doi: 10.4248/IJOS10067

CASE REPORTS

Clinical Management of Mid-Root Fracture in Maxillary Central Incisors: Case Reports

Deepak J. Parekh*, Ramarao Sathyanarayanan, Mangala Tiptur Manjunath

Department of Conservative Dentistry and Endodontics, Bapuji Dental College and Hospital, Davangere-4, Karnataka, India

Abstract

Management of mid-root fractures presents a formidable challenge for clinicians because of the difficulty of achieving a stable reunion of fracture fragments. This article presents two varied treatment options for mid-root fractures. A 15-year-old female reported an impact injury to the maxillary anterior teeth 2 days after its occurrence. Clinically, the maxillary left central incisor was palatally-extruded with a negative vitality response and radiographic evidence of an oblique fracture at the middle third of the root. An endodontic implant was employed which utilized an open technique and has been on follow-up for ten months. A 32-year-old male reported an injury, which resulted in a mobile maxillary right central incisor, three months after its occurrence. Through clinical and radiographic means, a discolored, extruded, and non-vital maxillary right central incisor with an oblique root fracture at the alveolar-crest level was observed. Exploratory surgery was performed; an apical barrier was created with a mineral trioxide aggregate and obturated with gutta percha. The fragments were stabilized with a fiber post and patient has been on follow-up for five months. Short-term follow-up for both of the cases showed promising results both clinically and radiographically.

Keywords endodontic implant, fiber post, maxillary central incisor, root fracture, titanium min screw

Received Feb. 3, 2010; Revision accepted Jun. 22, 2010

Introduction

Mid-root fractures occur most frequently in the upper anterior teeth due to their position in the arch. These fractures are generally transverse to oblique and may be single or multiple, complete or incomplete. The initial treatment consists of the repositioning of displaced coronal segments, followed by the stabilizing of the tooth to allow healing of the periodontal ligament supporting the coronal segment to occur (Andreasen and Andreasen, 1993). The amount of dislocation and the degree of mobility of the coronal segment affect the prognosis (Zachrisson and Jacobsen, 1975). Achieving stable fracture reduction is inversely proportional to the severity of dislocation, mobility, and pulpal injury (Jacobsen and Zachrisson, 1975).

Endodontic intervention is required for non-healing fractures. The following are the treatment options carried out with varied levels of success:

(1) root canal therapy of both segments (Ingle and Bakland, 2002). This may be indicated in fracture cases when the segments are not separated, but leakage from the fracture line can lead to failure;

(2) root canal treatment of the coronal segment only, if this segment shows no mobility (Flores *et al*., 2007). This is the current recommendation, particularly with the view that the apical segment may contain vital, healthy pulp tissue;

(3) the use of an intra-radicular splint has been recommended by Weine *et al.* 1971;

(4) Root extrusion is a solution for teeth with root fractures at or near the alveolar crest (Malmgren *et al*., 1991);

(5) placement of endodontic implant with or without periapical surgery (Linkow, 1970) or the last resort where the natural tooth cannot be saved would be;

(6) extraction and subsequent replacement with prosthesis (Ingle and Bakland, 2002).

The current recommendation for mid-root fracture is root canal treatment of the coronal segment only, if this segment shows no mobility (Flores *et al*., 2007). No treatment guidelines are available for a tooth showing increased mobility, other than extraction and subsequent replacement with prosthesis. The aim of this article is to article report successful management of mid root fracture with mobile coronal fragment.

