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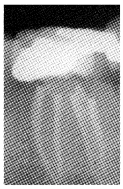

CASE REPORT

Complicated crown fractures – management and treatment options

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Abstract

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Aim Complicated crown fractures involve enamel, dentine and the pulp. The incidence of complicated crown fractures ranges from 2% to 13% of all dental injuries and the most commonly involved tooth is the maxillary central incisor. Various treatment modalities are available depending upon the clinical, physiological and radiographic status of the involved tooth. The aim of this article was to discuss techniques for the management of complicated crown fractures.

Summary Management of complicated crown fractures depends upon several factors with the result that various clinical modalities have been suggested. Seven case reports of complicated crown fractures are presented and risks/benefits of the treatment plans are discussed.

Key learning points:

- Proper diagnosis, treatment planning and follow-up care are important factors in the prognosis of complicated crown fractures.
- Thorough understanding of the available treatment modalities and their specific indications is critical.
- The risks and benefits of each treatment option should be carefully evaluated during the treatment planning process.

Keywords: crown fractures, dental trauma, orthodontic extrusion, treatment options.

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Introduction

Crown fractures have been defined as fractures of the crown involving enamel and dentine. If the fracture also exposes the dental pulp the injury is defined as a 'complicated

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crown fracture' or a Class 3 fracture (Ellis & Davey 1970, Andreasen & Andreasen 1993). The incidence of complicated crown fractures ranges from 2% to 13% of all dental injuries and the most commonly involved tooth is the maxillary central incisor (Andreasen & Andreasen 1993).

The degree of pulp exposure may vary from a minute pinpoint exposure to total exposure of the coronal pulp. The exposure of the pulp makes the treatment challenging. If left exposed, the pulp will become necrotic through bacterial contamination. The outcome of treatment depends on the extent of the injury, the quality and timeliness of the initial care and the recall protocol (Andreasen & Andreasen 1994a,b).

The following situations must be considered when choosing a treatment approach for a complicated crown fracture.

- Time period between the incidence of injury and initiation of treatment.
- Level and position of tooth fracture line.
- Root development stage.
- Pulpal involvement.
- Availability of displaced tooth fragments.
- Concomitant alveolar bone injury.

The aim of this article was to report and discuss the management of complicated crown fractures in a variety of clinical situations.

Case report 1: Reattachment of fractured tooth segment

A 10-year-old female patient attended the Emergency Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, 2 h after a bicycle accident. After the general medical, dental and traumatic incident histories were reviewed, clinical and radiographic examinations were conducted. Clinical examination revealed a fracture in the middle third of the crown of the maxillary right central incisor, exposing the pulp (Fig. 1a,b). The remaining maxillary and mandibular anterior teeth were intact. Periapical radiographs revealed an intact periodontal ligament space, complete root formation with no root fracture. The patient had brought the displaced tooth segment in water (Fig. 1c). The fractured segment could be closely adapted to the remaining crown structure. So a one-visit root canal treatment followed by reattachment of the fractured segment was planned. The procedure was explained to the patient and her parents and informed consent was obtained. Following local anaesthesia root canal treatment was performed. The fractured segment was stored in distilled water throughout and then cleaned to remove pulpal remnants. The remaining tooth structure, chamber and the fractured segment were etched with 35% Phosphoric acid (3M ESPE, St. Paul, MN, USA) for 15 s. The etchant was washed for 10 s and the cavity was dried with a gentle blast of air. Caution was taken not to desiccate the surfaces. Two coats of dentine bonding agent (Single bond 3M ESPE) were applied at an interval of 10 s and cured for 10 s. The segment was reattached with dual cure composite resin cement (3M™ RelyX™ Adhesive Resin Cement, 3M ESPE) (Fig. 1d). All margins were light cured for 40 s and then polished using diamond stones and a composite polishing kit (Shofu Co., Kyoto, Japan). At 14 months, the crown of the tooth was intact.

Case report 2: Reattachment of fractured tooth segment using a pre-fabricated fibre post- mature root apex

A 22-year-old male patient attended the Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, 3 days after a fall down stairs. After the general medical, dental and traumatic incident histories

