Literature review

MedInform

DOI: 10.18044/MEDINFORM.2024112.1881

ISSUE 2, 2024

Cementation of indirect partial restorations.

Types of composite resin cement. Part 2

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Abstract

Rapid development of CAD/CAM technologies has been observed in recent years. Adhesion of indirect restorations to hard dental tissues is influenced by two factors—the treatment of the internal surface of the restoration and the cement. The cementation of indirect partial restorations (inlay, onlay, overlay, veneers) is one of the most important steps in restorative dentistry The cement agent bonds enamel/dentin to the restorative material. The most commonly used cements are resin based. Composite cements used to lute indirect aesthetic restorations could be classified as total-etch, self-etching and self-adhesive. There is no luting material that can be universally used. Adhesion of extensive partial aesthetic restorations like veneers and overlays depend on the adhesive bond to the hard dental tissues by the adhesive cement and not so much on the retention forms of the prepared tooth. Therefore, it is important to know the quality and properties of cements in order to choose the best one for each clinical case. This study presents an overview of the types of composite cements, the protocol for their application, type of bond, their advantages and disadvantages.

Keywords: *CAD/CAM materials, cementation, adhesion, indirect partial restoration.*

Introduction

In recent years, dentistry has experienced a rapid evolution of digital technologies. Clinicians increasingly adopt computer-aided design/computer-aided manufacturing (CAD/CAM) technologies to fabricate inlays, onlays, overlays, partial crowns, and veneers. These technologies, with their high esthetic parameters, excellent restoration accuracy, and reduced clinical fabrication time, are setting new standards in the industry (1). The cementation of partial indirect restorations of the hard dental tissues - inlays, onlays, overlays, and veneers, presents unique challenges and opportunities. More than any other, this stage requires meticulous planning to ensure the retention of the partial indirect restorations and the fabrication of the appropriate retention forms and cavity elements for metal cast indirect partial restorations. Composite cement achieves retention through a micromechanical adhesion for esthetic constructions, especially veneers and so-called “table tops” (occlusal overlay). Part of the tooth enamel remains in contact with the oral contents in partial indirect restorations. This requires a stronger bond between the enamel, dentin, and the restoration material. The cementation is a crucial stage for the restoration's durability (1, 2, 3).
Cementation of the indirect partial restorations is influenced by two factors – the treatment of the internal surface of the restoration and the cementing agent (1,2). The inner surface treatment is essential and specific to different materials. The longevity of indirect restorations is related to the quality of the cement. Cementing agents are of various types, such as composite materials and glass-ionomers. They connect inherently different structures: composite material and complex dental structures – enamel and dentin (1,2). This places increased requirements for reliable and long-lasting relationships with enamel and dentin, tolerance to dental pulp, esthetics, etc. This is also why developing and applying different generations of composite cementing agents. Good knowledge of their qualities and the precise work protocol is necessary to ensure the long-lasting and reliable bonding of indirect partial restorations without damage to the underlying dental structures (postoperative sensitivity of the treated teeth and or necrosis of the pulp tissue).

Aim

This review aims to present an overview of the types of composite resin cement, the protocol for their application, and their advantages and disadvantages.

Results

COMPOSITE RESIN CEMENT

Composite luting cements have excellent aesthetics and good biocompatibility (1). When using them, the adhesion to two different substrates must always be considered: the tooth structures and the restorative material (4). The bonding of the cement to the hard dental tissues and material is critical to improving the fracture resistance of restored teeth, the retention of the restoration, reducing postoperative sensitivity (5), and extending the longevity of the restoration (6).

Composite luting cements are classified according to the mechanism of polymerisation and the mechanism of adhesion. Depending on the adhesion mechanism, pre-treatment of the tooth surface, such as etching and rinsing or application of self-etching adhesives, may be necessary.

According to the polymerization mechanism, they are:
1. Light-cured composite resin cement

2. Chemical-cured composite resin cement
3. Dual-cured composite resin cement

According to the mechanism of adhesion, they are:
1. Total-etch composite resin cement
2. Self-etching composite resin cement
3. Self-adhesive composite resin cement

TOTAL-ETCH COMPOSITE RESIN CEMENT

The first composite cements were produced to increase the requirements for aesthetic restoration cementation. The bonding agents are applied to the enamel and dentin. Compared to zinc phosphate and glass ionomer, they have improved mechanical properties for cementation of metal-free restorations and good long-term clinical results (7).

