Review Article

Repair of Root Surface Defect by Microsurgery: An Overview

Tiwari Sanjay Kumar[1], Yang Jin Bo[2]

[1]PhD Student, Department of Operative Dentistry and Endodontics
[1]Associate Professor, Department of Operative Dentistry and Endodontics

[1,2] West China College of Stomatology, Sichuan University

ABSTRACT

The persistent periapical infection is a squeal of presence of bacteria in root canal and host response towards it even after root canal treatment. Following higher standard for treatment, the error can be minimized, but cannot be avoided. The alternate methods are necessary to repair these defects. Root canal re-treatment or endodontic microsurgery is available methods to correct the defects. Modern approach and new biocompatible materials have made the surgical procedure more promising and reduced the number of teeth loss.
Keywords: perforation, persistent periapical lesion, root crack, root resorption; root repair

INTRODUCTION

Periapical microsurgery is performed on the tooth with failed root canal re-treatment or for the exploratory purpose. Leaking bacteria and bacterial products from root canal to the adjacent periodontal tissue is the major cause of persistent non-healing periapical lesion. The aim of micro-surgery is to locate and seal the leaking spaces, restore the health of periradicular tissue and return tooth back to function. The small osteotomy, low risk to damage adjacent vital structures, better visualization and sealing has made the endodontic microsurgery more acceptable.

Normally, tooth crack, lateral canal, root resorption and root perforation cannot be treated by non-surgical root canal treatment alone. It needs the combined effort of non-surgical and surgical root canal treatment. If the tooth has well filled canal space, have crown, or the lesion cannot be approached from coronal access then the surgical intervention becomes necessary.

Tooth root consists of root canal, dentinal tubules, lateral canal, accessory canal, fins, deltas and isthmus. This anatomic diversity possesses challenges during root canal treatment and if not adequately located, cleaned and sealed could fail the conventional non-surgical root canal treatment.[1,2] Similarly, the procedural error has negative impact on the outcome of root canal treatment as well.[3,4]

The objective of this review is to updates readers on clinical features, diagnosis and management of dental crack, lateral canal, resorption and perforation.

Tooth crack

The root crack is described as the fracture on root surface involving cementum and dentin. Pulp tissue may or may not be involved.[5] The discontinuity on root surface can be either crack or vertical/horizontal root fracture. The tooth crack or vertical root fractures (VRF) have some specific clinical manifestations. They clinical and radiographic signs and symptoms are similar to the non-healing root canal treated tooth and tooth with periodontal lesion. The common sign

Correspondence: ***Jin Bo Yang****; e-mail:* ***15884485592@163.com***

presented by patient is mild pain during mastication.

The vertical root fracture is common among female, above 40 years of age and mandibular molars and maxillary premolars are frequently involved[6,8] and involved tooth are severely attrited.[9] The reason for higher incidence of VRF on premolars and molars might be presence of isthmus.[10] The vertical root fracture presents clinically as isolated periodontal defect, presence of sinus tract.[6] The isolated periodontal defect is a narrow but deep periodontal pocket communicating with gingival sulcus and dehiscence type bone loss.[11] The more bone resorption in apical area and narrower bone defect towards coronal portion is the clinical feature seen after the flap is elevated and degranulation of area.The tooth with fenestration bone defect shows the presence of halo-type radiolucency around root.[1,11,13] The presence of sinus tract on buccal or lingual/palatal aspect or on both sides can be found.[12]

The prevalence of VRF is higher in endodontically treated tooth.[6] The clinical presentation of VRF in endodontically treated is similar to nonendodontically treated tooth, except the non-healing periapical lesion, symptomatic tooth, discomfort during mastication, click sound during condensation of gutta percha, more number of gutta percha accommodating in canal space, presence of blood in root canal during obturation.[14]

