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A Review Luting Agents Used In Dentistry

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Abstract

The assortment of an suitable luting agent influence the long-standing clinical attainment of fixed dental prosthesis and restorations. There are varieties of luting agents existing from conventional water-based to contemporary adhesive resin cements. There is no particular luting agent which is capable of assembling all the requirements. Recently adhesive resin systems has entirely changed the features of fixed prosthodontic practice leading to an improved use of bonded all-ceramic crowns and resin-retained fixed partial dentures. This article reviews on physical properties, biocompatibility and other properties that make particular cement which can be preferred in the clinical practise.

Keywords: Dental luting agents, Cements, Biocompatibility,Prosthodontic, Clinical

Introduction

The primary goal of any clinician is to endow patient with a restoration which conserve the longevity and pulpal vitality of usual abutments of fixed partial dentures and retrieval the lost function[1]. A dental cement is used to attach indirect restorations to prepared teeth is called a luting agent. A luting agent's primary function is to fill the void at restoration-tooth interface and mechanically lock the restoration in place to prevent its dislodgement during mastication [2]. Proper selection of a luting agent is a last important decision in a series of steps that require meticulous execution and will determine the long-term success of fixed restorations. Depending on the predictable longevity of the restoration, a luting agent may be considered to be definitive (long term) or provisional (short term) [3].

The long-standing success of a restoration is heavily reliant on the proper selection and manipulation of dental cements. Loss of retention has been found to be one of the most frequent causes of restoration failure[4]. Luting refers to a mechanism in which micromechanical locking occurs between the objects to be joining. Bond is a term that implies that chemical or physical interface occurs to both surfaces that to be engrossed. Cement is a generic term for a union medium provided adhesion and/or micromechanical locking between the two surfaces to be connected [5]. A appropriate generic description of material that provides the connection between restorative material and the tooth preparation should be a dental cement.

In current time, many luting agents and dental cements have been introduced with the assert of clinically superior performance than existing materials due to enhanced characteristics. In the past the decision was easy with the accessibility of only one luting agent, zinc phosphate cement. [6].

Now the preference of the optimal luting agent can be puzzling, even for the most skilled clinician. Restorations of metal, porcelain fused to metal, full or partial coverage, require a practical approach and the proper cement selection should be based on understanding of physical properties, biological properties and other properties of restorative materials and luting agents.

2. Development of Dental Cements

Zinc phosphate cement is the oldest luting agent, which was invented by Peirce in 1878 and it has the highest track record as a luting agent to secure cast restoration for more than 130 years. It serves as a typical by which newer systems can be compared [7,8].

In the commencement of the 20th century (1903) Silicate cements were introduced. These were the most primitive of the direct tooth colored filling materials. The silicate cements may be designed as precursors of more recent products such as composite resin and glass Ionomer cements. The strength of a silicate restoration depends critically on the care taken in handling the material and on the oral hygiene of the patient [8].

In 1968, a latest kind of cement was created by D.C. Smith using zinc oxide as powder and polycarboxylic acid as liquid component. The result is the so- called polyacrylate cement. It was the first cement developed for adhesion to tooth structure. It is largely used for cementation of indirect restorations and thermal insulating base [8,9].

Wilson and Kent introduced Glass Ionomer Cements in 1969. It is is the generic name of materials that use silicate glass powder and an aqueous solution of polyacrylic acid. This material acquires its name from its formulation of glass powder and an ionomeric acid that contains carboxylic (COOH) groups which help in chemical bonding with the natural tooth and to certain alloys as well. Glass ionomer cements are also referred to as polyalkanoate cements or ASPA (Aluminosilicate polyacrylic acid) cement [7,8,10,11]. In 1986, resin modified glass ionomer cements were developed [8].

Qualities Of Ideal Cement[7,8,10,12,13,14,15,16].

