sciendo
DOI: 10.2478/aoj-1995-0001

THE TREATMENT OF TRAUMATIZED PERMANENT ANTERIOR TEETH: CASE REPORT & LITERATURE REVIEW

PART I – MANAGEMENT OF INTRUDED INCISORS

AUTHOR
Stanley G. Jacobs,* B.D.Sc. (Melb) F.D.R.S.C.S. (Eng) D.Orth. R.C.S. (Eng) F.R.A.C.D.S.

A case is reported in which an intruded incisor was initially treated by an endodontic dressing with calcium hydroxide and then extruded using a removable orthodontic appliance.
A follow-up examination seven years after completion of endodontic therapy and bleaching showed a favourable response.
A review of the relevant literature indicates that intrusion occurs in five to twelve per cent of luxation cases.
In this type of injury maximum damage occurs to the pulp and all supporting structures because the tooth is driven into the alveolar process.
Complications which have been reported include: pulp necrosis, apical radiolucencies, partial or total pulp calcification, root resorption (surface, inflammatory or replacement), marginal periodontal bone breakdown, and arrested or disturbed root development.
The prognosis for pulp survival after intrusion is much more favourable for teeth with incomplete root formation than for teeth with complete root formation.
Treatment options available to bring an intruded tooth into alignment are: to await spontaneous re-eruption which may occur if root formation is incomplete, uncovering of the intruded crown, orthodontic extrusion which is allied with gentle luxation if the tooth does not move, and immediate surgical repositioning.

Key Words: Corrective orthodontics, pulp necrosis, root resorption, tooth luxation.

Aust Orthod J 1995; 13: 213-218

Submitted for publication: May, 1994.
Accepted: January, 1995.

* Specialist Orthodontist,
The Royal Dental Hospital of Melbourne;
Senior Associate,
The University of Melbourne.

Literature Review

Incidence of intrusion

Andreasen[1] carried out a retrospective investigation of 189 luxated permanent teeth. The observation period ranged from one to twelve years with a mean of 3.4 years. Three groups of traumatized teeth were examined, namely: subluxation, intrusive luxation and extrusive luxation. There were 23 intruded teeth (12%). If concussed, laterally luxated and exarticulated teeth had been included in the material the incidence of intruded teeth would have been lower.

Crona-Larsson and Noren,[2] in a retrospective study of 196 luxated teeth, found intrusive luxations comprised five per cent of the injuries. They categorized luxation as: subluxation, intrusive luxation, extrusive luxation, lateral luxation and exarticulation.

Types of complications

In Andreasen's investigation[1] all displaced teeth were repositioned except for one[1] intruded tooth which spontaneously re-erupted. The presence of pulp necrosis, pulp obliteration, root resorption and loss of marginal bone was registered. The highest frequency of pulp necrosis was found in the cases of intrusive luxation (96%). In addition, pulp necrosis was found more frequently among teeth with completed root formation when compared with teeth with incomplete root formation. There was a low frequency of pulp obliteration (4%) after intrusive luxation, probably as a result of the frequent occurrence of pulp necrosis in this group. The highest frequency (52%) of progressive root resorption (inflammatory and replacement resorption) was recorded among intrusive luxations. Loss of marginal bone support was very high (48%).

Surgical uncovering

Shapira, Regev and Liebfeld[3] reported on the treatment of four completely intruded permanent maxillary incisors, two of which had open apices. In the first case, one of the two intruded maxillary central incisors had commenced to erupt seventeen days after the trauma. Sixty days following the trauma, radiographic examination revealed periapical rarefactions around the apices of 11,21. Since access to the root canals of both incisors was not possible due to their intruded position, a palatal gingivectomy was performed. During this procedure scar tissue was removed from above and around both intruded teeth to permit re-eruption and then Endodontic treatment was commenced. Accelerated re-eruption of both incisors was observed after one week. Three months following the gingivectomy 11,21 were fully erupted and in a satisfactory clinical condition. In the second case, the patient who was first seen three weeks after the injury had 11,21 almost completely intruded. Seven weeks later the teeth had not erupted and external root resorption of one of the incisors was visible radiographically. A palatal gingivectomy around and above both incisors was carried out and access to the pulp chamber of the resorbed tooth was obtained. Two months after the gingivectomy 11,12 had re-erupted to an almost normal level.

