Evidence-Based Decision Making in Dentistry

Multidisciplinary Management of the Natural Dentition

Eyal Rosen
Carlos E. Nemcovsky
Igor Tsesis
Editors

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Editors
Eyal Rosen
Department of Endodontology
The Maurice and Gabriela Goldschleger
School of Dental Medicine
Tel Aviv University
Tel Aviv
Israel

Igor Tsesis
Department of Endodontology
The Maurice and Gabriela Goldschleger
School of Dental Medicine
Tel Aviv University
Tel Aviv
Israel

Carlos E. Nemcovsky
Department of Periodontology and
Implant Dentistry
The Maurice and Gabriela Goldschleger
School of Dental Medicine
Tel Aviv University
Tel Aviv
Israel

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Contents

Contributors

Veeratrishul Allareddy Department of Oral Pathology, Radiology & Medicine, The University of Iowa College of Dentistry, Iowa City, IA, USA

Stefano Corbella Dipartimento di Scienze Biomediche, Chirurgiche e Odontoiatriche, Università degli Studi di Milano, Milan, Italy

I.R.C.C.S. Istituto Ortopedico Galeazzi, Milan, Italy

Massimo Del Fabbro Dipartimento di Scienze Biomediche, Chirurgiche e Odontoiatriche, Università degli Studi di Milano, Milan, Italy

I.R.C.C.S. Istituto Ortopedico Galeazzi, Milan, Italy

Barbu Horia, DDS, PhD, MSc Oral Implantology Department, Dean of Dental Medicine,Titu Maiorescu University, Bucharest, Romania

Nissan Joseph, DMD Oral-Rehabilitation & Implant-Prosthodontics, Rabin Medical-Center, Belinson Hospital, Petah- Tikva, Israel

Department Oral-Rehabilitation, School of Dental-Medicine, Tel-Aviv University, Tel Aviv-Yafo, Israel

Syngcuk Kim, DDS, PhD, MD (Hon) Louis I. Grossman Professor of Endodontics, Department of Endodontics, Penn Dental Medicine, University of Pennsylvania, Philadelphia, PA, USA

Carlos E. Nemcovsky Department of Periodontology and Dental Implantology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel

Russell Paul Department of Endodontology, Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel

Private Practice Limited to Endodontics, Tallahassee, FL, USA

Eyal Rosen Department of Endodontology, Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel

Anton Sculean, DMD, MS, PhD Department of Periodontology, School of Dental Medicine, Universität Bern, Bern, Switzerland

Frank Setzer, DMD, PhD, MS Assistant Professor of Endodontics, Department of Endodontics, Penn Dental Medicine, University of Pennsylvania, Philadelphia, PA, USA

Silvio Taschieri Dipartimento di Scienze Biomediche, Chirurgiche e Odontoiatriche, Università degli Studi di Milano, Milan, Italy

I.R.C.C.S. Istituto Ortopedico Galeazzi, Milan, Italy

Igor Tsesis Department of Endodontology, Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel

Miron Weinreb Department of Oral Biology, The Maurice and Gabriela Goldschleger School of Dental Medicine, Tel Aviv University, Tel Aviv, Israel

3.3.2 Magnification and Illumination Systems

Common magnification systems used in modern endodontics are the dental operating microscope and the surgical loupes [22, 23]. Loupes, the most common magnification system used in dentistry, use convergent lenses to form a magnified image and are available in many configurations [22, 24].

Dental operating microscopes were introduced to conventional endodontics during the 1970s [24]. Modern microscopes facilitate the variable magnification needed in endodontic practice ranging from X3 to X30 magnification. The microscope is superior to loupes when using higher magnifications, in its available depth of field, and its fiber-optic light source is far superior compared to the surgical headlamp that is sometimes attached to loupes [22, 24].

The benefits of using magnification devices for conventional endodontic treatment include the improved visualization of the treatment field, enhanced possibilities in locating canals, aid in the removal of separated instruments, diagnosis of root and tooth fractures, perforation repair, as well as case documentation [22] (Figs. 3.5 and 3.6).