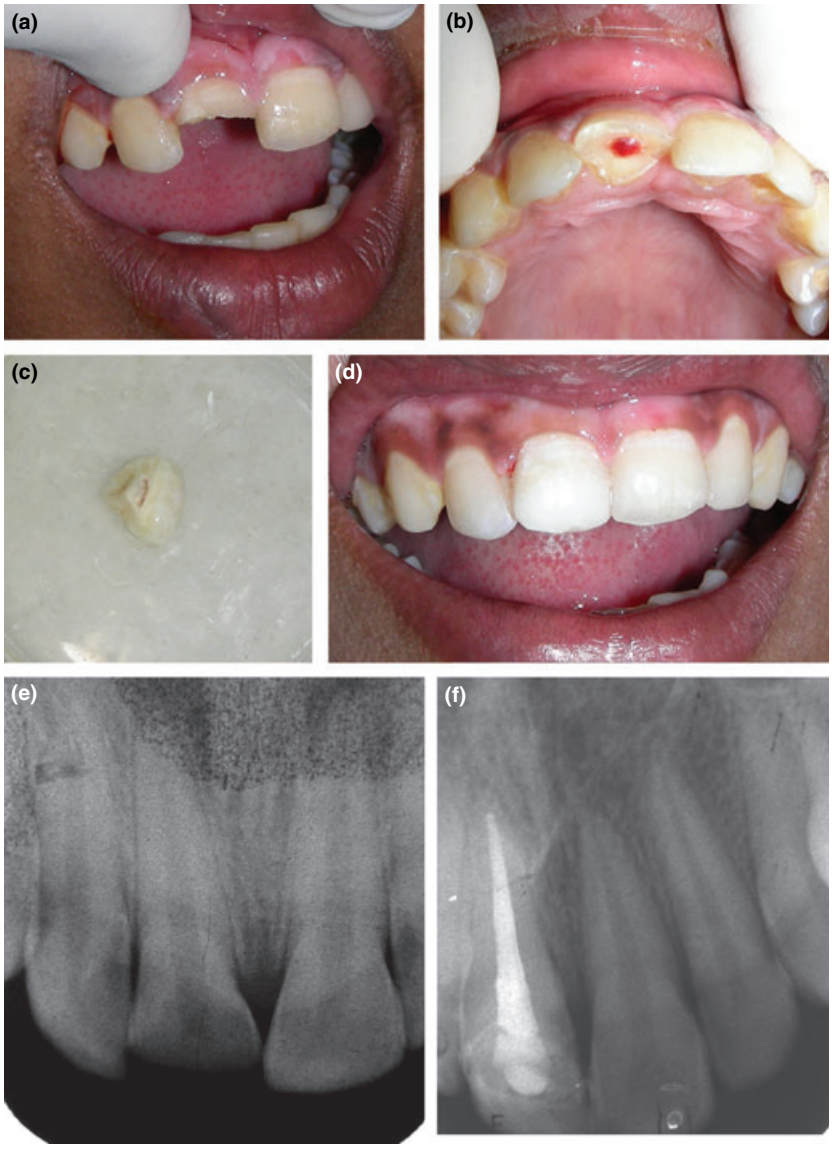

Figure 1 Reattachment of fractured tooth segment. (a) clinical appearance of the patient, (b) intraoral view showing fractured maxillary right central incisor with pulp exposure, (c) fractured crown segment, (d) clinical view after segment reattachment, (e) preoperative radiograph, (f) postoperative radiograph.

were reviewed, clinical and radiographic examinations were conducted. A cervical crown fracture was observed in the left maxillary central incisor (Fig. 2a). The periapical radiograph revealed an intact periodontal ligament space with complete root formation and no root fracture. It was not possible to determine from the initial radiograph whether the fracture was complete, although the radiograph suggested that the incisal fragment had separated from the remaining tooth structure. Local anaesthesia was administered and the fractured segment was removed (Fig. 2b). Because of the extensive and coronal fracture line, a one-visit root canal treatment followed by reattachment of the fractured segment using a fibre post as reinforcement was planned. The procedure was explained to the patient and informed consent obtained. After the root canal treatment, a 1.2 mm thick glass fibre post

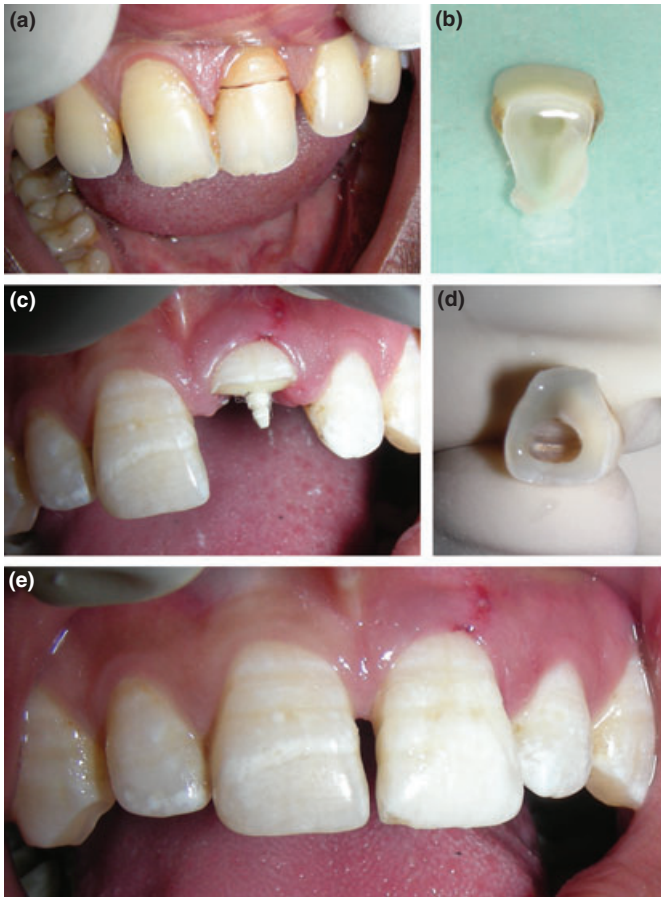

Figure 2 Reattachment of fractured tooth segment using a pre-fabricated fibre post- mature root apex. (a) clinical appearance of the patient, (b) fractured segment, (c) fibre post luted in the root canal with 2 mm of the retentive part of the post outside the chamber, (d) box like preparation in the fractured segment, (e) clinical view after segment reattachment.

(Stabitech, Mullo Ferdinando, Italy) was luted in the root canal such that 2 mm of its coronal portion was outside the chamber (Fig. 2c). The fractured segment was cleaned to remove pulpal remnants. A box like preparation was made in the fractured segment which corresponded to the retentive part of extruding fibre post (Fig. 2d). The remaining tooth structure, fibre post and the fractured segment were etched and two coats of dentine bonding agent (Single bond 3M ESPE) were applied. The segment was reattached with dual cure composite resin cement (3M™ RelyX™ Adhesive Resin Cement, 3M ESPE). All margins were light cured for 40 s and were polished using diamond stones and composite polishing kit (Shofu Co., Kyoto, Japan) (Fig. 2e). At 11 months follow-up, the tooth was symptom-free and the crown was aesthetically satisfactory.