Case Report

Case 1

A 15-year-old female reported an impact injury to the maxillary anterior teeth two days after initial occurrence. Clinically, the maxillary left central incisor was palatally extruded showing grade-3 mobility (Figure 1A). All maxillary anterior teeth were responding to electric pulp-testing, which acted as the baseline value. Radiographic examination revealed an oblique root fracture at the junction of the coronal and middle portion of the maxillary left central incisor (Figure 1B). Emergency treatment required immediate repositioning and stabilization with a labial fiber reinforced composite (Ribbond®, Ribbond Inc., USA) recommended by Flores *et al*. 2007 (Figure 1C). A one week follow-up revealed pus draining from the labial sulcus (Figure 1D). A tracing radiograph showed gutta percha extending up to the fracture line (Figure 1E). Hence, a pulpectomy of the coronal fragment and preservation of the vitality of the apical fragment were planned. Calcium hydroxide was inserted as an intracanal medicament and periodically changed after four weeks. The splint was removed after four months due to the coronal position of the fracture line (Flores *et al.* 2007). Upon removal, the tooth showed poor prognosis with class Ⅱ+ mobility and radiographically-increased in radiolucency between the coronal and apical fragment (Figure 1F). The treatment plan was revisited due to the poor prognosis. Two options were considered, analyzed and explained to the patient; extraction of the tooth followed by placement of either an osseointegrated implant or fixed partial denture, or the preservation of the natural tooth aided by an endodontic implant. Since the patient had high level of esthetic demand, an attempt to preserve the tooth was chosen. Hence, the surgical removal of the apical portion of the root and placement of an endodontic implant were then recommended. The treatment plan was explained to the patient and consent was taken.

The head of the orthopedic titanium mini screw (Ortho Max®, India) of length 16 mm and diameter of 2 mm, which is used in the ultra lock mandibular reconstruction system, was modified and used as an endodontic implant. The access preparation was modified so that the implant could reach the apex of the coronal portion of the root, and the implant was tried for fit. Once satisfactory adaptation of the implant was achieved, the implant was packed, autoclaved, and kept ready for cementation during the surgical procedure.

A rectangular flap was raised from the maxillary right central incisor to the left canine after anesthetizing the area. After achieving total haemostasis, well-preserved cortical plate with no evidence of fracture was observed. A small defect was created on the surface of the cortical plate at the level of the fracture line on which gutta percha was placed to provide guidance for the position of the fractured line (Figure 1G). Bone guttering was done with No. 6 and 8 round bur to expose the apical fragment (Figure 1H). A purchase point was prepared on the apical fragment with a No. 4 round bur and then was luxated with the help of a cross bar elevator and was then extracted. The area was completely curetted. It was then irrigated with tetracycline. The implant was positioned in the canal until the coronal level of the orifice. The point of its exit, from the apical end of the coronal fragment, was marked on the implant. A radiograph was taken to verify the position of the implant (Figure 1I). The part of implant residing in the canal was coated with Type Ⅰ glass ionomer cement (Fuji I, GC inc., Japan) and was cemented