Dental operating microscopes were introduced to endodontic surgery only in the early 1990s [25] and quickly became an integral part of modern endodontic surgical protocol [25, 26]. During endodontic surgery, locating, cleaning, and filling of the apical part of the root

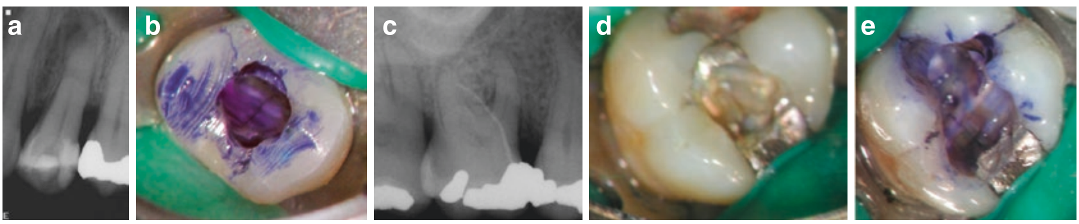


Fig. 3.5 Two cases of tooth fracture ("fracture necrosis") diagnosis using magnification. (**a**) A patient taking Tegretol due to trigeminal neuralgia presented after the referral source had already made coronal access to perform emergency treatment for a maxillary left second premolar. The initial diagnosis was "previously initiated therapy." (**b**) Under microscopic evaluation, a fracture under the distal composite not visible at the initial exam was observed. The prognosis is extremely poor. (**c**) A patient presented with a sinus tract leading to the distobuccal root apex of a maxillary right molar. Drainage from the sinus tract was present as well as limited vestibular swelling. (**d**) The restoration covered the fracture. (**e**) The amalgam restoration was removed, and the fracture was diagnosed with microscope

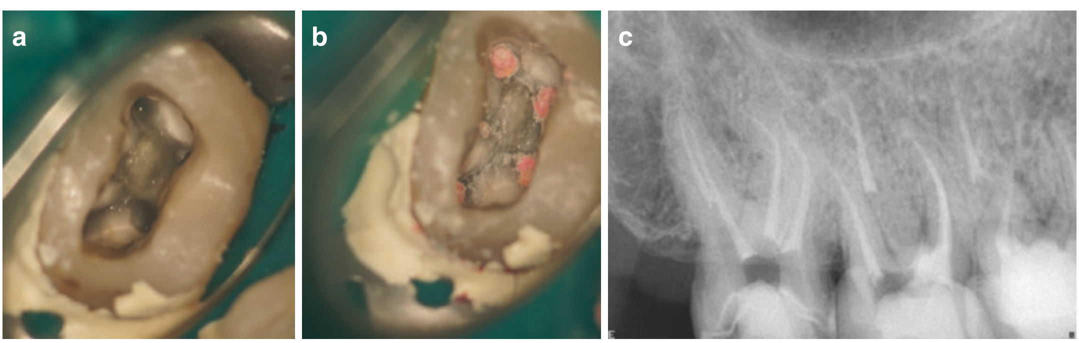


Fig. 3.6 A case of an upper 3rd molar referred to root canal treatment that was diagnosed with five root canals using a microscope. During endodontic treatment of an maxillary third molar,(**a**) a fifth canal was located in a distopalatal root, located with the aid of a surgical operating microscope. (**b**, **c**) All five canals were treated and filled

