7 mm intrusion of the permanent maxillary central incisors and 2 mm intrusion of the permanent maxillary right lateral incisor.

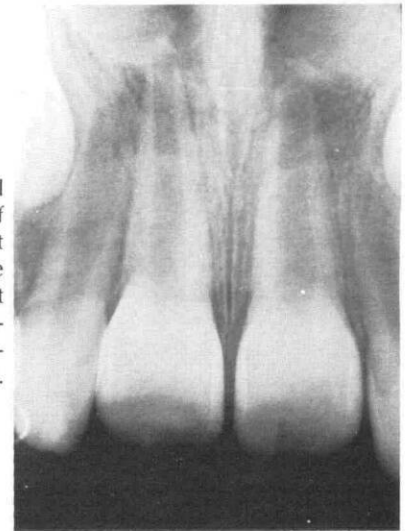


FIG 2. Patient 1, initial periapical radiograph of intruded permanent maxillary incisors. Note the incomplete root formation and the apparent absence of dental or alveolar fractures.

pulpal necrosis and the need to prevent root resorption. Teeth with immature root formation can be observed for pulp necrosis and root resorption — therapy can be instituted immediately if necessary.

Turley et al.<sup>8</sup> conducted an investigation studying spontaneous reeruption and orthodontic repositioning as treatment options for managing intrusive luxation of permanent teeth in dogs. They traumatically intruded first premolars with completely formed apices, subjected half of these teeth to orthodontic extrusive forces, and allowed the other half to erupt spontaneously. In their study, the more severely intruded teeth exhibited ankylosis and failed to erupt or respond to orthodontic extrusion. The less severely intruded teeth did not become ankylosed, but demonstrated some spontaneous eruption as well as extrusion from orthodontic forces.

In a later study, Turley et al.<sup>9</sup> found that severely intruded (5-6 mm) teeth could be extruded orthodontically if they were luxated following the trauma. Their conclusions suggest that the severity of the traumatic intrusion and the amount of mobility present are important factors affecting the prognosis for spontaneous reeruption or orthodontic extrusion.

## Clinical Reports

Two injuries are reported that demonstrate both the old and new treatment options recommended for intrusive luxation: allowing reeruption, and immediate orthodontic repositioning (as well as different timing for pulpal extirpation).

The first report involved a 6-year, 11-month-old black female injured in a fall on stairs at school. The patient was transported immediately to a hospital emergency room where her neurologic status was evaluated. No

neurologic problems were found, and subsequently she was referred to the pediatric dentistry clinic. The medical history was unremarkable and immunizations were current.

Extraoral examination was unremarkable except for a laceration on the lower lip. Intraoral examination revealed 7 mm intrusive luxations of the maxillary central incisors and a 2 mm intrusion of the maxillary right lateral incisor (Fig 1). The 3 intruded teeth were seated firmly in alveolar bone with no clinical mobility. The mandibular central incisors demonstrated slight mobility without apparent displacement. There was no clinical evidence of traumatic involvement of any other teeth or alveolar structures.

Radiographs revealed no apparent fractures of the dentition or surrounding alveolar bone. The radiographs confirmed the clinical impression of intrusive luxation and revealed that these teeth had incomplete root formation (approximately 7/8 complete) with open apices (Fig 2).

Treatment at the initial visit consisted of irrigation and suturing of the lower lip laceration with the aid of local anesthesia. The teeth were not repositioned or splinted at that time, but were monitored closely for evidence of reeruption and possible pathologic pulpal response.

At 1-week follow up, there was no clinical evidence of reeruption by measurement to adjacent uninjured teeth. This method, in addition to visual inspection, was used at subsequent appointments for reevaluation. Subsequent weekly visits revealed no reeruption of the intruded incisors or evidence of pulpal pathology.