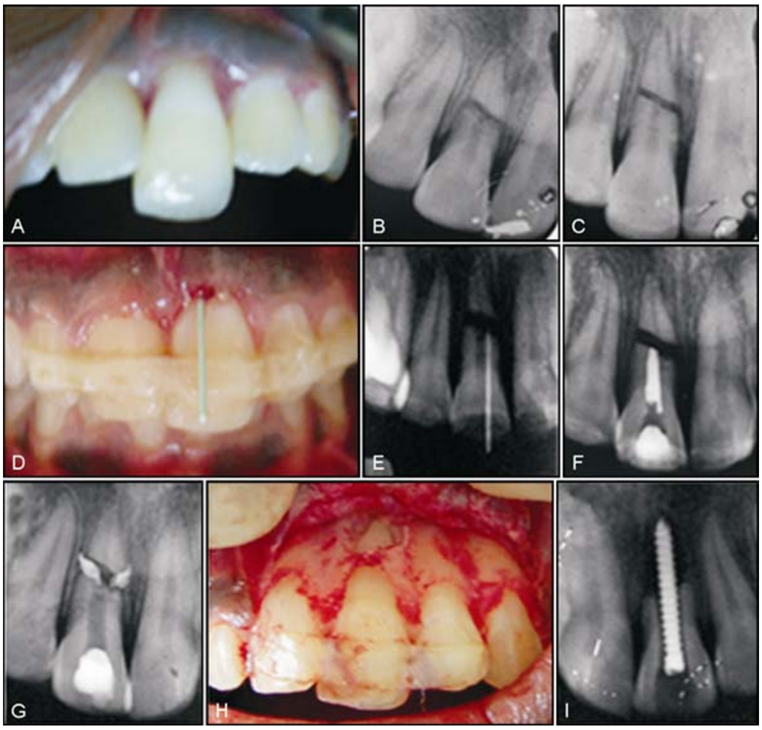

Figure 1 Management of horizontal root fracture using titanium mini screw

A: clinical appearance of the patient; B: preoperative radiograph; C: radiograph after repositioning and stabilization; D: clinical tracing of the sinus from the labial sulcus; E: gutta percha extending to the fracture line; F: increase in radiolucency between the coronal and apical fragment; G: gutta percha used for guidance; H: bone guttering performed, exposing the apical fragment; I: titanium mini screw fit test.

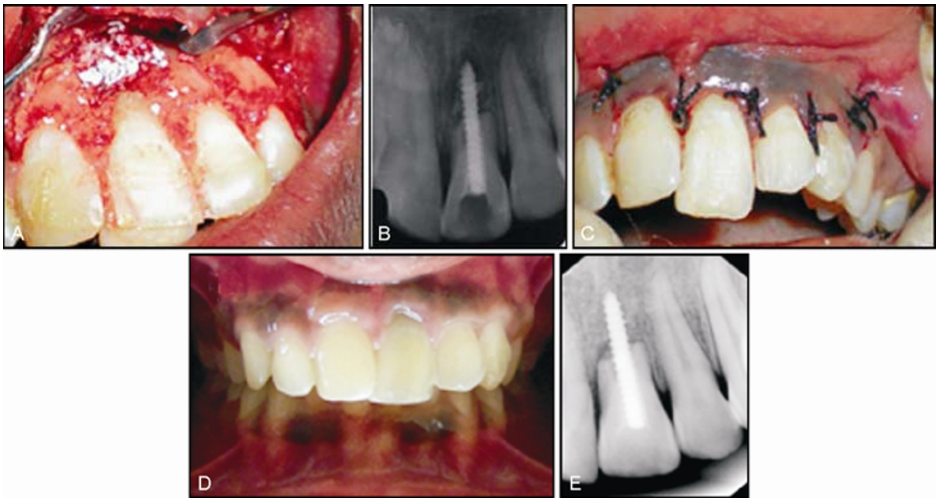

Figure 2 Continued-Management of horizontalroot fracture using titanium mini screw

A: bone substitute filled in the defect; B: post-surgical radiograph; C: discontinuous interrupted silk sutures placed; D: clinical appearance after eight months; E: radiograph after eight months showing bone formation around the threads of the screw.

into the canal with the assistance of locking tweezers. Caution was taken to prevent cement from becoming present in the part of the implant residing in the bone. The interface was sealed with MTA (Pro-root MTA, Dentsply Mallifer, USA) (a well documented biocompatible material to achieve a fluid tight seal (Stropko *et al*., 2005)). The socket was filled with bone substitute (Bio-Oss, Geistlich biomaterial, Switzerland) (Figure 2A) (Bahutski and Wang, 2009). A post-surgical radiograph confirmed the proper positioning of the implant (Figure 2B). The flap was repositioned and 3-0 silk sutures (Ethicon, Johnson & Johnson, India) were used (Figure 2C). Post-surgical instructions were given. Since the immediate stability could not be achieved to the expected level, the tooth was splinted for a week with fiber reinforced composite (Ribbond®, Ribbond Inc., USA). The sutures and splint were removed after a week. The case was followed for more than six months and the maxillary left central incisor showed no mobility and excellent soft tissue healing after eight months (Figures 2D, 2E).

