RESIN LUTING AGENTS IN DENTISTRY

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ABSTRACT

The restorative dentistry is largely dependent on adhesives currently. The resin luting cements are from this family, and indirect restorations in cosmetic dentistry often require these types of cements. This article discusses various aspects of these materials such as their classification, composition, physical, mechanical and biological properties. It also contains comparison of available luting agents, general considerations of resin luting agents, indications, contraindications, advantages, and disadvantages of these agents. Finally, a brief description of some of the resin luting agents available in market is also presented.

Key words: Resin luting agents, resin cements, luting agents

INTRODUCTION

Dental luting materials fill the space between an indirect restoration and the prepared tooth and therefore have an important function in the retention of the restoration and the prevention of leakages at its margins. Many different types of luting agents are available, each with inherent advantages and disadvantages. The primary luting agents in use today are zinc phosphate, glass ionomers (conventional and resin modified), polycarboxylate, and resin cements. Synthetic resin cements based on methyl methacrylate have been available since 1952 for use in cementation of inlays, crowns, and appliances. In early 70s resin composite luting materials were developed as crown and bridge cements. Since 1986, resin cements have gained in popularity because of their use in the cementation of resin-bonded bridges. These resin-luting agents are especially designed for use with indirect restorations in cosmetic dentistry, but they may also be used with cast restorations.

CLASSIFICATION OF RESIN-LUTING AGENTS

Resin-luting agents are broadly subdivided according to their method of curing, into visible light-cured, dual-cured and chemically cured.

1. Light-cure resin luting materials — polymerize by a similar mechanism to the composite restorative materials. These materials are used mainly for placement of porcelain veneers.

2. Dual-cure materials — contain a system for chemical activation of polymerization, which ensures that the material will polymerize even if it does not receive sufficient light of appropriate wavelength. This can be of value in the deepest areas of a cavity beneath an inlay or a crown. Dual-cure materials are available in a range of shades, opacities, and consistencies. Dual-cure resin cements are essential for providing invisible luting and use for bonding of porcelain laminate veneers, ceramic or composite inlays and onlays, and porcelain/ceramic full crowns without an opaque core.
3. **Chemically cured materials** — are used for placement of resin-retained bridges, any metal restoration for which resin cement is indicated, for placement of bonded amalgam restorations and for direct bonding of orthodontic brackets to acid-etched enamel. These materials have two components (base and catalyst) and are not light sensitive, and polymerize only by chemical reaction.

**COMPOSITION**

Resin luting materials are supplied as powder-liquid, paste-paste, or in the case of light-cured, as single paste systems. In powder-liquid materials, the powder is a finely divided borosilicate or silica glass together with a polymer powder and an organic peroxide initiator. The liquid is a mixture of Bis-GMA or other dimethacrylate monomers containing an amine promoter for polymerization. Some materials contain monomers with potentially adhesive groups such as phosphate or carboxyl. The paste-paste systems are essentially the same composition with various components divided between the two pastes. In light and dual-cured systems, light sensitive initiators and amine promoters are present in addition to the chemical initiation products.

**PHYSICAL, MECHANICAL AND BIOLOGICAL PROPERTIES**

Resin luting cements have the best physical properties of all of the cements.

- The **solubility** and **degradation** of cements have been a primary concern for restorative dentists because a void can result between the restoration and the tooth surface, which increases the risk of dental caries and pulp pathology. Resin luting cements are very low in solubility in comparison to the other luting agents.\(^5,6\)

- **Wear** is another property and is closely associated to solubility and degradation. A clinical study of 3-years' clinical evaluation of wear of resin cements demonstrated that the use of microfills in a resin cement significantly reduces wear.\(^7\) Wear factors suggest that microfilled resin cements with higher filler content are the materials of choice for indirect ceramic or composite inlays particularly when occlusal margins are involved.\(^8\)

- Resin-luting cements have the highest **compressive and tensile strengths** of all the cements.\(^2\) Resin cements have slightly higher proportional limits and resilience than polycarboxylate and zinc phosphate cements.\(^9\)

- The **elastic modulus** of resin cements is low as compared to dentin, which makes them less attractive materials.\(^1\)

