Role of provisional restorations in endodontic therapy

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ABSTRACT

Root-canal treatment can be carried out in single visit in vital, non-infected teeth, eliminating the need for dressing and provisionalization. Many clinical cases with infected canals require dressing with antibacterial medicaments in a multivisit treatment in which effective provisionalization for different periods of time becomes mandatory. Successful root-canal treatment requires effective mechanical and chemical debridement, elimination of bacteria and pulp tissue remnants and proper canal shaping to facilitate effective obturation. Lack of satisfactory temporary restorations during endodontic therapy ranked second amongst the contributing factors in continuing pain after the commencement of treatment. This review aims to provide an overview of the materials used for provisionalization during and immediately after endodontic treatment.

KEY WORDS: Endodontics, eugenol, resins, restoration

Provisional (also known as treatment, temporary, or interim) restorations are used during the interval between tooth preparation and placement of final restorations. Bacterial infection is the most common cause of pulpal and periradicular disease.1 The main principles of endodontic treatment should be aimed at eliminating all bacteria from the tooth, and then attempting to maintain the tooth in this disinfected state by preventing any further ingress of bacteria during and after treatment.

Clinicians must determine how the bacteria entered the tooth, in order to remove the pathway of entry and prevent further bacterial ingress. The most common pathways for bacterial penetration into a tooth are via caries, cracks, exposed dentine and broken down restoration margins.2 Hence, an integral part of endodontic treatment is to remove these pathways from the tooth prior to commencing the biomechanical management of the root canals. This implies that all existing restoration(s) must be removed, along with any caries and cracks in the tooth, as these are all potential pathways for re-infection of the tooth during and/or after the endodontic treatment.3 Removal of all restorations, caries and cracks can be called “investigation” of the tooth and it is during this phase of treatment that the long-term prognosis and the future restorative treatment needs of the tooth can be assessed, following that provisionalization is essential.

Recent in vitro studies have demonstrated that the exposure of the coronal root canal filling to saliva for a few days resulted in extensive coronal leakage ranging from 33% to 85% of the total root length. Lack of satisfactory temporary restorations during endodontic therapy ranked second amongst the contributing factors in continuing pain after commencement of treatment.4

For effective inter-appointment provisionalization, it is essential to have adequate knowledge of temporary restorative materials and their properties in order to satisfy a wide variety of clinical requirements such as time, occlusal load and wear, complexity of access and absence of tooth structure.

Rationale for Provisionalization in Endodontic Therapy

1. If the principle of removing all restorations, caries and cracks is followed, then it will be necessary to consider how to restore the tooth in an interim manner whilst the endodontic
treatment is carried out since endodontic treatment is usually completed over multiple appointments.[9]

2. Accordingly, temporary filling materials must provide an adequate seal against ingress of bacteria, fluids and organic materials from the oral cavity to the root-canal system, and at the same time prevent seepage of intracanal medicaments.[6]

3. Currently in many dental practices, the definitive coronal restoration is not placed at the same appointment as when the root filling is placed. In most regions where a specialist endodontist has done the endodontic treatment, the specialist does not place the definitive coronal restoration and the referring general dentist will complete this component of the treatment at a later appointment. Thus, the combination of an interim restoration with a temporary access cavity restoration may remain in place for variable periods of time.[7]

Ideal Requirements for a Provisional Restorative Material

In addition to preventing bacterial ingress, provisional restorations used during endodontic treatment must also meet the following three criteria:

1. The tooth must be able to continue functioning,
2. The operator must have adequate access to the root canal system, and
3. The patient must be able to maintain normal oral hygiene measures around the tooth to prevent caries and the retention of plaque and calculus.

Anusavice, has outlined the ideal properties of provisional restorative materials. He states that they must:

1. Have satisfactory appearance in areas of aesthetic concerns,
2. Have easily identifiable margins to facilitate removal after the completion of endodontic treatment,
3. Adhere to tooth structure – Thus, requiring no additional retention form and thereby indirectly allow conservation of tooth structure,
4. Be easy to place and handle,
5. Be cost effective,
6. Have good tensile strength in minimal thickness and bulk,
7. Have good dimensional stability when an access cavity is cut through it and not be adversely affected by heat once set (e.g., during obturation of the canal),
8. Be able to reproduce tooth contours to allow ease of cleaning and maintain space,
9. Have a moderate degree of moisture tolerance during subgingival marginal placement,
10. Adhere to stainless steel if a band is being used,
11. Have a long shelf life, and
12. Require only minimal tooth preparation prior to placement.[8]

Materials that are currently used are a compromise in many aspects but the clinical results are still promising.

