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Review Article

Practical clinical considerations of luting cements: A review

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Abstract:

The longevity of fixed partial denture depends on the type of luting cement used with tooth preparation. The clinician's understating of various cements, their advantages and disadvantages is of utmost importance. In recent years, many luting agents cements have been introduced claiming clinically better performance than existing materials due to improved characteristics. Both conventional and contemporary dental luting cements are discussed here. The various agents discussed are: Zinc phosphate, Zinc polycarboxylate, Zinc oxide-eugenol, Glass-ionomer, Resin modified GIC, Compomers and Resin cement. The purpose of this article is to provide a discus¬sion that provides a clinical perspective of luting cements currently available to help the general practitioner make smarter and appropriate choices.

Key Words: Dental luting cements, GIC, luting cements, provisional and definitive luting cements, resin cements, resin modified luting cements

Introduction

The foremost goal of any clinician is providing the patient with a restoration which preserves the longevity and pulpal vitality of natural abutments of fixed partial dentures and regaining the lost function.[1] A dental cement used to attach indirect restorations to prepared teeth is called a luting agent.[2] 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. Depending on the expected longevity of the restoration, a luting agent may be considered to be definitive (long term) or provisional (short term).[2,3] In recent years, many luting agents and dental cements have been introduced with the claim of clinically better performance than existing materials due to improved characteristics. The purpose of this article is to provide a discussion that provides a clinical perspective of luting cements currently available to help the general practitioner make smarter and appropriate choices.

Search strategy

A protocol was established and studies were sourced from four electronic databases. Screening and quality assessment was conducted by all authors. The databases including Pubmed, Google Scholar, EBSCO and SCOPUS were considered from inception of data base to November 2013. In addition, we hand searched World Wide Web, bibliographies of all included studies and Library of the institution for additional information.

Inclusion Criteria

Studies published with following keywords were included in the study; Dental luting cements, Luting cements, GIC, Resin Modified luting cements, Resin cements, provisional and definitive luting cements. Above mentioned keywords with various combinations using the Boolean operators were searched to get the desired literature.

Ideal requirements of luting cements

An ideal luting agent must meet the basic mechanical, biological and handling requisites like compatibility to the tooth and tissue, sufficient working time, flowability, compressive strength, minimal microleakage, low solubility in oral fluids, adhesiveness, esthetics, low cost, ease of excess removal etc.[2]

Extensive review of literature states that no currently available material satisfies all the ideal requisites and the material selection should be based on the clinician's expertise and patient requirement. Ideally, luting agent selection should be based on the specific needs of each clinical situation and the clinician should have a thorough knowledge of all available options.[2,4-8]

Classifications

There is considerable variability regarding the classification of dental cements in the reviewed literature. Various classifications given by different authors are as follows:

1. Based on the chief ingredients (Craig):[9]
    a. Zinc phosphate,
    b. Zinc silicophosphate,
    c. Zinc oxide-eugenol,
    d. Zinc polyacrylate,
    e. Glass-ionomer,
    f. Resin
2. Based on matrix bond type (O'Brien):[10]
    a. Phosphate,
    b. Phenolate,
    c. Polycarboxylate,
    d. Resin,
    e. Resin-modified glass-ionomer.
3. Based on knowledge and experience of use (Donovan):[7]
    a. Conventional (zinc phosphate, polycarboxylate, glass- ionomer)
    b. Contemporary (resin-modified glass-ionomers, resin)
4. Based on the principal setting reaction (Wilson):[11]
    a. Acid-base cements
    b. Polymerization cements

Conventional luting agents

Zinc phosphate

Zinc phosphate cement is one of the oldest luting cements which has been in use for long because of advantages like, a high early strength which makes it suitable for cementation of a prefabricated or for a cast metal post-core.[12] Zinc phosphate cement has been the standard to which other luting cements are compared.[2] It sets by an acid-base reaction and its physical properties are subject to variables like powder-liquid ratio, water content, mixing temperature, etc. It has a high compressive strength and low tensile strength and is inexpensive. 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.[13] A cavity varnish may be used to reduce the effect of low pH on the pulp. Mixing is done for 60 to 90 seconds on a cool, dry glass slab with the powder brought into the liquid in small increments and is spread over a broad area thus allowing maximal powder incorporation and keeping the viscosity low. It is placed in or on the restoration which is seated on a clean, dry tooth with firm steady pressure that should be maintained for several minutes to prevent pressure rebound. The initial setting reaction occurs about 5 to 9 minutes after mixing. The excess should not be removed for at least several minutes after the initial hardening to reduce the risk of saliva contact as zinc phosphate is very soluble in the initial setting stage.[1]

Table 1[8]: compares the properties of various luting cements currently available.

