

Endodontic Prognosis

Clinical Guide for
Optimal Treatment
Outcome

Nadia Chugal
Louis M. Lin
Editors

 Springer

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ISBN 978-3-319-42410-1

ISBN 978-3-319-42412-5 (eBook)

DOI 10.1007/978-3-319-42412-5

Library of Congress Control Number: 2016960548

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The registered company is Springer International Publishing AG Switzerland

The registered company address is Gewerbstrasse 11, 6330 Cham, Switzerland

*To my family, friends, and mentors for their
love, support, and encouragement.*

Nadia Chugal

Foreword

It is indeed a privilege to write this foreword for an Endodontics book with prognosis as its main emphasis. While all practitioners aspire to achieve the highest levels of success of treatment, the definition of this success and the factors that affect it receive very little attention among clinicians. Complicating this matter is that, with the exception of resolution of pain or purulent drainage, true and complete endodontic success is not demonstrable clinically until a long period has passed after treatment, typically measured in years. The difficulty in establishing an effective follow-up program for all patients, especially that they are typically asymptomatic, has led many practitioners to rely only on surrogate measures of success like the quality of the obturation and the resolutions of symptoms. While there are some population-based data in the literature to support reliance on these parameters, they clearly provide an incomplete assessment of prognosis.

As one reflects on this book's working definition of endodontics, as the prevention and/or elimination of apical periodontitis, it is reasonable to reconsider whether this is still consistent with recent information as noted in the relevant chapters. For example, the word "prevention" is used in a discipline in which home care is not thought to affect the outcome of treatment. The intent likely arose from the need to diagnose irreversible pathosis more vigilantly, in order to perform the endodontic treatment at this stage, and avoid pathogenesis of apical periodontitis. However, recent advances in vital pulp therapy leads one to question whether the priority is still to remove the vital inflamed pulp at all costs to assure the goal of preventing apical periodontitis. The growing interest in pulp and dentin regeneration, the advent of more biocompatible reparative materials, and the presence of good outcome studies on vital pulp therapy make one reflect more on this classic definition of endodontic therapy.

This book also provides an excellent discussion in several chapters of the radiographic detection of emergent and residual disease, as it has evolved in the last 60 years or so. Today, tools like CBCT allow us to visualize this disease earlier in the diagnostic process, and for a longer period after treatment. Therefore, there is more of an overlap in the pulpitis/apical periodontitis spectrum of diagnosis, and perhaps a longer period when teeth with apical radiolucencies may be considered healing. There are even questions as to whether teeth with long-standing small

radiolucencies, and no other abnormalities, should be retreated or subjected to root end surgery. There is more realization that complete bone regeneration may not be achievable in many of these asymptomatic cases, the way it is not achievable in cases with marginal periodontitis.

Postoperative factors that affect the prognosis are also of particular interest. The profession has in the last decade transitioned from relying on bench-top laboratory studies to clinical outcome studies in making many clinical decisions that are related to coronal leakage. The question remains as to who controls the prognosis to a larger extent: is it the practitioner that did the endodontic therapy or the one who restored the tooth?

Finally, this book eloquently addresses the emerging concept of personalized endodontics, in which the prognosis may be affected by a combination of the unique and complex microbiota that causes the disease, together with the systemic health of the patient, as well as genetic and epigenetic variability among patients. This area promises to provide us in future more detailed predictors for outcomes, which can help the provider with treatment planning and help the patient with decision making.

Ashraf F. Fouad, DDS, MS

Preface

This book distinguishes itself from endodontic textbooks because it is the first textbook completely focused on the prognosis of endodontic treatments. Our goal for this book was to make recent results at the forefront of endodontics accessible for clinical practice.

The book is intended to serve as a clinical guide to help practitioners in their clinical decision-making process and ultimately improve endodontic treatment outcomes.

The goal of endodontic treatment is to prevent and/or eliminate apical periodontitis, a disease entity occurring as a result of microbiologic challenge to the pulp and periradicular tissues. Like many other human diseases, endodontic treatment outcomes are profoundly affected by a multitude of prognostic factors. These determinants of treatment success or failure can exert their effect preoperatively, intraoperatively, and postoperatively. Therefore, it is important for the clinician to be familiar with the favorable predictors of outcome as well as prognostic risk factors. This knowledge is essential to effectively circumvent and manage risks in order to achieve the desired treatment result.

We first outlined the theme of every chapter that we considered important for the book. We then invited experts in their respective areas to write on the specific topics. These topics include both basic and clinical sciences and cover several key aspects of endodontic prognosis. The multidisciplinary authorship by highly respected clinicians and scientists reflects the multifactorial nature of endodontic outcome.