The root fractures in bucco-lingual direction. The initial lesion is difficult to diagnose on radiograph and time is needed for fracture to propagate and lesion to establish.[11,13] The multiple radiographs taken with horizontal angulation of 20°-40° is more helpful to detect the fracture.[12] Staining the tooth, use of fiberoptic trans-illumination and surgical exploratory surgery are some clinical options to diagnose VRF.[15] The cone beam computed tomography (CBCT), an advanced imaging technology, is more helpful to diagnose the VRF and determine the extent of lesion.[16] But, both CBCT and periapical radiograph cannot detect early VRF.[17,19] The sensitivity of CBCT to detect VRF in endodontically treated tooth is high.[20] But, the specificity is reduced due to the presence of artifact.[21,23] Therefore, it will be too early to say that CBCT is better tool to diagnose VRF in root filled tooth.[24]

The VRF not communicating with gingival sulcus can be treated by sealing the crack with resins. But, the cases with crack on lingual aspect, crack present both on lingual and buccal side of root, split root or periodontal lesion communicating with apical lesions are contraindicated for microsurgery.

Lateral Canal

Lateral root canal is formed when the existing blood vessel and nerve gets entrapped by hertwig's epithelial root sheet during root development, but these are not collateral circulation and nerve supply to pulp.[25] The lateral canal is present on apical third, middle third and coronal third of root in varying proportion[26] and varying diameters from 01 to 200 microns.[27] It is consist of bacteria and necrotic tissue in tooth with chronic pulpitis and is constant source of irritation to adjacent periodontal tissue.[28] Lateral canals are almost invisible on radiographs, but it becomes visible after the space is filled with sealer. The sinus on attached gingiva and isolated radiolucency not involving the apex of root is the sign for presence of lateral canal. The tooth with symptomatic lateral canal must be re-treated and when the re-treatment fails, or tooth has no access to the re-treatment then the microsurgery is the backup.

Resorption

The external root resorption is due to trauma and loss of cementum and replacement of periodontal ligament space, cementum and dentin by bone.[29] The external resorption is especially found in tooth after luxation injury. The resorption in traumatized tooth can be minimized by use of lendermix[30,32], tetracycline group medication Minocycline, Demeclocycline[32,33], Corticosteroid[32] and Triamcinolone.[32] Their use delays the proliferation of osteoblast and osteoclast

towards denuded root surface, allows adequate time for periodontal tissue and cementoblasts on the denuded surface and minimizes the risk of resorption. The ankylosis, inflammatory resorption and replacement resorption is fate of delayed replanted tooth.[34] Although, the tooth gets lost by resorption but it preserves the alveolar ridge height for prosthetic replacement.

Perforation

Perforation is defined as the mechanical or pathologic communication between root and external surface of root.[5] The communication developed during root canal treatment or intracanal post placement is of iatrogenic origin and communication developed by root resorption is pathologic origin. The presence of pain, swelling, sinus tract, previous history of non-surgical root canal treatment and radiolucency associated with perforation.[35] The prognosis of perforation is dependent on the association with radiolucency and communication with oral cavity[33-38] ; and patient age, perforation location, perforation size, and tooth types.[38,39]

DISCUSSION

The diagnosis and management follow the normal guidelines. An early management can save the tooth and restore the periodontal health back to normal. The discussion on this article will be based on the methods adopted to identify, manage and selection of materials.

Diagnosis

The clinical signs of dental defect are the persistence of sinus tract, not healing periodontal pocket and mild pain while teeth are in contacts. The presence of granulation tissue is the confirmatory sign of the persistence of defect and the granulation tissue is attached to the site of defect. The area of defect can be highlighted with methylene blue. Radiograph of central incisor (Fig.1.A) shows widen periodontal ligament space on mesial aspect of root, the adequately filled canal and flow of sealing material toward the periodontal space. CBCT image of same tooth, the horizontal image verifies the flow of material on mesial aspect (Fig. 1.B) but the sagittal section shows the under filled canal and flow of material (Fig. 1.C)