Case report 3: Reattachment of fractured segment using a pre-fabricated fibre post- immature root apex

An 8-year-old male patient attended the Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, with the chief complaint of a fractured anterior tooth following a fall down stairs at school 15 days

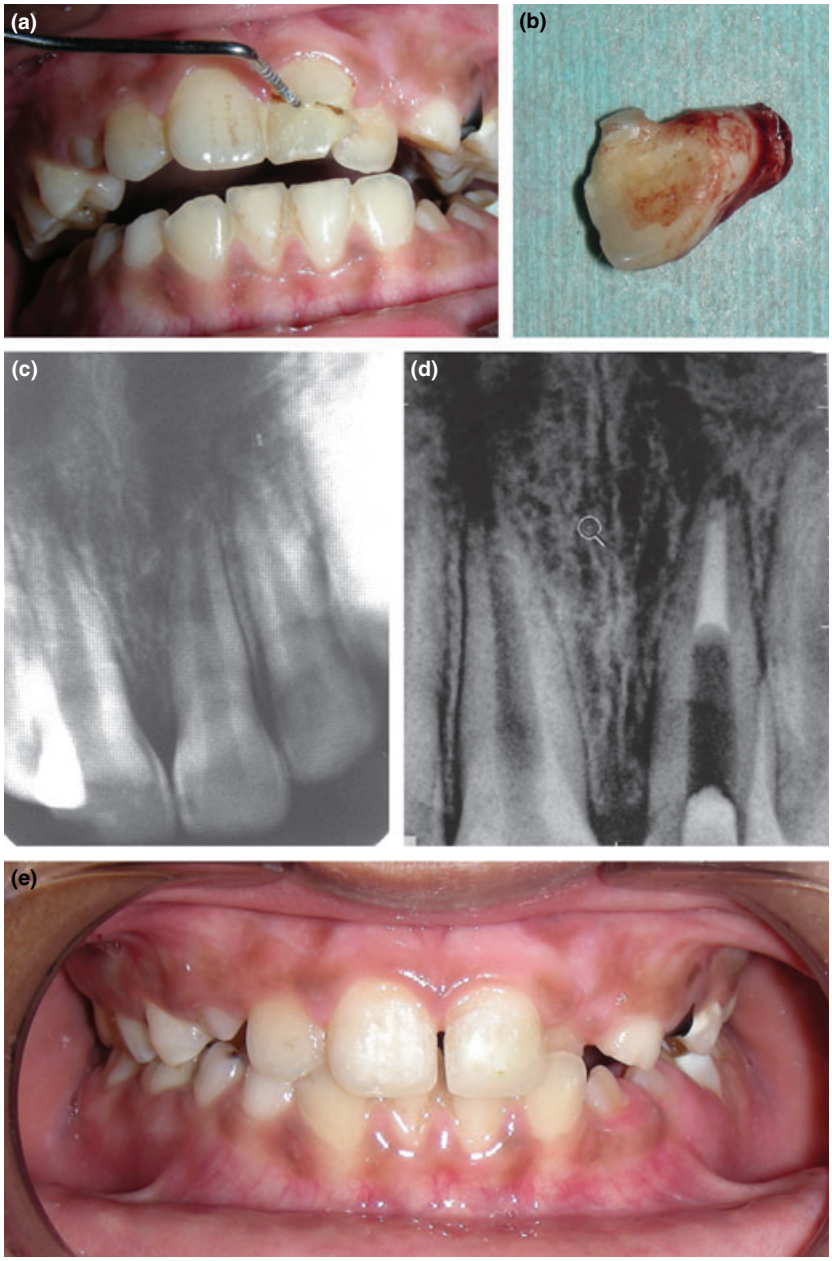

Figure 3 Reattachment of fractured segment using a pre-fabricated fibre post- immature root apex (a) clinical appearance of the patient, (b) fractured segment, (c) preoperative radiographic view showing immature open apex of maxillary left central incisor, (d) radiographic view showing apical barrier using MTA, (e) clinical view after segment reattachment.

previously. Medical history and the extra-oral examination were normal. The intra-oral examination revealed a complicated crown fracture of the maxillary left central incisor (Fig. 3a). The periapical radiograph revealed an intact periodontal ligament space, incomplete root formation but no root fracture. A single visit apical barrier technique using MTA and subsequent reattachment of the fractured segment was planned. Local anaesthesia was administered and the fractured segment was removed. Following canal

preparation, an apical barrier of MTA (Dentsply Maillefer SA, Ballaigues, Switzerland) was placed (Fig. 3c,d). The fractured segment was reattached as described in case report 2 (Fig. 3e). The case was followed for more than 1 year and the patient has no signs or symptoms.