Outcome assessment of endodontic therapy has evolved from Strindberg's stringent criteria that emphasized the absence of clinical symptoms/signs and restoration of normal structure of the periapical tissues to newer patient-centered criteria focusing on the absence of clinical symptoms/signs and survivability and functionality of endodontically treated teeth even with the presence of small and stable periapical lesions. However, as pulpal and periapical pathosis is a disease, a tooth with a persistent inflammatory periapical lesion after treatment, regardless of its size, should be considered as unsuccessful elimination of the disease. Therefore, complete elimination of the disease still remains the ultimate goal of root canal treatment.

We hope that the readers will enjoy this book and benefit from it, as much as we have enjoyed spending our time and energy working on it.

Nadia Chugal
Louis M. Lin

Acknowledgments

We thank all contributors for their time, support, and contributions to this book. Without their generosity and dedication, this book would not have been published. We wish to express our deep appreciation for the many cases, radiographic images, photographs, and histologic slides provided by our colleagues. We also thank the editors from Springer for believing in us and for their support, understanding, and patience.

Nadia Chugal
Louis M. Lin

Contents

| | | |
|-----------|--|-----|
| 1 | Introduction: Endodontic Prognosis and Outcome | 1 |
| | Nadia Chugal, Louis M. Lin, and Bill Kahler | |
| 2 | Microbiology and Immunology of Endodontic Infections | 13 |
| | Luis E. Chávez de Paz and Gunnar Dahlén | |
| 3 | Diagnosis of Pulpal and Periradicular Disease | 29 |
| | Katsushi Okazaki, Matthew Malek, Nadia Chugal, and Louis M. Lin | |
| 4 | Endodontic Treatment of Mature Teeth | 43 |
| | Louis M. Lin, Simona Loghin, and Domenico Ricucci | |
| 5 | Regenerative Approaches in Endodontic Therapies of Immature Teeth | 65 |
| | Mo K. Kang and George Bogen | |
| 6 | Endodontic Pharmacotherapeutics | 87 |
| | Helaine De Brito-Gariepy, Thereza Cristina Botelho-Dantas, and Jennifer Lynn Gibbs | |
| 7 | Anatomy, Access, and Length Determination | 115 |
| | Frederick Barnett | |
| 8 | Instrumentation and Disinfection of Root Canals | 131 |
| | Frederic Barnett and José F. Siqueira Jr. | |
| 9 | Obturation of Root Canals | 141 |
| | Dag Ørstavik | |
| 10 | Restoration of Endodontically Treated Teeth | 161 |
| | Nadim Z. Baba, Shane N. White, and George Bogen | |
| 11 | Local, Systemic, and Genetic Considerations of Endodontic Treatment Prognosis | 193 |
| | Matthew Malek and Louis M. Lin | |

12 Criteria for Outcome Assessment of Nonsurgical Endodontic Treatment 211
Nadia Chugal, Sanjay M. Mallya, and Bill Kahler

13 From Tooth Retention Through Root Canal Treatment to Extraction and Replacement 229
Shane N. White and Mahmoud Torabinejad

Index 239

Introduction: Endodontic Prognosis and Outcome

1

Nadia Chugal, Louis M. Lin, and Bill Kahler

Many authors display a propensity to reduce complex problems such as success and failure to terms so simple that a casual reader with little effort can expand a narrow grasp of the subject into a broad convenient misunderstanding

Dudley Glick, DDS
Excerpt from a lecture
Year unknown

Abstract

Prognosis and outcome are two terms routinely used in medicine and dentistry to predict and assess the treatment of disease. Prognosis is a practitioner's assessment about how a patient will recover from an illness or injury. It is a forecast of the probable course of recovery for any particular disease considering the assessment of the case. Outcome is the end result of the treatment and a consequence of treatment decisions made by the practitioner. In endodontics, there are prognostic factors which are universal to all cases as well as variables unique to a specific case, all of which can affect endodontic treatment outcomes. Prognostic factors can be grouped into preoperative, intraoperative, and postoperative. They influence endodontic treatment outcomes indirectly through control and elimination of infection. Importantly, an understanding of prognostic factors helps practitioners as well as patients decide the appropriate treatment procedures and is especially important for higher-risk conditions such as teeth with a periapical

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lesion, calcified canals, resorption, and others. This applies to immature or mature teeth for consideration for nonsurgical or surgical management. Although many prognostic factors are not under the control of the practitioners, they can nevertheless be managed by a practitioner's thorough evaluation of the presenting condition, risk assessment inherent in each individual case, and application of biologically based therapies alongside with technical competency. Treatment outcome is usually assessed using clinical and radiographic examination and has evolved from Strindberg's stringent criteria to patient-centered criteria. Practitioners have to be familiar with the prognostic factors to inform patients of the appropriate treatment modalities and to achieve the optimal treatment outcome.