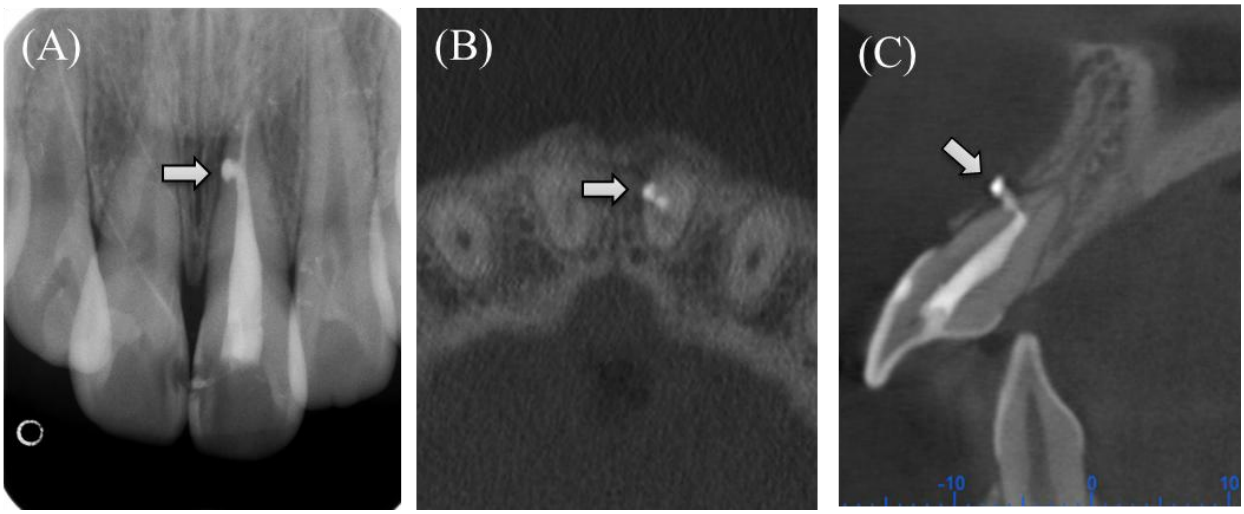

Figure 1: (A) Intraoral radiograph of maxillary central incisor showing widen periodontal ligament space on mesial aspect of root, adequately filled canal space and flow of material towards the periodontal defect area from root canal space. (B) CBCT horizontal section of same tooth showing the filled canal and flow of material on mesial aspect. (C) CBCT sagittal section showing the under obturated apical third of root canal, discontinued labial cortical plate and sealing material extruded from root canal space. Arrow marks the area of interest.

Design of Incision

After diagnosis, access to the area of lesion is major step. The access to the site of lesion can be achieved through flap designs. Sulcular full thickness (triangular and rectangular or trapezoid design) and modified Ochsenbein and Luebke are three methods adopted in endodontic microsurgery. Triangular flap design is adequate to get access the defect in coronal third and middle third of root or full coverage of till apical third of root if the vertical incision is with 1% methylene blue application. The localization of defect becomes more placed deeper in vestibule (Fig 2A and 2B), while rectangular or trapezoid flap design gives full access to periapical area (Fig. 2C). The modified Ochsenbein and Luebke flap design is aesthetic design commonly adopted in cases with demanding cosmetic and if the lesion does not communicates the sulcular area (Fig 2D). The area of incision is guided by the extent of lesion and need to place suture on tissue with boney base. The granulation tissue is attached to the area of exit and the area of exit is highlighted distinguished with aided benefits from dental operating microscope.

