Classification of the Luting Materials

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Contributor: Gary Kwun-Hong Leung , Amy Wai-Yee Wong , Chun-Hung Chu , Ollie Yiru Yu

A dental luting material aids in the retention and stability of indirect restorations on the prepared tooth structure. The luting materials can generally be classified by their chemical compositions, bonding mechanisms or clinical indications.

indirect restoration luting agents luting cements

1. Introduction

A luting cement is a material that is used to attach indirect restorations to prepared tooth surfaces by filling minute voids between the restorations and the tooth structures, thereby locking the restoration mechanically to prevent dislodgement [1][2]. A luting material provides the retention of indirect restorations by providing mechanical interlocking, chemical bonding or both of them. Traditional cementation rely mostly on the frictional forces between the prepared tooth surfaces and fitting walls of restorations [3]. More contemporary materials utilize chemical and micromechanical adhesion to bond between the tooth surface, cement and restorative material [4].

Understanding the properties of the luting materials and their clinical indications is helpful to ensure the quality of the cementation. The luting materials create the seal between the restoration and the tooth. A good seal is important not only to hold the restoration in place but also to make the surface impervious to microleakage and caries. Hence, luting materials affect the longevity of indirect restorations. In addition, the luting materials are widely indicated in the cementation of crowns, inlays, onlays, veneers, multiple-unit fixed prostheses, endodontic posts and orthodontic appliances. It is essential for dental practitioners to comprehend the clinical indications of the common luting materials.

2. Historical Development of Common Luting Cements

Over the past 50 years, a range of new materials has been developed which are known as luting cements. However, before this period, zinc phosphate had been the only choice of material for permanent cement for almost 100 years since the late 19th century. Therefore, it is often regarded as the “gold standard” for permanent dental cements [5]. In the late 1960s, zinc polycarboxylate was introduced, which offered more options of luting material to clinicians at that time [3]. Contemporary cements shifted from the utilization of a bonding mechanism to luting (filling in the space between the tooth and the restoration). Between the 1970s and the 1980s, glass ionomer cement (GIC) and resin-modified glass ionomer cement (RMGIC) was invented. Resin cement, which was invented in the 1950s, has undergone many reformulations and improvements over the years. Owing to the increasing demand for aesthetic all-ceramic restorations, it has gained high popularity in contemporary dentistry [5]. In the 2000s, self-adhesive resin cement was developed to simplify the clinical procedure of traditional resin cements [6]. Calcium aluminate/glass ionomer cement (CaAl/GI) has a bioactivity property by creating hydroxyapatite crystals, and this was introduced in 2009 [7][8][9]. An ideal luting cement should be biocompatible, insoluble, resistant to thermal and chemical assaults, antibacterial, aesthetic, simple and easy to use. It should have high strength properties under tension, shear and compression to resist the stress at the restoration–tooth interface, as well as adequate working and setting times. So far, no luting material possesses all of these properties of an ideal cement.

3. Classification of the Luting Materials

The luting materials can generally be classified by their chemical compositions, bonding mechanisms or clinical indications. Luting materials can be classified as water- or resin-based luting cements based on their chemical composition. Water-based materials include zinc-oxide eugenol and non-eugenol, zinc polycarboxylate, zinc phosphate, GIC and hybrid CaAl/GI cements. Resin-based luting cements include conventional and self-adhesive resin cements. RMGIC, which has the properties of GIC and resin cements, is a mix of water- and resin-based cement.

Luting materials can also be classified as non-adhesive, chemically adhesive and micromechanically adhesive luting agents by means of a bonding mechanism. Non-adhesive luting materials achieve restoration by friction only. Chemically adhesive luting materials can establish molecular interactions with the tooth structures to form chemical bonding, whereas micromechanically adhesive materials accomplish adhesion via micromechanical interlocking between the adhesive and the tooth surfaces [10]. Non-adhesive cements include zinc oxide eugenol and non-eugenol and zinc phosphate cements. Chemically adhesive materials include zinc polycarboxylate, GIC and hybrid CaAl/GI cements. Both types of resin cement are micromechanically adhesive materials. RMGIC can be both chemically adhesive and micromechanically adhesive.

Based on the clinical indication, luting materials can be categorized into temporary or permanent cements. Temporary cements are used to retain provisional restorations, and these include zinc oxide eugenol and non-eugenol and zinc polycarboxylate [11] (**Table 1**).