Case reports, such as that by Vail and Guba, demonstrated the role of the interim restoration in eliminating bacterial ingress and thereby changing the microbial niche to allow healing despite not having complete endodontic treatment. These authors reported a case where a patient had emergency endodontic treatment but did not return for further treatment for another two and a half years. The interim restoration was still intact and complete periapical healing was demonstrated by radiographs, despite minimal palliative treatment.[9]

Gutta-percha

1. It is a pure solidified juice obtained by tapping Isonandra gutta, an evergreen tree of the order sapotaceae found principally in the Malay Peninsula and Archipelago. Chemically, it consists of a hydrocarbon (pure gutta) C_{15}H_{22}, albane (C_{6}H_{10}O_{2}) and guttane, thereby resembling rubber in origin and composition. For practical purposes, gutta-percha is not used in its pure state but other ingredients are often added such as burgundy pitch, white wax, zinc oxide, calcium oxide, magnesium oxide, carbon, pieszegutta, etc., to give it the desirable working qualities. It was introduced in dentistry by Hill in 1847, and was famous as Hill’s stopping.

2. Base plate gutta-percha and temporary stopping gutta-percha were amongst the first materials tested, with less than ideal characteristics. Using dye and bacterial penetration tests in extracted teeth, Parris et al. found that gutta-percha temporary fillings leaked when subjected to two temperature extremes, 4-60°C.[10]

3. In an in vivo study, Krakow et al. re-made access cavities in successfully root-filled teeth. The cavities were chemically disinfected with 15 ml sodium hypochlorite irrigation (concentration not stated) followed by 15 ml of 0.067 M phosphate buffer (pH 7.2). Cotton pellets were left in the cavities under the temporary fillings for at least 1 week, after which the pellets were retrieved and cultured anaerobically. Six out of eight samples temporized with gutta-percha demonstrated gross leakage.[11] Findings from these studies are consistent with findings reported by Kakar and Subramanian, in which gutta-percha was inferior to Zinc oxide eugenol (ZOE) with and without thermocycling.[12]

Zinc Phosphate Cement

1. Zinc phosphate cement is one of the widely used materials in dentistry though its use is declining now because of advent of other modified cements. Introduced by Pierce in 1879, the cement has successfully been used as a provisional restoration and as a luting agent.

2. Studies have shown controversial results concerning the sealing ability of zinc phosphate cement. Access cavities temporized with this material showed no leakage in more than two-thirds of cases in an in vivo study by Krakow et al.[11] In another study by Bobotis et al. using the fluid filtration method to test microleakage, zinc phosphate cement did not show significant microleakage when compared to the intact crown, but visible leakage was observed in some of the samples temporized with this material.[13]
Polycarboxylate Cement

1. Polycarboxylate cements were introduced by Smith in 1968. These cements, have the strength and manipulative properties comparable to phosphate cements and low irritant potential under suitable conditions. The advantage of this cement is its adhesive quality.

2. This material has been tested as a temporary restoration in in vitro studies with conflicting results. Marosky et al. [14] found polycarboxylate cement to provide the least desirable seal when compared to temp-seal, Cavit, ZOE, zinc phosphate cement and intermediate restorative material. On the other hand, Pashley et al. [15] using a fluid filtration method found that polycarboxylate cement at a powder to liquid ratio 2:4 was not significantly different from Cavit-G, even after thermocycling. Polycarboxylate cement is not commonly used in endodontics and cannot be recommended, as its clinical effectiveness for endodontic temporization does not appear to have been well established.