1.1 Introduction

The terms prognosis and outcome are routinely applied in medicine and dentistry. They are used to predict and evaluate the result of disease treatment. Prognosis is a forecast about probable course and outcome of a disease and chances of recovery [1]. Applied to endodontics, it is a prediction of the outcome of resolution of apical periodontitis. This forecast of the outcome is summarized by the practitioner for the patients and serves to inform them how they will recover from an illness or injury [1]. It synthesizes the prospect of recovery as anticipated from the usual course of disease, or in the case of endodontics, the risk assessment of variables that may influence the treatment outcome [1]. Outcome, on the other hand, is a measure of the success of the treatment, as a result of an activity or a process, and is a consequence of the decisions made during the course of treatment. Applied to endodontics, outcome is the end result that follows as a consequence of endodontic treatment [1].

There are a number of well-researched studies that elucidated prognostic factors that exert significant effect on endodontic outcome. In turn, this information can be used to prognosticate the course of disease resolution and predict the end result of the proposed treatment.

Practitioners can systematically evaluate prognostic factors to guide their patients in the decision-making process and ultimately propose the best treatment options to achieve an optimal outcome. In accordance with evidence-based dentistry principles, the patients are also members of the treatment planning team and have the right to know the prognosis and expected outcome before commencement of treatment. Given this information, patients can evaluate their treatment options and make an informed decision about the need or preference for their treatment choices [2].

Optimal dental treatment planning requires an accurate assessment of the outcome of the proposed endodontic treatment. This assessment, however, is dependent on a correct understanding of variables affecting the outcome and must be done with both high validity and reliability [3]. When such assessment

is made, it is possible to offer the patient a wide range of appropriate endodontic treatment options.

1.2 Multifactorial Nature of Endodontic Outcome

The multifactorial nature of endodontic outcome has been demonstrated in numerous studies that have addressed a wide range of factors with the potential to impact on endodontic treatment outcome. Outcome studies and recent systematic reviews identified biologic- and treatment-associated variables as well as restorative factors that are the most predictive of treatment outcome for contemporary conventional endodontic therapy [4–9]. These studies applied advanced statistical methods to determine the magnitude of risk the identified variables exert on outcome [3, 10]. Therefore, prognostic factors, which can affect the outcome of endodontic therapies, are multiple and intertwined in complex relationships. An overview of these interconnected variables and their possible relationships is illustrated (Fig. 1.1).

Some prognostic factors, such as the presence and extent of periapical lesion (Fig. 1.2); the complexity of the root canal system, especially in cases with apical periodontitis (Fig. 1.3); obliterated canal(s) due to hyper-mineralization (Figs. 1.4 and 1.5); pathologic or idiopathic root resorption (Fig. 1.6); and infection-induced apical root resorption (Fig. 1.7), are not under the control of treatment providers. However, most conditions can be managed by practitioners through a systematic evaluation and risk assessment followed by application of sound biologic treatment

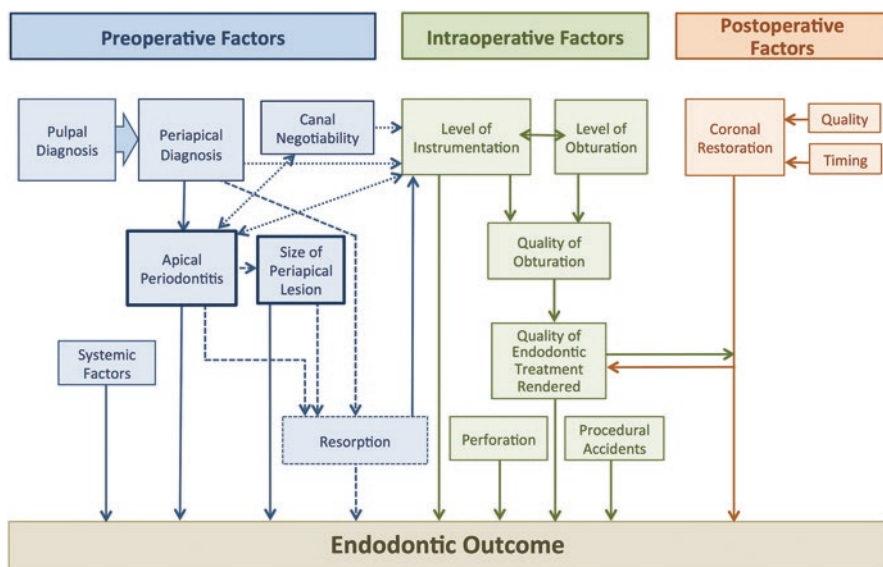


Fig. 1.1 Possible relationships between prognostic factors affecting the outcome of endodontic treatment

