



Factors Affecting Outcomes of Traumatically Extruded Permanent Teeth in Children

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Abstract

Purpose: The objectives of the present study were to determine the prevalence of residual extrusion, pulpal necrosis, and resorption for extruded permanent teeth and to establish the effect of presentation and treatment factors.

Methods: Seventy-two traumatically extruded permanent incisors were studied at the Departments of Paediatric Dentistry in Belfast, Newcastle upon Tyne, and Glasgow. The mean age of the patients was 10.1 years (range=6 to 18 years). Clinical and radiographic outcomes were analyzed and related to presenting and treatment factors.

Results: The initial degree of extrusion was moderate for 46 teeth (64%), and the median delay prior to repositioning was 3 hours (range=1 to 168 hours). Pulp necrosis occurred in 31 teeth (43%), residual extrusion was present in 16 teeth (23%), and inflammatory resorption occurred in 11 teeth (15%). Residual extrusion was significantly associated with a delay in repositioning the tooth, pulpal necrosis was significantly more common in teeth with closed apices and in severely extruded teeth, and inflammatory resorption was more common after pulpal necrosis.

Conclusions: Residual extrusion could be minimized by earlier presentation and repositioning. The risk of pulpal necrosis is greatest for severely extruded teeth and for those with closed apices. (*Pediatr Dent.* 2003;25:475-478)

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Extrusion is a form of luxation injury that may result after trauma where the tooth is partially displaced from the socket in an axial direction and may be regarded as partial avulsion. Injuries of this type result in rupture of the periodontal ligament along with damage to the apical vessels; however, the tooth is not displaced through alveolar bone. Clinically the tooth will appear elongated and is initially mobile. Bleeding is seen in the gingival sulcus and the percussion sound is dull. Radiographic evidence will confirm the displacement from the socket and an increase in the width of the periodontal ligament. Histological changes show the rupture of the periodontal ligament and damage to the neurovascular supply.

Luxation injuries account for approximately 15% of traumatic injuries affecting the permanent dentition. The direction and type of force will determine the nature of the

luxation injury.¹ Few studies have examined extrusive injuries alone, but it has been reported that they account for approximately 3% of all traumatic injuries to the dentition.² There are important differences in extrusion and lateral luxation, as the extrusive injury results in tearing of the periodontium as opposed to the crushing injury seen in lateral luxation. Studies have concluded that pulpal necrosis following luxation injuries depends on the stage of root development with an increase in pulpal necrosis in these teeth with mature apices.^{2,3}

More than 4% of luxation injuries show radiographic evidence of transient apical radiolucency, which can be mistaken for apical infection. The frequency is highest in extrusive and lateral luxations (11%-12%).⁴ Further radiographic follow-up is required to demonstrate resolution of this radiolucency. Endodontic treatment is

not always necessary but should be reserved for cases where there is evidence of pulpal necrosis. The immediate treatment of extruded teeth consists of careful repositioning of the tooth into the alveolar socket and fixation with a nonrigid splint.^{1,5} Local anesthesia is not always essential,^{5,6} but its use is recommended to prevent unnecessary pain.⁷ In cases of resistance to repositioning due to clot organization, more manipulation and pressure is needed.⁷ Gentle and steady pressure can be applied by the patient for 15 to 20 minutes by biting on a gauze compress.⁸

After repositioning, a splint should be applied to stabilize the tooth and prevent it from moving incisally. It should be maintained until commencement of periodontal healing and a reduction in mobility^{1,9} is noted. It had been recommended that extruded teeth must be splinted for a period of 3 to 6 weeks, but more recently a shorter duration of 1 to 2 weeks has been advocated.⁷ In cases where the treatment is delayed and the tooth is firm in the new position, forceful reduction may produce an additional injury and increase the risk of complication.⁶ Where the tooth fails to come to its normal position, orthodontic repositioning may be indicated.^{1,8} Because of the high incidence of pulp necrosis in traumatically extruded teeth with complete root formation, some authors recommend routine endodontic treatment for extruded teeth with complete root formation. In contrast, immature teeth should be managed by pulpal monitoring and radiographs and endodontic treatment reserved for cases where pulpal necrosis occurs. Other authors state that all traumatically extruded teeth with open or closed apices should be monitored regularly and, in cases where signs of pulp necrosis develop, endodontic treatment should be instigated and the root canal dressed with calcium hydroxide.^{10,11} In extruded teeth, there is a moderate risk of inflammatory resorption, which can occur in teeth with open as well as closed apices.¹

This study was undertaken because there are limited data on the outcomes of extruded permanent teeth in children and the possible factors that can affect them. The aims of this study were to:

1. determine the frequencies of the presenting and treatment factors for a sample of traumatically extruded permanent teeth;
2. examine the prevalences of residual incisor extrusion after the repositioning procedure and pulpal necrosis and inflammatory root resorption; and
3. investigate the association between the presenting and treatment factors and the above outcomes.