Shapira, Regev and Liebfield[3] concluded that the gingivectomies performed in order to gain access to the root canals may have removed scar tissue from around the teeththat otherwise would have been a mechanical obstacle to spontaneous re-eruption. They suggested that perhaps this procedure should be used routinely in cases of delayed eruption of intruded incisors.

Tronstad, Trope, Bank *et al.*[4] described the treatment of a case where access to the root canals of completely intruded 11, 21 was obtained by means of a surgical approach ten days post trauma. The patient was eleven years old, root formation of 11, 21 was complete and the apices were closed. The canals were filled with calcium hydroxide paste and the uncovered teeth were allowed to erupt. Eight weeks after the injury the intruded teeth had erupted to almost their original positions.

Pulp necrosis

Andreasen and Pedersen[5] carried out a prospective study of 400 patients with 637 luxated permanent teeth. They studied the development of pulp necrosis after the injuries. Sixty-one of the 637 teeth had been intruded. Like Andreasen,[1] they concluded that the major factors influencing development of pulp necrosis appeared to be the extent of the initial injury to the pulp and periodontium as reflected by the type of luxation (intrusion was found to be the most severe type) and the repair potential of the injured tooth as reflected by the stage of root development. Other factors studied which were found not to be significant were: the age of the patient, degree of dislocation, reduction/ repositioning procedure, type of fixation and restorations in place at the time of injury.

Andreasen and Pedersen[5] found that most cases of pulp necrosis could be diagnosed within three months of the trauma. However, a few cases were diagnosed as late as two years after intrusive luxation. The percentage of teeth in which the pulp survived one year after intrusion was approximately 45 per cent of those with incomplete root formation and one to two per cent of teeth with complete root formation (closed apex). They presented a table with a distribution of complications after luxation injuries. The findings for the 61 intruded teeth were: pulp necrosis 85 per cent, root resorptions 66 per cent, ankylosis 24 per cent, inflammatory resorption 38 per cent, ankylosis and inflammatory resorption 2 per cent, surface resorption 24 per cent, internal resorption 2 per cent, apical radiolucency 67 per cent, marginal periodontal breakdown 31 per cent, partial pulp obliteration 10 per cent, total pulp obliteration 3 per cent, arrested root development 16 per cent, disturbed root development 6 per cent, and gingival retraction 11 per cent. Andreasen and Pedersen[5] did not indicate whether any teeth were eventually lost as a result of any complication after the injury.

Andreasen, Zhijie and Thomsen[6] followed up the work of Andreasen and Pedersen,[5] and investigated whether pulp survival in luxated teeth could be predicted more precisely by considering pulp dimensions instead of root dimensions. The diameter of the apical foramen and the distance from the apical foramen to the pulp horn (pulp length) were investigated radiographically. From their investigation they determined that for intrusive injuries the stage of root development is all that is necessary to determine prognosis with respect to development of pulp necrosis.

Marginal bone loss

Andreasen[1] found marginal bone loss in 48 per cent of his 23 intrusion cases (which were generally immediately repositioned). Andreasen[7] reported that immediate surgical repositioning increased the frequency of loss of marginal bone support. Andreasen and Pedersen[5] found marginal bone breakdown in 31 per cent of their 61 intruded teeth. The treatment procedures for the 61 teeth were those described by Andreasen and Andreasen,[8] that is, intruded permanent incisors with completed root formation were generally repositioned by orthodontic traction and intruded permanent incisors with incomplete root formation generally were allowed to erupt spontaneously.

Immediate surgical repositioning

Kinirons and Sutcliffe[9] reported on 29 traumatically intruded permanent maxillary incisors of 20 consecutive patients who were examined, treated and monitored for two years. Ten teeth received no active treatment and were observed for signs of re-eruption and 19 were surgically repositioned into a removable splint. No teeth were repositioned orthodontically. More moderately intruded teeth (< 5 mm intrusion) were preserved than severely intruded teeth (5 mm intrusion or more). Nine teeth were extracted. The teeth which were surgically repositioned were more frequently preserved and were associated with less frequent marginal bone loss (10%) than those which were passively observed (50%). External root resorption occurred in similar proportions in both groups (38%). More teeth that were delayed in presentation prior to surgical repositioning (>24 hours) were lost than those without such a delay. A significantly higher proportion of teeth with convergent apices were retained than those with less developed roots. The authors stated that root length and area of attachment are more important for tooth survival following intrusion than apical blood supply. One of the 29 teeth gave a vital pulpal response two years after injury. The remainder received endodontic treatment.