Case report 4: Extrusion of retained fractured root using a fixed orthodontic appliance

A 30-year-old male patient attended the Emergency Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, 4 days after an automobile accident. After the general medical, dental and traumatic incident histories were reviewed, clinical and radiographic examinations were conducted. Ecchymosis of the lower lip and a fractured maxillary left central incisor (Fig. 4a) were identified. The crown was fractured in the cervical one third with a subgingival palatal margin (Fig. 4b). The patient was unable to retrieve the fractured segment. Intra oral radiography revealed an intact periodontal ligament and no root fractures. It was planned to orthodontically extrude the remaining tooth structure to restore the physiological periodontal attachment. The procedure was explained to the patient and informed consent obtained. At the first appointment, a single-visit root canal treatment was performed with sectional apical canal filling. To achieve the tooth extrusion an orthodontic device, with an offset bend, was fabricated using a 0.7 stainless steel wire, which was bonded to the centre of the two neighbouring teeth employing the composite resin Esthet-X (Dentsply Maillefer SA, Ballaigues, Switzerland). A 0.022-inch standard orthodontic bracket was cemented to the fractured tooth and elastic was applied from the bracket of the fractured tooth to the orthodontic device (Fig. 4c). The patient was recalled every week to reactivate the orthodontic device. The extrusion rate used was 1 mm/week. After 4 weeks, the active treatment was completed and an extrusion of approximately 3 mm was clinically and radiographically evident (Fig. 4d–h). To avoid reintrusion and to repair the periodontal tissue, the patient wore the orthodontic device for 60 days. After the extrusion was completed, gingivoplasty was undertaken to improve the gingival contour. The fractured tooth was then restored with an aesthetic post and core and a full ceramic fused to metal crown (Fig. 4i). The case has been under review for 14 months and the aesthetic result is satisfactory.

Case report 5: Extrusion of retained fractured root using a removable orthodontic appliance

A 26-year-old female patient attended the Emergency Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, with an injury to the maxillary anterior teeth, abrasion of the chin and upper lip mucosa and skin, contusion and oedema in the left zygomatic area and corner of the left eye following an automobile accident. After the general medical, dental and traumatic incident histories were reviewed, clinical and radiographic examinations were conducted. The examinations revealed a complicated crown fracture in the maxillary right central incisor and uncomplicated crown fractures of the maxillary right lateral incisor and left central incisor (Fig. 5a). Local anaesthesia was administered and mobile fractured tooth segments were removed. The remaining apical segment was below the gingival margin (Fig. 5b) so an orthodontic extrusion of the incisor was planned to restore the physiological periodontal attachment. The procedure was explained to the patient and informed consent obtained. Root canal treatment was initiated in the right central incisor and a calcium hydroxide dressing placed. After 3 days the patient complained of severe pain and tenderness in the

