Direct composite versus glass-ceramic endocrowns for mechanically compromised molar teeth

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1 General introduction
1. GENERAL INTRODUCTION

1.1. Restoration of endodontically treated teeth

1.1.1. Survival of endodontically treated teeth

Restoration of endodontically treated teeth is a challenge due to several clinical dilemmas (Figure 1). Prior to restoration, periodontal and endodontic prognosis needs to be assessed and optimized. Restorative decisions include the preparation of and adhesion to dental tissues and the choice of a suitable restorative material. When periodontal, endodontic and restorative parameters are optimized, this would ideally result in a healthy tooth-restoration complex that maintains its function in the oral cavity over the years. Cumulative survival rate for endodontically treated teeth is estimated to be 87% (95% CI: 82%-92%) after 8 to 10 years.1

1.1.2. Factors influencing tooth survival

Factors that affect the survival of an endodontically treated tooth can be classified according to operator-, patient-, tooth- and technique-related variables.2,3 Of the tooth-related variables, tooth type and the amount of remaining coronal tooth structure seem to be important determinants for tooth survival (Figure 2).4–8 Endodontically treated molar teeth seem more prone to failure than endodontically treated premolars or anterior teeth.9 This is mainly due to the fact that molar teeth have a more complex root canal system, which might hinder adequate disinfection and complicate endodontic treatment. An inadequate endodontic treatment results in an increased risk of tooth loss.10–12 In order to have the highest odds for endodontic success, an adequate endodontic treatment should be followed by an adequate coronal restoration.13 Other technique-related factors that are deemed important are the type (direct/indirect)12,14,15 and timing of restoration16 and cusp coverage.17

Figure 1. Restoration of endodontically treated teeth is challenging due to A) periodontal considerations, B) estimation of the endodontic prognosis, C) preparation and adhesion to tooth tissue and D) restorative choices that have to be made.

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Minimal</th>
<th>Substantial</th>
<th>Total</th>
<th>Weight</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foster et al. 2007</td>
<td>17</td>
<td>111</td>
<td>128</td>
<td>52.6%</td>
<td>1.68 (0.94, 3.32)</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>Kuan et al. 2012</td>
<td>93</td>
<td>67</td>
<td>160</td>
<td>49.4%</td>
<td>2.34 (1.10, 4.74)</td>
<td>2012</td>
<td></td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>156</td>
<td>188</td>
<td>344</td>
<td>100.0%</td>
<td>1.84 [0.73, 4.52]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Forest plots of the odds for tooth retention of endodontically treated teeth according to remaining dentin height (minimal versus substantial). A: Short-term follow-up (3-4 years).5–7 B: Long-term follow-up (≥10 years).4,8

1.2. From retentive to bonded restorations for endodontically treated teeth

1.2.1. Retentive restoration

Several decades ago endodontically treated molar teeth were predominantly restored using full contour crown restorations with the aid of a post and core build-up. These restorations relied on macromechanical retention where a ferrule of 1.5-2mm was essential.18 In order to create such a ferrule effect, there should be sufficient peri-cervical dentin. However, wall thickness cannot always be adequately assessed without removing all restorative materials from the pulp chamber. This might result in a false sense of confidence in the ferrule effect, especially in cases where wall thickness is inadequate (Figure 3). It is estimated that a full contour crown preparation on a molar removes around 70% of the dental hard tissues.19

Figure 3. The importance of peri-cervical dentin. When an adequate amount of peri-cervical dentin is present, ferrule aids in the retention of a full contour crown (A). However, when the thickness of the peri-cervical dentin is limited (B), a preparation for a ferrule may result in thin walls (C). A more reliable way to restore such a tooth, might be the use of an adhesive approach and to restore the undercuts with composite resin (D).
1.2.2. Adhesive rehabilitation
In contrast to retentive restorations, adhesive rehabilitation allows for preservation of tooth structure and might therefore be a more reliable approach to restore such a severely compromised endodontically treated molar tooth.19,20 Furthermore, the pulp chamber offers a large surface area for adhesive retention in the case of severe coronal destruction. A post, which requires additional preparation of the root canal, might be thus superfluous.21 Instead, undercuts in the pulp chamber can be restored with composite resin, followed by a bonded direct or indirect restoration (Figure 3D).

1.2.3. Direct restoration
A direct composite resin restoration has the potential for minimal preparation which can be fabricated in one appointment and is a relatively inexpensive treatment option (Figure 4). Furthermore, when the prognosis of the tooth is uncertain or needs to be assessed over time, a direct restoration is frequently indicated. In case of severely destructed teeth, a direct composite resin restoration requires skills of the operator for reliable restoration of the morphology, especially in the proximal areas.

1.2.4. Indirect restoration
The other option would be to fabricate an indirect restoration outside the oral cavity which allows for better control over the anatomy. Furthermore, the broader range of restorative materials for bonded indirect restorations, such as glass-ceramic or indirect composite restorations, could be an advantage. These materials have a higher flexural strength and no shrinkage stress as compared to a direct composite resin. Indirect restorations also have a better surface gloss retention over time.22–24 On the other hand, indirect restorations are more expensive than direct ones.