Properties	Ideal Requirements
Biological	• Should be/have • Non-toxic and non-irritant. • Non-carcinogenic. • Should not cause any systemic reactions. • Should be cariostatic thus preventing secondary caries formation.
Chemical	• Should be chemically inert. • Solubility of the cement in oral fluids or any other fluids being taken by the patient should be negligible (maximum allowable solubility of cements in oral conditions is 0.2%). • Should bond chemically to the enamel and dentin. • PH should be neutral.
Rheological	Should be/have • Low film thickness to enable the easy flow of luting cement. • Longer mixing and working time. • Shorter setting time.
Mechanical	Should be/have • High compressive strength to withstand the masticatory forces. • High tensile strength to reduce the brittleness. • High modulus of elasticity. • Exhibit minimum dimensional changes on setting. • Restoration should take and retain a smooth surface finish. • Should bond chemically to the enamel and dentin.
Thermal	Should be/have • Good thermal insulator. • Coefficient of thermal expansion (COTE) should be similar to the tooth and artificial prosthesis.
Optical/aesthetic	• Should not alter the color of the tooth and artificial restorations/prosthesis. • Should have adequate radiopacity to enable detection of secondary caries and detection of incompletely filled cavities due to trapped air.
Miscellaneous	Should be /have • Easy to manipulate. • Inexpensive. • Longer shelf life.

Classification :[17,18,19,20]

Various classifications given by different authors are as follows:

1. Based on knowledge and experience of use (Donovan) :

a. Conventional (zinc phosphate, polycarboxylate, glass- ionomer)

b. Contemporary (resin-modified glassionomers, resin)

2. Based on the chief ingredients (Craig) :

a. Zinc phosphate,

b. Zinc silicophosphate,

c. Zinc oxide-eugenol,

d. Zinc polyacrylate,

e. Glass-ionomer,

f. Resin

3. Based on matrix bond type (O'Brien):

a. Phosphate,

b. Phenolate,

c. Polycarboxylate,

d. Resin,

e. Resin-modified glass-ionomer.

4. Based on the principal setting reaction (Wilson):

a. Acid-base cements

b. Polymerization cements

Conventional Luting Agents

Zinc Phosphate :

The cement comes as a powder and liquid and is classified as an acid-base reaction cement. Zinc phosphate cement is a acid- base reaction cement. It is one of the oldest luting cements which has been use for wide-ranging because of advantages like, a reaction and its physical properties are subject to variables like powder-liquid ratio, water content, mixing

temperature, etc. The basic constituent of the powder is zinc oxide. Magnesium oxide is used as a modifier while other oxides such as bismuth and silica may be present. The liquid is essentially composed of phosphoric acid, water, aluminum phosphate, and occasionally zinc phosphate. The water content is key factor as it controls the rate and type of powder/liquid reaction[21].

It has a more compressive strength and less tensile strength and is cheap. It is a good choice for luting long span fixed partial dentures. It does not chemically bond to tooth structure. The mixed cement is at a very low pH, hence, the smear layer should be maintained to minimize penetration into dentinal tubules. A cavity varnish may be used to reduce the effect of low pH on the pulp[22].

Zinc Oxide Eugenol :

This is another acid- base reaction cement. Zinc oxide eugenol (ZOE) is a provisional luting cement. ZOE is commonly dispensed as two pastes and equal parts of the pastes are mixed until uniform in colour. Exposure to water reduces the working time of the cement. ZOE has good sealing ability but poor physical properties hence, it is used for luting temporary restorations. To get better the properties of ZOE cement, 2-ethoxybenzoic acid (EBA) modified

ZOE cement was introduced. ZOE is not used as a material of choice for definitive restoration because of its brittleness and high solubility[23].

Zinc Polycarboxylate :

Zinc polycarboxylate was developed by DC Smith in 1968. Polycarboxylate cement is also an acid-base reaction cement. The powder is composed of mainly zinc oxide, magnesium oxide, bismuth, and aluminum oxide[24].It may also contain stannous fluoride, which increases strength. The liquid is composed of an aqueous solution of polyacrylic acid or a copolymer of acrylic acid and other unsaturated carboxylic acids. It was the first dental cement that adhered mechanically to the tooth structure and was widely recommended. Fluoride release by the cement is a small fraction (15–20%) of that released from materials such as silicophosphate and glass ionomer cements. It is mixed for about 30 to 60 sec on either a cooled glass slab or a paper pad and the dispensed powder is incorporated into the liquid in two halves. When mixed at the recommended P/L ratio the final mix appears more viscous than zinc phosphate cement. The pH of cement is very low at initial contact with the tooth but the high molecular weight prevents acid penetration into dentinal tubules. Hence, it is compatible to the pulp tissue[25].