Case 2

A 32-year-old male patient complained of mobility of the upper front tooth and gave a history of trauma three months prior. Clinically, a discolored maxillary right central incisor showed grade-3 mobility, with a negative vitality response (Figure 3A). Radiography revealed a fracture at mid-root level with horizontal bone loss. The root exhibited resorption with a blunderbuss configuration (Figure 3B). Extraction of the tooth would lead to compromised esthetics, hence the procedure involving a single-step closure of the apex and splinting of the fragment with a fiber post was explained to the patient and consent was taken.

A horizontal buccal flap was raised from right canine to left lateral incisor after anesthetizing the area. A palatal flap was raised only in relation to the maxillary right central incisor. After raising the flap, the fracture line was seen at the alveolar crest level in the labial side. The coronal fragment was removed and cleaned (Figure 3C). Retrograde endodontics were not planned as there was no peri-apical lesion present. Also, retrograde endodontics would also lead to poor bony support. Bone contouring was performed on the labial side to expose 1mm of apical fragment. AN apical fragment was cleaned and shaped. Due to the open apex, MTA (Pro-Root MTA, Dentsply Mallifer, USA) was condensed in the apical 2 mm to achieve a fluid-tight seal (Figure 3D) (Stropko *et al.*, 2005). Sectional thermoplasticized gutta percha was condensed in the apical 3 mm (Figure 3E) and epoxy-bonded root canal sealer (R C Seal, Prime dental Pvt limited, India) was used. Post space was prepared and a fiber post (Para Post® Taper Lux™, Coltene Whaldent, USA) was tried in and the coronal fragment repositioning was performed (Figure 3F). Access opening was performed on the coronal fragment. Complete haemostasis was achieved with the aid of electrocautery (Tissue contouring system or TCS, Coltene Whaldent, USA). A total-etch bonding agent (Adper™ Single Bond 2, 3M ESPE, USA) was applied to the canal of both coronal and apical fragments. The post and the canal were coated with resin-based cement (Rely X™ ARC, 3M ESPE, USA.) and the fragments were repositioned (Figure 4A). The excess cement was removed and a radiograph was taken to confirm the position (Figure 4B). The root was treated with tetracycline (Minabe *et al.*, 1994). The

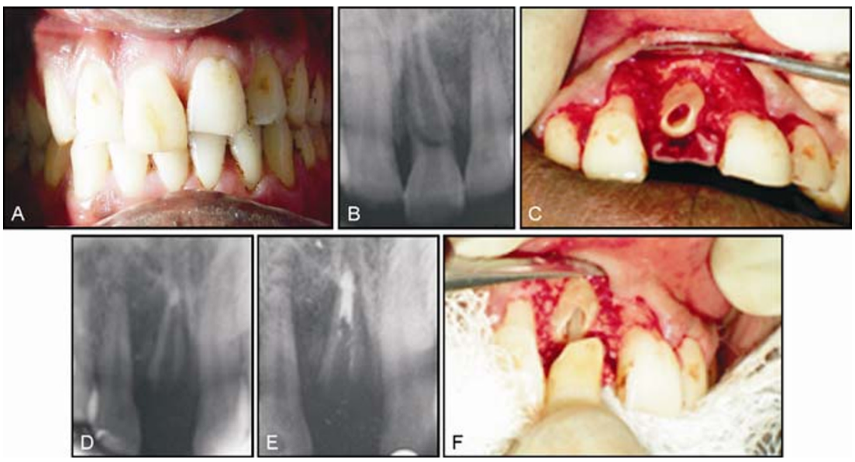

Figure 3 Reattachment of fractured segment using a prefabricated post-open apex

A: clinical appearance of the patient; B: preoperative radiograph; C: surgical removal of coronal fragment; D: apexification performed with MTA; E: sectional obturation; F: fiber post fit test.

