

Jorge Perdigão
Editor

Restoration of Root Canal-Treated Teeth

An Adhesive
Dentistry Perspective

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Preface

I have read some dentistry books in which the respective authors describe how daunting it is to write a book that involves so many different coauthors. Yet, writing this book was not a very difficult task. I am fortunate to have known so many talented colleagues who accepted my challenge to write the book chapters. Although they come from different countries with different dental education philosophies, such as Brazil, Canada, Finland, Germany, Portugal, South Korea, and USA, they all speak the same common “dental” language.

I have taught clinical dentistry to undergraduate students continuously since 1985, the year I finished dental school. The idea to write this book has been fermenting in my mind inspired by the need to teach evidence-based concepts on the restoration of endodontically treated teeth to our dental students at the University of Minnesota, as well as to colleagues who attend my lectures around the world. The conceptual blueprint behind the book was far from writing an encyclopedia on the topic of the restoration of endodontically treated teeth. Our goal was to compile the perspectives from experts in this particular subject on the different aspects that involve the diagnosis, treatment planning, material properties, clinical procedures, and longevity of restored endodontically treated tooth. The ultimate goal was to help clinicians make decisions based on the available evidence.

We all hope that you will enjoy this book.

Minneapolis, MN, USA

Jorge Perdigão

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To all of those who helped me during my 40-year-long career in Portugal, USA, and Belgium, I am grateful for everything that I have learned from you. Among those, I must leave here my everlasting appreciation to the late Prof. Humberto Ferreira da Costa, one of my mentors at the University of Lisbon Dental School.

I am eternally grateful to my father Adelino and my mother Arlete for their humbleness, honesty, and extreme hard work, which made it possible that I became the first member of my family to finish secondary education or high school.

I am grateful to my colleagues Dr. Andressa Ballarin and Dr. Guilherme C. Lopes for their exceptional design skills. Besides being a full-time dentist and mother, Andressa found time to draw Figs. [1.1](#) and [1.2](#).

Last, but not the least, special thanks to my colleagues Dr. Ana Sezinando and Dr. Elen Borges.

We never quit.

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Endodontic Considerations for the Restoration of Endodontically Treated Teeth

1

Brian D. Barsness and Samantha Harris Roach

Abstract

The aim of this chapter is to offer a guide, from the endodontist's perspective, as to how root canal-treated teeth should be restored, and to give some clinical recommendations to help meet these restorative goals. The endodontic and restorative components of treatment are typically considered as independent phases. However, when considering the impact of each of these phases on the long-term prognosis of the tooth, it becomes apparent that both the endodontic and restorative plans should be considered jointly before treatment is carried out. With so many options for the timing of treatment, endodontic and restorative materials, and restoration design, the clinician is left with some difficult decisions at the treatment planning phase. In this chapter, considerations for the material characteristics, restoration design, and management of post placement complications are presented and discussed with respect to their impact on long-term prognosis. In addition, treatment sequencing, techniques of temporization, and strategies to prevent coronal microleakage of endodontically treated teeth are discussed in detail.

1.1 Introduction

The objectives of nonsurgical endodontic therapy have been described classically as being twofold: biological and mechanical. The biological objectives of endodontic therapy are focused on removing diseased and infected tissues, as well as eliminating bacterial products such as endotoxins, from the canal system. The successful

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outcome of healing and function, ultimately, depends upon maintaining the coronal and apical seal of the endodontically treated tooth.

Similarly, when determining the long-term prognosis for a tooth requiring endodontic therapy, it has been suggested by the results of several studies (Ray and Trope 1995; Gillen et al. 2011) that the quality of the coronal restoration after endodontic therapy may be as important as the quality of the endodontic treatment itself. These studies highlight the importance of coronal restoration after endodontic treatment. It follows that the plan for the definitive occlusal restoration should ideally be established at the time the endodontic therapy is planned. The question then arises of how these endodontically treated teeth are best restored.

Although there has been a recent trend in endodontic research to promote conservative access and canal preparation (Krishan et al. 2014), the fact remains that some loss of tooth structure does occur even with conservative endodontic treatment techniques. Additionally, the materials used during root canal therapy may also play a role in decreasing the integrity of dentin (White et al. 2002). And in many cases, teeth requiring endodontic therapy present with preoperative tooth structure loss due to caries or previous restorations, thereby adding complexity to both the endodontic and restorative phases of treatment.

The aim of this chapter is to offer a guide, from the endodontist's perspective, as to how root canal-treated teeth should be restored, and to give some clinical recommendations to help meet these restorative goals.

1.2 How Does the Coronal Restoration Impact the Success of Endodontic Treatment?

It is generally accepted that a favorable outcome of endodontic treatment relates to the technical quality of the canal disinfection and long-term seal of the obturating material. Several prospective outcome studies (Marquis et al. 2006) have presented an expected favorable outcome for primary root canal therapy at above 90 % in the absence of preoperative apical periodontitis and approximately 80 % in the presence of preoperative apical periodontitis. These favorable outcomes decrease dramatically in the presence of inadequate root canal fillings and apical periodontitis (de Chevigny et al. 2008).