- Resin cements have a higher **retentive strength** than other luting cements, and exhibit high micromechanical bonding to prepared tooth surface, alloys and ceramic surfaces.\(^5,6,9\) If used in combination with a dentin adhesive system, they bond to tooth surface and some types of metals and they are often recommended for less retentive preparations.\(^2\) However, adhesive resin luting agents have the potential to improve the performance of post and core restorations, and laboratory studies have shown improved retention.\(^2\)

- Some studies have demonstrated the effect of using eugenol-containing temporary cements on the bond strength of resin cements to the enamel and dentin,\(^10\), while other studies have shown no significant effects.\(^11,12\)

- Studies indicate that resin cements prevent **microleakage** more than polycarboxylate and zinc phosphate cements.\(^13-15\)

- Resin luting agents **shrink** during setting, which causes undesirable **stresses** in the set material. Contraction gaps can occur at dentin-cement interface that may be in the range of 1.6 to 7.1 pm. This is 3 to 10 times greater than wall to wall contraction in percentage observed when resin composites are used as filling materials.\(^16\)

- Resin cements, particularly the urethane-based materials, are susceptible to **water resorption** \(^17,18\), with less heavily filled materials exhibiting greater sorption \(^19-21\). Water sorption will adversely affect the mechanical properties of the resin, although the resultant expansion may be beneficial as it counteracts polymerization shrinkage.\(^22-24\)

- Resin cements have been shown to result in significantly higher incidence of tilted castings, which demonstrated **uneven cement thickness** in com-
parison to zinc phosphate, glass ionomer or polycarboxylate cements, presumably because of higher viscosity of resin.\textsuperscript{28} As the concentration of microfills increases, the viscosity, film thickness, and expected wear resistance of the cement increases. However, lower viscosity cements provide a lower film thickness. But low-viscosity resin exhibits a relatively poor performance compared to a high-viscosity resin. Therefore, resin with higher filler content and a higher viscosity are preferable.\textsuperscript{5}

- The \textit{esthetic properties} of luting agents are of considerable significance with increasing translucent ceramic restorations. Expanded kits of resin cements with accessories, tints, opaque, and multiple shades are tailored to anterior ceramic restorations and enable subtle shade corrections to be made.\textsuperscript{26} The amine accelerator necessary for dual polymerization can cause the color of luting agent to change over time.\textsuperscript{27}

- Resin cements are more \textit{radio-opaque} than other luting agents; and this assists practitioners to distinguish between a cement line and recurrent caries, as well as detect cement overhangs.\textsuperscript{6}

- \textbf{Biocompatibility:} Allergy to the constituents of resin luting agents has been reported, by the patients and dental personal, but it is apparently quite rare.\textsuperscript{6}

\section*{COMPARISON OF AVAILABLE LUTING AGENTS}

There are different types of luting cements available in the market and Table #1 summarizes the classes of these luting agents and some of their properties.

\section*{GENERAL CONSIDERATIONS OF RESIN LUTING AGENTS}

\subsection*{Indications:}\textsuperscript{3,4,6}

The selection of cement for permanent cementation is a very important in the success of the final restoration. There are several indications for using of resin luting agents:

1) Conventional crowns (full casted metal, metal ceramic), posts, and fixed bridges with less than adequate retention, 2) All etched-bonded bridges, 3) Porcelain laminates veneers, 4) Ceramics inlays, and onlays, 5) Posterior composite inlays, 6) Strength requirements of all ceramics/porcelains full crowns, 7) Recementation of old restorations with less than ideal accuracy and retention, 8) Direct bonding of orthodontic brackets to acid-etched enamel.

\subsection*{Contraindications}\textsuperscript{5,6}

1. When moisture is difficult to control, such as in case of subgingival margins.


\subsection*{Advantages:}\textsuperscript{29,30}

1) There is good adhesion to tooth structure, and therefore these materials provide good retention even in cavity preparations which have less than ideal retention due to over-tapered and/or short longitudinal walls, 2) Microleakage is reduced since they are used with dentin bonding agents, 3) They are virtually insoluble in oral fluids, 4) Higher strength, 5) Fast setting time.

\subsection*{Disadvantages:}\textsuperscript{2,6,28,29}

1) High cost, 2) They are technique sensitive, with a marked difference in handling characteristics between brands, 3) Short working time with chemically cured materials, 4) Film thickness tends to be greater than that of other cements, so incomplete or titled seating of the casting can be a problem, 5. Polymerization shrinkage, 6) Tendency for pulp irritation, 7) Difficult to remove excess, 8) Resin cements are relatively new, so there are no long-term clinical studies to determine if the high retention values and low microleakage are long lasting, 9) Difficulty in removing restorations if there is any problem after using of resin luting cement for cementation.

