Interdisciplinary management of severe intrusion injuries in permanent incisors: a case series

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VERIFIABLE CPD PAPER

IN BRIEF

- Outlines interdisciplinary management techniques of severe intrusion injuries in permanent incisors.
- Highlights the benefits of orthodontic repositioning of severely intruded teeth in the short and medium terms.
- Stresses the importance of an immediate referral of such complex cases to a specialist centre.

PRACTICE

Intrusion injuries to the permanent dentition are among the most severe types of dental injuries, occurring in 0.3–1.9% of all dental trauma cases. The current clinical guidelines in the management of intrusion injuries are based on level B evidence due to the infrequent nature of this type of injury, coupled with a lack of high quality evidence-based studies. This paper presents four cases of severe intrusion injuries that were successfully managed using an interdisciplinary approach. The cases described here highlight the benefits of orthodontic repositioning of severely intruded teeth in the short and medium terms. Although orthodontic repositioning was unsuccessful in the final case, this did not preclude subsequent surgical repositioning. Interdisciplinary collaboration allowed two of the cases described to be effectively managed with premolar autotransplantation alongside orthodontic treatment. The cases demonstrated here indicate the difficulties in providing the current recommended treatment modalities at non-specialist clinics. They accentuate the importance of an immediate referral of such complex cases to a specialist centre where interdisciplinary management is readily available.

INTRODUCTION

Intrusion injuries to the permanent dentition, although rare (0.3–1.9%),¹ are one of the most severe types of traumatic dental injuries. By definition, an intrusion is an axial displacement of the tooth into the alveolar socket.^{1,2} This type of injury is often associated with severe damage to the tooth, gingival tissues, alveolar bone and pulpal tissues.^{1–3} The rarity of this injury, coupled with the lack of well-conducted outcome studies, means that the clinical guidelines are based on grade B evidence (clinical/case-control/cohort studies).²

The British Society of Paediatric Dentistry (BSPD)² and the International Association of Dental Traumatology (IADT)⁴ guidelines recommend that teeth with severe intrusion injuries (>6–7 mm) and open apices should be repositioned either orthodontically or

surgically, while those with closed apices should be surgically repositioned.

Many patients in the UK receive their emergency treatment from accident and emergency (A&E) practitioners and general dental practitioners (GDP) who may be uncertain of current guidelines⁵ and may not have the experience or confidence to manage these severe injuries.⁶ Furthermore, such injuries can be complicated by other concomitant tooth injuries (67.3% of cases),¹ thus increasing the complexity of the overall management of such cases. Patient cooperation is also a crucial factor, especially as injuries of this type occur mostly in children aged 6–12 years and patients often present in distressing circumstances.¹

Four intrusion cases are described in this paper, two of which presented to the specialist centre several days after the injury had occurred. All of the cases were successfully managed using an interdisciplinary approach with paediatric and orthodontic involvement.

CASE SERIES

Case one

A healthy girl aged 8 years 11 months was referred by the Salaried Dental Services (SDS) for the management of her severe intrusion injury that had been sustained 5 days earlier. The patient reported tripping and falling 'head first' in the bathroom

with the maxillary dentition contacting the toilet seat.

The patient was initially seen at her local A&E department where a dental panoramic tomogram (DPT) and a chest x-ray were taken by the maxillofacial team to assess the type of the trauma and rule out inhalation of the fractured tooth tissue. The patient was admitted overnight, prescribed a course of amoxicillin and referred the following morning to the local SDS.

Upon presentation, the patient was found to have uncomplicated enamel/dentine (E/D) fractures of 12, 11, 21 and 41. The patient also sustained moderate intrusion of the 11 and severe intrusion of the 21. The SDS practitioner provided emergency treatment in the form of composite bandages on the teeth with E/D fractures. The patient was subsequently referred to our specialist centre for further management.