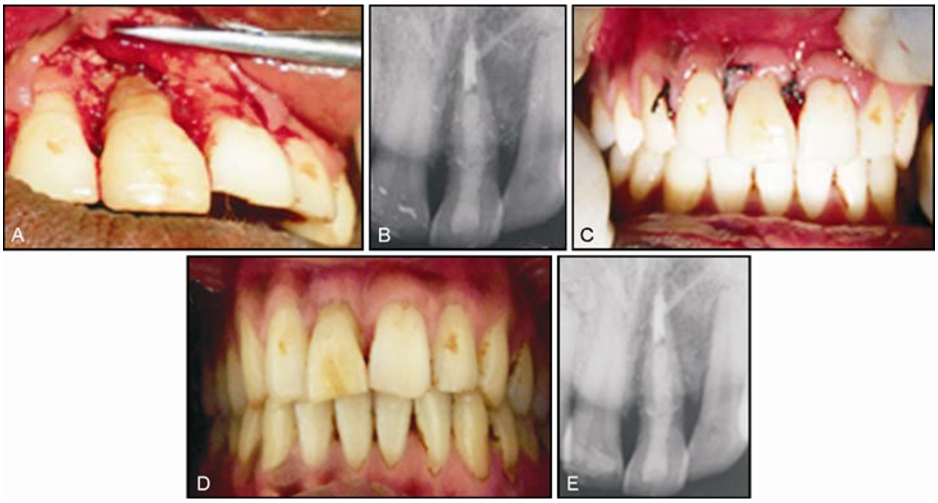

Figure 4 Continued-reattachment of fractured segment using a prefabricated post-open apex

A: reattachment of the coronal fragment; B: post surgical radiograph; C: discontinuous interrupted silk sutures placed; D: clinical appearance after five months; E: radiograph after five month recall.

flap was repositioned and simple loop sutures were placed with 3-0 silk sutures (Ethicon, Johnson & Johnson, India) (Figure 4C). Periodontal non-eugenol pack (Coe-Pak, GC inc., USA) was placed. Post surgical instructions were given and immediate stability was achieved. Sutures were removed after a week. The case has been under review for five months and the aesthetic result was satisfactory with no signs or symptoms (Figures 4D, 4E).

Discussion

Preservation of the natural dentition and restoration of the oral cavity to a normal functional state is a primary goal in dentistry (Linkow, 1970). Extraction and subsequent replacement with osseointegrated implants should only be considered after all other means of retaining the natural tooth have been fully explored (Linkow, 1970).

The first step for management of horizontal root-fracture cases is to reposition the tooth and confirm its position radiographically (Andreasen and Andreasen, 1993). Sequelae to root fractures may be divided into four types, as proposed by Andreasen and Andreasen (1993):

(1) healing with calcified tissue. Radiographically, the fracture line is discernible, but the fragments are in close contact;

(2) healing with interproximal connective tissue. Radiographically, the fragments appear separated by a narrow radiolucent line, and the fractured edges appear rounded;

(3) healing with interproximal bone and connective tissue. Radiographically, the fragments are separated by a distinct bony bridge;

(4) interproximal inflammatory tissue without healing. Radiographically, a widening of the fracture line and/or a developing radiolucency corresponding to the fracture line becomes apparent.

Unfortunately, the clinical use of the endodontic implant has been surrounded by controversy. The success and failure ratio varies considerably among clinicians (Weine and Frank, 1993). The endodontic implant uses the root canal space in an existing tooth as a pathway for the implant to extend into the apical bone (Orlay, 1965). A major advantage of the endodontic implant, in comparison with the prosthetic implant, is that it provides a closed environment reducing the complications of periodontal breakdown often responsible for implant failures (Linkow, 1970). There are two techniques for the use of these implants; these are the closed and the open technique (Stockdale, 1992). The closed technique is not a surgical procedure in that the implant is introduced via the root canal into the peri-apical bone. This technique is employed when the root is intact but has lost support due to the loss of alveolar bone, hence acting as a periodontal splint. The open technique, on the other hand, involves the raising of a flap and is used where there is a root fracture requiring the removal of the apical fragment (Stockdale, 1992). The mechanical principle is simple: by pushing a rigid-post through the tooth deep into the bone and cementing the intra dental part to the root canal walls, the fulcrum of the movement of a loose tooth is moved deeper into the jaw, and the support in the bone is increased and the mobility of the tooth is lessened (Linkow, 1970). This means that the vicious spiral of excessive mobility causing destruction of the periodontium, which in turn causes even more mobility, is halted and immediately healthier conditions prevail. With the tooth stabilized, the periodontal membrane can re-grow if prior damage has not been too extensive. Bone condenses around the apex of the tooth and the implanted pin. This, plus general reconditioning, leads to even further security of the tooth (Linkow, 1970).