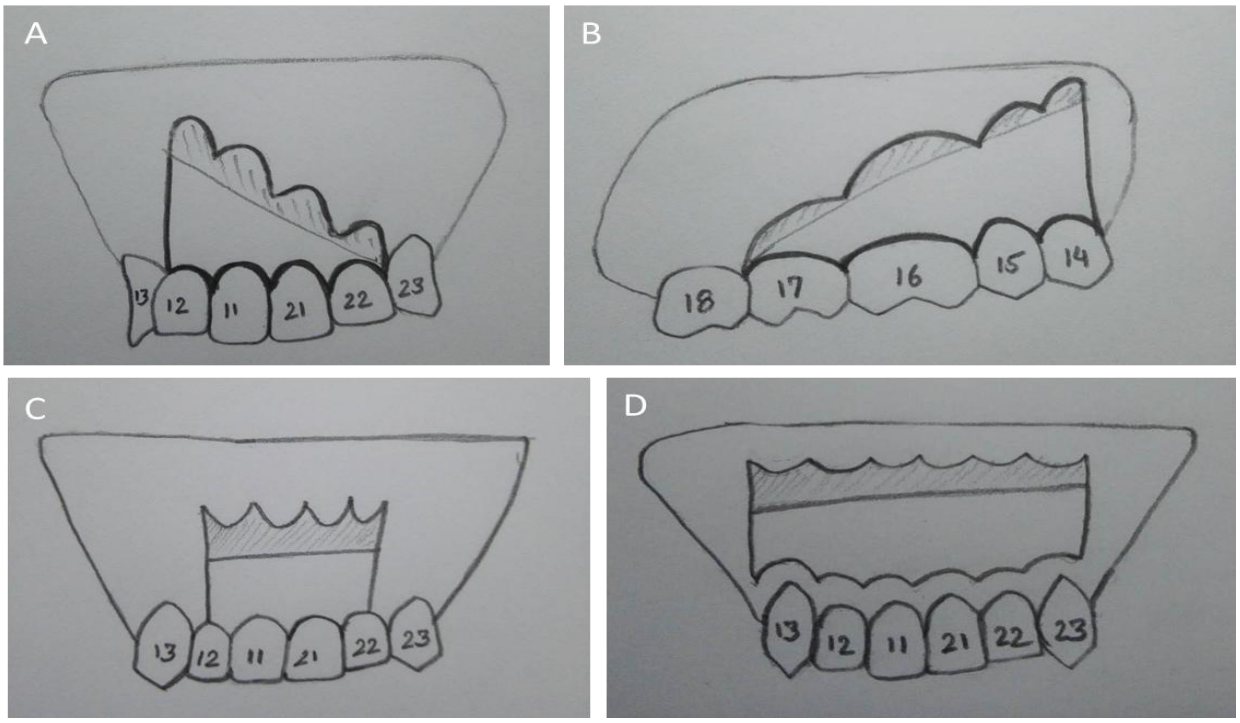

Figure 2: Types of flap designs. (A) Triangular in anterior segment. (B) Triangular in posterior segment. (C) Rectangular Flap. (D)Modified Ochsenbein and Luebke flap.

Seal It

Use of amalgam to seal the apex is history now. It was replaced by Zinc Oxide eugenol (ZOE) based Intermediate restorative material (IRM) and Ortho-ethoxybenzoic acid (SuperEBA). Currently, Mineral Trioxide Aggregate (MTA) is common choice for sealing. MTA poses excellent biocompatibility and seal, but it lacks the chemical bonding with dentin. Therefore, it needs to be packed in adequate consistency and its use is to be limited to the confined space (Fig. 4.A). Recently, bioceramic is used as root end filling material. Both MTA and bioceramic poses similar clinical significance. MTA or bioceramic if used in crack or the lesion communicating sulcular area does not give desired results because of prolonged setting duration and material gets washed out. Dentin bonded resin modified cements are used in these area and they have shown satisfying results.