\section*{AVAILABLE RESIN LUTING AGENTS}

There are different brands of materials in market and Table #2 presents a comparison between some of them in terms of their properties. The use of resin luting cements is on the increase and it is hoped that this overview of these materials will assist dental practitioners in understanding and selection of these materials in their clinical use.
TABLE 1: COMPARISON OF AVAILABLE LUTING AGENTS.6

<table>
<thead>
<tr>
<th>Property</th>
<th>Ideal material</th>
<th>Zinc phosphate</th>
<th>Polycarboxylate</th>
<th>GI</th>
<th>Resin Ionomer</th>
<th>Composite</th>
<th>Adhesive Resin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Film thickness (pm)</td>
<td>Low</td>
<td>&lt;25</td>
<td>&lt;25</td>
<td>&lt;25</td>
<td>&lt;25</td>
<td>&lt;25</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Working time (min)</td>
<td>Long</td>
<td>1.5-5</td>
<td>1.75-2.5</td>
<td>2-4</td>
<td>2-10</td>
<td>3-10</td>
<td>0.5-5</td>
</tr>
<tr>
<td>Setting time (min)</td>
<td>Short</td>
<td>5-14</td>
<td>6-9</td>
<td>2</td>
<td>2-3</td>
<td>3-7</td>
<td>1-15</td>
</tr>
<tr>
<td>Compressive Strength (Mpa)</td>
<td>High</td>
<td>62-101</td>
<td>67-91</td>
<td>122-162</td>
<td>194-200</td>
<td>179-255</td>
<td></td>
</tr>
<tr>
<td>Elastic Modulus (Gpa)</td>
<td>Dent=13.7</td>
<td>13.2</td>
<td>Not tested</td>
<td>11.2</td>
<td>Not tested</td>
<td>17</td>
<td>4.5-9.8</td>
</tr>
<tr>
<td>Pulp irritation</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Solubility</td>
<td>Very Low</td>
<td>High</td>
<td>High to very high</td>
<td>Medium</td>
<td>Low to moderate</td>
<td>Medium Moderate to high</td>
<td></td>
</tr>
<tr>
<td>Microleakage</td>
<td>Very Low</td>
<td>High</td>
<td>High to very high</td>
<td>Medium</td>
<td>Low to moderate</td>
<td>Medium Moderate to high</td>
<td></td>
</tr>
<tr>
<td>Removal of excess</td>
<td>Easy</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Difficult</td>
</tr>
<tr>
<td>Retention</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Moderate</td>
<td>Medium Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

TABLE 2: COMPARISON OF AVAILABLE RESIN LUTING AGENTS.6,6

<table>
<thead>
<tr>
<th>Product name</th>
<th>Manufacturer</th>
<th>Curing</th>
<th>Resin family</th>
<th>Filler content</th>
<th>Filler type</th>
<th>Working time (min)</th>
<th>Setting time (min)</th>
<th>Shelf life (yrs)</th>
<th>Shades</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&amp;B Cement-It Choice</td>
<td>Bisco</td>
<td>Self</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-10</td>
<td>2-4</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Dual Cemen</td>
<td>Ivoclar/t Vivadent</td>
<td>Dual</td>
<td>Bis-GMA/UDMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>DUO-Link EnForce</td>
<td>Bisco</td>
<td>Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Insure</td>
<td>Cosmedent</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Lute-It</td>
<td>Jeneric/ Pentron</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Nexus</td>
<td>Kerr</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Luting composite Panavia</td>
<td>Ultradent</td>
<td>Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Panavia 21</td>
<td>3M</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Permalute Scotchbond</td>
<td>J. Morita</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Resin Cement Twinlook</td>
<td>3M</td>
<td>Self</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>Ultra-bond</td>
<td>Heraeus Kulzer</td>
<td>Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
<tr>
<td>VarioLink II</td>
<td>Ivoclar/ Vivadent</td>
<td>Light/Dual</td>
<td>Bis-GMA</td>
<td>67% Hybrid</td>
<td>2-4</td>
<td>2-7</td>
<td>2-7</td>
<td>2-4</td>
<td>2-1</td>
</tr>
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REFERENCES