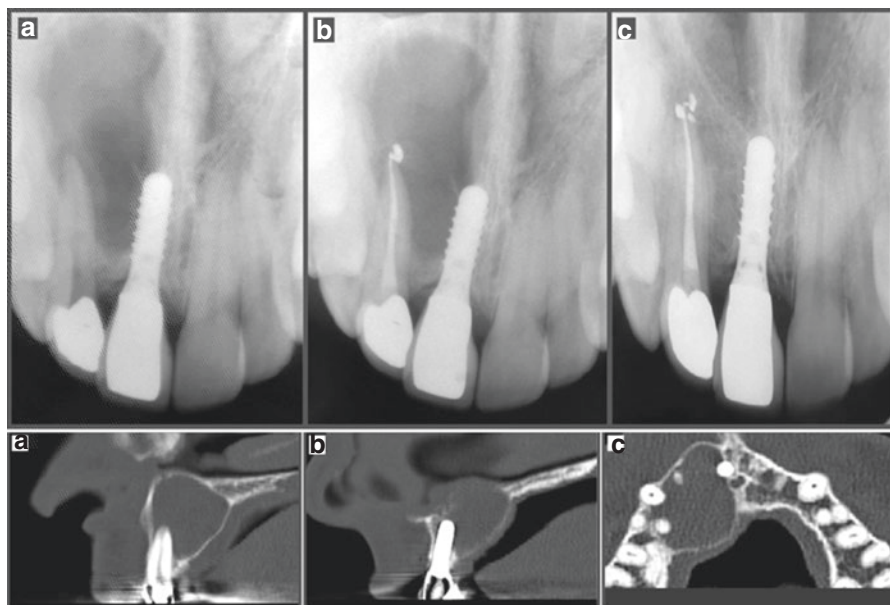


Fig. 1.2 (a) Occlusal radiograph showing large periradicular cyst-like lesion that extended to the floor of the nasal sinuses and along the mesial surface of the canine and the distal border of the implant in the central incisor site. (b) Occlusal radiograph showing the completed root filling. Some extrusion of sealer is evident. (c) Occlusal radiograph showing complete osseous repair consistent with favorable healing outcome.

Lower frame (a) Cone-beam imaging showing extent of lesion surrounding the lateral incisor. (b) Cone-beam imaging showing extent of lesion surrounding the implant. (c) Cone-beam imaging showing lesion involving the distal aspect of the implant and the roots of the lateral incisor, canine, and first premolar tooth (Images reproduced from Kahler B. Healing of a cyst-like lesion involving an implant with nonsurgical management. *Journal of Endodontics* 2015;41:749–752)

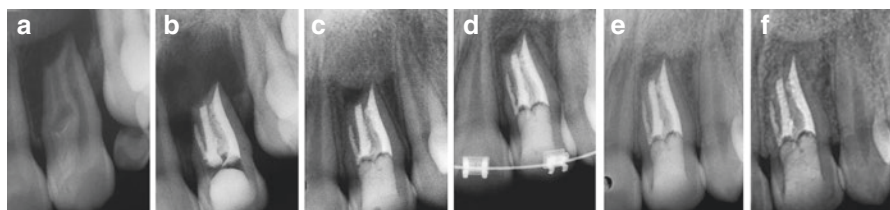


Fig. 1.3 (a) Preoperative radiograph of tooth #10 exhibiting complex tooth anatomy. Large periapical radiolucency is approximately 10 mm in diameter. (b) Completion of root canal treatment. Final radiograph after obturation shows the extent of periapical bone destruction. (c) A 15 month follow up radiograph prior to commencing orthodontic treatment shows significant reduction in size of periapical radiolucency. (d) A two year post endodontic treatment and one year in orthodontic treatment. The residual radiolucency that remains may be indicative of healing with scar formation. (e) A four year follow up after endodontic treatment and six months after completion of orthodontic treatment, the treatment exhibits successful outcome. (f) An eighteen year follow up shows normal periradicular structures (Images courtesy of Dr. Nadia Chugal)

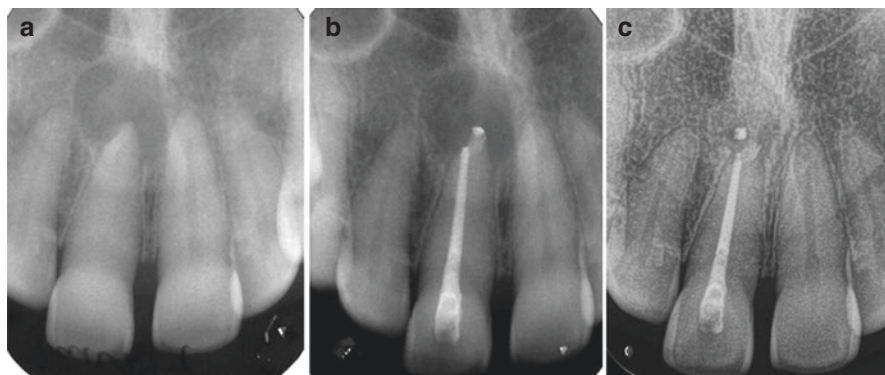


Fig. 1.4 (a) Radiograph of tooth #8 showing large periapical lucency and no canal is evident. (b) The tooth is root filled though the root filling is not centered in the root which has the potential to affect outcome. (c) At 18 month review the PA lucency is reduced in size and the tooth is asymptomatic. This case is an example of a ‘functional outcome’ as the strict Strindberg criterion has not yet been met. However further healing with time is still possible (Images courtesy of Dr. Bill Kahler)

principles and technical expertise in order to achieve an optimal treatment outcome. Often, a complex-presenting condition of the tooth comprises multiple risk factors (Fig. 1.8).