Seven weeks following the trauma, a decision was made to reposition the intruded teeth orthodontically. An appliance was constructed that included a heavy, round wire soldered to bands placed on the

primary maxillary second molars and canines, bonded attachments on the intruded teeth, and elastic traction. This appliance delivered an extrusive force of approximately 100 gm to each incisor.

At the appliance insertion appointment, a periapical radiograph revealed external root resorption involving the maxillary central incisors. In order to prevent progression of the pathologic resorption and permit root end closure, calcium hydroxide pulpectomies were planned. Since the teeth could not be isolated for endodontic treatment due to their intruded position, a decision was made to wait 1 week with the expectation that orthodontic movement would provide enough lingual access to perform the calcium hydroxide pulpectomies.

One week following placement of the appliance (9 weeks posttrauma), approximately 1 mm of extrusive orthodontic movement had occurred. Nevertheless, the movement was still insufficient for adequate endodontic access. Since it was believed that endodontic treatment was needed immediately, a local gingivectomy was performed lingual to the intruded teeth to provide sufficient access for the calcium hydroxide pulpectomies. A rubber dam then was placed, access to the pulps was obtained, necrotic pulp tissue was extirpated, and calcium hydroxide was packed in the instrumented canals to within 1 mm of the apices.

Twelve weeks following the original trauma, a periapical radiograph revealed external root resorption involving the intruded maxillary right lateral incisor. The tooth was opened, necrotic pulp tissue was extirpated, and calcium hydroxide was placed to within 1 mm of the tooth apex.

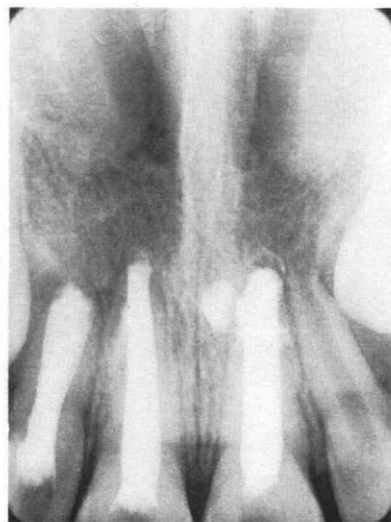
Two weeks later, less than 6 weeks following the initial appliance placement, orthodontic extrusion was complete and the appliance was removed. The position of the teeth was retained with a .0195 twisted multistrand wire bonded with resin on the labial surface of the maxillary teeth for 3 months.

Seven weeks following the initial endodontic treatment (4 months posttrauma), the calcium hydroxide was removed from the 3 incisors and the pulp canals were refilled with fresh calcium hydroxide. A periapical radiograph revealed no apparent progression of the external root resorption, but the teeth were monitored monthly with radiographs.

Eleven weeks following placement of the retention appliance, the retention was removed and the 3 incisors again were refilled with fresh calcium hydroxide. A study model of the maxillary dentition was obtained as a reference to assess further tooth movement.

Ten months posttrauma, the calcium hydroxide was removed and positive apical stops were apparent on all 3 teeth. Final obturation was achieved with lateral

FIG 3. Patient 1, post-operative periapical radiograph demonstrating final obturation of the orthodontically repositioned incisors 10 months posttrauma. Note the extrusion of canal filling material beyond the apex of the left central incisor.



condensation of gutta percha. The postoperative periapical radiograph of the left central incisor revealed that root canal sealer had been extruded beyond the apex (Fig 3).

A periapical radiograph was obtained 7 weeks following the final obturation procedures (1 year post-trauma). The film indicated no further pathology. The teeth had remained in position, providing adequate function and an esthetic appearance (Fig 4).

Follow-up periapical radiographs obtained 6 years, 6 months posttrauma revealed the incisors were free of pathology and no further resorption had occurred (Fig 5). The teeth were in the appropriate positions and demonstrated normal mobility with no sensitivity to percussion (Fig 6).