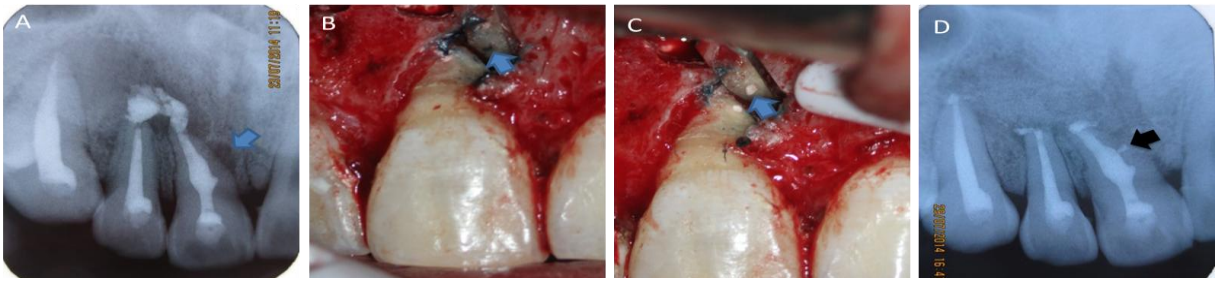

Figure 3:(A) The IOPA shows the presence of dumb-bell shaped periapical lesion involving periapical and mesial surface of maxillary central incisor. (B) Image shows the presence of lateral canal on mesiobuccal aspect of root surface (blue arrow). (C) The lateral canal sealed with MTA (blue arrow). (D) The IOPA confirms the seal of lateral canal.

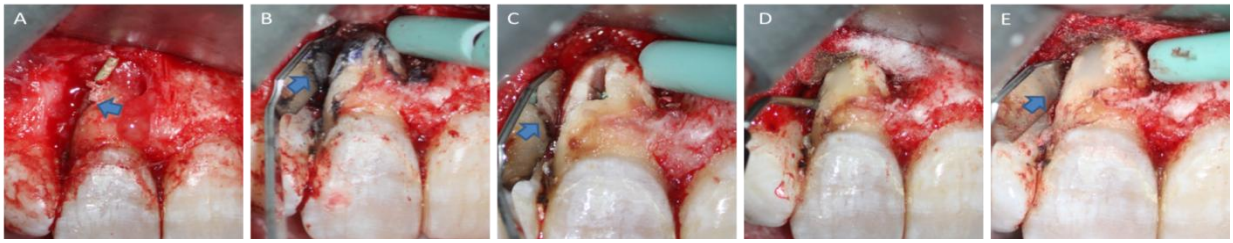

Figure 4: (A) Image of Maxillary central crack on buccal aspect of root extending towards distal aspect of root. (B) Image taken after degranulation and staining area with 1% methylene blue. (C) The defect was prepared with ultrasonic tip. (D) Placing flowable resin cement in area after defect elimination. (E) Area visualized with micro-mirror after final restoration of involved area. The field of interest is marked with light blue arrow.

Figure 5: (A) Image of rightmaxillary central and lateral incisor. (B) Area of labial perforation seen after debridement of area and methylene blue staining (blue arrow indicates area of perforation and light brown arrow marks lateral canal. (C) Image taken after preparation of areas with ultrasonic tip. (D) Restoring the defect with flowable resin cement. (E) Apical preparation and lateral canal was sealed with MTA.

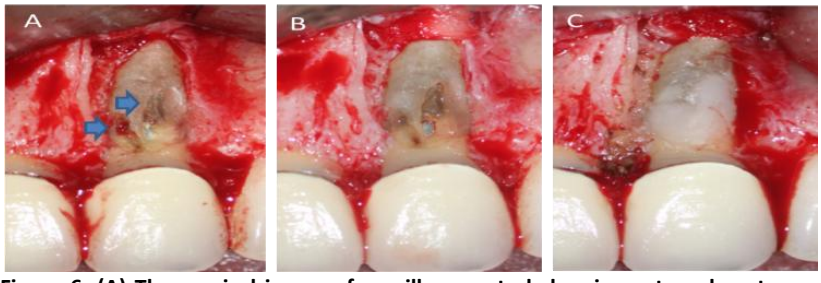

Figure 6: (A) The surgical image of maxillary central showing external root resorption on buccal and distal aspect of root surface. (B) Image taken after preparation of defects with ultrasonic defect. (C) The defect was restored with flowable resin cement. The area of interest is marked with light blue arrow.