At the specialist centre, the patient was examined clinically (Fig. 1) and radiographically (Figs 2a and b) and it was noted that 11 had an E/D fracture with moderate intrusion of approximately 4 mm while 21 had sustained an E/D fracture with severe intrusion of over 7 mm. Following an interdisciplinary discussion between the paediatric and orthodontic practitioners, a treatment plan was devised that included orthodontic repositioning of 11 and 21.

The 11 and 21 were first minimally loosened, that is, disimpacted from the

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Fig. 1 Case one clinical photographs (a) at presentation to our specialist centre (IOR); (b) 5 weeks after IOR; (c) following debond and composite build-ups; (d) 18 months following trauma – note that 21 is 1 mm infraoccluded

alveolar bone, under local analgesia. Orthodontic repositioning was initiated at this visit using rapid fixed orthodontic extrusion with a stainless steel arch wire and elastic tubing (Fig. 1a).

The patient was reviewed after 3 weeks at which point 11 had been sufficiently extruded to facilitate extirpation of the necrotic pulp and placement of UltracalXS (Ultradent Products, Inc. 505 W. 10200 S. South Jordan, UT 84,095) dressing in the root canal. Five weeks after the initiation of orthodontic repositioning (IOR), 21 had also been sufficiently extruded to facilitate pulp extirpation and dressing of the tooth with UltracalXS (Fig. 1b). At this session, the 12, and 41 were restored using composite restorative material. These teeth were then

Fig. 2 Case one radiographic assessment (a) upper standard occlusal at presentation to the specialist centre showing severe intrusion of 21 with E/D fracture, and moderate intrusion of 11 with E/D fracture; (b) Long cone periapicals (LCPA) of 11 and 21 at 10 weeks after IOR showing inflammatory root resorption; (c) LCPAs after obturation of the intruded teeth 44 weeks after IOR; (d) LCPA at 18 months following trauma showing replacement resorption of 21

monitored for pulpal and periodontal healing as part of the overall trauma management.

Ten weeks after IOR, 21 was built up with composite to facilitate further orthodontic management. Radiographic examination showed evidence of minimal inflammatory resorption of 11 and severe inflammatory resorption of 21 (Fig. 2b). The patient was reviewed every 4 weeks thereafter until 11 and 21 were aligned at 24 weeks following IOR (Fig. 2c). This was followed by a 3-month period of retention after which the appliances were debonded. The traumatised teeth were built up with composite resin restorations at this stage, to create sufficient overbite to establish physiologic retention (Fig. 1c).

Ten weeks later, no further inflammatory root resorption or adjacent radiolucency in the alveolar bone was seen on the radiographic assessment and therefore both teeth were obturated with gutta percha filling (Fig. 2c). The overall time that had elapsed between IOR and obturation of the teeth following debond was almost 10 months with a total number of 12 visits.

Eighteen months following the traumatic injury, 21 was found to be infra-occluded by 1 mm. There were no other clinical signs of ankylosis such as a high percussive sound, however, the periapical radiograph taken at this stage revealed that replacement resorption of 21 had occurred. 12 and 41

demonstrated clinical and radiographic evidence of pulpal and periodontal healing (Figs 1d and 2d).

Case two

A healthy 8-year-old boy was referred by his GDP to our specialist centre following dental trauma that had been sustained 2 weeks earlier. The injury had occurred following a fall that resulted in the patient striking his face against some concrete steps. The patient presented with severe intrusion of 11 and subluxation of 21 (Fig. 3). Radiographic examination showed incomplete root formation and a wide-open apex of both 11 and 21 with severe intrusion of 11 (7 mm). Radiographically, there was no evidence of root fracture of 11 or 21 (Fig. 4).

The 21 was assessed for pulpal and periodontal healing. Orthodontic repositioning was commenced at the initial appointment using fixed appliance therapy utilising an eyelet bracket and nickel titanium arch wire (Fig. 3a). The 11 showed a positive response to sensibility testing and a decision was made to monitor the pulpal health of this tooth.