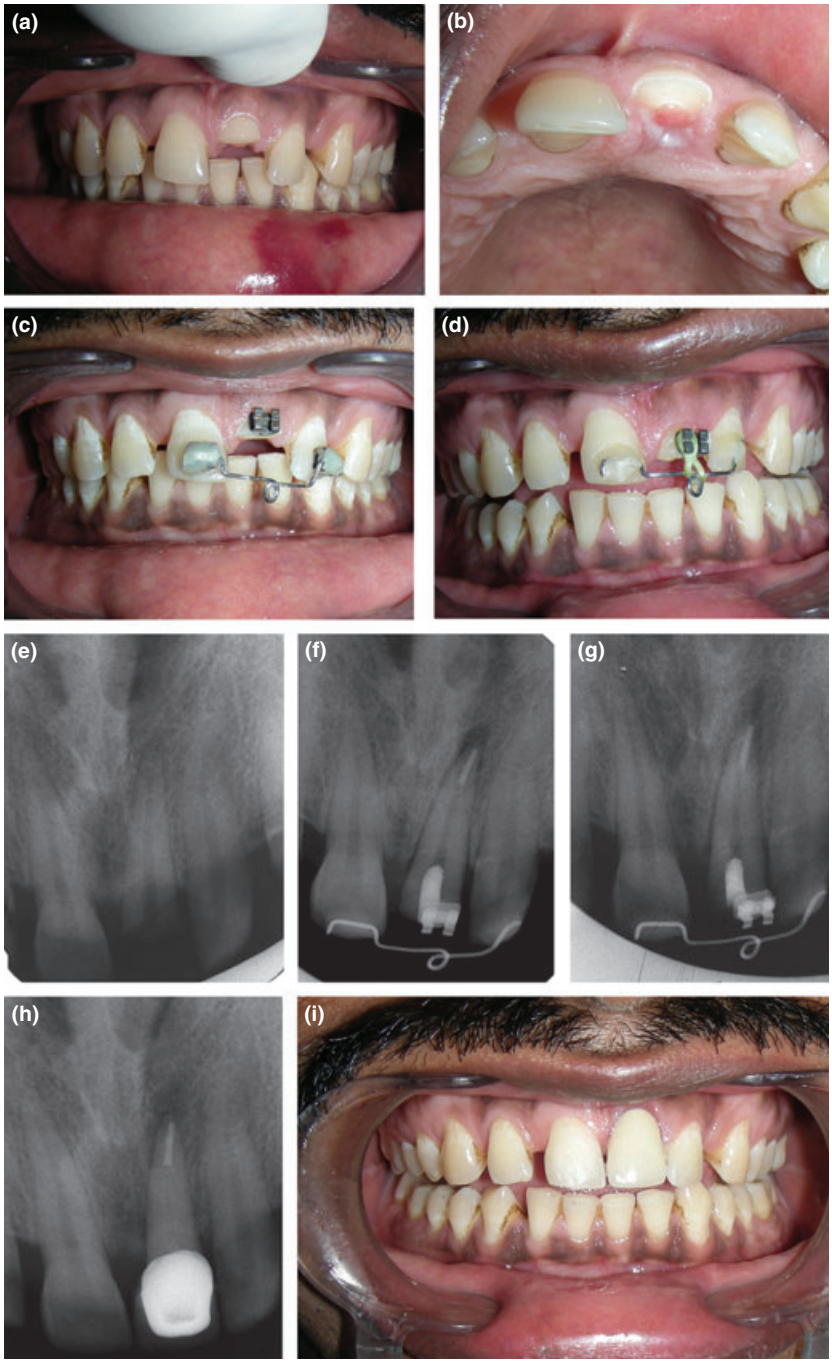

Figure 4 Extrusion of retained fractured root using a fixed orthodontic appliance. (a) clinical appearance of the patient, (b) intraoral view showing fractured maxillary left central incisor with pulp exposure and subgingival palatal margin, (c) clinical view showing 0.022-inch standard orthodontic bracket cemented to the fractured tooth and an elastic applied from the bracket to an orthodontic device, (d) clinical view after 4 weeks, (e) preoperative radiographs, (f) radiograph after 2 weeks showing 1 mm extrusion, (g) radiograph after 4 weeks showing 3 mm extrusion, (h) postoperative radiograph, (i) postoperative clinical view.

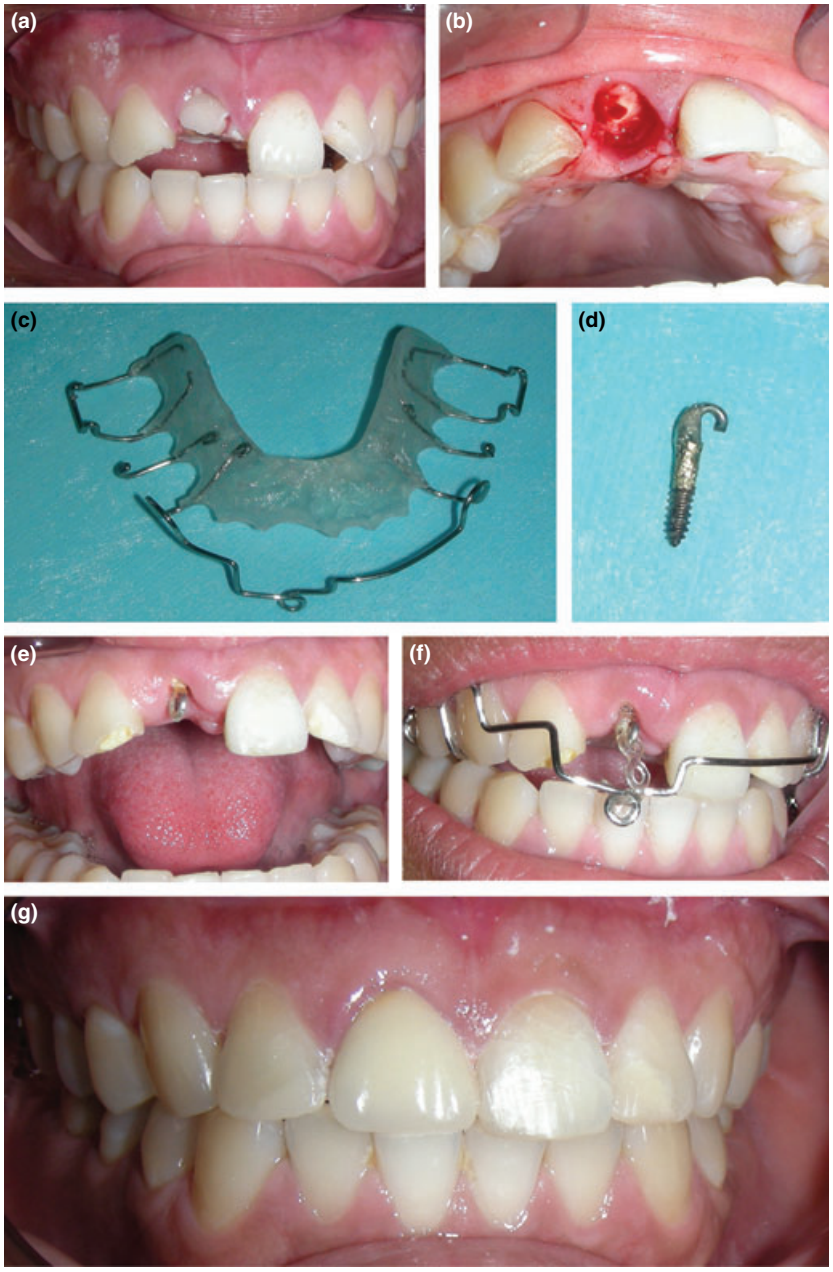

Figure 5 Extrusion of retained fractured root using a removable orthodontic appliance. (a) clinical appearance of the patient, (b) intraoral view showing fractured maxillary right central incisor with subgingival margins, (c) removable appliance with an occlusal offset bend loop, (d) modified screw post, with a hook soldered onto it, (e) clinical view of cemented screw post with hook, (f) clinical view after 6 weeks showing 3 mm extrusion of the segment, (g) postoperative clinical view.

left central incisor. Root canal therapy was initiated in the left central incisor and a calcium hydroxide dressing was placed. The right central incisor was root filled with an apical sectional root filling and a modified screw post, with a hook soldered onto it, was inserted and cemented into the root canal (Fig. 5d,e). A removable appliance, comprising of two Adams clasps and a labial bow with an occlusal offset bend loop, was fabricated (Fig. 5c).

An elastic string was placed around the screw post and tied to the loop of the labial bow (Fig. 5f). The patient was instructed to wear the appliance continuously. The elastic string was changed twice a week. After 6 weeks, the active treatment was completed and an extrusion of approximately 3 mm was clinically and radiographically evident. To avoid reintrusion and to repair the periodontal tissue, the patient wore the orthodontic device for 60 days. After the extrusion was completed, a gingivoplasty was undertaken to achieve a better gingival contour. The fractured tooth was then restored with an aesthetic post and core and a full ceramic fused to metal crown (Fig. 5f). The case has been under review for 18 months and the aesthetics is satisfactory.