Titanium would appear to be a desirable biocompatible material for use as an endodontic implant based on reported corrosion and tissue toxicity studies (Laing *et al.*, 1967, Clarke and Hickman, 1953). Most of the metals corrode in the human tissue fluids. However, the corrosion products of titanium, which have been reported to be oxides, such as $Ti_2O_3{\cdot}5TiO_2$ passivate the titanium surface and protect it from the attack of electrolytes (Aragon and Hlbert, 1972). Favorable results have been reported when titanium has been implanted in the bones of rabbit, sheep, dogs and humans. The findings indicated that the implants were well-tolerated by the bones. Also, when the titanium was fabricated to have open pores or was threaded, the bone grows into the pores and irregularities of the metal (Seltzer *et al.*, 1976). Root surfaces were conditioned with tetracycline, as it removes the smear layer and endotoxin from contaminated root surfaces (Minabe *et al.*, 1994).

Traditional metal posts have a high modulus of elasticity (Assif *et al.*, 1989), whereas the fiber-reinforced post system has a modulus similar to that of the dentin. The glass fiber-reinforced post has been reported to exhibit high fatigue strength, high tensile strength and a modulus of elasticity closer to dentin than that of carbon fiber-reinforced posts (Galhano *et al.*, 2005).

Long term clinical studies regarding various treatment options and their prognosis are not available in the literature. The healing of mid-root fractures was described by Cvek *et al*. (2001) in a retrospective study of 208 root-fractured incisors, treated with or without external stabilization. Hard-tissue healing of the fragments was observed in 33%, and interposition of PDL alone in 36%, of the teeth. Healing could not be confirmed in 23% of the teeth. Cvek *et al*. (2002) had concluded that the pattern and frequency of healing remains the same, regardless of the location of the root fracture in relation to the gingival crevice, although the frequencies may vary to some extent. Long-term prognosis of permanent anterior teeth with root fractures is related to the amount of dislocation, stage of root development, and probably whether treatment was done (Jacobsen and Zachrisson, 1975; Cvek *et al*., 2001).

The treatment plans of these cases were based on the relationship of fracture line with the bone level. In the first case, the fracture line was apical to the alveolar crest level and removal of the coronal fragment would lead to poor crown-root ratio, hence the open technique of endodontic implant placement was employed. In the second case, splinting both of the fragments was carried out as the fracture line was at the alveolar crest level. Following apically sealing with MTA and Thermoplasticized gutta percha, a postspace was prepared in the canal to extend from the coronal segment into the apical one, allowing placement of a post to stabilize the two root segments.

Short term follow up for both of the cases showed promising results. Patients should be reviewed after one year to confirm the success of such treatment options for mid root fractures.

Conclusion

Mid-root fractures have long been considered to have hopeless prognosis because of poor understanding of the biologic concept of such fracture and lack of availability of biocompatible materials. Availability of bondable material, like fiber posts and biocompatible materials like titanium and MTA have put forth varied treatment options for clinicians in the management of mid root fractures.

References

Andreasen FM, Andreasen JO (1993). Root fractures // Andreasen JO, Andreasen FM. *Textbook and color atlas of traumatic injuries to the teeth.* 3rd ed. Copenhagen: Munksgaard, pp279–311.