REFERENCES

1. *Qian WH, Hong J, Xu PC. Analysis of the possible causes of endodontic treatment failure by inspection during apicalmicrosurgery treatment. Shanghai Kou Qiang Yi Xue 2015;24:206-9.*
2. *Song M, Kim HC, Lee W, Kim E. Analysis of the cause of failure in nonsurgical endodontic treatment by microscopic inspection during endodontic microsurgery. J Endod 2011;37:1516-9.*
3. *Yousuf W, Khan M, Mehdi H. Endodontic Procedural Errors: Frequency, Type of Error, and the Most Frequently Treated Tooth. Int J Dent 2015;2015:673914.*
4. *Mozayeni MA, Asnaashari M, Modaresi SJ. Clinical and Radiographic Evaluation of Procedural Accidents and Errors during Root Canal Therapy. Iran Endod J 2006;1:97-100.*
5. *American Association of Endodontics. Glossary of Endodontic terms. Eighth edition*
6. *Cohen S, Berman LH, Blanco L, Bakland L, Kim JS. A demographic analysis of verticalrootfractures.J Endod 2006;32:1160-3.*
7. *Chan CP, Lin CP, Tseng SC, Jeng JH. Verticalrootfracture in endodontically versus nonendodonticallytreatedteeth: a survey of 315 cases in Chinese patients.Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;87:504-7.*
8. *Chan CP, Tseng SC, Lin CP, Huang CC, Tsai TP, Chen CC. Verticalrootfracture in nonendodonticallytreatedteeth--a clinical report of 64 cases in Chinese patients.J Endod 1998;24:678-81.*
9. *Yang SF, Rivera EM, Walton RE. Verticalrootfracture in nonendodonticallytreatedteeth.J Endod 1995;21:337-9.*
10. *Chai H, Tamse A. The Effect of Isthmus on VerticalRootFracture in EndodonticallyTreatedTeeth.J Endod 2015;41:1515-9.*
11. *Rud J, Omnell KA. Root fractures due to corrosion. Diagnostic aspects. Scand J Dent Res 1970;78:397-403.*
12. *Lustig JP, Tamse A, Fuss Z. Pattern of bone resorption in vertically fractured, endodontically treated teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:224-7.*
13. *Meister F Jr, Lommel TJ, Gerstein H. Diagnosis and possible causes of vertical root fractures. Oral Surg Oral Med Oral Pathol 1980;49:243-53.*
14. *Pitts DL, Natkin E. Diagnosis and treatment of verticalrootfractures.J Endod 1983;9:338-46.*
15. *Meister F Jr, Lommel TJ, Gerstein H. Diagnosis and possible causes of verticalrootfractures.Oral Surg Oral Med Oral Pathol 1980;49:243-53.*
16. *Talwar S, Utneja S, Nawal RR, Kaushik A, Srivastava D, Oberoy SS. Role of Cone-beam Computed Tomography in Diagnosis of Vertical Root Fractures: A Systematic Review and Meta-analysis.J Endod 2016;42:12-24.*
17. *Makeeva IM, Byakova SF, Novozhilova NE, Adzhieva EK, Golubeva GI, Grachev VI, Kasatkina IV. Detection of artificially induced verticalrootfractures of different widths by cone beam computed tomography in vitro and in vivo.Int Endod J 2015. In Press.*
18. *Brady E, Mannocci F, Brown J, Wilson R, Patel S. A comparison of cone beam computed tomography and periapical radiography for the detection of verticalrootfractures in nonendodontically treated teeth.Int Endod J 2014;47:735-46.*
19. *Ozer SY. Detection of verticalrootfractures of different thicknesses in endodontically enlarged teeth by cone beam computed tomography versus digital radiography.J Endod 2010;36:1245-9.*
20. *Hassan B, Metska ME, Ozok AR, van der Stelt P, Wesselink PR. Detection of vertical root fractures in endodontically treated teeth by a cone beam computed tomography scan.J Endod 2009;35:719-22.*
21. *Patel S, Brady E, Wilson R, Brown J, Mannocci F. The detection of verticalrootfractures in root filled teeth with periapical radiographs and CBCT scans. Int Endod J 2013;46:1140-52.*
22. *Hassan B, Metska ME, Ozok AR, van der Stelt P, Wesselink PR. Comparison of five cone beam computed tomography systems for the detection of vertical root fractures. J Endod 2010;36:126-9.*
23. *Khedmat S, Rouhi N, Drage N, Shokouhinejad N, Nekoofar MH. Evaluation of three imaging techniques for the detection of vertical root fractures in the absence and presence of*