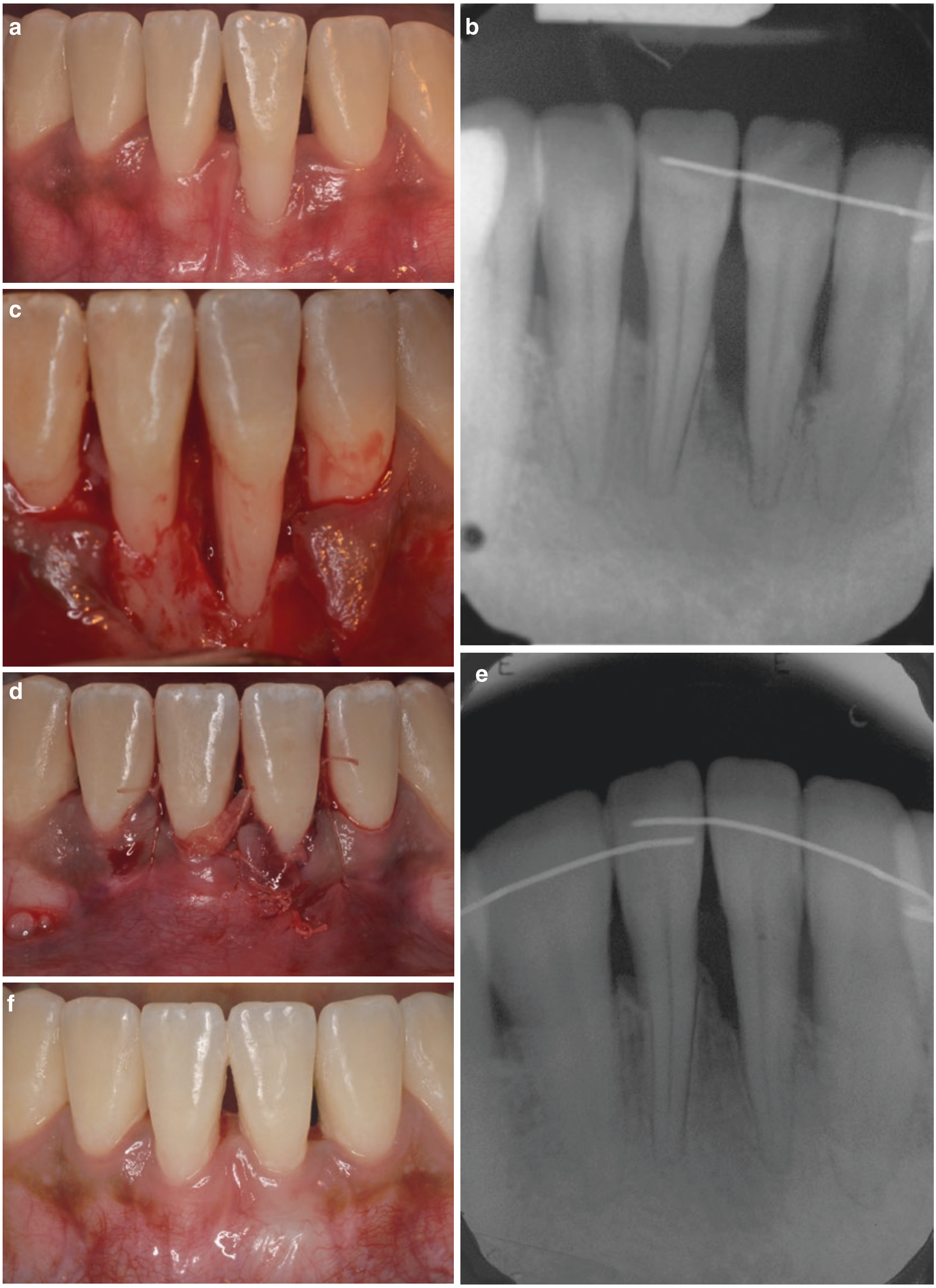


Fig. 4.2 (**a**). Gingival recession together with interdental loss of periodontal support on central lower incisors, especially on the left, and lack of attached keratinizing gingiva is evident. (**b**) Periapical radiograph shows large periodontal destruction around central lower incisors. (**c**) Intraoperative aspect shows large loss of periodontal support around lower left central incisor. (**d**) Immediate postoperative aspect of central lower incisors. Regenerative periodontal therapy combined with a free soft tissue graft was performed. (**e**) 1-year postoperative aspect of lower anterior segment. (**f**) 1-year postoperative periapical radiograph shows periodontal support gain on lower incisors

cedures [55, 56]. Teeth with deeper intrabony components of the defects at baseline will respond to therapy with larger bone gains [15]. Non-contained (one- to two-wall) defects show greater recession and lower bone defect fill and periodontal regeneration extent than contained (three-wall) defects after regenerative periodontal surgery [58]. Bone grafting in combination with regenerative periodontal surgery is advised in the treatment of non-contained bony defects [58]. Large clinical attachment level gains (5.4–6.8 mm) and resolution of the initial intrabony component of the defect (88.2–94.7 %) can be achieved 1 year after regenerative periodontal surgery of deep (9-mm baseline probing pocket depth) contained and non-contained intrabony defects [59]. Regenerative periodontal treatment presents a valuable treatment alternative for the management of severely compromised teeth with intrabony defects; tooth retention and clinical improvements can be maintained for long periods of time in the vast majority of cases. Tooth survival, more than 10 years after regenerative treatment of deep intrabony defects (average depth 6.6 mm), was greater than 96 %; in those cases, clinical attachment level was equal or coronal than pretreatment in 92 % of cases followed for 15 years [38]. However, the type of bone loss appears to have little impact on tooth survival [14] (Fig. 4.6).