Importantly, an understanding of these high-impact factors assists practitioner’s decision-making process about the appropriate treatment procedures. In addition, it also has practical implications related to treatment execution and preparation of armamentariums necessary to treat these preexisting conditions. For example, protocols may be different for immature vs. mature teeth, teeth with or without a periapical lesion, and for both nonsurgical and surgical management.

For clarity of analysis and comprehension, they can be grouped into three major categories: preoperative, intraoperative, and postoperative.

1.3 Preoperative Factors

An accurate assessment of the pulpal and periapical diagnosis is essential for an understanding of the major biological factors as this diagnosis reflects a change in the disease process and the extent of the infection into the periapical tissues [4, 6, 11, 12]. The literature is unequivocal that preoperative presence vs. absence of periradicular osteolysis is one major indicator of postoperative healing or failure [4, 10, 13, 14]. Consequently, teeth with a preoperative periapical lesion have a poorer outcome than teeth without a periapical lesion after nonsurgical root canal treatment [4, 7, 10, 14]. In addition, larger bone lesions show a significantly lower frequency of complete regeneration of the periapical bone than smaller lesions (4, 103). Therefore, when a periapical lesion is present, the smaller the lesion, the more favorable is the treatment prognosis [4, 10]. However, successful resolution of large

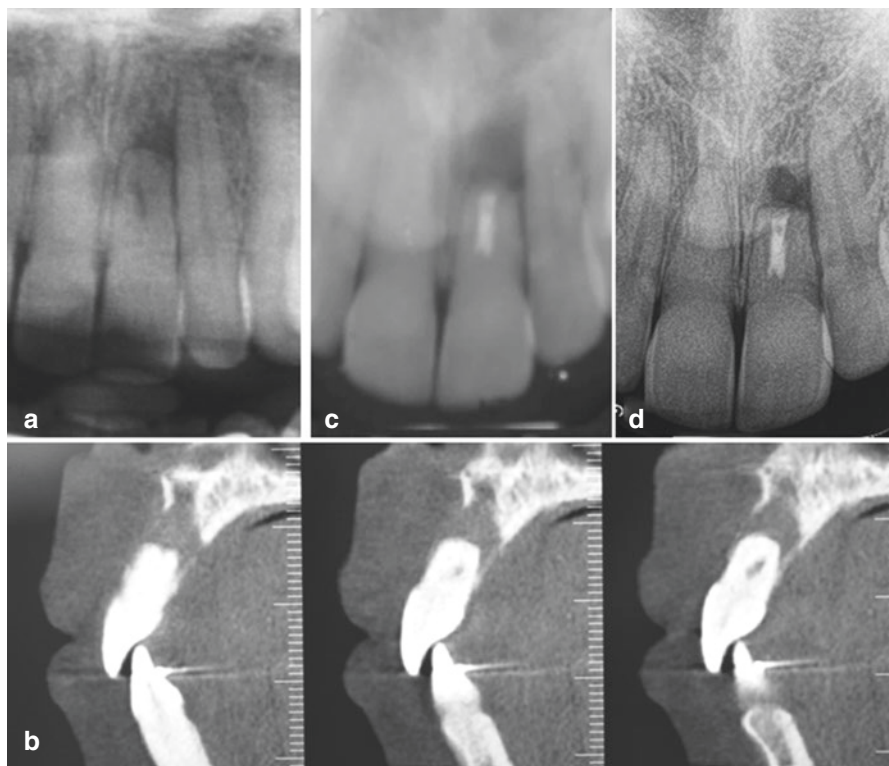


Fig. 1.5 (a) Radiograph of tooth #9 with a history of trauma. The root tip is blunted consistent with apical resorption. The canal appears to have undergone complete obliteration in the coronal half of the root. The canal in the apical half of the root is of an irregular shape and not centered in the root. (b) CBCT imaging revealed an irregular resorptive lesion in the apical half of the root. Therefore more complex imaging was advantageous as interpretation of conventional periapical radiography was suggestive of canal patency. Furthermore the extensive periapical radiolucency is revealed with erosion of the buccal and palatal cortical bone plates. After consultation with the patient it was decided that optimal treatment option was surgical management due to the prognostic considerations of calcified canal, resorptive defect in the apical third of the root and the extensive periapical radiolucency. (c) A radiograph taken after the surgical revision and placement of a MTA retrofill. (d) A radiograph at a 2 year review showing an intact lamina dura and periodontal ligament space around the root. The periapical radiolucency is consistent with a periapical scar and is a common observation following surgery when both cortical plates have been eroded (Images courtesy of Dr. Bill Kahler)

periapical radiolucencies is often achieved (Figs. 1.2 and 1.3), although the risk of future surgical treatment remains.