Zinc Oxide/Calcium Sulphate Preparations

1. Cavit is a premixed temporary filling material that contains zinc oxide, calcium sulphate, zinc sulphate, glycol acetate, polyvinylacetate resins, polyvinyl chloride acetate, triethanolamine and pigments. As a hygroscopic material, Cavit possesses a high coefficient of linear expansion resulting from water sorption. Its linear expansion is almost double that of ZOE, which explains its excellent marginal sealing ability. (Webber et al.).[16] Body discoloration of this material was observed in fresh samples allowed to set in vegetable dye indicating sorption of the dye rather than body leakage (Widerman et al.).[17] However, it was proved later that this material showed body leakage even when allowed to set in water before immersion in dye. It was also suggested that the marked body discoloration resulting from sorption or body leakage could influence the marginal leakage observed (Kazemi et al.).[18]

2. The sealing ability of Cavit has been tested in many studies, both in vitro and in vivo, with generally favorable results. In in vitro studies, Webber et al. tested the thickness of Cavit required to prevent methylene blue dye leakage. It was found that at least 3.5 mm of the material was required to prevent dye leakage.[16] Comparing sealing ability in parallel or divergent class I cavity preparations, Cavit proved more effective than temporary endodontic restorative material (IRM), and Intermediate Restorative Material (IRM) in that order. However, the difference between Cavit and IRM and the effect of the two cavity designs did not reach significance (Barkhordar and Stark).[19]

3. In in vivo studies, no leakage or minor leakage was found in 27 out of 32 cases when Cavit was used to temporize access cavities in anterior teeth and only 15% of cases tested showed gross leakage.[11] In another study, Cavit in a 4 mm thickness provided the best seal over a 5 week temporization period when compared to IRM and TERM (Beach et al. 1996).[20]

4. Cavit-G and Cavit-W are varieties of Cavit that differ in the content of resin and their resulting hardness and setting. The hardness and dimensional stability of Cavit, Cavit-W and Cavit-G decrease, respectively. It was found that Cavit and Cavit-W provided almost equal water tight seals, which was significantly superior to the seal provided by Cavit-G.[21]

5. Cavidentin, is another calcium sulphate-based material, which has a similar formula to Cavit but with the addition of potassium aluminium sulphide as catalysts and thymol as an antiseptic. In an in vitro study by Tamse et al. [22] reported that a 5 mm thickness of Cavidentin provided superior sealing ability compared with IRM, Kalsogen Plus (a reinforced ZOE preparation) and Cavit. Cavidentin and Cavit-G were almost equally effective.

6. Coltosol is a zinc oxide, zinc sulphate and calcium sulphate hemihydrate-based material. The surface of Coltosol hardens within 20-30 min when in contact with moisture and according to the manufacturers the filling can be subjected to mastication pressure after 2-3 h. This material is designed for short term temporization not exceeding 2 weeks.

7. Clinically, Cavit and its relatives have the advantages of ease of manipulation, availability in premixed paste and of being easily removed from access cavities after setting. Additionally, it is clear that Cavit can provide adequate seal of an access cavity between appointments. However, its hardness, wear resistance, slow-setting reaction, and deterioration with time are key disadvantages. For these reasons, Cavit can be recommended for short term temporization in small cavities. A double seal using Cavit as an inner layer and IRM as an outer layer has been recommended to compensate for the undesirable physical properties of Cavit. Furthermore, this combination showed better dentine adaptation when compared to IRM alone.[23]

Zinc Oxide and Eugenol Preparations

1. ZOE is the most widely used provisional restorative material. It seems to have been developed from zinc oxy-chloride cements, which consisted of a powder: 75% zinc oxide and 25% pulverized glass or silica and a liquid: Zinc chloride and a little borax. They were slow setting, and a notable shrinkage was generally observed. Earlier workers used to mix zinc-oxide powder with cresote and oil of cloves. Later the liquid was replaced with eugenol.