Orthodontic repositioning

Perez, Becker and Chosack[10] reviewed a case in which a deeply intruded maxillary cental incisor was repositioned with a removable orthodontic appliance. The spring comprised half of a Hawley labial arch wire which hooked over a button bonded to the labial surface of the intruded incisor. Seven millimetres of extrusion was achieved over a period of five months. Lack of cooperation by the patient extended the treatment time. The authors chose to use a removable appliance in this case because:

a) the intruded tooth was very firmly embedded and had penetrated the floor of the nose, therefore awaiting spontaneous re-eruption was contra-indicated; and surgical repositioning could have led to complete luxation of the tooth and the necessity for implantation in a widely expanded socket.

b) adjacent permanent incisors were mobile, and the canines were partly erupted, therefore, these teeth were not suitable for bonding with a fixed appliance.

c) the spring allowed for accurate measurement of the applied light force (10gm) over a wide range of movement.

Mamber[11] 1 presented a case report in which two maxillary central incisors were deeply intruded. Both incisors sustained concomitant uncomplicated crown fractures, and the lateral incisors were concussed. The intruded teeth were repositioned using a removable appliance which was a Hawley appliance with a cut in the middle of the labial bow, hooked on to buttons bonded to the central incisors.

Poor patient compliance impeded treatment but both central incisors were extruded to some extent, 21 almost to its original position. The 11 was extruded

2mm in the first 45 days of active treatment and then could not be moved for the next six months of appliance wear. Twelve months post-trauma, spontaneous eruption of 11 occurred. All four maxillary incisors required endodontic treatment. The 11 exhibited ankylosis, which resolved. The 22 exhibited inflammatory root resorption, which was arrested. Mamber[11] emphasized that follow-up of dental trauma requires special attention for all the structures involved: that is, the pulp, periodontal ligament and the alveolar bone (as well as restorative measures for the crown).

Spalding, Fields, Torney *et al.*,[12] reported on two patients, the first with three and the second with two intruded incisors. One case was treated by initially allowing re-eruption and the other by immediate application of extrusive orthodontic forces. The first case was observed for seven weeks during which period no re-eruption of the intruded teeth occurred. The 11, 21 had been intruded 7 mm, the 12 only 2 mm. In the eighth week post-trauma fixed appliances were inserted to extrude 11, 12, 21 and radiographically external root resorption was noted on 11, 21. However, access for endodontic treatment was inadequate. A gingivectomy lingual to the intruded teeth was performed and calcium hydroxide packed in the instrumented canals of 11, 21. A radiograph taken three weeks later showed external root resorption on 12 which was also treated with root canal debridement and calcium hydroxide. Six weeks after appliance placement orthodontic extrusion was completed and the case retained. Ten months post- trauma the three teeth were permanently root filled. at follow-up six years and six months post-trauma, the appearance of the teeth was satisfactory.

In the second case, 11, 21 were intruded 8 mm, fixed appliances were placed immediately and the central incisors extruded as rapidly as possible. Within four months the teeth exhibited radiographic evidence of external root resorption. The canal of one incisor was opened, debrided and calcium hydroxide placed. The other incisor was extracted because of a vertical root fracture. Spalding, Fields, Torney *et al.* [12] advocate, as a result of these cases and a review of the literature, immediate orthodontic repositioning as the treatment of choice. They state that immediate repositioning improves access for endodontic treatment, may avoid ankylosis and reduces marginal bone loss.