The second history involved a 10-year, 1-month-



FIG 4. Patient 1, postoperative intraoral condition of the orthodontically repositioned and endodontically treated incisors 12 months posttrauma.

old black female who fell while roller skating. The patient reported to a local emergency room where she was evaluated and dismissed with antibiotics and pain medications. Two days later the patient presented to the pediatric dentistry clinic in no apparent distress and with no evidence of neurologic problems. Extraoral examination was unremarkable, with the exception of facial abrasions and an edematous upper lip. Intraoral examination revealed edematous soft tissue facial and lingual to the maxillary incisors. The maxillary central incisors were intruded 8 mm. The maxillary right central and lateral incisors had mesial incisal Ellis Class I fractures while the maxillary left central incisor had a mesial incisal Ellis Class II fracture.<sup>10</sup> All teeth exhibited limited mobility (Fig 7).

A panorex radiograph revealed no mandibular fractures and the maxillary periapical radiographs confirmed the incisal fractures, but were negative for root or alveolar fractures. Root development on all maxillary incisors was complete (Fig 8).

Orthodontic attachments were placed on anterior

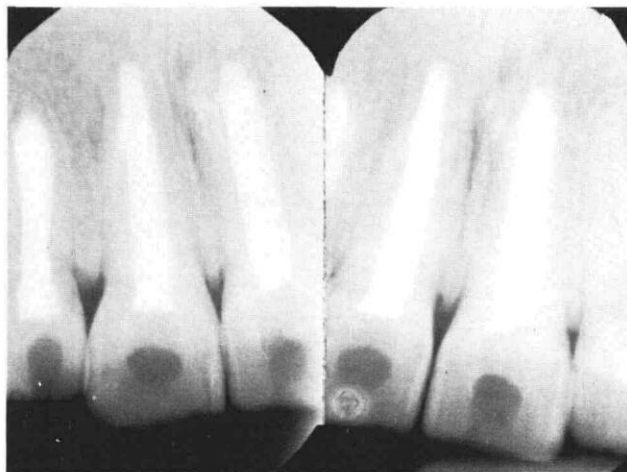


FIG 5. Patient 1, follow-up radiographs illustrating arrested root resorption and absence of pathology 6 years, 6 months posttrauma.



FIG 6. Patient 1, follow-up intraoral condition of the patient 6 years, 6 months posttrauma.

and posterior teeth and an archwire and elastic traction were used to reposition the central incisors as rapidly as possible. Since the apices were closed in these teeth, they were to be opened, the pulp extirpated, and a calcium hydroxide material placed when access was favorable.

Due to poor patient compliance with appointments, extrusion was continued over a 4-month period before access was possible. At that time, the central incisors also were evaluated clinically and radiographically. The right central incisor demonstrated external root resorption and the left central incisor had a vertical crown fracture extending to the midroot region and external root resorption. The right central incisor was opened, the necrotic pulp extirpated, and a calcium hydroxide material placed. The left central incisor was extracted due to the hopeless prognosis (Figs 9, 10).



FIG 7. Patient 2, initial condition of traumatically intruded permanent central incisors at presentation for treatment 48 hr posttrauma.

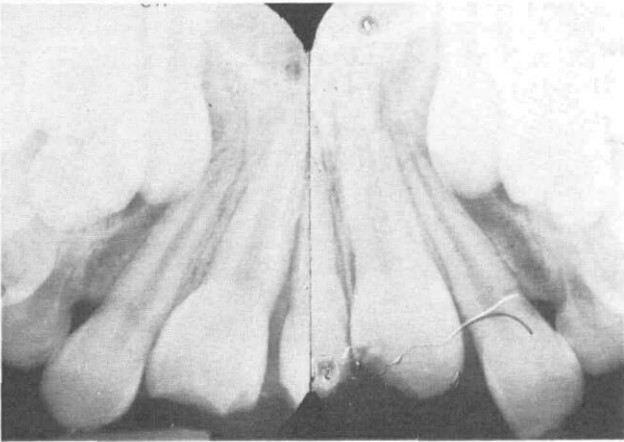


FIG 8. Patient 2, initial periapical radiographs of intruded permanent incisors 48 hr posttrauma. Note the apparent absence of root or alveolar fractures.