2. Many temporary restoration products are ZOE based, with or without reinforcement. Plain ZOE with a powder to liquid ratio of 4:1 (g ml⁻¹) as commonly used results in a poor initial seal, which shows some improvement after 1 week. A lower powder to liquid ratio of 2:1 gives better initial sealability but this seal may slightly deteriorate with time.[13] Simple ZOE temporary cement was found less effective in precluding radioactive tracer leakage when compared to Cavit and Temp-Seal, but superior to zinc phosphate cement, IRM and polycarboxylate cement.[14]

3. In an in vitro study Mayer and Eickholz, commercial products based on ZOE such as Dentemp (a ZOE-based material that lacks reinforcement) and Kalsogen Plus (a ZOE based material that lacks reinforcement) have been tested and compared. After thermocycling, Dentemp proved
less effective in preventing silver nitrate penetration when compared to TERM and three different Cavit preparations, but almost equally effective when compared to IRM. Kalsogen was also found less effective in preventing dye penetration when compared to Cavit and TERM after thermocycling and mechanical loading.[24]

4. Kalzinol is a ZOE-based cement reinforced with 2% by weight polystyrene polymer to double its compressive strength. Using an electrochemical technique to test microleakage, Lim et al. reported that this cement provided better sealing properties when compared to Cavit-W and was almost equal to glass-ionomer cement used in unconditioned cavities.[25]

5. IRM is a ZOE cement reinforced with polymethyl methacrylate. This reinforcement provides the restoration with improved compressive strength, abrasion resistance and hardness.[26] The manufacturers recommend the use of IRM as a temporary restoration for cavities for up to 1 year using a powder to liquid ratio of 6:1 (g ml⁻¹). Following these recommendations usually results in a less than ideal seal but provides more optimum physical properties. The use of less powder provides a better seal at the expense of minimally compromising the physical properties.[19] In addition, a softer mix exhibits greater antibacterial activity due to hydrolysis and the subsequent increase in the release of eugenol, an antibacterial agent which may prevent bacterial colonization if leakage takes place. In this regard, IRM is also supplied in pre-measured capsules for mixing in an amalgamator. Leakage of IRM increased when subjected to thermal stress, which was attributed to its dimensional instability.

6. IRM was assessed and compared to other temporary restorative materials in a number of studies both in vivo and in vitro with conflicting findings. In an in vivo study, IRM performed almost equally to Cavit for temporizing class I access cavities in human teeth using a 4 mm thickness over a 3 week period. In an in vitro study by Blaney et al.[27] IRM allowed to set next to Camphorated Mono Chloro Phenol (CMCP) prevented Proteus vulgaris penetration significantly better than Cavit set next to both CMCP and saline solution. These findings are of special interest knowing that CMCP significantly reduced the surface hardness of IRM whilst it did not influence the hardness of Cavit.

7. Based on the previous discussion and the results of in vivo studies, it can be stated that ZOE temporary restorative materials, including IRM, can provide adequate resistance to bacterial penetration during the course of endodontic treatment especially when used with a low powder to liquid ratio.

**Glass-ionomer Cement**

1. Glass ionomer cements have a variety of applications in endodontics. Use of these materials as a temporary restoration during endodontic therapy has been investigated in a number of studies with favorable results. In one study using the fluid filtration method, glass ionomer cement microleakage values did not differ significantly from the intact crown values after 8 weeks Bobotis et al.[13]

2. In another in vitro study using an electrochemical technique, glass ionomer cement placed in unconditioned cavities was almost equally effective compared to Kalzinol and superior to Cavit-W after a 1 month experiment period Lim et al.[25] In a more recent study Barthel et al.[28] glass ionomer cement alone or on top of an IRM base provided a significantly superior seal against penetration of *Streptococcus mutans* when compared to Cavit, IRM and glass ionomer cement on a Cavit base, over a one-month period.

3. The adhesion mechanisms of glass ionomer cements explains their acceptable sealing ability in addition, they possess antibacterial properties against many bacterial strains (Heling and Chandler, Herrera et al.,) [19,20] The antibacterial activity of the material is attributed to the release of fluoride, low pH and/or the presence of certain captions, such as strontium and zinc in some cements. For these reasons, glass ionomer cements can be considered as a satisfactory TERM and may also be used in cases requiring longer term temporization. The cost, speed of setting and the difficulty in differentiating glass ionomers from the surrounding tooth structure during removal have presented problems.

**Conclusion**

The entire above are worthy of investigation as they are representing the everyday clinical practice. The presence of bacteria within the root canal system is the most common cause of ongoing periapical disease following endodontic treatment and therefore all efforts must be made to remove all bacteria and prevent further ingress into the tooth during and after endodontic treatment. Hence, the role of provisional and temporary restorations should not be undervalued and more emphasis should be placed upon their importance within endodontic treatment protocols.

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