Although an adequate coronal seal may be provided by a well-obtured root canal system, over time an inadequate coronal restoration may allow for the ingress of microbes and contribute to the recontamination and ultimate failure of the endodontic and restorative treatment. There has been debate regarding the priority of impact regarding such an outcome. Which is more important; an adequate endodontic treatment or an adequate coronal restoration? Could they be equally important? One early study by Ray and Trope (1995) presented a thought-provoking finding, in that the effect of the restoration on the radiographic success was statistically greater than the effect of a good endodontic filling. Adding to the debate, Tronstad et al. (2000) raised the counterpoint, stating that the quality of the root canal filling was the most important factor for the outcome of endodontic treatment. If the quality of the root filling was good, a good restoration improved on the endodontic success

rate by more than 10 %. However, if the quality of the root canal filling was poor, the quality of the coronal restoration was of no importance for the outcome of the endodontic treatment.

In a systematic review published by Gillen et al. (2011), the impact of the quality of coronal restoration and the quality of root canal fillings on success of root canal treatment were considered. Their findings gave support to the notion that all aspects of treatment have impact on outcome. The odds for healing of apical periodontitis increase with both adequate root canal treatment and adequate restorative treatment. Poorer clinical outcomes may be expected with adequate root filling-inadequate coronal restoration and inadequate root filling-adequate coronal restoration. There seemed to be no significant difference in the odds of healing between these two combinations.

It is difficult at best to understand the risk of unfavorable outcomes where there exists such variation in treatment protocols and outcome measures. Large, epidemiological studies can be useful in assessing cohorts to better interpret clinical decision making and outcomes. One such study by Salehrabi and Rotstein (2004) retrospectively evaluated the records of 1,126,288 patients having received an initial endodontic treatment over a period of 8 years. Over this 8-year follow-up period, 97 % of teeth treated by nonsurgical root canal therapy were retained in the oral cavity. Of the teeth requiring extraction, 85 % did not have a permanent crown placed.

So, while it becomes imperative to provide a permanent restoration on the endodontically treated tooth, is there an expected rate of unfavorable outcome associated with prosthodontic failure? Vire (1991) evaluated and classified failures of endodontically treated teeth according to prosthodontic, periodontic, and endodontic categories. Teeth that had been crowned had a greater longevity (87 months) than uncrowned teeth (50 months). Interestingly, of the 116 endodontically treated teeth, 59.4 % were prosthetic failures, primarily due to crown fracture.

Further adding to the complexity of restorative considerations, Iqbal et al. (2003) performed a retrospective analysis of factors associated with the periapical status of restored endodontically treated teeth. The benefit and uniqueness of this study were that the authors explored possible associations between prosthodontic, occlusal, endodontic, and periodontal factors with the apical health of endodontically treated teeth. Three factors were significantly associated with the presence of an apical radiolucency: confirmed occlusal contact, by virtue of the tooth being involved in group function or the only contact in working side and protrusive movements, and endodontic filling and crown margins of poor quality. Good-quality endodontic filling and crown margins improved endodontic outcome. However, occlusal contact was shown to be associated with failing endodontic treatment, thereby increasing the range of factors that may influence endodontic outcomes.

In support of the considerations of permanent restoration, restorative material, and tooth position, Ng et al. (2010) performed a prospective study on the factors affecting outcomes of nonsurgical root canal treatment. This study evaluated tooth survival following primary and secondary root canal treatment. Five hundred seventy-two patients receiving primary root canal treatment and 642 patients receiving secondary treatment were followed annually between 2 and 4 years. Survival was determined as the tooth being present and potentially functional at the time of

recall, whereas failure was determined to be a tooth that had been extracted. As a result, the 4-year survival following primary and secondary root canal treatment was 95.4 and 95.2 %, respectively. The restorative factors found to increase the chance of tooth loss were restoration with a temporary restoration only, restoration with a cast post and core, lack of two interproximal contacts, and a position as the terminal tooth in the arch.

In summary, the endodontic and restorative treatment complex poses numerous clinical considerations to the clinician. As presented, the significance of both endodontic and restorative measures relies on thoughtful consideration of material science, biomechanical principles, and treatment timeframes. With proper application of these considerations, the restored endodontically treated tooth can be expected to serve its intended function for many years.

1.3 When and Why Do Endodontically Treated Teeth Require Full Coverage?

The need for a full-coverage restoration after endodontic therapy is largely determined by tooth type, amount of tooth structure loss, and the amount of occlusal stress on the tooth.

1.3.1 Anterior Teeth

By an in vitro study, Trabert et al. (1978) found that there was no significant difference in resistance to fracture between untreated anterior teeth and endodontically treated anterior teeth without full-coverage restoration. In a more clinically based retrospective study including 1273 endodontically treated teeth, Sorensen and Martinoff (1984) found that long-term prognosis for anterior teeth, both maxillary and mandibular, was not increased with full-coverage restoration with or without a metal post versus simple restoration of the endodontic access. However, some current research may indicate that bonded fiber posts may offer some reinforcement (for more on this concept, see Chap. 6). In most cases, anterior teeth with small proximal restorations can be restored with lingual resin restorations. To restore these teeth, the gutta-percha should be sealed off at or below the level of the cemento-enamel junction, and the resin should be placed directly on top of the gutta-percha. In anterior teeth, full coverage may only be necessary when there has been significant loss of tooth structure prior to endodontic therapy or for esthetic reasons.

1.3.2 Posterior Teeth

In the same study by Sorensen and Martinoff (1984), it was found that full coronal coverage did significantly improve the long-term success rate for endodontically treated maxillary and mandibular premolars and molars. The reasoning behind