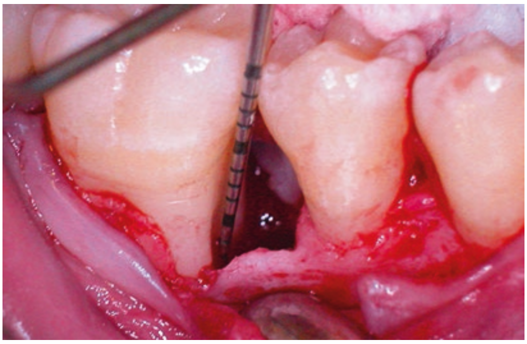


Fig. 4.3 Vertical bone defect on mesial aspect of lower molar. In the most coronal aspect, a one-wall defect, while in the apical area, a two–three-wall defect, may be appreciated

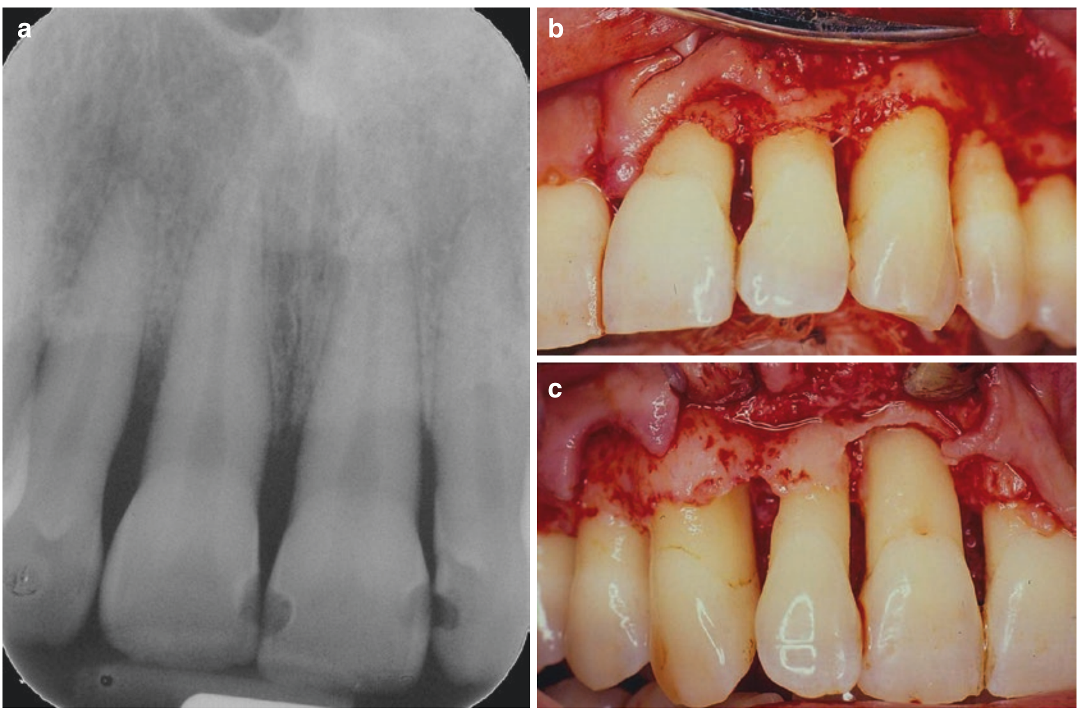


Fig. 4.4 (**a**). Periapical radiograph of upper incisors shows horizontal bone loss. (**b**) Intraoperative aspect shows horizontal bone loss on *left side*. (**c**) Intraoperative aspect shows horizontal bone loss on *right side*

5.3 Post Type, Size, and Cementation

Posts are advocated in teeth with extensive coronal destruction to retain the core that replaces lost coronal structure, but not to reinforce the endodontically treated tooth [22]. Loss of post retention and root fractures is common and can affect tooth survival [23–28]. Therefore, the use of a post that minimizes these risks is of utmost importance. The preservation of sound root structure while using posts increases fracture resistance and decreases occurrence of periapical lesions of the restored endodontically treated teeth [19, 29–36]. Sound root structure and the apical seal of the endodontic filling are preserved by using posts with a reduced length in combination with composite resin cement in order to improve tooth survival [37].

In the past, some researchers believed that posts could improve the fracture resistance in endodontically treated tooth; nowadays, it is known that preparation of a post space may increase the chances of root fracture [38]; for that reason, posts should only be used when other options to retain a core are not available [22]. The decision to use root posts depends on the amount of remaining coronal tooth structure and the functional requirements [39, 40]. Depending on the remaining tooth structure, different treatment plans can be suggested. Loss of tooth structure greater than 50 % would determine the use of root posts to retain a core.

Posts should be used only for retention of a core within remaining tooth structure when there are no other alternatives and not to strengthen endodontically treated teeth.

