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REVIEW ARTICLE

LUTING AGENTS USED IN DENTISTRY: A REVIEW OF LITERATURE

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ABSTRACT:
Due to the availability of a large number of luting agents proper selection can be a difficult task and is usually based on a practitioner's reliance on experience and preference and less on in depth knowledge of materials that are used for the restoration and luting agent properties. 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. 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.
Key word: GIC, Luting agent, Zinc oxide.

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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] The number of materials available for restoring teeth has increased enormously over recent decades. A dental cement 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 expected longevity of the restoration, a luting agent may be considered to be definitive (long term) or provisional (short term)[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. One hundred years ago this decision was easy with the availability of essentially only one luting agent, zinc phosphate cement. Currently, a plethora of luting agents is available.[4] Now the choice of the optimal luting agent can be confusing, even for the most experienced clinician. Restorations of metal, porcelain fused to metal, low- and high-strength ceramics, full or partial coverage, require a prudent approach and the proper cement selection should be based on knowledge of physical properties, biological properties and other attributes of both restorative materials and luting agents.

QUALITIES OF IDEAL CEMENT[5,6]

1. It should have very low resolution ratios within the liquids inside the mouth.
2. It should be well adapted to living dental tissues, it should contain no pulp irritating toxic material and it should further have anticariogenic qualities.
3. In order to reach the smallest details between restoration and tooth, it should possess low viscosity and film thickness.
4. It should have sufficient light transparency.

5. It should be resistant against mastication forces and pulling forces formed through the effect of gummy foods.
6. It should provide sufficient heat insulation to protect living tooth from thermal effects.
7. It should be able to bond to hard dental tissues.
8. It should have a long shelf-life.
9. It should give sufficient working time and be easy to manipulate.

CLASSIFICATION

Various classifications given by different authors are as follows:

1. **Based on knowledge and experience of use (Donovan)[7]:**
   a. Conventional (zinc phosphate, polycarboxylate, glass- ionomer)
   b. Contemporary (resin-modified glass-ionomers, resin)

2. **Based on the chief ingredients (Craig)[8]:**
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)[9]:**
a. Phosphate,
b. Phenolate,
c. Polycarboxylate,
d. Resin,
e. Resin-modified glass-ionomer.

4. **Based on the principal setting reaction (Wilson)[10]:**
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 in use for long 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 sometimes zinc phosphate. The water content is approximately 33±5% and is an important factor as it controls the rate and type of powder/liquid reaction.[11] 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. 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.[12]

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 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.[13]

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.[14] 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.[15]

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.[16] 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.[17]

GICs set bymeans of chelation as a result of an acid-base 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.[18]

Resin-modified glass-ionomer cement (RMGI)

They are essentially hybrid formulations of resin and glass ionomer components. 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.[19] 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. 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. 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. In general few complaints have been reported about postoperative cementation hypersensitivity.[20] Yet, RMGIs are in the category of resin cements and water sorption and degradation through hydrolysis are negative features that should not be ignored or underestimated.

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[21]. 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.[22]

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 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[23]. 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.[24] 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. 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.[25]

Adhesive Resin Cements

Today many 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 early 1980s, conventional Bis-GMA resin cement was modified by adding a phosphate ester to the monomer component, introducing to dentistry a unique 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 first 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.[26]

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

PROPERTIES OF VARIOUS LUTING AGENTS[27]

Luting agent	Setting time	Strength (MPa)		Solubility	Modulus of elasticity	Bond to tooth
		compressive	Tensile			
Zinc phosphate	5-9	96-133	3.1-4.5	0.2	13	No
Zinc polycarboxylate	7-9	57-99	3.6-6.3	0.06	5-6	some
Glass-ionomer cement	6-8	93-226	4.2-5.3	1	7-8	Chemical
Resin modified Glass-ionomer	5-6	85-126	13-24	0.4-0.7	2.5-7.8	Chemical
Resin	4+	180-265	34-37	0.05	4-6	Mico-mechanical
Adhesive resin	-	52-224	37-41	-	1.2-10.7	Mico-mechanical

CONCLUSION

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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