Total-etch composite cement involves etching the enamel and dentin surfaces, applying an adhesive (primer and adhesive in one or two bottles) and subsequent cement placement. Phosphoric acid is used to etch hard dental tissues. The smear layer is removed, and the dentin is demineralized to a 5-8 μm depth. The dentinal tubules enlarge, exposing the collagen fibers (8, 9). When using this type of cement, a micromechanical interlocking between the dentine collagen and the monomers occurs. Total etching provides the most incredible bond strength of the three types of composite cement. Excellent retention and superior mechanical properties were found. However, composite cements using total hard tooth tissue etching have excellent postoperative sensitivity (8, 9). The protocol of working with composite cementing agents by total etching is susceptible to moisture and desiccation. The result of cementation with this type of composite cement largely depends on the operator's skill, the restoration's design and the intraoral conditions (10). The application protocol includes total etching of the hard dental tissues (followed by rinsing and drying), adhesive application in one step or two steps, and cement application.

Several authors also noted that the potential incompatibility of chemical-cured and dual-cured composite resin cement (regarding the adverse reaction of residual acid monomers and aromatic tertiary amines) may compromise the entire polymerization process. Accordingly, they promote using cement with self-cured activators or chemical co-initiators such as sodium sulfate (11, 12, 13). Sodium sulfate is already present in most commercially available adhesives based on two-component "etch and prime" technology (11).

Advantages of total-etch composite resin cements (9):
• Highest bond strengths to enamel and adequate to dentin.
• Available in different colors.
• Reduces microleakage.

Disadvantages of total-etch composite resin cements (9):
• Sensitive technique due to the need for etching, washing and drying.
• More steps are required compared to the other composite cements.
• Risk of postoperative sensitivity
• Possibility of damage to the dental pulp
• Cohesive destruction of dentin.

Total-etch composite resin cement is recommended for indirect restorations where the predominant tooth structures are enamel or calcified hard tooth tissues, low-strength ceramics, and cementing ceramic Maryland bridges (9).

SELF-ETCHING COMPOSITE RESIN CEMENT

Self-etching composite cements are being developed to mitigate the adverse effect of dentin etching and simplify the working protocol. They do not use phosphoric acid for etching but apply an acidic primer (8, 9). The primer/adhesive can be one or two bottles. Depending on the acidity of the adhesive, it affects the dentin at different depths. Ultra mild self-etching adhesives (pH > 2.5) interact at the nano level with dental substrates. Mild self-etch adhesives (pH ≈ 2.0) create a submicron hybrid layer with less visible “tags” from the composite, and strong self-etch adhesives (pH ≤ 1.0) produce an interfacial morphology like that formed by total-etch adhesives (14). The fouling layer is not removed but covered with acid monomers. The interlocking that takes place is mainly micromechanical (15, 16). The functional monomers such as 10-MDP (10-methacryloyloxydecyl dihydrogen phosphate) are added to obtain a chemical bond. A chemical bond occurs through them with the collagen fibers, which are not wholly devoid of hydroxyapatite (9, 16, 17).
Self-etching composite resin cements have a quick working protocol, which makes them easier to use and reduces the risk of errors (18). However, difficulties isolating the operative field and subgingival cavities remain a disadvantage (19). Clinical studies demonstrate that they have a weaker bond to enamel compared to total etching (9).

Self-etching composite resin cement is used to cement crowns and bridges, where mostly dentin is preserved; inlays and onlays are made for significant clinical crown defects and compromised retention (9). Examples of self-etching composite resin cement are Panavia V5 (Kuraray Noritake Dental Inc., 2018) and Panavia F Veneer LC (Brochure, 2023). The working protocol for self-etching composite resin cement involves applying an acidic primer to the hard dental tissues and the restoration material. The second step is to use the cementing agent. Self-etching composite resin cement bonds weakly to enamel and higher to dentin (9).

Advantages of self-etching composite resin cement (9):
• Higher adhesive bond to dentin compared to conventional composite types of cement.
• Fewer steps and risk of errors.
• Lower technique sensitivity.
• Lower postoperative sensitivity.
• More stable and durable than self-adhesive.

Disadvantages of self-etching composite resin cement (9):
• Lower bond strength to enamel than cements that use etch and rinse steps.
• Fewer shades are available compared to conventional.
• Recommended to be stored in refrigeration, away from sunlight.