Teeth with a preoperative periapical lesion usually have a long-standing root canal infection compared to teeth without a periapical lesion. Therefore, these teeth have a well-established biofilm in the canal [15]. In addition, bacteria may also establish infection in some periapical lesions, resulting in an extraradicular infection [16].

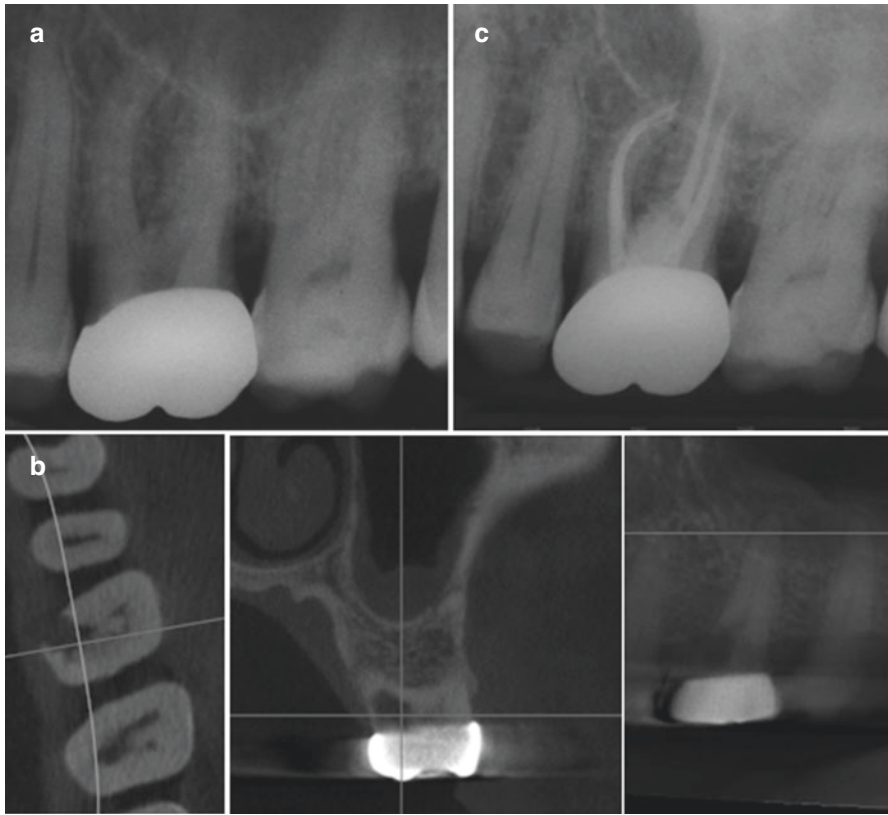


Fig. 1.6 (a) Preoperative periapical radiograph of symptomatic first maxillary molar where crown was placed one month earlier. (b) CBCT images revealed a Heathersay Grade III invasive cervical lesion highly suggestive of pulpal involvement. (c) Radiograph showing completed root filling and restorative lesion filled with mineral trioxide aggregate (Images courtesy of Dr. Bill Kahler)

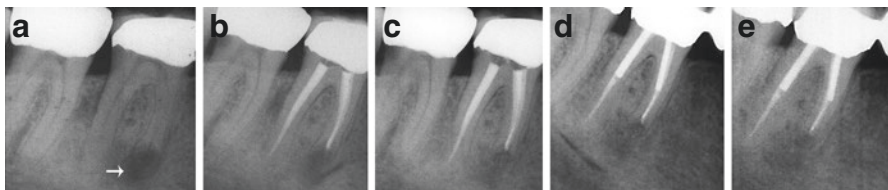


Fig. 1.7 (a) Pre-treatment periapical radiograph showing periapical radiolucency around the mesial root of the mandibular first molar (*white arrow*). Note external resorption of the mesial root apex. (b–e) Sequential periapical radiographs over twenty four months follow up after completion of endodontic treatment show an increase in the radiodensity of the periapical bone, although a minimal area of rarefaction remains. Further resolution of the radiolucency with time is expected and at this stage can be considered as healing and a functional outcome as the tooth is asymptomatic (Images courtesy of Dr. Nadia Chugal)

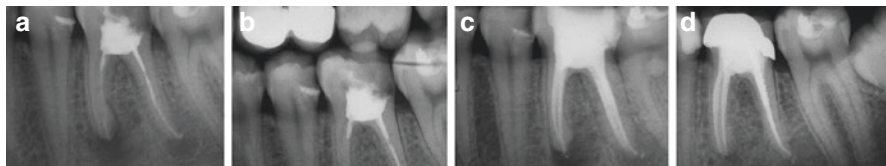


Fig. 1.8 (a) Preoperative periapical and (b) bitewing radiographs shows large periapical radiolucencies associated with mesial and distal root apices, missed and untreated canals, fractured instrument and near perforation of pulpal floor. (c) Completion of root canal treatment. (d) Nine months follow up radiograph shows significant reduction in size of periapical lesion. Further healing with time is likely. Patient remained asymptomatic and the tooth was functional (Images courtesy of Dr. Nadia Chugal)

Consequently, it would be more difficult to eliminate bacteria in the root canal system in teeth with than without a periapical lesion, thus affecting treatment outcome.