Table 1. Properties and the types of temporary luting cements.

Properties	Ideal Materials [12]	Zinc Oxide Eugenol	Zinc Oxide Non-Eugenol	Zinc Polycarboxylate
Bond strength	Low (for easy of removal)	Low	Low	Low
Handling properties [13]	Good	Good	Good	Fair (cement is hard to mix)

Properties	Ideal Materials [12]	Zinc Oxide Eugenol	Zinc Oxide Non-Eugenol	Zinc Polycarboxylate
Ease of cleaning up [13][14]	High	High	High	Low (cement is hard to remove)
Effect on permanent cementation [15][16][17]	No adverse effect	Interfere resin cement	No adverse effect	No adverse effect
Pulpal effect [13][18][19]	Minimal pulpal irritation Sedative	Anti-inflammatory anaesthetic	Minimal pulpal irritation	Minimal pulpal irritation

and self-adhesive resin cement and hybrid CaAl/GI cement. They are used in the cementation of definitive restorations (**Table 2**).

Table 2. Properties and permanent luting cements.

Properties	Ideal Material [4]	Zinc Phosphate	Zinc Poly-Carboxylate	GIC	RMGIC	Hybrid CaAl/GIC	Conventional Resin Cement	Self-Adhesive Resin Cement
Compressive strength (MPa) [20][21]	High	48 (Flecks)	63 (Durelon)	105 (Ketac Cem)	96.3 (RelyX Luting)	160 (Ceramir C&B)	209 (Scotchbond resin cement)	157 (RelyX Unicem)
Elastic modulus (GPa) [21][22]	13.7 (dentine)	19.8 (Flecks)	16.1 (Durelon)	19.5 (Ketac Cem)	6.8 (Vitremer)	No data	11.8 (Scotchbond resin cement)	16.5 (RelyX Unicem)
Shear bond strength [1] (MPa) [9][23][24]	High	0.65 (N.A.)	1.40 (N.A.)	2.36 (GC Fuji 9)	2.53 (GC Fuji Plus)	5.79 [2] (Ceramir C&B)	6.99 (Panavia F 2.0)	5.07 (Clearfil SA)
Fluoride release	Yes	No	No	Yes	Yes	Yes	No	Yes
Microleakage [12][25][26][27]	Minimal	High	High to very high	Low to very high	Very low	Low to high	Very low	Very low
Film thickness (µm) [12][20][28][29][30][31]	Thin	<25 (N.A.)	<25 (N.A.)	24.2 (GC luting)	25.2 (GC Fuji Plus)	16.4 (Ceramir C&B)	24.3 (Panavia 21)	16.0 (RelyX Unicem)

Properties	Ideal Material [4]	Zinc Phosphate	Zinc Poly-Carboxylate	GIC	RMGIC	Hybrid CaAl/GIC	Conventional Resin Cement	Self-Adhesive Resin Cement
Working time (min) [12][31][32][33][34]	Long	~2:30 (DeTrey Zinc)	2:00–2:30 (Poly-F Plus)	3:10 (Ketac Cem)	2:30 (GC Fuji Plus)	2:00 (Ceramir C&B)	4:00 (Panavia 21)	2:30 (RelyX Unicem)
Setting time (min) [20][31][32][33][34]	Short	5:00–6:00 (DeTrey Zinc)	5:00–7:00 (Poly-F Plus)	7:00 (Ketac Cem)	4:30 (GC Fuji Plus)	~4:48 (Ceramir C&B)	7:00 (Panavia 21)	6:00 (RelyX Unicem)
Removal of excess [9][12]	Easy	Easy	Medium	Medium	Medium	Easy	Difficult	Medium
Water solubility [12]	Minimal	High	High	Low	Very low	Low	Very low	Very low
Aesthetics	High	Low	Low	Low	Moderate	Low	Highest	High
Color stability	High	Low	Low	Low	Moderate	Low	Highest	High
Pulpal irritation [12]	Low	Moderate	Low	High	High	No data	High	High

[1]: Values based on studies of cementation of zirconia onto dentine. [2]: Not tested under universal setting. GIC—Glass ionomer cement; RMGIC—Resin-modified glass ionomer cement; Hybrid CaAl/GIC; Hybrid calcium aluminate/glass ionomer cement.

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