Methods

This was a retrospective study based on patients treated at the Schools of Dentistry of Belfast, Glasgow, and Newcastle upon Tyne. The records of 76 children between the ages of 6 to 18 years attending the units with an extrusive injury of a permanent tooth were included in the study. All cases were included, provided they met the inclusion criteria of age and a minimum of 1 year at-

tendance after the trauma. Cases where there was an appreciable lateral movement of the tooth were not included. The patient's age, the tooth involved, and the degree of extrusion were all recorded.

Standard intraoral radiographs were taken using the paralleling technique, and the state of apical development at the first presentation was recorded as open or closed. The position of the tooth was assessed radiographically as the relationship of the cemento-enamel junction to the alveolar crest and relative to the lamina dura. The degree of extrusion was judged as *moderate* if it was less than or equal to 3 mm or *severe* if it was more than 3 mm. The period of delay from the time of trauma to the repositioning procedure was recorded as minimal if it was less than 3 hours, which was considered reasonable as there is always some time interval between an accident and attendance. The delay was considered more significant in all other cases, as increased delay means a firmer blood clot which could make repositioning difficult. The teeth were repositioned manually and splinted until there was a satisfactory reduction in mobility. The teeth were then examined for the presence of residual extrusion, as evidenced by the presence of an increased space between the apex of the root and the adjacent lamina dura.

Cases were reviewed and examined for clinical or radiographic evidence of pulp necrosis or inflammatory root resorption. Pulpal status was examined by means of electrical pulp tests at 2 weeks, 6 weeks, and, subsequently, at 3-month intervals. Radiographs taken up to 1 year after the trauma were examined for inflammatory resorption, as evidenced by loss of root tissue with loss of adjoining bone. Surface resorption was not included in this study. A minimum follow-up of 1 year was considered reasonable because the complications examined in the present study can be detected within this period.¹² Frequency tables were constructed and values of means and ranges were calculated. Analysis was carried out using cross-tabulations to examine the outcomes of residual extrusion, pulpal necrosis, and inflammatory resorption and the effect of presenting and treatment factors. The significance of relationships between outcomes and factors was examined using χ^2 and Fisher exact *P* tests as appropriate, and odds ratios were subsequently calculated for significant factors.

Results

A total of 72 traumatically extruded permanent incisors were studied. The patients' ages at the time of injury varied from 6.1 to 18.1 years with a mean of 10.1 years. There were 58 maxillary central incisors, 7 maxillary lateral incisors, 5 mandibular incisors, and 2 maxillary canines. The delay prior to repositioning ranged from 1 to 168 hours with a median of 3 hours. The initial degree of extrusion was moderate for 46 teeth (64%) and severe in 26 teeth (36%). The initial apical development was noted as open in 36 teeth (50%) and closed in the remainder. After treatment, 16 teeth (22%) were not fully repositioned, pulpal

Table 1. Factors Affecting the Prevalence of Residual Incisor Extrusion After the Repositioning Procedure

Factor	No residual extrusion	Residual extrusion	Statistical significance
Minimal delay	32	4	$P=.039$
Significant delay	22	11	
Moderate extrusion	32	12	$P=.378^*$
Severe extrusion	22	4	
Open apex	25	10	$P=.394^*$
Closed apex	29	6	

* Not significant

Table 2. Factors Affecting the Presence of Pulpal Necrosis in Traumatically Extruded Incisors

Factor	No pulpal necrosis	Pulpal necrosis	Statistical significance
Open apex	27	9	$P=.002$
Closed apex	14	22	
Moderate extrusion	31	15	$P=.017$
Severe extrusion	10	16	
Minimal delay	22	14	$P=.581^*$
Significant delay	18	15	

* Not significant

Table 3. Factors Affecting the Presence of Inflammatory Resorption in Traumatically Extruded Incisors

Factor	No inflammatory resorption	Inflammatory resorption	Statistical significance
No pulpal necrosis	37	4	$P=.188^*$
Pulpal necrosis	24	7	
Open apex	31	5	$P=.757^*$
Closed apex	30	6	
Moderate extrusion	40	6	$P=.511^*$
Severe extrusion	21	5	
Minimal delay	30	6	$P=.736^*$
Significant delay	29	4	

* Not significant

necrosis occurred in 31 teeth (43%), inflammatory resorption was present in 11 teeth (15%), and there was evidence of pulpal sclerosis in 20 teeth (28%).