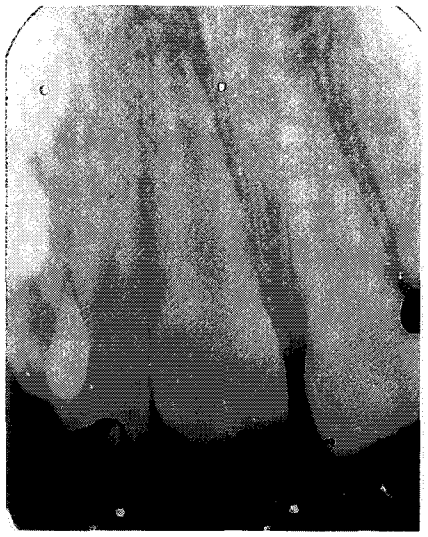

Fig. 1. Periapical radiograph of 11, 12 taken immediately after these teeth received an intrusive luxation - 9/1/82.

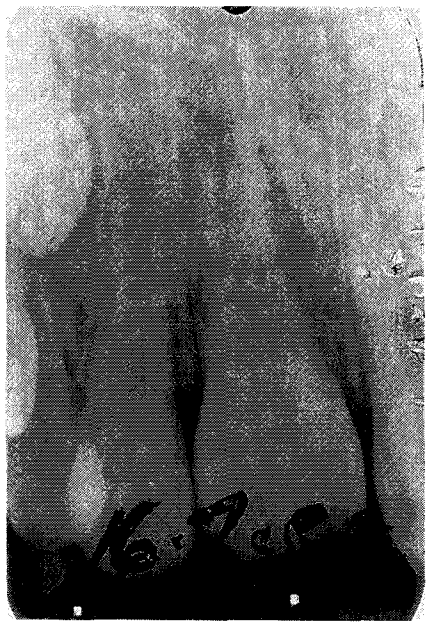

Fig. 2. Radiograph taken five weeks later showing evidence of severe mid-root inflammatory resorption of 11 commencing 16/2/82.

Animal experiments

Turley, Joiner and Hellstrom[13] investigated the management of experimentally induced traumatic intrusion of first premolars in three dogs. Extrusive orthodontic forces were applied to half the teeth after intrusion. The control teeth were observed for re-eruption. The investigations were clinical, radiographical and histological. The authors stated that, with severe intrusion, orthodontic extrusion had little effect on repositioning of the injured tooth. When the injury was less severe, orthodontic extrusion facilitated repositioning of the one affected tooth. There were ten useable first premolars in this study and the amount of intrusion varied from <0.5 to 4.1mm. The only control tooth to erupt had been intruded <0.5 mm.

Turley, Crawford and Carrington, [14] in a follow-up study, again investigated by orthodontic extrusion and by observation for eruption, the manage-

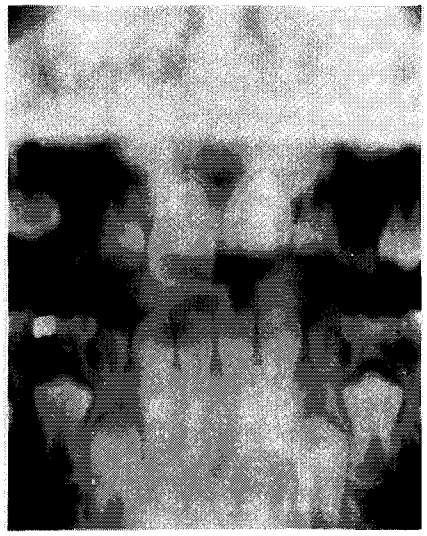

Fig. 3. Part of OPG taken same day as Fig. 2 showing intrusion of 11, 12 and temporary root filling of 11 - 16/2/82.

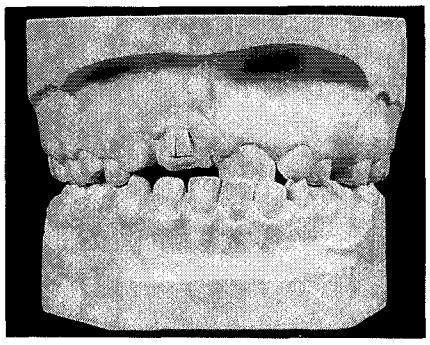

Fig. 4. Study models at commencement of extrusion with a bracket on 11 - 24/2/82.