The patient was reviewed 4 weeks later (Fig. 3b) with 11 exhibiting 3 mm extrusion. The eyelet on 11 was removed and replaced with an orthodontic bracket. The patient was regularly reviewed 4 weekly and 11 was aligned after 14 weeks. The appliance was

Fig. 3 Case two clinical photographs (a) at IOR (2 weeks post trauma); (b) 8 weeks after IOR; (c) 14 weeks after IOR

debonded 14 weeks after IOR (Fig. 3c). At this visit 11 was asymptomatic, showed a positive response to sensibility testing, and had a good gingival margin. There were no radiographic signs of resorption, radiolucency or marginal bone loss at the 18 week review (Fig. 4). The patient, unfortunately, failed to attend any of his review appointments and was discharged into the care of his general dental practitioner.

Case three

A fit and healthy girl of 9 years 10 months attended the paediatric department at our specialist centre following an intrusion injury to 11 and concussion to 21. This injury was sustained following a fall in the school playground. 11 also sustained a complicated E/D fracture, while 21 had sustained an E/D fracture (Fig. 5).

Clinical and radiographic examination revealed severe intrusion injury and enamel/dentine fracture of 11 and enamel/dentine fracture of 21. Both teeth had open apices with convergent walls (Fig 6a). An attempt to manually reposition 11 under local anaesthesia was made, however, it was only possible to move the tooth a few millimetres due to lack of patient cooperation. The initial management also involved placement of a

glass ionomer dressing over the E/D fracture and a 5-day course of amoxicillin. The patient and their parent were also advised of the poor long-term prognosis of 11. The following treatment plan was devised:

1. In the short term: orthodontic repositioning of 11 in order to enhance bone height and quality, therefore facilitating any future restorative options for prosthetic replacement of 11 in the long term. In addition, the 11 and 21 were restored with composite and monitored
2. In the long term: since the patient was in need of orthodontic treatment for the underlying malocclusion, upper arch extractions were planned, along with extraction of 11 and auto-transplantation of one of the upper second premolar teeth into 11 socket.

Six days after surgical repositioning, fixed orthodontic rapid extrusion utilising a stainless steel arch wire and elastomeric power-chain was initiated and composite build up of the 11 and 21 was performed. The patient was reviewed 3 weeks after IOR. Further orthodontic repositioning was undertaken (Fig. 5b) to optimise the gingival and bony architecture for the subsequent transplant while also facilitating extirpation of the root canal system (Fig. 6b). Nickel titanium push-coil was used to create space between 12 and 21 in preparation for placement of the premolar transplant.

Eight months after initial presentation, 11, 15, 25 were extracted and 15 was transplanted into 11 socket under general anaesthesia. The 15 had incomplete root formation at the time of transplantation. The transplanted premolar was reshaped into a central incisor with the placement of a composite veneer 10 days post-transplantation (Figs 5c and d).

The transplanted tooth was then monitored radiographically for 2.5 years (Fig. 6c) and clinically for 4.5 years (Figs. 5e and f). To date, the transplanted tooth and the fractured 21 show no clinical or radiographic signs of loss of vitality, root resorption or periapical radiolucency. There was evidence of labial gingival recession associated with 11 and the patient is currently awaiting a gingival graft and porcelain veneer for aesthetic improvement of this transplanted tooth.

Case four

A 9-year-old boy with mild autism was referred by his GDP to our specialist centre following a fall onto a table resulting in avulsion of 11 and intrusion of 21. Both 11 and 21 had complete root development at the time of the injury. 21 was intruded by 7 mm, while 11 was placed in milk within

Fig. 4 Case two radiographic assessment (a) a standard occlusal of 11 and 21 at IOR (2 weeks post trauma); (b) LCPT of 11 and 21 8 weeks after IOR; (c) LCPT of 11 and 21 18 weeks after IOR

Fig. 5 Case three clinical photographs (a) on day of traumatic injury; (b) 3 weeks after IOR; (c, d) 8 months following trauma showing the transplanted tooth in 11 position with a composite veneer, and an upper fixed appliance with a transpalatal arch (TPA) and Nance button; (e, f) following completion of orthodontic treatment showing the transplanted premolar in 11 space with well aligned upper and lower arches

Fig. 6 Case three radiographic assessment (a) at presentation (same day of the trauma); (b) 3 weeks after IOR showing periapical radiolucency; (c) LCPA showing the premolar transplanted into 11 position 2.5 years after transplantation, showing no evidence of loss of vitality, or progressive root resorption

10 minutes of the injury and was replanted 2 hours later at the local A&E department under local analgesia. A composite splint was placed on 11, 21 and 22.