Glass-Ionomer Cement :

Glass-ionomer cement, originally known as ASPA (aluminosilicatepolyacrylic acid) were invented in the late 1960s in the laboratory of the Government Chemist in Great Britain and were first reported on by Wilson and Kent in 1971[26]. The powder consists of aluminosilicates with high fluoride content. The material is formed by the fusion of quartz, alumina, cryolite, fluortite, aluminum trifluoride, and aluminum phosphate at temperatures of 1100–1300◦C. The liquid is composed of polyacrylic acid and tartaric acid, the latter to accelerate the setting reaction. The reaction of the powder with the liquid causes decomposition, migration, gelation, postsetting hardening and further slow maturation. The polyacrylic acid reacts with the outer surface of the particles resulting in release of calcium, aluminum, and fluoride ions. When a sufficient amount of metal ions has been released, gelation occurs, and hardening continues for about 24 hours[27].

GICs set bymeans of chelation as a result of an acidbase reaction. They strongly adhere to enamel and to some extent to dentin and release fluoride. Initially used as a restorative material, GI further evolved into a luting agent, which is now the predominant application of this class of material. Exposure to saliva, blood or water must be avoided for up to ten minutes after mixing to prevent marginal loss of cement. Also, microcracking can occur if the material becomes excessively dry. Sensitivity after placement can be avoided by maintaining the smear layer, preventing dehydration of the cement or by using a dentine sealer[28].

Resin-Modified Glass-Ionomer Cement (RMGI):

They are essentially hybrid formulations of resin and glass ionomer components. Resin-modified glassionomer cement (RMGI), developed in 1980s, and is a hybrid material derived from adding polymerizable resins to conventional glass-ionomer cement. Upon mixing, the resin phase polymerizes quickly and the glass-ionomer phase proceeds slowly via an acid base reaction over a period of time[29].RMGI is less susceptible to early erosion during setting, less soluble, and has higher compressive and tensile strengths than unmodified glass-ionomer luting cement. The RMGI cements are relatively easy to handle and are suitable for routine application with metal based crown and bridgework. Film thickness and adhesion to tooth structure are similar. Because of the possibility of hygroscopic expansion, these cements are not recommended for luting all-ceramic restorations that are susceptible to etching or posts.

Compomers

Shortly after the introduction of RMGICs,"compomers" were introduced to the market. It was appeared in the late 1990s. The compomers, also known as poly acid-modified composite resins, were described as being a combination of composite resin (comp) and glass-ionomer (omer), offering the advantages of both. These materials have two main constituents: dimethacrylate monomer(s) with two carboxylic groups present in their structure[31].

Compomers are anhydrous resins that contain ionleachable glass as a part of the filler, and dehydrated polyalkenoic acid. The physical properties of compomers is more like composite resins than glass-ionomer. They have higher compressive and flexural strengths than RMGI but lesser than conventional composite. A resin bonding agent is required to achieve required adhesion. Fluoride release and recharge potential is lower than conventional GIC. The proposed nomenclature for these materials as polyacid-modified composite resins. Constant re-formulations of these types of materials may eventually lead to them being comparable or even superior to existing composites, but, as long as they do not set via an acid-base reaction and do not bond to hard-tooth tissues, they cannot and should not be classified with GICs. They are, after all, just another dental composite[32].

Resins

As an alternative to acid-base reaction cements, resin cements were introduced in the mid-1980s, these materials have a setting reaction based on polymerization. Today resin cements are a popularchoice due to their high compressive and tensile strengths, low solubility and aesthetic qualities.

They do have limitations like technique sensitivity and high cost [33].Resins are useful for all-ceramic, veneers, metal or metal-ceramic restorations where retention and resistance form is compromised and for post cementation in endodontically treated teeth. In combination with a dentin bonding agent, however, many resin cements have superior properties and are frequently used for the cementation (bonding) of porcelain laminate veneers. These materials are classified by mechanism of matrix formation: (1) self cure; (2)light cure and (3) dual cure. Etching followed by application of bonding agent is an important step in application of light cure resin luting agents[34].

Many shades of resins are available in the market to suit the need of the clinician. Auto-curing self-adhesive, automixed or pre-encapsulated, resin luting agents may be useful for metal or metal ceramic restorations.Dual-cure resins may discolour with time due to their aromatic amine content.