Clinical and radiographic observation at 6 weeks revealed that the resorption was controlled, the teeth were asymptomatic, and reasonable vertical tooth position had been achieved (Figs 11, 12).

## Discussion

Appropriate treatment for traumatic dental intrusion has been controversial in the dental profession. The current state of knowledge regarding treatment is based largely on empirical clinical experience rather than scientific evidence. Investigation is needed to improve the prognosis of these cases.

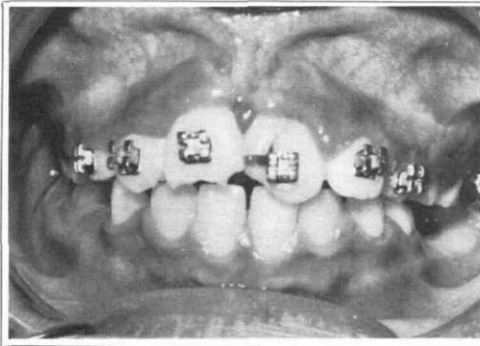
The choice of treatment in these cases was made with careful consideration of the specific type of injury. Waiting for spontaneous reeruption, once thought to be the best choice for teeth with intrusive luxation and incomplete root formation, was at-

tempted in the first patient. The complications encountered in this case graphically point to the shortcomings of this treatment philosophy. If inadequate eruption, pulpal necrosis, or internal or external root resorption occur, intruded teeth will require adjunctive orthodontic repositioning. Because of a lack of immediate orthodontic repositioning of the teeth in the first patient, a gingivectomy and delayed placement of calcium hydroxide in the root canals were required. In the second patient, the immediate orthodontic repositioning provided access to the lingual surface for calcium hydroxide treatment and helped to provide the definitive diagnosis on 1 of the teeth since a direct visual examination was made possible. Unfortunately, patient compliance problems delayed root canal treatment with calcium hydroxide and root resorption began.

Recent evidence indicates that failure to begin orthodontic extrusion immediately following severe intrusion of permanent teeth with fully formed apices may result in ankylosis, precluding orthodontic repositioning.<sup>8</sup> Regardless of the status of the root development, immediate orthodontic repositioning appears to be the treatment of choice to improve access for endodontic treatment deemed necessary, speed placement of calcium hydroxide, and reduce marginal bone loss. This type of treatment requires careful assessment of the orthodontic mechanics in order not to impinge on the soft tissue and maintain light continuous forces. Excellent patient compliance is necessary to maintain good oral hygiene and meet appointment schedules.

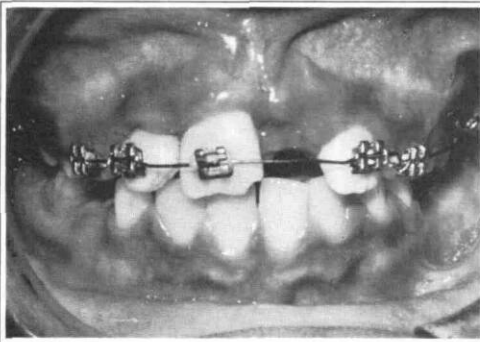
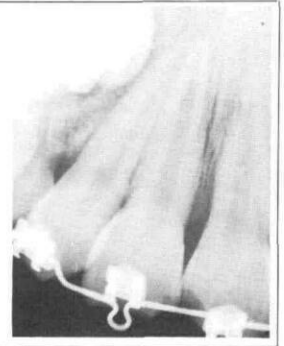
The loss of pulp vitality is another common finding with traumatically luxated teeth.<sup>1</sup> The direction of the force associated with intrusive luxation often crushes the apical blood vessels and periodontal ligament of the affected tooth. Complications manifested by the traumatized tissue such as external or internal root resorption are an indication of pulpal and periodontal pathology and the teeth must be treated endodontically. In both patients presented here, pulpal necrosis followed the intrusive injury as is seen in most teeth with nearly complete or complete root development.