Case report 6: Surgical repositioning of apical segment

A 10-year-old female patient attended the Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, 12 days after a fall at school. After the general medical, dental and traumatic incident histories were reviewed, clinical and radiographic examinations were conducted. The patient gave a history of trauma 3 years previously. The examinations revealed a complicated crown fracture in the maxillary right central incisor and uncomplicated crown fractures of the maxillary left central incisor (Fig. 6a,b). Intraoral radiographs revealed an intact periodontal ligament space and no root fractures. The left central incisor had an immature apex with a periapical radiolucency and gave no response to electric and thermal pulp testing. The patient was administered local anaesthesia and the mobile tooth segments were removed (Fig. 6c,d). An immediate surgical repositioning of right central incisor was planned. The procedure was explained to the patient and her parents and informed consent obtained. The apical segment was initially luxated with the help of an elevator. Following elevation, the tooth was brought into a position so that its crown could be grasped with a forceps (Fig. 6e). After bringing it into a favourable position, the segment was splinted using a stainless steel wire and acid etch-composite resin (Fig. 6f). Root canal treatment was initiated in both the central incisors and a calcium hydroxide dressing was placed. Both teeth were asymptomatic at the second month recall and the splinting was removed. After canal shaping and irrigation, the right central incisor was root filled with gutta-percha and sealer. The tooth segment and the endodontic access cavity were restored with composite resin (Fig. 6l). Intentional bleeding was induced in the canal space in the left central incisor with the help of a sterile reamer. Mineral trioxide aggregate was placed in the coronal third of the canal and the access cavity was sealed with glass-ionomer cement. Six month recall revealed normal periodontal ligament and physiological mobility. The periapical radiolucency associated with left central incisor was absent and there was evidence of lateral dentinal wall thickening. The case is under review and the involved and adjacent teeth have been symptom free for the past 15 months.

Case report 7: Intra alveolar repositioning of tooth segment

An 18-year-old female patient attended the Endodontic clinic of the Centre for Dental Education and Research, All India Institute of Medical Sciences, New Delhi, India, 15 days after an automobile accident. After the general medical, dental and traumatic incident histories were reviewed, clinical and radiographic examinations were conducted. The examinations revealed oblique complicated crown-root fractures in the maxillary right and left central incisors (Fig. 7a,b). An immediate surgical repositioning of right central incisor was planned to expose the fracture margins and restore biological width. The procedure was explained to the patient and her parents and informed consent was obtained. Local anaesthesia was given and the fractured segment was removed. The remaining segment