Based on the evidence from laboratory studies, root-filled premolars and molars with limited tissue loss, where 50 % or more coronal structure is preserved, can be restored without intraradicular retention, particularly when total coverage are planned [41, 42] (Figs. 5.1, 5.2, and 5.3).

Figs. 5.1, 5.2, and 5.3 The molar with limited tissue loss restored with crown without intraradicular retention

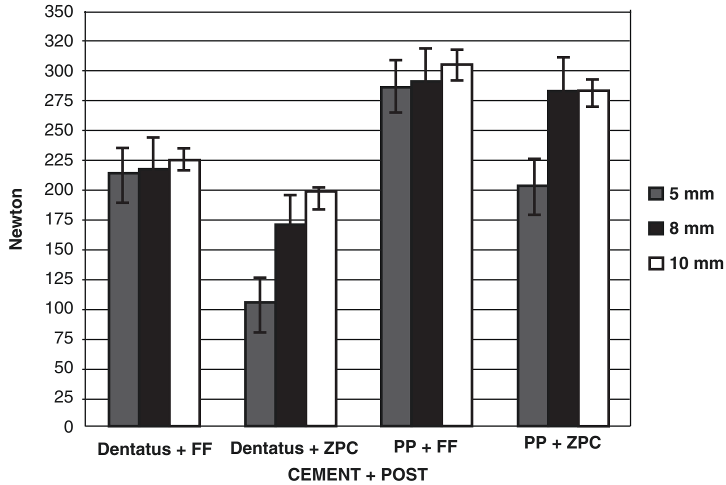
The center of root or canal is neutral area with regard to occlusal force concentration, and in its given position, post receives minimal stresses under occlusal load and consequently does little to reinforce root under such a load [22]. Many studies [22, 23, 32, 33] support the assumption that the resistance to fracture of endodontically treated teeth covered by a complete cast crown with a 2-mm margin on healthy tooth structure is not affected by the post. The crown becomes the equalizer because it changes the force distribution to the root and the post and core complex, rendering the post characteristics insignificant [22].

Fiber posts have been indicated with loss of root structure since its modulus of elasticity is close to the dentin; however, some coronal remaining structure is necessary to retain the core using adhesive systems. Fiber post failures are more associated to displacement or detachment of the post and crown or prosthesis decementation than root fractures, a common failure related to conventional metal cast posts. Because metal cast posts present high rigidity, they appear to vibrate at high frequencies when loaded with lateral forces, which achieving critical points, may determine longitudinal fractures of the root [43] (Figs. 5.4, 5.5 and 5.6).

The choice of a root post should follow some principles like preservation of tooth structure, retention and resistance, retrievability, ferrule effect, and failure mode [44]. Preparation for a post space should, whenever possible, preserve coronal and radicular tooth structure (removing only root canal filling and not radicular dentin). Retention form is associated to the cement used, usually composite resin cement (allowing use of reduced post length and avoiding coronal microleakage), in correlation to post length. Post must be placed in a passive mode into the root canal. Post length does not influence the fracture resistance of endodontically treated teeth restored with a complete cast crown with a 2-mm ferrule on healthy tooth structure. The selection of a dowel should be based on a system that preserves maximal sound tooth structure and apical seal (reduced post length, no more than 5 mm) and possesses suitable retention (composite resin cement) of the core for the restoration [37, 45, 46] (Fig. 5.7).

Figs. 5.4, 5.5 and 5.6 Fiber post with composite resin as core material in the aesthetic zone

Fig. 5.7 No statistical significance difference between mean failure forces for all post length groups (5, 8, 10 mm), post cemented with resin (*FF*) superior to post cementation with *ZPC*



In most cases, passive, tapered posts offer the least retention of the prefabricated since their tapered shape resembles the overall canal morphology. If adequate canal length is available, they are a good choice, particularly in thin roots such as maxillary premolars [47]. Adequate length is considered to be 5 mm into the root canal; additional retention can be gained by the use of resin cement.

The resistance is affected by the remaining tooth structure and the ferrule area of the restoration that contributes for the ability of the tooth to withstand lateral and rotational forces and transmitting occlusal loads. Retrievability should also be considered in a choice of a post, so as the failure mode observed when different posts are used.

5.4 Core Materials

The purpose of the post is to retain the core, which in sequence helps retain the crown.