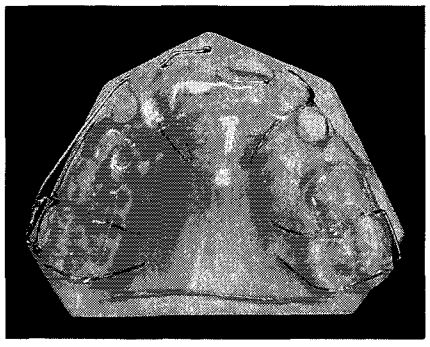

Fig. 5. Removable appliance used to extrude 11 and procline 21.

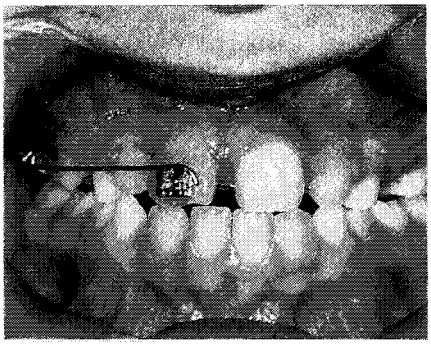

Fig. 6. Clinical appearance at end of active treatment - 10/5/82.

Fig. 7. Radiograph taken day of permanent root filling of 11 - 17/2/82.

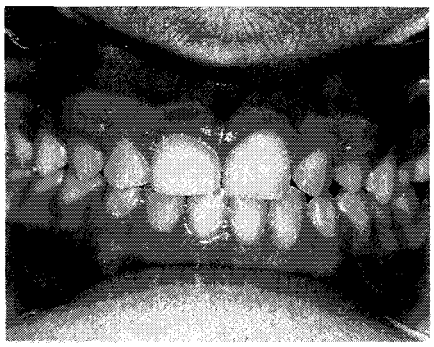

Fig. 8. Appearance eighteen months after orthodontic retention ceased. Bleaching of 11 had been carried out that day -1/8/84.

ment of traumatic intrusion in three dogs. The added element, compared with the previous investigation, was that clinically non-mobile intruded teeth were luxated with an elevator immediately before applying the orthodontic force; the authors found that luxation aided extrusion. There were eleven useable first premolars in this study. Both studies found that replacement resorption of the root, pulp necrosis and pulp calcification commonly occurred after traumatic intrusion.

Fig. 9. Appearance 7 years 3 months after bleaching. The Class III tendency has worsened, overbite of 11, 21 has reduced and the lower centreline has shifted more to the left 18/11/91.

Fig. 10. Radiograph 9 years 10 months after the original injury. It shows an apparently stable state with repair of bone and some remodelling of the root surface. 12 shows extensive calcification but no evidence of periapical pathology - 18/11/91.

Case report

A male Caucasian (d.o.b. 20/1/73) presented on 9/1/82 at the Endodontic Department of The Royal Dental Hospital of Melbourne for treatment of 11, 12 injured earlier that day. On examination it was found that 11,12 had been intruded and, in addition, the crown of 11 was fractured (Fig. 1).

There was a gingival exudate from the area of 11, 12. The lower lip was contused and the skin of the chin was grazed. The 11, 12 were not mobile. Emergency treatment comprised reduction of the labial alveolar bone with digital pressure.

On 16/2/82 the 11, 12 did not respond to vitality testing. Commencement of resorption in the middle third of the root of 11 was observed radiographically (Fig. 2), so the root canal was debrided and filled temporarily with calcium hydroxide (Fig. 3). Eight days later a bracket was bonded to 11 (Fig. 4) and a removable appliance inserted to extrude 11 and procline 21. The appliance is shown in Fig. 5. By 10/5/82 the 11, 21 were in satisfactory positions (Fig. 6) and the appliance was modified, by removal of the springs and the addition of acrylic palatal to 11, 21, to act as an orthodontic retainer. On 17/8/82 the root canal of 11 was filled with gutta percha (Fig. 7). Six months later orthodontic retention was discontinued. On 1/8/84 the discoloured 11 was bleached (Fig. 8). Figures 9 and 10 illustrate the clinical and radiographic appearance approximately seven years later.