The prevalence of such pathology is so high in instances of intruded teeth with complete root formation that pulpal extirpation and placement of a calcium hydroxide material should occur as soon as possible after the injury. In teeth with open apices, careful observation is necessary so that necrotic pulp tissue can be removed as soon as it is diagnosed. One should be aware that pulpal survival following traumatic intrusion is extremely rare even if root formation is incomplete. If pulp tissue is extirpated, all degenerating tissue must be removed before obturation with calcium hydroxide, but the level to which this will be accomplished depends on the individual tooth and



**FIG 9.** Patient 2, intraoral condition revealing vertical crown fracture extending onto root surface 4 months posttrauma.

**FIG 10.** Patient 2, periapical radiograph illustrating external resorption on the apical portions of the maxillary central incisors. Note that the crown and root fracture of the maxillary left central incisor is difficult to detect 4 months posttrauma.



**FIG 11.** Patient 2, intraoral view of the orthodontically repositioned tooth 5 months, 2 weeks posttrauma.

**FIG 12.** Patient 2, radiograph of the remaining central incisor following calcium hydroxide fill. Note that the root resorption has not progressed.



the state of its pathology. It is most desirable to maintain some vital healthy radicular pulp tissue in order to allow apical closure to occur and to allow continued root development. A better crown to root ratio, improved root strength, and a more desirable situation for endodontic therapy will result. With complete pulpal necrosis, apexification is indicated in order to generate a positive apical stop, facilitating root canal therapy.<sup>11</sup>

All 5 retained teeth in these two patients developed root resorption. Complete removal of degenerative tissue and obliteration of the root canal with calcium hydroxide in teeth with complete root development will help reduce the onset of external or internal root resorption if instituted early enough. Calcium hydroxide treatment limited the root resorption in all intruded teeth reported here. Calcium hydroxide can be placed in teeth with incomplete root formation if root resorption is noted. This usually stops root resorption and eliminates periodontal ligament pathology which may provide the additional benefit of maintaining the integrity of Hertwig's root sheath and allowing continued root development. If root closure is achieved, surgical endodontic treatment can be eliminated in a large number of teeth.

If contemporary recommendations for repositioning teeth orthodontically are followed, root resorption may be a problem. When the injury has been

minor or moderate in severity, root resorption probably will not result with orthodontic movement.<sup>12</sup> However, teeth with a history of severe trauma or resorption prior to orthodontic treatment may be more prone to root resorption.<sup>12,13</sup>

## Conclusions

These clinical reports illustrate the complicating factors associated with intrusively luxated teeth. The necessity for coordination of orthodontic and endodontic treatment has been reported. The treatment includes immediate orthodontic repositioning of all intruded teeth and the indicated endodontic treatment for pulpal necrosis to prevent or arrest root resorption. These recommendations are based on the best available evidence, but should be evaluated constantly in the face of new reports from controlled studies.

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### **Quotable quote: smokeless tobacco**

This paper compared the use of smokeless tobacco and its effects in rural and urban teenagers. A random sample of 445 subjects from rural Colorado were examined: 82.9% of the total sample were Caucasian, and 94.6% of those who used smokeless tobacco were Caucasian. This percentage supports the findings of an earlier urban study that the habit is predominately one of male Caucasians. The average age of the users was 16.7 years, slightly older than in the urban study.

Of the rural users, 62.5% had lesions of the oral tissues, compared with a 48.7% lesion incidence in urban users. In both studies, those subjects with lesions had longer daily contact with smokeless tobacco, as well as a longer history of use than those without lesions.

Poulson TO, Lindenmuth, JE Greer Jr RO:  
A comparison of the use of smokeless  
tobacco in rural and urban teenagers. *CA*  
Sept/Oct, 1984.