With cast post and cores, the core is formed on the post directly on the tooth or indirectly on a cast. The shape and orientation of the core is developed during fabrication. Its advantage is strength and durability, but on the other hand, it demands extensive removal of tooth structure in order to achieve path of insertion for both post and core; it is very difficult to retrieve for performing retreatment and expansive due to lab preparation. The incidence of complications, such as core loosening and tooth extraction, was significantly higher in cast metal cores; it also was associated with a significantly lower core survival rates [40, 48] (Fig. 5.8).

Fig. 5.8 Cast post and core for extensive tooth structure loss

On the other hand, prefabricated posts are used in combination with a restorative buildup

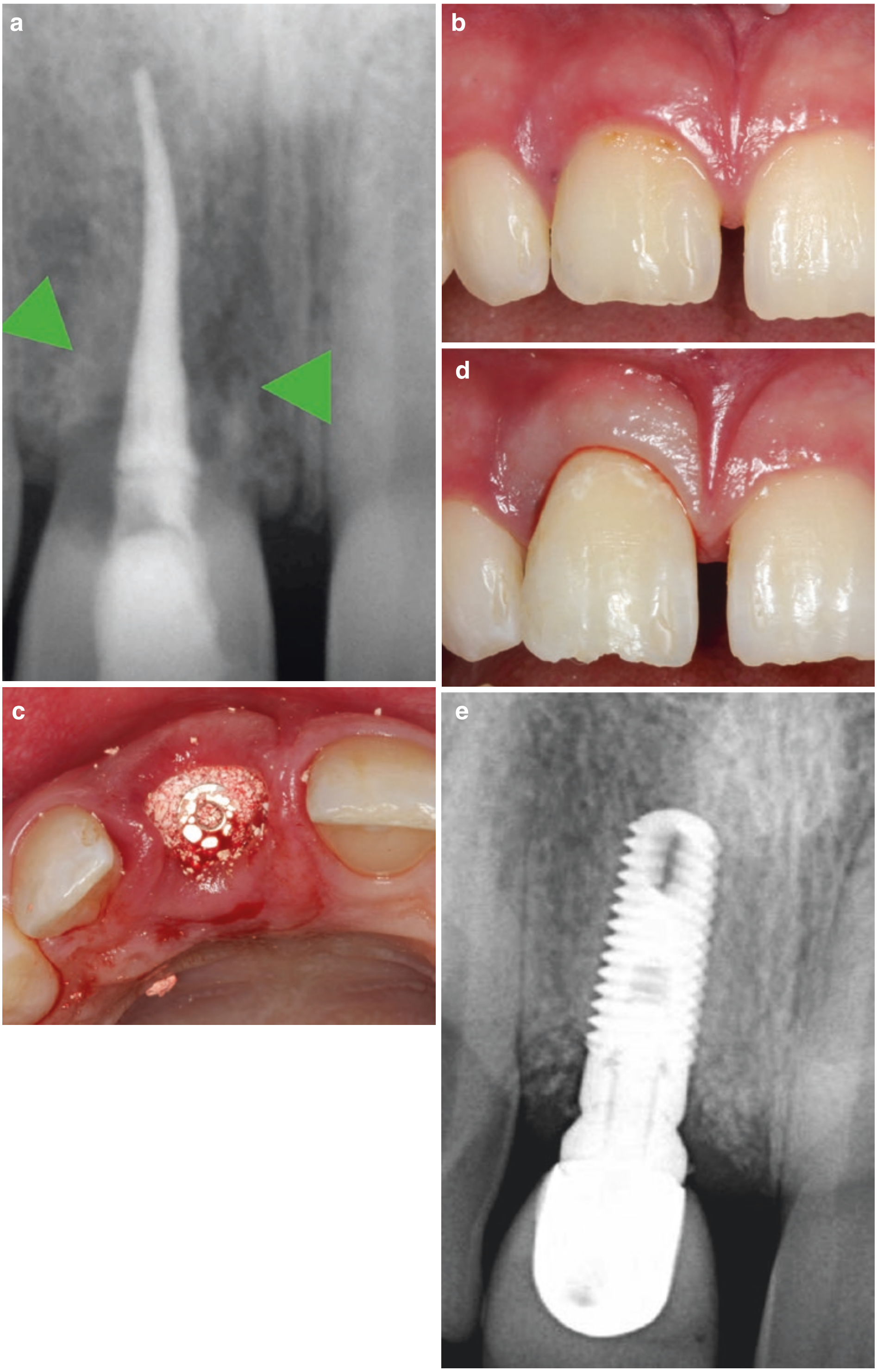


Fig. 6.2 A 22-year-old male patient with history of trauma to right central maxillary incisor. Case demonstrates the complexity and difficulties of implant restorations in the esthetic zone. Despite applying careful treatment planning and thoughtful execution of the clinical procedures, failure of the unit occurred. The mismatch of root versus implant shape and the non-integration of the bone grafting material will result in an extremely difficult situation for repair or replacement of the implant unit due to osseointegration of parts of the fixture, the