The cementation protocol includes treating the inner surface of restoration material (depending on the type of material), treating the dentin and enamel using a primer containing etching systems and functional monomers like 10% MDP, placing the composite cement, and final polymerization.

Research by various authors has shown that self-etching composite resin cements of the PANAVIA V5 type also have an improved organic matrix.

SELF-ADHESIVE COMPOSITE RESIN CEMENT

Self-adhesive composite resin cements are a new generation. They can be placed in the "all in one" group or universal cements. Self-adhesive composite resin cements are the most widely used. They show satisfactory adhesion to enamel, dentin, porcelain and composite materials without using different adhesive agents (20), as they have a simplified working protocol. Self-adhesive cement can bond to an untreated dentin surface that has not been etched, primed adhesive applied, or air abraded. This system was developed due to clinicians' desire for a simplified protocol of the cementation process (10). In their initial polymerization phase, they have the qualities of self-etching materials – they have low pH and high hydrophilicity, which leads to surface demineralization (21). Self-adhesive composite resin cement includes new methacrylate monomers with phosphoric acid groups that react with the hydroxyapatite in the teeth to enable a self-adhesive reaction between this type of cement and the dental tissues. The polymerization reaction is of the free radical type and is initiated by a photoinitiator or a redox system (22). According to information provided by the manufacturers, these cements contain acidic and hydrophilic monomers that demineralize and infiltrate enamel and dentin, creating a solid bond. Thanks to their application, a low pH value and hydrophilic properties can be achieved at the beginning of the curing process. Multiple lines of evidence show that, at a specific concentration, acid monomers successfully demineralize dentin and support both dentin and enamel, thereby allowing adhesion to dental tissues through a micromechanical process (23-26). However, the concentration of acidic monomers must be high enough to ensure adequate demineralization and bonding to enamel and dentin and low enough to avoid additional hydrophilicity in the polymerized material (27).

In the following stages, the negatively charged monomer groups bind to Ca^{2+} ions in the tooth, facilitating the neutralization reaction in combination with the alkaline part of the filler (28). With this type of cement, a chemical bond is formed. Data from Burgess et al (2010) show that self-adhesive cements bond better to dentin than to enamel (29). This necessitates using the so-called selective etching of the enamel surface (30). The etching of dentin gives worse results than the enamel (30).

Unlike other types of composite cement and self-adhesive composite resin cement, it does not require tooth surface treatment, thereby reducing the technique's sensitivity and manipulation time. Most self-adhesive composite resin cements contain fillers such as fluoro aluminosilicate glass and release fluoride. Self-adhesive composite resin cement provides bond strength like that of self-etching cement. Most group members contain 10-MDP adhesive monomer, which allows chemical bonding to teeth and appropriately prepared metal restorations (31).

Advantages of self-adhesive composite resin cement (8, 9):

• Eliminates the need to etch tooth structure or apply a primer/bonding agent. Therefore, it dramatically reduces postoperative sensitivity.

• Double curing: Excess cement can be briefly light-cured for easier use. Light curing can be performed through the crown material for faster initial fixation when used with a non-metallic crown.

• Most products come with an auto-mix tip that eliminates the possibility of air bubbles and allows direct delivery into the crown or retainer.

Disadvantages of self-adhesive composite resin cement (8, 9):

• Has lower bond strength to tooth structure compared to cements that use etch and rinse steps.

• Should not be used in situations where mechanical retention is compromised.

• Not all self-adhesive cements work the same way. Dentists need to choose products with documented reliability.

• Not indicated for veneers.

Self-adhesive cements are used for cementation where isolation of the operative field is difficult; high-strength ceramics compromise retention when restoring teeth with little remaining hard dental tissue, mainly in dentin (9).

Conclusion

Within the limitations of this study, conventional cements are recommended when restoring teeth with preserved enamel. Self-etching and self-adhesive cements are used in the restoration of large defective clinical crowns, where the dentin tissues are mostly preserved. Self-etching cement have a stronger adhesive bond than self-adhesive cement.

ACKNOWLEDGEMENT

The study was supported by grant No D—188/03.08.2023 from the Council of Medical Science at the Medical University in Sofia, Bulgaria.

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Kirilova J, Petrova V, Yantcheva S, Iliev G, Bozhkovski Chr, Bakardjiev P, Cementation of indirect partial restorations. Types of composite resin cement. Part 2. Medinform 2024; 11(2):1881-1887.