At our specialist centre, the patient was assessed clinically (Fig. 7) and radiographically (Fig. 8a) and following discussion of the case by orthodontic and paediatric dentistry specialists, the following treatment plan was devised:

- Remove composite splint
- Orthodontic repositioning of 21 and intrusion of replanted 11
- Root canal treatment 11 7 days post-injury
- Sensibility testing and monitoring of 21 with the high probability of undertaking root canal treatment.

Rapid extrusion was carried out using a fixed orthodontic appliance with a round nickel titanium arch wire and elastomeric power-chain (Fig. 7b). The 11 was extirpated and dressed with non-setting calcium hydroxide dressing 7 days post-injury.

Two weeks later, a round stainless steel arch wire was placed with a step-down bend

to allow extrusion of 21 and elastomeric power-chain was used to extrude 21 (Fig. 7b).

Eight weeks later, no further extrusion was achieved as 21 was found to be ankylosed. Following an interdisciplinary discussion, a decision was taken to surgically extrude 21, which was performed at the same appointment under local anaesthetic using forceps (Fig. 7c). Due to the poor long-term prognosis of 11 and 21, a decision was also made to transplant the lower first premolar teeth into the upper central incisor area upon eruption of these teeth. A titanium trauma splint (TTS) was applied and included 12, 11 and 21. 21 was subsequently accessed and dressed with calcium hydroxide 7 days later when the splint was removed.

Twelve months after the initial injury, the patient presented with pain and mobility of 11. A long-cone periapical (LCPA) radiograph revealed severe replacement resorption. The tooth was found to be very mobile and therefore stabilised with a TTS splint until the patient was ready for autotransplantation of the lower premolars.

Twenty-six months following the trauma, the patient received his premolar

Fig. 7 Case four clinical photos (a) at presentation to our specialist centre; (b) 5 weeks after IOR; (c) After surgical repositioning of 21; (d) 10 days after premolar transplantation; (e) 9 months following autotransplantation showing further eruption of the transplanted premolars; (f) 15 months following transplantation showing temporary composite veneers and twin block (more definitive restoration of the transplanted teeth will be provided following discussion with the orthodontic team)

transplantation under GA where 44 and 34 were transplanted into 21 and 11 sockets (Figs 7d and 8b). The premolars were allowed to erupt in their new position and both showed signs of continued root formation on follow-up radiographic assessment (Fig. 8c). The transplanted premolars were restored with temporary composite veneers while the patient receives his orthodontic treatment.

DISCUSSION

We have presented four cases of severe intrusion injuries that have been managed using an interdisciplinary approach. These cases highlight:

1. The difficulties in providing current recommended treatment modalities at non-specialist clinics (general dental practices and accident and emergency departments), both in providing the emergency and long-term care
2. The importance of urgently referring such cases to a specialist centre where interdisciplinary management is available

3. The benefits of using orthodontic repositioning of traumatically intruded teeth.

Often intrusion injuries do not occur in isolation, as shown in the four cases illustrated. Other injuries were managed in line with the current guidelines.^{4,7}

Initial management of intrusion injuries at emergency clinics (non-specialist centres)

The current guidelines for management of severe intrusion injuries recommend active repositioning in the form of surgical or orthodontic repositioning depending on the degree of root formation stage of the tooth.^{2,4}

According to the current guidelines, a severely intruded tooth with immature root formation requires orthodontic repositioning in addition to monitoring the vitality of the tooth. This is difficult to achieve in a non-specialist setting. The emergency treatment of other traumatised teeth and a rapid referral to a specialist centre for intruded teeth is, however, appropriate in a more general setting.