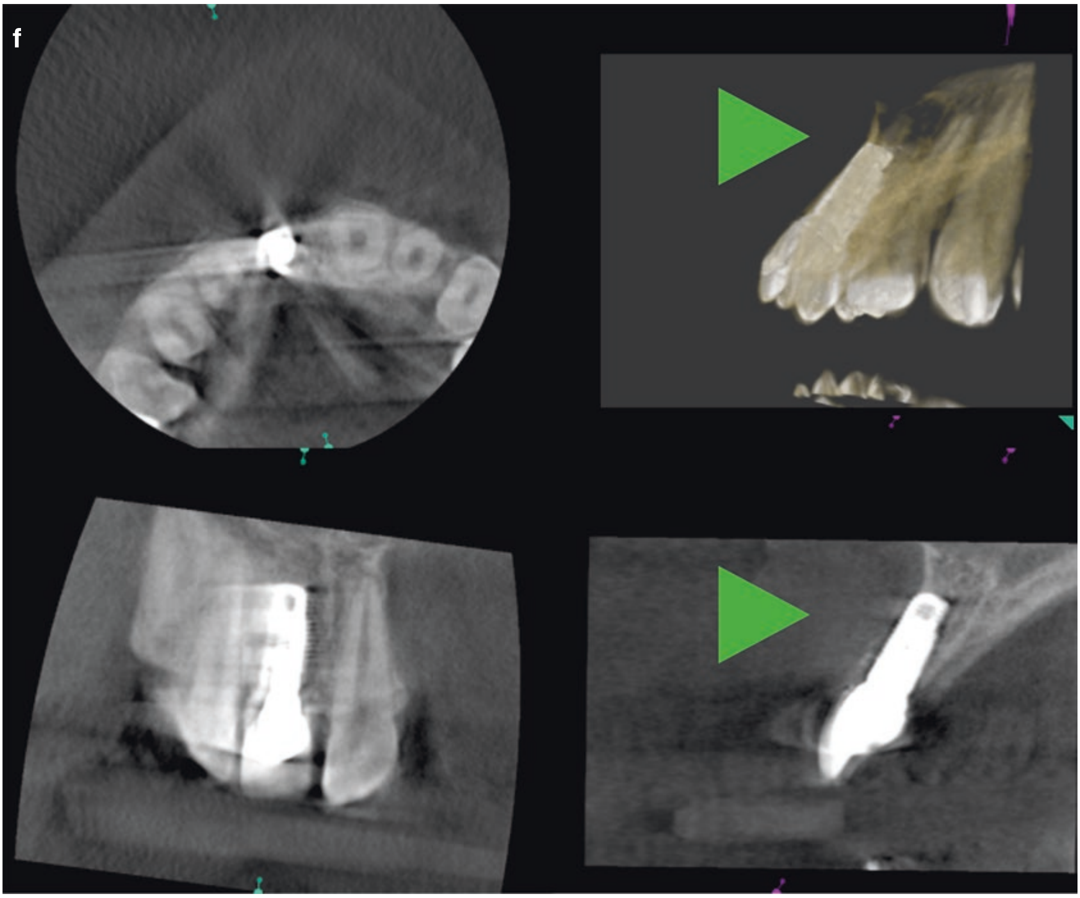


Fig. 6.2 (continued)

foreign body reaction to the grafting material, and possible damage to the gingival architecture after fixture removal and reimplantation. (**a**) Radiograph of endodontically treated tooth, multiple severe root resorptions (*arrows*), tooth was deemed not restorable; (**b**) preoperative clinical situation; (**c**) immediate implant placement with bone grafting; (**d**) temporary restoration after implant placement; (**e**) implant in situ with permanent restoration; (**f**, **g**) 3-year follow-up, CBCT, and clinical situation. CBCT demonstrates perforation of the buccal plate (*arrows*), clinical situation with non-integrated grafting material perforation of the buccal mucosa (Courtesy Dr. Luciano Retana, San José, Costa Rica, and Dr. Joon Park, Scarsdale, NY, USA) the pulp-dentin complex" [200], and *guided tissue regeneration* (*GTR*) *procedures* that are performed during surgical endodontic treatments in order to improve the outcome of the surgery and to promote periodontal bone healing [201].