Medical conditions such as diabetes is one of the constitutive preoperative factors, negatively affecting the success of endodontic treatment of teeth with apical periodontitis [17, 18]. This is in addition to the major effect of the presence and magnitude of the infection of root canal system and structural condition of the tooth in question. The existence of these factors is usually not under the control of the practitioner.

1.4 Intraoperative Factors

Practitioners through systematic and thorough preoperative evaluation and a well-executed clinical protocol can manage most intraoperative factors, such as level of instrumentation, quality of root canal obturation, and procedural mishaps. Over-instrumentation could introduce necrotic tissue and bacteria in the root canal into the periapical tissues [19, 20]. Under-instrumentation could leave bacteria in the apical few millimeters of the root canal [21].

The level of instrumentation of root canals is important for elimination of infection and may not be the same for roots with a normal periapex or with apical periodontitis [22]. For teeth with apical periodontitis, it has been shown that one millimeter loss of working length is associated with 14% and 12% decrease in favorable outcome, respectively [10, 23].

In terms of underfilling, it should be distinguished between complete instrumentation and underfilling and incomplete instrumentation and underfilling. The former has a better outcome than the latter because of elimination of intra-canal bacteria. Inadequate root canal obturation with voids may allow coronal leakage of oral bacteria to reach the periapical tissues [24, 25]. A separated instrument or root perforation may prevent complete chemomechanical debridement of the canal system apical to the separated instrument or perforation, thus preventing effective elimination of bacteria in the root canal system and compromising the treatment outcome [26].

1.5 Postoperative Factors

Postoperative factors, such as timely placement and quality of coronal restoration of endodontically treated teeth, are under the control of the dentist and the patient. The importance of an adequate coronal restoration of endodontically treated teeth in relation to the success of root canal treatment has been demonstrated in many studies [27–30]. For the best outcome, endodontically treated teeth should have both an adequate root canal treatment and adequate coronal restoration [30]. A permanent coronal restoration is critical for prevention of reinfection and further damage to the structural integrity of the tooth [3, 9, 27, 28, 31].

1.6 Effect of Root Canal Infection on Treatment Outcome

Maximizing successful outcomes for endodontic treatment rests on the elimination of microorganisms from the infected root canals [6, 11–14] and without bacterial inoculation of the periapical tissue [19, 20]. It must be emphasized that of all prognostic factors, the reduction and/or elimination of root canal infection is the key to the successful endodontic treatment outcome [32]. The effect of residual infection on treatment results was demonstrated in human and animal studies. A clinical study of the human teeth with apical periodontitis showed that negative bacteriologic cultures before root filling resulted in 94% success rate of root canal therapy. In contrast, if bacteriologic cultures were positive, the success rate was reduced to 68% [13, 14]. An animal model study on monkeys showed that 79% of treated root canals had non-healed periapical lesions when bacteria remained after endodontic treatment, compared to 28% where no bacteria were found [33]. It was also reported that it is the presence of bacteria in the canal and not underfilling or overfilling that is the primary cause of persistent apical periodontitis of endodontically treated teeth [12]. Periapical lesions could heal even without placement of a root canal filling, if the root canal infection was effectively controlled and coronal leakage was prevented [34, 35]. Sometimes, even endodontically well-treated teeth could fail [36]. Therefore, prognostic factors have a profound effect on the control of root canal infection and subsequent treatment outcome.

1.7 Outcomes in Endodontic Therapy

Outcome is the consequence or the result of the treatment of disease, which is profoundly influenced by a multitude of prognostic factors. Outcome of endodontic therapy is usually assessed using radiographic and clinical examination. Radiographic examination is to detect the presence or absence of a periapical lesion and clinical examination for the presence or absence of symptoms/signs. Both conventional periapical radiography and cone beam computed tomography have been employed for radiographic examination in endodontics [37, 38]. Outcome assessment of endodontic therapy has evolved from Strindberg's stringent criteria

emphasizing the absence of clinical symptoms/signs and restoration of normal structure of the periapical tissues [4] to the patient-centered criteria focusing on absence of clinical symptoms/signs and survivability and functionality of endodontically treated teeth even with the presence of small and stable periapical lesions [39, 40]. However, the patient should be fully informed of the difference between disease and survival or function of a tooth. As pulpal and periapical pathosis is considered a disease, then a tooth with persistent inflammatory periapical lesion after treatment, regardless of its size, should be considered as unsuccessful elimination of the disease. Therefore, complete elimination of disease still remains the ultimate goal of root canal treatment.