Comments

The space between the bracket wing and the bracket base was a convenient place in which to position the spring to extrude 11. The long spring provided a low force which extruded the tooth approximately 1.5 mm within seven days and the required 3 mm in eleven weeks. The intruded 12 re-erupted without assistance. It is uncommon to combine banding with the use of a removable appliance but it was a useful technique for this patient in the mixed dentition, with traumatized and malpositioned anterior teeth.

The pulp of 12 showed signs of calcification within seven months of injury (Fig. 7) and was completely calcified four years later. To date there have been no adverse sequelae of this calcification. Resorption of 11 was arrested.

The gingival margins of the intruded 11, 12 were above those of 21, 22 (Fig. 4). Active extrusion of 11 and eruption of 12 brought their accompanying gingival tissues incisally to the same height as those of 21, 22 (Fig. 6).

During the course of treatment and follow-up the patient's Class III tendency worsened, the overbite of 11, 21 reduced and his mandible became asymmetrical with the lower centre-line shifting progressively to the left (Figs. 4, 8, 9).

Discussion

Andreasen and Andreasen[15] noted that, in the adult dentition, diagnosis of intrusive luxation is primarily dependent upon the difference in incisal height of

the affected and adjacent non-affected teeth. In the mixed dentition, diagnosis is more difficult as the intrusion can mimic an erupting tooth. The percussion test, however, will reveal whether the tooth in question is erupting (a dull tone) or locked into bone (a high metallic tone). With intrusive luxation, maximum damage occurs to the pulp and all supporting structures as a result of the axially directed impact which drives the tooth into the alveolar process. The resulting damage is dependent upon the age of the patient. Healing after intrusion is usually complicated, as the extensive injury to the periodontal ligament can lead to progressive replacement root resorption (ankylosis). In a similar way, damage to the pulp bears with it the risk of pulp necrosis with bacterial invasion which may induce external inflammatory root resorption. Treatment should, therefore, be directed towards eliminating or reducing the extent of both of these healing complications.

In the present case, moderately severe inflammatory root resorption was observed within five weeks which indicates the rapidity of the progress. In the case of the immature root, spontaneous re-eruption can be anticipated. During this process, the crushed cervical bone is usually repaired. As spontaneous re-eruption can occur over a period of several months, it is important that the pulpal status is constantly monitored. The immature 12 in this case reflected these principles. The tooth spontaneously re-erupted and, as there was no radiographic sign of inflammatory root resorption, no endodontic intervention was required. The long term evaluation of the pulpal response revealed progressive root canal calcification with no evidence of periapical breakdown.

In immature teeth in which a periapical radiolucency or inflammatory root resorption develops, it is essential that the infected pulp be extirpated as soon as the healing complication is diagnosed and the root canal dressed with a suitable intra-canal medicament.

Calcium hydroxide paste has been used for many years for this purpose and was the material inserted in this case. Ledermix paste® (Lederle Pharmaceuticals, Wolfrashausen) a cortico-steroid antibiotic compound has been shown experimentally and clinically also to control inflammatory root resorption.[16]

In cases of intrusion of a mature tooth, the early removal of the pulp and the placement of an anti-clastic anti-inflammatory dressing is desirable. Spontaneous re-eruption of a mature tooth is unpredictable.

Andreasen and Andreasen[17] wrote that, in most cases, the treatment of choice for both immature and mature teeth appears, in most cases, to be orthodontic repositioning over a period of three to four weeks. Ideally, orthodontic extrusion should be at a pace that keeps up with the repair of marginal bone. It is important that the tooth be sufficiently repositioned within two to three weeks to assure access to the pulp chamber should endodontic treatment be necessary. This is important as external inflammatory root resorption will be initiated by this time and the only way to arrest this process is with endodontic therapy. This is also the reason for not awaiting spontaneous eruption, a process which can take two to three months and during which time the resorption can become quite advanced. Orthodontic movement may begin at the examination at the time of injury, or some days later when the swelling has subsided. If the tooth has been completely embedded, it is essential that it is partially repositioned so that half of the crown is exposed to facilitate application of an orthodontic bracket.