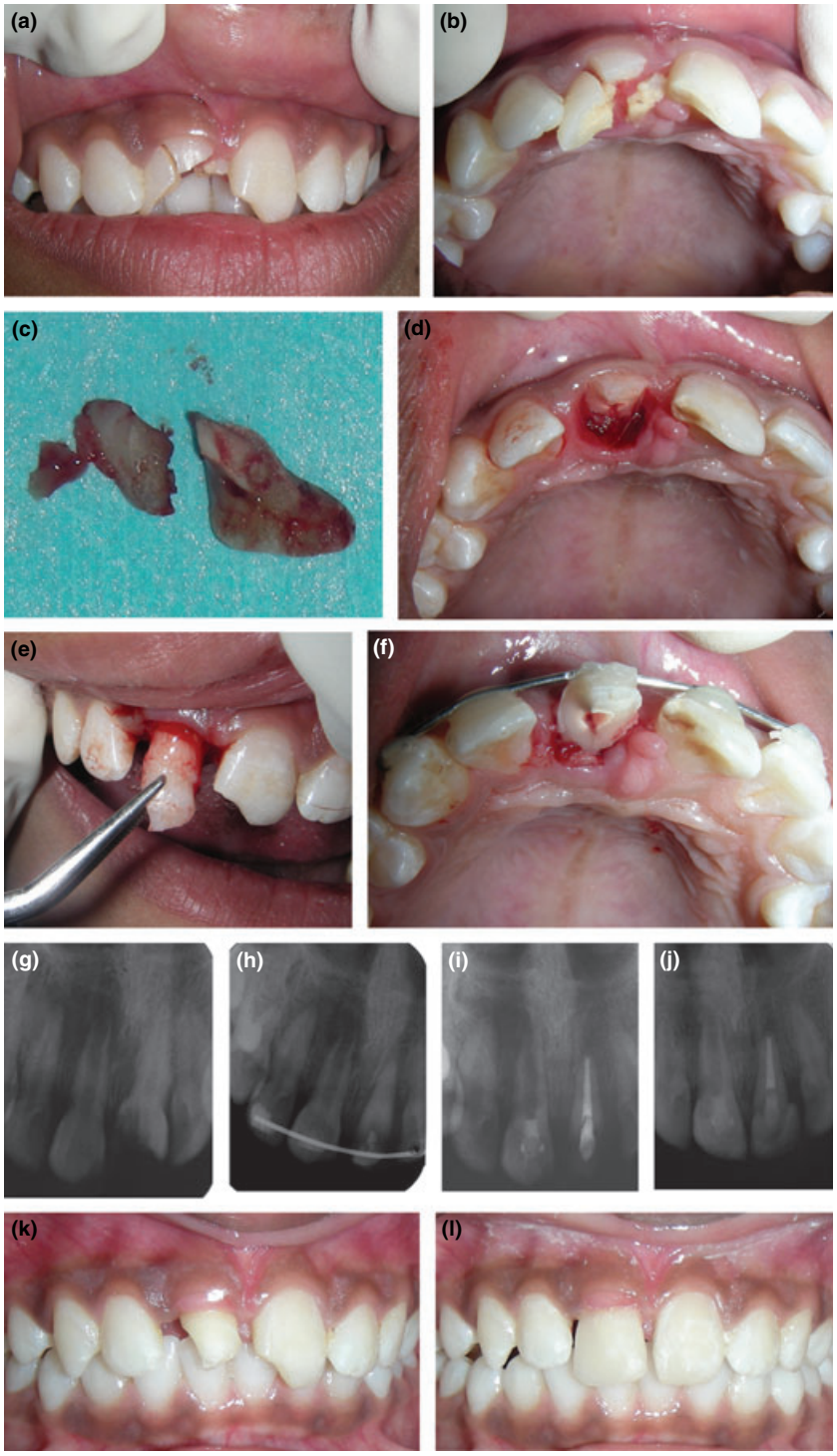

Figure 6 Surgical repositioning of apical segment. (a) clinical appearance of the patient, (b) intraoral view showing fractured segment of maxillary right central incisor, (c) fractured segments removed, (d) intraoral view after removal of segments showing fractured maxillary right central incisor with subgingival margins, (e) Surgical repositioning of apical segment, (f) splinted using a stainless steel wire and acid etch-composite resin, (g) preoperative radiograph, (h) radiograph showing surgical repositioning and splinting, (i) 6th week recall, (j) 6 months recall, (k) clinical presentation after 6 weeks of surgical repositioning, (l) postoperative view.

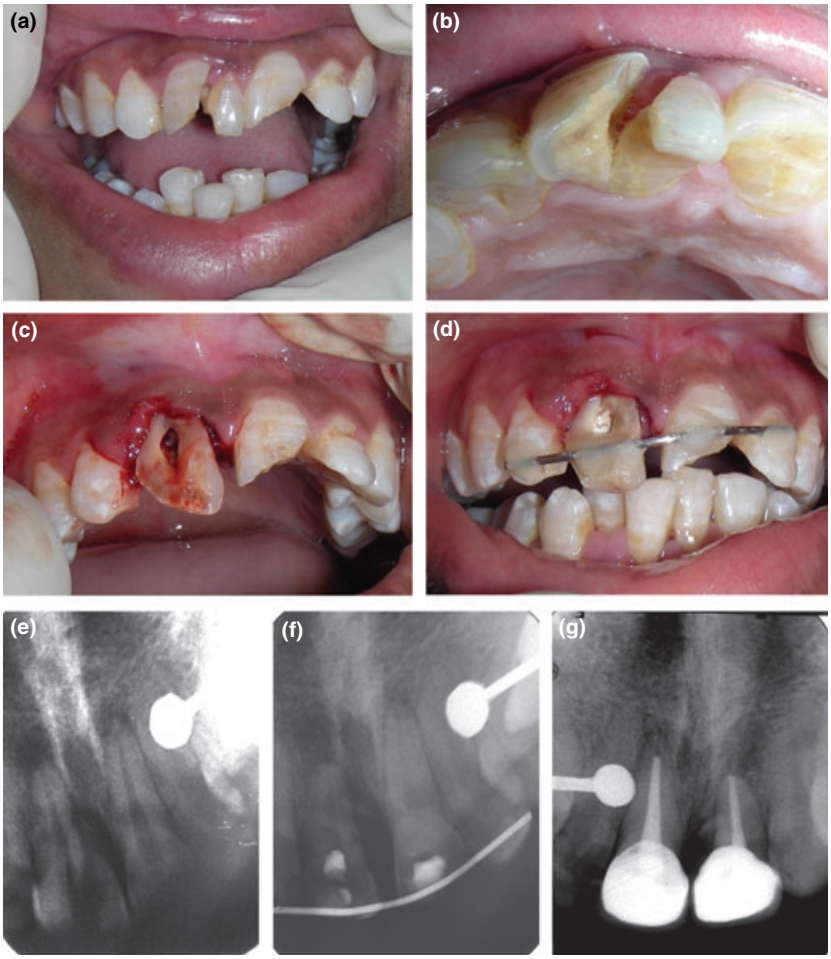

Figure 7 Intra-alveolar repositioning of tooth segment. (a) clinical appearance of the patient, (b) intraoral view showing oblique complicated crown-root fracture in the maxillary right central incisor, (c) clinical view showing rotated remaining segment at an angle of 180° in mesio-labial direction, (d) splinting using wire and resin composites, (e) preoperative radiograph, (f) radiograph showing surgical repositioning and splinting, (g) 6 months recall.

was luxated with an elevator and was rotated 180º in a mesio-labial direction to place the fracture line in a favourable position (Fig. 7c). The segment was splinted using a stainless steel wire and acid etch-composite resin (Fig. 7d). Root canal treatment was initiated in both central incisors and a calcium hydroxide dressing was placed. The dressing was changed once a month for 2 months. The splint was removed after 2 months and the canals were prepared and root filled (Fig. 7e–g). The crowns were restored with full ceramic fused to metal crowns. The case is under review for 14 months and both the central incisors are symptom free.