Aragon PJ, Hulbert SF (1972). Corrosion of Ti-6A1-4V in simulated body fluids and bovine plasma. *J Biomed Mater Res*, 6(3): 155–164.

Assif D, Oren E, Marshak BL, Aviv I (1989). Photoelastic analysis of stress transfer by endodontically treated teeth to the supporting structure using different restorative techniques. *J Prosthet Dent*, 61(5): 535–543.

Bashutski JD, Wang HL (2009). Periodontal and endodontic regeneration. *J Endod*, 35(3): 321–328.

Clarke EG, Hickman J (1953). An investigation into the correlation between the electrical potentials of metals and their behaviour in biological fluids. *J Bone Joint Surg Br*, 35-B(3): 467–473.

Cvek M, Andreasen JO, Borum MK (2001). Healing of 208 intra-alveolar root fractures in patients aged 7-17 years. *Dent Traumatol*, 17(2): 53–62.

Cvek M, Mejàre I, Andreasen JO (2002). Healing and prognosis of teeth with intra-alveolar fractures involving the cervical part of the root. *Dent Traumatol*, 18(2): 57–65.

Flores MT, Andersson L, Andreasen JO, Bakland LK, Malmgren B, Barnett F *et al.* (2007). Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth. *International Association of Dental Traumatol*, 23(2): 66–71.

Galhano GA, Valandro LF, de Melo RM, Scotti R, Bottino MA (2005). Evaluation of the flexural strength of carbon fiber-, quartz fiber-, and glass fiber-based posts. *J Endod*, 31(3): 209–211.

Ingle IJ, Bakland LK (2002). *Endodontics.* 5th ed. London: BC Decker Inc, pp795–844.

Jacobsen I, Zachrisson BU (1975). Repair characteristics of root fractures in permanent anterior teeth. *Scand J Dent Res*, 83(6): 355–364.

Laing PG, Ferguson AB Jr, Hodge ES (1967). Tissue reaction in rabbit muscle exposed to metallic implants. *J Biomed Mater Res*, 1(1): 135–149.

Linkow LI (1970). *Theories and Technique of Oral Implantology-2*. Saint Louis: Mosby Co, pp581–607.

Malmgren O, Malmgren B, Frykholm A (1991). Rapid orthodontic extrusion of crown root and cervical root fractured teeth. *Endod Dent Traumatol*, 7(2): 49–54.

Minabe M, Takeuchi K, Kumada H, Umemoto T (1994). The effect of root conditioning with minocycline HCl in removing endotoxin from the roots of periodontally-involved teeth. *J Periodontol*, 65(5): 387–392.

Orlay HG (1965). Stabilization with endodontic implants. *J Oral Implant Transplant Surg*, 11: 44–53.

Seltzer S, Maggio J, Wollard R, Green D (1976). Titanium endodontic implants: a scanning electron microscope, electron microprobe, and histologic investigation. *J Endod*, 2(9): 267–276.

Stockdale LR (1992). *Endodontic Surgery.* London: Quintessence Pub, pp90–95.

Stropko JJ, Doyon GE, Gutmann JL (2005). Root-end management: resection, cavity preparation, and material placement. *Endodontic Topics*, 11: 131–151.

Weine FS, Altman A, Healey HJ (1971). Treatment of fractures of the middle third of the root. *ASDC J Dent Child*, 38(3): 215–219.

Weine FS, Frank AL (1993). Survival of the endodontic endosseous implant. *J Endod,* 19(10): 524–528.

Zachrisson BU, Jacobsen I (1975). Long-term prognosis of 66 permanent anterior teeth with root fracture. *Scand J Dent Res*, 83(6): 345–354.

*Corresponding author: Deepak J. Parekh
Address: 1-6-237, Subhash road, Secunderabad, 500003, Andhra Pradesh, India.
Tel: 040 27842353 E-mail: d_j_p_84@yahoo.com