Fig. 8 Case four radiographic assessment (a) standard occlusal at presentation to specialist centre; (b) 10 days after transplantation of the lower first premolars into upper central incisor area; (c) 9 months following transplantation

Case two was that of a patient seen 2 weeks after a severe intrusion injury to 11. The GDP was not sure of the referral pathway of such cases to a specialist centre, which lead to a delay in presentation of 2 weeks. Fortunately, 11 had a wide-open apex with divergent walls and therefore the tooth retained vitality. This highlights the importance of developing a care pathway for traumatic dental injuries and of educating practitioners as to the existence of such pathways, so that appropriate referrals are made and received in a timely fashion.

Severely intruded teeth with complete root formation require surgical repositioning soon after the trauma. This is not always possible due to several factors including patient cooperation and the experience of the clinician to whom the patient initially presents.

The cooperation of children during emergency treatment has been reported as one of the most important barriers to treatment of dental trauma in children by GDPs.⁵

Intrusion injuries are also rare and therefore treating practitioners find themselves unsure of the management guidelines. A lack of experience and possibly confidence may result. In a survey of 417 GDPs, in six local health authority districts in North East England,⁶ none of the GDPs reported treating any intrusion cases in the preceding 6 months.

In case one, 21 had almost complete root formation and had suffered a severe intrusion injury. According to the current guidelines this tooth should have been surgically repositioned. However, despite being seen by her local A&E department and the oral and maxillofacial surgery department shortly after the injury, followed by the SDS practitioner 2 days later, this had not been performed. The patient was seen at our specialist centre 5 days after the injury and a decision was made to orthodontically reposition 21 at this stage. Intrusion injuries are unique in that although they are considered among the most severe of the dental injuries,² acute management may be postponed by a few days.⁸

In a retrospective study examining 140 intruded teeth, Andreasen *et al.*⁸ reported that there was no significant effect of repositioning delay on pulp necrosis, root resorption or marginal bone loss. Interestingly, Humphrey *et al.*⁹ showed a trend towards failure if active repositioning was postponed for more than 2 weeks after the injury and as such recommend immediate active repositioning be applied. This view is also consistent with the review by Medeiros *et al.*¹⁰ who reported that teeth receiving

immediate orthodontic repositioning (in a maximum period of 7 weeks post-trauma) were repositioned seven times faster in comparison to those receiving late orthodontic repositioning (3 months or more post-trauma).

Therefore, provided that all intrusion injuries are correctly diagnosed and any other dento-alveolar injury is managed appropriately, intruded teeth can be left untreated provided an urgent referral (within a few days) to a specialist centre is made for immediate and long-term management.

Management of intrusion injuries at specialist centres

Orthodontic versus surgical repositioning

Surgical repositioning is an invasive procedure that requires a minimum of local analgesia in cooperative children and general anaesthesia in uncooperative children. This procedure leads to an additional insult to the tooth, which could further compromise tooth survival.⁸ It is, however, recommended for teeth with complete root formation and a moderate to severe intrusion injury, as it allows access to the root canal system within the recommended 2 weeks following injury.^{2,4}

Orthodontic repositioning is a non-invasive procedure suitable for managing apprehensive children, especially when surgical repositioning would otherwise necessitate a general anaesthesia. It may be argued that this technique provides better long-term outcomes with respect to the alveolar bone contour and marginal gingival healing.⁸ In addition, should ankylosis occur, surgical repositioning would still be possible as demonstrated in case four. However, this option does lead to a delay in extirpation, thus increasing the risk of inflammatory resorption in teeth with complete root formation. Orthodontic repositioning does require more appointments than surgical repositioning. This would generate an increase in overall economic cost to the National Health Service (NHS) as well as an economic and social cost to the parents and children involved. It may also be associated with a greater inconvenience to parents and impact on school attendance.