Discussion

There is evidence of an increased incidence of traumatic injuries to anterior teeth (Blatz 2001) with the most common injuries being crown fractures (Villat *et al.* 2004). Loss of tooth tissue in the anterior region in a young patient may create severe aesthetic and

emotional problems (Callskan 1999). Various treatment approaches have been indicated for fractured teeth including:

- fragment removal followed by restoration (Olsburgh *et al.* 2002);
- fragmant reattachment (Trushkowsky 1988);
- gingivectomy and osteotomy (crown lengthening) (Trushkowsky 1988);
- orthodontic extrusion with/without gingivoplasty (Trushkowsky 1988, Olsburgh *et al.* 2002);
- forced surgical extrusion (Trushkowsky 1988, Olsburgh *et al.* 2002);
- vital root submergence (Trushkowsky 1988);
- extraction followed by surgical implants (Trushkowsky 1988) or fixed partial denture (Meiers & Freilich 2001).

The treatment modality chosen depends mainly upon the location and extent of the fracture. If the fracture line is in the middle or incisal third of the crown and the patient is unable to retrieve the fractured segment, a resin composite restoration is used for aesthetics and function (Buonocore & Davila 1973). If the patient is able to retrieve a closely adapting fractured segment, reattachment of the segment is a possibility. The segment reattachment technique has been widely accepted with the development of composites and resin adhesives (Trushkowsky 1988, Rapelli *et al.* 2002). This technique requires only a thin layer of composite resin and restores the original form and colour of the tooth that often provides the best aesthetic result. Several case reports show that even subgingival tooth fractures can be restored successfully (Baratieri *et al.* 1993, Noguiera Filho Gda *et al.* 2002, Rapelli *et al.* 2002, Palma-Dibb *et al.* 2004). Use of a fibre post luted with resin cements increases the retention of the segment and provides a monoblock effect (Tay & Pashley 2007).

Traumatized teeth with immature apices present a challenge as apexification treatment requires an extended period without a final restoration. Use of Mineral Trioxide Aggregate (MTA) has been advocated in single visit apical barrier placement in immature teeth. In case report no.3 reinforcement of the fragile walls was obtained with a fibre post and adhesive resin after a single visit apical barrier was placed with MTA. The original fractured segment was reattached providing good aesthetics with original tooth contours, texture and function.

Subgingival crown fractures are challenging in terms of coronal rehabilitation (Callskan 1999). In such cases the treatment should be aimed at exposing the fractured margins, so that all clinical procedures can be achieved with strict moisture and haemorrhage control. Furthermore, the prognosis may be improved further through better plaque control by the patient (Olsburgh *et al.* 2002). Orthodontic and/or surgical extrusion combined with or without gingival and osseous recontouring for adequate margination to save such teeth has been suggested (Callskan 1999, Olsburgh *et al.* 2002, Villat *et al.* 2004).

Orthodontic extrusion (Heithersay 1973), has been referred to as forced eruption, orthodontic eruption, vertical extrusion or assisted eruption (Heithersay 1973, Oesterle & Wood 1991). The technique restores the physiological periodontal attachment and preserves alveolar bone (Oesterle & Wood 1991, Bondemark *et al.* 1997). Extrusion can be achieved either with the help of removable or fixed orthodontic appliances (Heithersay 1973, Cooke & Scheer 1980, Mandel *et al.* 1982, Oesterle & Wood 1991, Hovland 1992, Bondemark *et al.* 1997). Patient cooperation is a critical factor whilst using a removable appliance.

The extrusion rate used in case report no.4 & 5 was 1 mm/week. After orthodontic extrusion is completed, the tooth should be stabilized for a period of 7–14 weeks (Heithersay 1973, Cooke & Scheer 1980, Mandel *et al.* 1982, Oesterle & Wood 1991, Hovland 1992, Bondemark *et al.* 1997). It has been reported that with single extrusion techniques, the alveolar bone and gingiva extrude with the tooth, so gingivoplasty is advised just before the beginning of stabilization period. Some authors have suggested a sulcular incision performed at every follow-up visit (Ivey *et al.* 1980, Bondemark *et al.* 1997).

Orthodontic extrusion requires multiple visits and excellent patient cooperation whereas surgical extrusion is a procedure which is simpler and less time-consuming (Kahnberg 1985, 1988, Roeters & Bressers 2002). In case report no.6, extrusion of the tooth was completed by marginal luxation with elevators and stabilization by stainless steel wire and resin composites. Surgical extrusion can be compared with extrusive luxation as the root never leaves the alveolus. Hence, this procedure has a comparably favourable prognosis with root resorption occurring in only 7–12% of cases (Andreasen 1981, Tegsjo *et al.* 1987).

Case report no. 7 had a bucco-palatal fracture line extending through the pulp chamber into the subgingival palatal area. Because of the extension of the fracture, re-establishment of lost biologic space was required. So intra-alveolar repositioning of the tooth segment with 180° rotation with more coronal position was preferred as it provided a better biological space for periodontal healing and minimized periodontal pocket formation (Fariniuk *et al.* 2003). Unlike the previous case report (Fariniuk *et al.* 2003), the tooth segment was not taken out of the socket, thus minimizing the chances of root resorption.

Conclusions

Anterior tooth trauma commonly found in permanent teeth, can cause psychological distress, especially in children. It is important to retain the natural tooth to maintain space and also to maintain the alveolar bone height, so that later long-term prosthetic replacement/implants, if required, are feasible. There are various treatment guidelines and options available for management of complicated crown fractures. Thorough knowledge of techniques, their indications, risks/benefits, research based evidence as well as expectation of the patients and their parents should be kept in mind whilst choosing a treatment plan. Such cases require regular and long-term follow-up so that complications, if any, can be treated early.

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