More cement exposure may be seen with all-ceramic restorations hence either dual- or self-curing resin cements are preferred. Dual affinity adhesive resins have very high tensile strengths and bond to etched enamel and metal and noble metal alloys. The use of eugenol containing provisional cement should be avoided when resin will be used as the definitive luting agent since residual eugenol may decrease the effectiveness of some bonding agents[35].

Adhesive Resin Cements

Nowadays numerous of the resins that are termed as adhesive are not actually with adhesive attributions. Only adhesive resins with monomers containing 4-META and MDP have adhesive quality. In the beginning 1980s, conventional Bis-GMA resin cement was modified by adding a phosphate ester to the monomer component, introducing to dentistry a exclusive group of resin luting agents that have a degree of chemical bonding as well as a micromechanical bonding to tooth structure and base metal alloys. The foremost product marketed, Panavia, contained the bifunctional adhesive monomer MDP (10-methacryloyloxydecyl dihydrogen phosphate) and was a powder-liquid system. Bond strength to etched base metal greatly exceeded that to tooth and Panavia quickly became the luting agent of choice for resin retained fixed partial dentures[36].

These materials are usually costly and demand sensitive technique, difficult to clean up when set, and they have no extensive shelf lives.

Advantages Of Luting Cements :[7,8,9]

Zinc Phosphate	Zinc Polycarboxy-late	Glass Ionomer	RMGIC	Resin Cement
1. Good compress- ive strength. 2. Adequate film thickness (25 µm). 3. Reasonable working time. 4. Can be used in regions of high mastic-atory stress or long span prosthesis.	1. Biocompatib-ility with the dental pulp. 2. Adequate resistance to water dissolution. 3. Pseudoplastic. 4. Favourable tensile strength. 5. Chemical bonding	1. Anticariogenic. 2. Ability to absorb fluoride recharge from the oral environment makes it the cement of choice in patients with high caries rate. 3. Coefficient of thermal expansion similar to tooth 4. Translucent. 5. Adequate resistance to acid dissolution 6. Low film thickness and maintains constant viscosity for a short time after mixing. 7. Chemical bonding.	1. Improved compressive strength, diametral tensile strength, and flexural strength. 2. Less sensitive to early moisture contamination and desiccation during setting. 3. Less soluble than the glass-ionomer cement. 4. Easy to manipulate 5. Adequately low film thickness. 6. Fluoride release similar to conventional GIC. 7. Minimal post-operative sensitivity 8. High bond strength to moist dentin.	1. Superior compressive and tensile strengths. 2. Low solubility 3. Available in wide range of shades and translucencies.

Disadvantages Of Luting cements :

Zinc Phosphate	Zinc Polycarboxylate	Glass Ionomer	RMGIC	Resin Cement
1. Highly acidic. 2. Low tensile strength. 3. No chemical bonding. 4. Solubility in oral fluids. 5. Lack of antibacterial properties.	1. No resistance to acid dissolution. 2. Manipulation critical. 3. Early rapid rise in film thickness that may interfere with proper seating of a casting	1. Initial slow setting. 2. Sensitivity to early moisture contamination and desiccation 3. MOE is lower than zinc phosphate. 4. Post ceme-ntation sensitivity. 5. Insufficient wear-resistance	1. Polymeriz-ation shrink-age. 2. More water sorption due to the presence of HEMA. 3. Although rare, may elicit an allergic response due to free monomer. 4. Cement bulk is very hard and difficult to remove.	1. Severe pulpal reactions when applied to cut vital dentin. 2. High film thickness 3. Marginal leakage due to polymerization shrinkage 4. Lack of acnticariogenic properties. 5. Low MOE. 6. No Chemical bonding. 7. Meticulous and critical manipulate-on technique

Conclusion

Restorative dentistry has been going through numerous changes as an outcome of clinical applications and development of new materials. Several new materials are available differing each other in content and physical attributions. Therefore it may be difficult to the dentist to make a choice amongst so many alternative products. Each luting agent has different physical, mechanical and biological characteristics resulting from its chemical structure. The choice of an appropriate luting agent (cement) for final cementation of fixed crown and bridge units needs careful consideration as the ultimate success to a large extent depends on the correct choice. Selection of luting agent to be used for a given restoration should be based on a basic knowledge of the materials available, the type of restoration to be placed, the requirements of the patient and the expertise & experience of the clinician. With the advent of newer luting agents flooding the markets, the practitioner must have sufficient knowledge to help choose the material for each clinical situation

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