The current evidence, although based on retrospective studies and typically small sample sizes, shows no significant effect of the method of repositioning used (orthodontic *versus* surgical repositioning) on the development of pulpal necrosis, root resorption or marginal bone loss.^{2,8,9,11,12} The recommendation to apply surgical repositioning is therefore merely to allow rapid pulp extirpation of the root canal

systems of teeth with complete root formation.

The four cases that have been presented demonstrate the use of orthodontic repositioning in the management of severely intruded teeth with a variety of clinical scenarios where different short and long-term outcomes were achieved. In the short term, orthodontic repositioning of these cases yielded good outcomes in the first three cases as these teeth were extruded to their occlusal level. In the fourth case, although the tooth became ankylosed, this did not prevent surgical repositioning, which was eventually performed. Good aesthetics and function were maintained in each case and bone integrity was preserved for more definitive treatment in the future as shown in cases one, three and four.

Regardless of the treatment modality used, the successful management of severe intrusion both in the short and long term requires an interdisciplinary approach with careful monitoring of the case and consideration of future treatment options. In the third case, due to the poor long-term prognosis of 11, it was identified that the patient would be suitable for a premolar transplant at a very early stage of treatment. Therefore the treatment plan was modified, as the tooth was extruded and then space was created for the transplanted premolar.

Healing complications:

Severe intrusion injuries are associated with a loss of pulp vitality in 61–67% of immature teeth and 88–98% of mature teeth.² It is therefore recommended that mature teeth are extirpated within approximately 2 weeks of the injury, and to closely monitor immature teeth for signs of loss of vitality.² This is to minimise the risk of inflammatory (infection-related) resorption, which is reported to occur in 42–68% of immature teeth and 51–73% of mature teeth following intrusion injuries.²

Orthodontic repositioning is slower than surgical repositioning and may lead to an increased risk of inflammatory root resorption due to a delay in access for root canal treatment. Delaying pulp extirpation for more than 10 days following an avulsion injury, which has a similar pulpal prognosis to that of intrusion, has been shown to be associated with a higher prevalence of inflammatory root resorption.¹³ Although inflammatory resorption can be treated with long-term calcium hydroxide intra-canal medicament, outcomes where inflammatory resorption has been allowed to become established are poorer.¹⁴ Interestingly four out of seven orthodontically repositioned teeth developed inflammatory resorption in the study by Wigen *et al.*¹²

Orthodontic repositioning allowed access to the necrotic pulp of the 21 after 5 weeks in case one and 3 weeks in case three. In the first case, this resulted in inflammatory resorption of 11, which was controlled with long-term application of non-setting calcium hydroxide (Fig. 2c).¹⁴ The 21 was subsequently obturated approximately 10 months after IOR (Fig. 2d). In case three, however, although there was a delay of 3 weeks for pulp extirpation, no signs of inflammatory resorption were detected in the 8 months preceding autotransplantation. This highlights the unpredictability of the sequelae of traumatic dental injuries.

When considering orthodontic repositioning, it is important to extirpate intruded teeth that have complete root formation as soon as possible, dress the canal with calcium hydroxide and to monitor these teeth for signs of inflammatory resorption. Should inflammatory resorption develop, these teeth should be treated with long-term calcium hydroxide medicament. The teeth should be obturated as soon as the resorption ceases (as shown by the lack of radiolucency in the adjacent bone), and the canal can be kept dry.

Speed of orthodontic repositioning:

The 21 was completely repositioned after 24 weeks in case one and 12 weeks in case two from the start of orthodontic repositioning. This is consistent with the review by Medeiros *et al.*¹⁰ who reported a range from 5 to 28 weeks (mean = 12 weeks). In case three a longer duration of orthodontic treatment was undertaken as space was required for the premolar transplant.

CONCLUSIONS

When severe intrusion injuries of the teeth occur, the initial emergency management

of no intervention is often appropriate if GDPs and A&E practitioners undertake the following actions:

- A detailed medical and trauma history
- A comprehensive extra-oral and intra-oral examination
- A correct diagnosis of all injuries
- Manage other injuries requiring acute intervention
- Advise the patient of appropriate oral hygiene instructions in addition to prescribing chlorhexidine mouthwash where appropriate.
- Provide a rapid referral to a specialist centre where interdisciplinary management is available, following the local care pathway.