The effect of factors on the prevalence of residual extrusion after repositioning is shown in Table 1. The results show that a delay in repositioning had a significant effect on residual incisor extrusion ($P=.039$; odds ratio=4), indicating that those teeth repositioned at a late stage after the trauma were significantly more likely to have been less than fully repositioned. For teeth with residual extrusion, the median delay prior to the repositioning procedure was 24 hours. None of the other factors had a significant effect on residual extrusion. Table 2 shows the effect of factors on the prevalence of pulpal necrosis. The degree of apical closure ($P=.002$) and the initial degree of extrusion ($P=.017$) significantly affected pulpal necrosis. The presence of a closed apex had the biggest effect ($P=.002$; odds ratio=4.7) followed by the degree of the initial extrusion ($P=.017$; odds

ratio=3.3). In contrast, a delay in repositioning the tooth did not have a significant effect on pulp necrosis. The median time of diagnosis of pulpal necrosis was 8 weeks after the trauma, the evidence being obtained by pulp testing and periapical radiographic changes. Table 3 shows the results relating to the presence of inflammatory resorption, and this reveals that while pulp necrosis was the strongest factor, none of the factors reached a significant level of effect. The median time of detection of inflammatory resorption was 15 weeks after the trauma.

Discussion

Extruded teeth, when gently repositioned and splinted for a short duration, appear to have a good prognosis. Due to the nature of the injury, with damage and ischaemic changes occurring in the periodontal membrane and pulp, regular clinical and radiographic review are important because the incidence of pulp necrosis is high, especially in teeth with closed apices.¹³⁻¹⁵

Since the present study was based on clinical practice, pulpal vitality was judged on the basis of electrical pulp testing and radiographic findings. In the present study, a closed apex and the degree of initial extrusion were found to be significant factors in the loss of vitality. While other studies have shown the stage of apical development to be a very significant factor in pulp vitality,^{1,2,15,16} the effect of the degree of extrusion has not been reported previously. It has been suggested that extruded teeth with closed apices should either be treated endodontically or be closely monitored,¹ and the results of the present study suggest that the degree of extrusion should also be considered.

More than one fifth of the teeth in the study had residual extrusion after repositioning. A delay in presentation had a significant effect on the final position, as the blood clot would have had time to establish. This delay can make full manual repositioning very difficult, and excessive force should be avoided as this may increase the risk to the supporting structures. While approximately half of all teeth in the present study were repositioned within the first 3 hours of trauma,

there were many instances of significantly delayed presentation. In cases where there is considerable delay or if it is not possible to fully reposition the tooth into its original position, then healing may be allowed to occur and the discrepancy could be corrected orthodontically.^{2,6,14} The present study did not show that the original degree of extrusion or the apical development state had any marked effect on the postoperative tooth position. Replacement resorption is known to be very rare after extrusive injuries, as it usually results from a crushing rather than a tearing injury, and, therefore, it was not included in the present study. With regard to inflammatory root resorption, the prevalence in the authors' study was similar to that reported previously,^{14,17} and the authors found that it was most likely to occur in teeth with pulp necrosis.

This study quantifies the prevalence of residual extrusion after repositioning and confirms that extrusive injuries to teeth should be treated as soon as possible after the trauma to obtain optimal tooth position. It appears that the prognosis for this type of injury is good, the loss of pulp vitality being the most common complication, especially in cases with closed apices and in severely extruded teeth. The study confirms that there is a moderate risk of inflammatory root resorption, especially in cases where the pulp becomes necrotic. Clinical and radiographic monitoring should be carried out regularly to assess pulpal vitality, and, if pulpal necrosis occurs, endodontic treatment should be undertaken to minimize the risk of inflammatory resorption.

Conclusions

1. Delay in repositioning extruded teeth increases the risk of residual extrusion.
2. In extruded teeth, the main sequela is pulpal necrosis, which can often be detected within the first 8 weeks.
3. Apical closure and the degree of extrusion increase the risk of pulp necrosis.
4. In extruded teeth, there is a lower risk of inflammatory resorption; when it occurs, it can often be detected within the first few months.
5. Extruded teeth should be repositioned promptly and monitored carefully for signs of pulp necrosis and resorption.

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