1.2.5. Endocrown
After endodontic treatment the pulp chamber can be restored with a direct composite resin restoration where an indirect restoration can be bonded to using a dual-polymerizing composite resin cement or a microhybrid composite.23,25 Another option to restore such severely compromised endodontically treated molar teeth is an endocrown.26–28 An endocrown is a bonded indirect restoration with an extension in the pulp chamber (Figure 5). It was first introduced as the ‘monobloc technique’.26 With the advent of glass-ceramic materials, Pissis proposed the ‘monobloc technique’ in 1995 as an esthetic alternative for the traditional cast post and core, which often would lead to a greyish discoloration of the root of maxillary incisors.26 The author also indicated the monobloc technique for the restoration of endodontically treated premolars and molars. Bindl and Mörmann coined the term ‘endocrown’ a few years later.27 Throughout the following years, the main focus of in vitro30,31 and in vivo studies27,32–36 was the performance of endocrowns in the posterior dentition. The first endocrowns were made of leucite-reinforced feldspathic porcelain. Other restorative materials used for the fabrication of endocrowns are indirect composites or lithium disilicate. The latter is a suitable material for bonded partial indirect restorations to adequately restore the function of posterior teeth.23,27

Figure 4. Occlusal (A) and palatal (B) view of an endodontically treated 26. Occlusal (C) and palatal (D) view after application of a sectional matrix system. Occlusal (E) and palatal (F) view after restoration with a direct composite resin. Radiograph before (G) and after (H) restoration with a direct composite resin.
1.2.6. Factors influencing bonded restorations

An important factor that influences the success of a bonded restoration is the location of the preparation outline. While an outline in dentin negatively affects the success rate of both direct and indirect restorations, adhesion to freshly cut dentin is more reliable than dentin that is contaminated by temporary cement. In the case of adhesive indirect restorations, in vitro studies show that Immediate Dentin Sealing (IDS) improves the adhesion to dentin as compared to Delayed Dentin Sealing (DDS). After preparation of the tooth for an indirect restoration, the freshly cut dentin is sealed using an adhesive, before an impression is made. This way the dentin is not contaminated by temporary cements and the hybrid layer is allowed to mature. In the case of endodontically treated teeth, IDS may also facilitate blocking out undercuts in the pulp chamber, resulting in preservation of coronal tissue.

1.3. Rationale thesis

Although several studies have been conducted to assess the cumulative survival of endodontically treated teeth, frequently all tooth types were clustered. When a patient presents with an endodontically treated molar tooth that is in need of complex endodontic (re)treatment, other treatment options should be considered and weighed against the efforts necessary for the retention of the tooth. To date, information concerning survival of molars in need of complex endodontic (re)treatment is lacking.

Another dilemma the clinicians are often faced with, is the choice between a bonded direct composite resin or a bonded indirect restoration. There is a paucity of literature that compares direct and indirect bonded restorations on endodontically treated posterior teeth. To date, the majority of the systematic reviews on the topic relied upon clustering of data for composite resin and amalgam restorations. Furthermore, no studies have investigated the influence of tooth- and technique-related variables on the decision-making in general practice and to what extent endodontically treated teeth are restored using adhesive techniques. Moreover, no randomized clinical trial has yet compared the clinical performance of bonded direct and indirect restorations on endodontically treated molar teeth.

In the case of indirect endocrowns, no guidelines exist for the amount of extension in the pulp chamber. The possibility to lute such thick ceramic restorations with a microhybrid composite resin needs more attention. The use of a photo-polymerizing composite resin has been introduced as an alternative for luting glass-ceramic veneers to overcome the problem of discoloration of the dual-polymerizing composite cements. However, in recent years, microhybrid composites are increasingly used to bond indirect partial restorations in the posterior zone. More guidelines are needed concerning polymerization strategies taking the thickness and translucency of the glass-ceramic into account.
1.4. Objectives of this thesis
The following objectives were addressed in this thesis:

1. To evaluate the current knowledge on the influence of the type of restoration (direct composite resin versus indirect) on tooth survival and restorative success for endodontically treated posterior teeth (chapter 2);
2. To identify relevant tooth- and technique-related variables that could be of influence on clinical decision-making among general dentists and endodontic specialists in the Netherlands (chapter 3);
3. To evaluate to what extent adhesive indirect restoration of endodontically treated posterior teeth is a treatment option within the Dutch general practices (chapter 3);
4. To investigate the survival of endodontically treated molar teeth in need of complex endodontic (re)treatment in a referral clinic (chapter 4);
5. To evaluate the mechanical behavior of severely compromised endodontically treated molar teeth restored with direct or indirect restorations (chapter 5a and 5b);
6. To evaluate the mechanical behavior of severely compromised endodontically treated molar teeth restored with direct or indirect restorations (chapter 5c);
7. To present an interim report of a randomized clinical trial describing the clinical performance of direct composite resin and glass-ceramic endocrowns in severely compromised endodontically treated molar teeth (chapter 6).

REFERENCES