There is a wide range in reported success rates of endodontic therapy [4–6]. This can be attributed to variations in criteria for outcome measures, proportion of teeth of a given type in a study, length of follow-up period, distribution of preoperative diagnoses, interoperator and inter-evaluator variability, and endodontic treatment-associated factors [4, 5, 41–43]. These variations make it difficult to make a valid comparison between the findings of different studies.

Most prognostic factors in endodontic therapy can be managed by practitioners through careful evaluation of the risk factors and execution of appropriate treatment planning. Practitioners should always perform at the best standard of care to achieve the best treatment outcome [44]. It is paramount that both the patient and practitioner have a full understanding of the prognostic factors and the risks to subsequent outcome before commencement of root canal treatment.

Conclusion

To augment understanding and effective management of prognostic factors associated with optimal outcome of endodontic treatment, individual chapters of this book are dedicated to key facets of endodontic therapy. These include the range of essential topics, from accurate diagnosis of pulpal-periapical status to pathobiology of pulpal-periapical tissues. The appropriate treatment plan for the various stages of pulpal-periapical disease and meticulous treatment procedures to eliminate root canal infection and prevent reinfection are presented. At the end, the outcome assessment of the treatment and post-treatment sequelae is presented.

Acknowledgments We thank Dr. Sanjay Mallya and Brian Lozano for assistance with preparation of the illustrations.

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Abstract

Endodontic infections are complex diseases associated with apical tissue inflammation that is determined by microbial, immunological, and environmental factors. During the past years, the integration of research tools, including molecular techniques for identification, sophisticated *in vitro* modeling, and human microbiome analysis, has provided additional insight in the understanding of endodontic infections. Recent studies suggest that the basis for infections associated to root canals of teeth is polymicrobial in nature and includes the emergence of microbial colonization in form of biofilms. Biofilms deep seated in areas that are difficult to reach by mechanical treatment will enhance microbial virulence, antibiotic resistance, colonization potential, and resistance. Furthermore, with the advent of the human oral microbiome project, insights on the differences among oral microfloras in different individuals appear to have an important role in progressing endodontic infections. This chapter discusses the current data regarding the role that microbial biofilms play in endodontic infections, as well as its place in the current knowledge of endodontic microbiology. The complex relations between the root canal microflora and the inflammatory response in apical periodontitis are also highlighted in this chapter, as well as their implications in regard to the diagnosis and clinical management of endodontic infections.

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2.1 The Oral and Root Canal Environments

2.1.1 The Oral Ecosystem

The oral ecosystem comprises a group of sites including the tongue, mucosa, gingival sulcus, and tooth surfaces, each of which possesses unique ecological characteristics that foster the growth of different kinds of microorganisms. The general characteristics of the oral ecosystem include a constant temperature; the presence of various soft and hard tissue surfaces to adhere, colonize, and grow; and a variable supply of soluble nutrients. Specific collections of oral bacteria, also known as oral plaque, are associated to different sites in the oral ecosystem [1,2].

2.1.2 Microbial Colonization of Tooth Surfaces

The tooth surface is an ideal site for microbial colonization, as it comprises plenty of moisture, air, and the intervallic input of nutrients during food intake [3,4]. The microbial plaque associated to the tooth surfaces is divided into supragingival and subgingival, in reference to its location from the gingival margin. The microbial composition and differences of these two types of dental plaque are principally connected to ecological changes, pH, and nutritional factors. While the nutritional sources for supragingival plaque include dietary components, saliva, and gingival crevicular fluid, the subgingival plaque depends predominately on host-derived components of crevicular fluid, which has a composition similar to serum [5].

2.1.3 Oral Health and Disease

Health of the different structures in the oral cavity is dependent on the interplay between bacteria and their microenvironments, including the participation of immunological factors such as antigens, both humoral and cellular. This ecological balance affecting oral health is of great complexity as it can also be influenced by external factors such as nutrition, habits, and the social lifestyle of each individual.

Marsh in 2003 proposed the ecological plaque hypothesis to clarify the changes in oral ecology that lead to the development of common oral diseases such as caries or periodontal disease. Caries and periodontitis occur as consequence of imbalances in the resident microflora resulting from enrichment within the microbial community of selected microorganisms that are associated with disease [6,7]. Excessive consumption of dietary fermentable carbohydrates will favor the overgrowth of highly fermentative aciduric organisms, e.g., *Streptococcus mutans* and *Lactobacillus* species. The acidified microenvironment produced by these organisms promotes the demineralization of the hydroxyapatite matrix of enamel, thus increasing the risk of dental caries. In the case of periodontal disease, lack of oral hygiene causes accumulation of dental biofilm in the subgingival sulcus, thus inducing a chronic inflammatory condition. This inflammatory process will concomitantly lead to a change of the subgingival flora favoring the increase of anaerobic proteolytic Gram-negative