At specialist centres, the provision of interdisciplinary care ensures that patients receive optimal short and long-term management. The use of orthodontic repositioning of intruded teeth should be considered as a viable alternative treatment option in severe intrusion injuries, where there has been complete root formation, to optimise gingival and bony healing. When used, gentle forces should be employed and careful clinical and radiographic monitoring should be conducted, and patients counselled, due to the potential for short and long-term complications.

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1. Andreasen J O, Bakland L K, Matras R C, Andreasen F M. Traumatic intrusion of permanent teeth. Part 1. An epidemiological study of 216 intruded permanent teeth. *Dent Traumatol* 2006; **22**: 83–89.
2. Al-Badri S, Zaitoun H, Kinirons M. UK national clinical guidelines in paediatric dentistry. Treatment of traumatically intruded permanent incisor teeth in

- children. *Int J Paediatr Dent* 2009; **7**: 267–268.
3. Andreasen J O, Bakland L K, Andreasen F M. Traumatic intrusion of permanent teeth. Part 2. A clinical study of the effect of preinjury and injury factors, such as sex, age, stage of root development, tooth location, and extent of injury including number of intruded teeth on 140 intruded permanent teeth. *Dent Traumatol* 2006; **22**: 90–98.
4. DiAngelis A J, Andreasen J O, Ebeleseder K A *et al.* International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth. *Dent Traumatol* 2012; **28**: 2–12.
5. Kostopoulou M N, Duggal M S. A study into dentists' knowledge of the treatment of traumatic injuries to young permanent incisors. *Int J Paediatr Dent* 2005; **15**: 10–19.
6. Jackson N G, Waterhouse P J, Maguire A. Management of dental trauma in primary care: a postal survey of general dental practitioners. *Br Dent J* 2005; **198**: 293–297.
7. Day P, Gregg T. Treatment of avulsed permanent teeth in children. UK national clinical guidelines in paediatric dentistry. British Society of Paediatric Dentistry, 2012. Online guidelines available at <http://www.bspdp.co.uk/LinkClick.aspx?fileticket=PYXAON6L75c9%3d&tabid=62> (accessed August 2014).
8. Andreasen J O, Bakland L K, Andreasen F M. Traumatic intrusion of permanent teeth. Part 3. A clinical study of the effect of treatment variables such as treatment delay, method of repositioning, type of splint, length of splinting and antibiotics on 140 teeth. *Dent Traumatol* 2006; **22**: 99–111.
9. Humphrey J M, Kenny D J, Barrett E J. Clinical outcomes for permanent incisor luxations in a paediatric population. I. Intrusions. *Dent Traumatol* 2003; **19**: 266–273.
10. Medeiros R B, Mucha J N. Immediate vs late orthodontic extrusion of traumatically intruded teeth. *Dent Traumatol* 2009; **25**: 380–385.
11. Al-Badri S, Kinirons M, Cole B, Welbury R. Factors affecting resorption in traumatically intruded permanent incisors in children. *Dent Traumatol* 2002; **18**: 73–76.
12. Wigen T I, Agnalt R, Jacobsen I. Intrusive luxation of permanent incisors in Norwegians aged 6–17 years: a retrospective study of treatment and outcome. *Dent Traumatol* 2008; **24**: 612–618.
13. Stewart C, Elledge R, Kinirons M, Welbury R. Factors affecting the timing of pulp extirpation in a sample of 66 replanted avulsed teeth in children and adolescents. *Dent Traumatol* 2008; **24**: 625–627.
14. Trope M, Moshonov J, Nissan R, Bux P, Yesilsoy C. Short vs. long-term calcium hydroxide treatment of established inflammatory root resorption in replanted dog teeth. *Dent Traumatol* 1995; **11**: 124–128.