	Setting time (min)	Strength (MPa)		Solubility (weight % at 24 hrs)	Modulus of elasticity (GPa)	Bond to tooth	Excess removal	Frelease
		compressive	tensile					
Zinc phosphate	5-9	96-133	3.1-4.5	0.2 max	13	no	easy	-
Zinc polycarboxylate	7-9	57-99	3.6-6.3	0.06	5-6	some	some	-
Glass-ionomer	6-8	93-226	4.2-5.3	1	7-8	chemical	fair	+
Resin-modified glass-ionomer	5-6	85-126	13-24	0.4-0.7	2.5-7.8	chemical	difficult	+
Resin	4+	180-265	34-37	0.05	4-6	micro-mechanical	very difficult	-
Adhesive resin	-	52-224	37-41	-	1.2-10.7	micro-mechanical	very difficult	-

Zinc polycarboxylate

Zinc polycarboxylate was developed by DC Smith in 1968. It was the first dental cement that adhered mechanically to the tooth structure and was widely recommended.[2,11] The powder is zinc oxide like to zinc phosphate cement and the liquid is polyalkenoic acid.[11] 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. Viscosity is inversely proportional to the rate of mixing. The setting time is about 7 minutes.[1,2,8] Premeasured and encapsulated ready for mixing are also commercially available. 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. Early compressive strength is lower and tensile strength is higher than zinc phosphate.[8] Zinc polycarboxylate may undergo considerable plastic deformation under masticatory forces hence its use is limited to short span fixed partial dentures. It also has relatively low resistance to erosion in an acidic environment.[1,2,8]

Zinc oxide eugenol

Zinc oxide eugenol (ZOE) is a provisional luting cement that reacts via a complex acid-base type reaction with the help of an accelerator. Exposure to water reduces the working time of the cement.[2,11] ZOE is commonly dispensed as two pastes and equal parts of the pastes are mixed until uniform in colour. ZOE has good sealing ability but poor physical properties hence, it is used for luting temporary restorations. To improve the properties of ZOE cement, 2-ethoxybenzoic acid (EBA) modified ZOE cement was introduced. ZOE is not a material of choice for definitive restoration owing to its brittleness and high solubility.[1,8,11]

Glass-ionomer cement

Glass-ionomer cement, originally known as ASPA (aluminosilicatepolyacrylic acid) was introduced in 1969 by Wilson and Kent. It has many desirable properties like ease of mixing, good flow, adhesion to tooth structure and base metals, fluoride release and recharge, good esthetics, adequate strength, and relatively low cost.[1,2,14] A fluoride containing aluminosilicate glass reacts via an acid-base reaction with polyalkenoic acids to form a hydrogel matrix. It undergoes an initial rapid setting reaction followed by several stages of maturation which may take up to several months to reach completion.[11] Hence, the restoration has to be seated before the cement loses its gloss. It is not recommended for luting posts because vibration from tooth preparation may reduce the retention provided by the cement. Premeasured capsules are available to reduce discrepancy in the physical properties due to altered powder/liquid ratio. 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.[1,2,15] Sensitivity after placement can be avoided by maintaining the smear layer, preventing dehydration of the cement or by using a dentine sealer.[1,2,13,16]

Contemporary luting agents

Resin-modified glass-ionomer cement

Resin-modified glass-ionomer 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.[1,2,11] RMGI is less susceptible to early erosion during setting, less soluble, and has higher compressive and tensile strengths than unmodified glass-ionomer luting cement. Film thickness and adhesion to tooth structure are similar[17] Because of the possibility of hygroscopic expansion, these cements are not recommended for luting all-ceramic restorations that are susceptible to etching or posts.[15] The cement should be mixed according to the manufacturer's instructions on a glass slab or mixing pad and the restoration should be seated with firm finger pressure while the material still has its glossy appearance. Soon after the snap set the excess material should be removed carefully or removal can be extremely difficult.[18] The tooth should be well isolated and the material kept dry for 7 to 10 minutes to minimize loss of cement at the margins due to its early solubility.[2,15]

Compomers

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, and appeared in the late 1990s. Compomers are anhydrous resins that contain ion-leachable 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.[1,2,15,19,20]

Resins

Methyl methyacrylate based resin of the 1950s did not adhere to tooth, underwent polymerization shrinkage, had a high coefficient of thermal expansion, underwent microleakage, and excess removal was difficult.[21] Today resin cements are a popular choice due to their high compressive and tensile strengths, low solubility and aesthetic qualities. They do have limitations like technique sensitivity and high cost.[2] Newer resins claim to be anticariogenic like GIC but how relevant is this property is still a question of debate.[22] 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.[23,24] 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.[25] Many shades of resins are available in the market to suit the need of the clinician. Dual-cure resins may discolour with time due to their aromatic amine content.[24] Multiple studies vouch for the fracture resistance and sealing of resins.[26] Over etching should be avoided as it reduces bond strength.[27] Excess removal is usually done after 2 to 5 seconds of light cure and final curing is done after that. Creating a gap or void should be avoided. More cement exposure may be seen with all-ceramic restorations hence either dual- or self-curing resin cements are preferred. Auto-curing self-adhesive, automixed or pre-encapsulated, resin luting agents may be useful for metal or metal ceramic restorations. If adequate preparation and resistance form exists or where moisture control and clean-up access may be problems, more conventional luting agents (glass-ionomer, resinmodified glass-ionomer or zinc phosphate) are often a better choice. Three-step etch and rinse or two-step self-etch resin bonding systems are preferred for posts.[23] Zinc phosphate may be a better choice for luting of a cast metal post or titanium post due to its longer working time, rigidity and extremely high early strength.[1,2,12] Dual-affinity adhesive resins have very high tensile strengths and bond to etched enamel and metal and noble metal alloys.[28,29] These materials are technique sensitive and manufacturer's instructions should be followed for attaining best results. 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.[13]

Conclusion

The pros and cons of the various luting cements have been discussed, and it can be safely concluded that no one material is perfect. 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 plethora 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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