gutta-percha root fillings. Int Endod J 2012;45:1004-9.

24. *Chang E, Lam E, Shah P, Azarpazhooh A. Cone-beam Computed Tomography for Detecting VerticalRootFractures in Endodontically Treated Teeth: A Systematic Review.J Endod 2016;42:177-85.*
25. *Vertucci FJ, Haddix JE. Cohen's Pathways of the Pulp, 10th ed. St. Louis: Mosby, 2011:136*
26. *Vertucci FJ. Root canal anatomy of the humanpermanent teeth.Oral Surg Oral Med Oral Pathol 1984;58:589-99.*
27. *Dammaschke T, Witt M, Ott K, Schäfer E. Scanningelectronmicroscopicinvestigation of incidence, location, and size of accessoryforamina in primary and permanentmolars. Quintessence Int 2004;35:699-705.*
28. *Weine FS. The enigma of the lateralcanal.Dent Clin North Am 1984;28:833-52.*
29. *Wedenberg C, Lindskog S. Experimentalinternalresorption in monkeyteeth.Endod Dent Traumatol 1985;1:221-7.*
30. *Wong KS, Sae-Lim V. The effect of intracanalLedermix on root resorption of delayed-replantedmonkeyteeth.Dent Traumatol 2002;18:309-15.*
31. *Bryson EC, Levin L, Banchs F, Abbott PV, Trope M. Effect of immediate intracanal placement of Ledermix Paste(R) on healing of replanted dog teeth after extended dry times.Dent Traumatol 2002;18:316-21.*
32. *Chen H, Teixeira FB, Ritter AL, Levin L, Trope M. The effect of intracanal anti-inflammatory medicaments on external root resorption of replanted dog teeth after extended extra-oral dry time.Dent Traumatol 2008;24:74-8.*
33. *Ma KM, Sae-Lim V. The effect of topical minocycline on replacement resorption of replanted monkeys' teeth.Dent Traumatol 2003;19:96-102.*
34. *Panzarini SR, Gulinelli JL, Poi WR, Sonoda CK, Pedrini D, Brandini DA. Treatment of rootsurface in delayedtoothreplantation: a review of literature.Dent Traumatol 2008;24:277-82.*
35. *Kim S. Prevalence of referralreasons and clinicalsymptoms for endodonticreferrals.Restor Dent Endod 2014;39:210-4.*
36. *Krupp C, Bargholz C, Brüsehaber M, Hülsmann M. Treatmentoutcomeafterrepair of rootperforations with mineraltrioxideaggregate: a retrospectiveevaluation of 90teeth.J Endod 2013;39:1364-8.*
37. *Siew K, Lee AH, Cheung GS. TreatmentOutcome of RepairedRootPerforation: A SystematicReview and Meta-analysis.J Endod 2015;41:1795-804.*
38. *Gorni FG, Andreano A, Ambrogi F, Brambilla E, Gagliani M.Patient and ClinicalCharacteristicsAssociated with PrimaryHealing of IatrogenicPerforationsafterRootCanalTreatment: Results of a Long-termItalianStudy.J Endod 2016;42:211-5.*
39. *Tsesis I, Rosenberg E, Faivishevsky V, Kfir A, Katz M, Rosen E. Prevalence and associated periodontal status of teeth with root perforation: a retrospective study of 2,002 patients' medical records.J Endod 2010;36:797-800.*