In the present case, endodontic treatment with the placement of a calcium hydroxide dressing preceded the orthodontic extrusion. Extrusion occurred, without difficulty, over a period of eleven weeks. If no extrusion had been achieved after ten days, a local anaesthhetic could have been administered and the tooth luxated slightly with forceps. Root filling with gutta percha may be carried out once periodontal healing has been established radiographically. Continuous clinical and radiographic monitoring of intruded teeth is necessary as pulpal and periodontal healing complications are common.

With respect to periodontal healing, there is a high risk of replacement root resorption (58% for teeth with immature root formation and 70% for teeth with mature root formation). Moreover, some teeth have been found to demonstrate ankylosis as late as five years following injury. An extended follow-up period is therefore necessary. The presented case report showed excellent repair over a nine-year period and compares favourably with earlier reports.

No investigations have been reported to determine whether orthodontic retention is necessary following orthodontic extrusion.

Conclusion

Many questions remain unanswered in respect to the treatment of an intruded tooth but orthodontic extrusion offers one important treatment option. It must, however, be carefully coordinated with endodontic assessment and, where indicated, endodontic therapy.

References

1. Andreasen JO. Luxation of permanent teeth due to trauma. Scand J Dent Res 1970; 78:273-86.
2. Crona-Larsson G, Noren JG. Luxation injuries to permanent teeth - a retrospective study of aetiological factors. Endod Dent Traumatol 1989; 5:176-9.
3. Shapira J, Regev L, Liebfeld H. Re-eruption of completely intruded immature permanent incisors. Endod Dent Traumatol 1986; 2:113-6.
4. Tronstad L, Trope M, Bank M, Barnett F. Surgical access for endodontic treatment of intruded teeth. Endod Dent Traumatol 1986; 2:75-8.
5. Andreasen FM, Pedersen BV. Prognosis of luxated permanent teeth - the development of pulp necrosis. Endod Dent Traumatol 1985; 1:207-20.
6. Andreasen FM, Zhijie Y, Thomsen BL. Relationship between pulp dimensions and development of pulp necrosis after luxation injuries in the permanent dentition. Endod Dent Traumatool 1986; 2:90-8.
7. Andreasen JO. Traumatic injuries of the teeth. 2nd ed.Copenhagen: Munksgaard, 1981; 164.
8. Andreasen FM, Andreasen JO. Diagnosis of luxation injuries: the importance of standardized clinical, radiographic and photographic techniques in clinical investigations. Endod Dent Traumatol 1985; 1:160-9.
9. Kinirons MJ, Sutcliffe J. Traumatically intruded permanent incisors: a study of treatment and outcome. Br Dent J 1991; 170:144-6.
10. Perez B, Becker A, Chosack A. The repositioning of a traumatically

intruded mature, rooted permanent incisor with a removable orthodontic appliance. J Pedodont 1982; 6:345-54.

11. Mamber E. Treatment of intruded permanent incisors: a multi-disciplinary approach. Endod Dent Traumatol 1994; 10:98-104.
12. Spalding PM, Fields HW Jr, Torney D, et al. The changing role of endodontics and orthodontics in the management of traumatically intruded permanent incisors. Pediatr Dent 1985; 7:104-10.
13. Turley PK, Joiner MW, Hellstrom S. The effect of orthodontic extrusion on traumatically intruded teeth. Am J Orthod 1984; 85:47-56.
14. Turley PK, Crawford LB, Carrington KW. Traumatically intruded teeth. Angle Orthod 1987; 57:234-44.
15. Andreasen JO, Andreasen FM. Essentials of traumatic injuries to the teeth. Copenhagen: Munksgaard, 1990; 105-12.
16. Pierce AM, Lindskog S. Early responses by osteoclasts in vivo and dentinoclasts in vitro to corticosteroids. J Submicrose Cytol Pathol 1989; 21:501-8.
17. Andreasen JO, Andreasen FM. Luxation injuries. In Andreasen JO, Andreasen FM, eds. Textbook and colour atlas of traumatic injuries to the teeth. 3rd edn. Copenhagen: Munksgaard, 1994; 315-82.

Address for Correspondence:
Dr Stanley Jacobs
Orthodontic Department
The Royal Dental Hospital of Melbourne,
711 Elizabeth Street,
Melbourne, Victoria 3000 Australia