8.12 Regenerative Endodontic Procedures

Traditionally, long-term calcium hydroxide root canal dressing was used to induce apexification of immature teeth with pulpal necrosis before placing an obturation material. However, calcium hydroxide apexification has several limitations including a required long duration for formation of the calcified barrier (months to years), multiple appointments needed, the adverse effect of long-term calcium hydroxide dressing on the mechanical properties of the tooth dentin, and the risk of infection due to the absence of a definitive root canal filling during the long-term dressing period [200, 202].

Mineral trioxide aggregate (MTA) has been successfully used as a modern alternative treatment for calcium hydroxide apexification, with success rates of over 90 %. MTA induces apexification and enables an immediate obturation of open apex teeth, due to its ability to induce cementum-like hard tissue, its sealing property, its ability to set up in the presence of moisture, and its biocompatibility [202] (Fig. 8.6).

However, it had been claimed that calcium hydroxide- or MTA-based apexification treatments may not enable further root development and that the immature teeth remain vulnerable to fractures. In contrast, regenerative endodontic procedures (sometimes termed "revascularization") were recently proposed as an alternative to the apexification procedures in immature teeth with

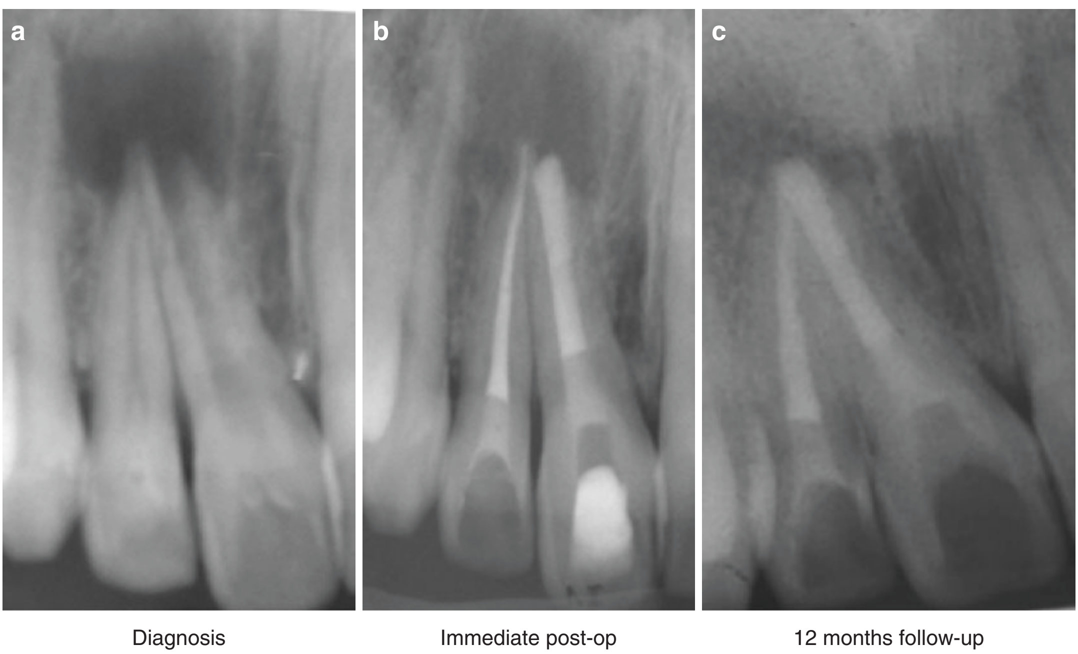


Fig. 8.6 A 15 yrs old female patient presented with an open apex right upper central incisor, diagnosed with pulp necrosis, acute apical abscess, and a large periapical lesion (The adjacent lateral incisor was also diagnosed with pulp necrosis, and was scheduled for a routine endodontic treatment) (**a**). Following non-surgical root canal treatment, a calcium hydroxide paste was used as an inter-appointment intra-canal medicament. Two weeks later, the tooth was a-symptomatic, and a 5-6 mm MTA apical plug was placed. The remainder of the canal system was restored with glass ionomer applied directly to the MTA (**b**). A bonded composite material was later used to restore the tooth crown. At 12 months follow-up, the tooth remained a-symptomatic, and the radiographic evaluation revealed a process of periapical healing (**c**)