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Ideal Direct Posterior Restoration: Yellow / Black / White - A Review

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Abstract: ***The quest to search an ideal direct posterior restorative material has been a challenge for researchers and fraternities in Restorative Dentistry. At one point, gold alloy and pure gold were considered to be the ideal in direct*** **and indir*****ect posterior restorations and over time it was replaced due to its cost factor by other successors. Silver Amalgam has been the traditional material for filling cavities in posterior teeth for the last 150 years and due to its effectiveness and cost, amalgam is still the material of choice in dentistry. As tooth-coloured direct resin-based composite restorations and glass ionomer restorations have become popular with the lay public, clinicians rarely offer gold restorations as an option to patients. The simple fact that tooth-coloured restorations offer better aesthetic results seems to imply that they are superior in other aspects such as strength, wear and longevity. This misconception has led to abuse of the currently available aesthetic materials, cessation of proven techniques of cavity preparation and general ignorance of the shortcomings of the new and reportedly improved direct posterior restorations. The purpose of this article is to discuss about the most popular direct posterior restoratives – Direct Filling Gold, Silver Amalgam, Glass ionomer cement and Resin-based Composites – and provide direction on how they are best used within current limitations.***

Keywords: Posterior dental restorations, Direct filling gold, Dental Amalgam, Resin composites, GIC

Introduction

Dental restorations are the well-known mode of treatment for dental caries. Restorations have limited clinical durability with the chance of increased loss of tooth structure and leading to more complex cavity extension for prevention and reduced tooth strength[2]. As the cavity size increases, the range of restorative materials to effectively restore and placing a more economical direct restorative material with the idea of conservation of tooth structure is lost. Where active dental caries is evident, proper diagnosis, treatment plan along with the prudent choice of materials are imperative[4]. Several factors to be considered to the placement of a restoration includes extent of caries, strength of remaining tooth structure, characteristics of the patient's dentition and periodontal health, oral hygiene and dental caries history, risks and benefits of the procedure to the patient, skill and preferences of the dentist and the prevailing standard of care, acceptance and affordability by the patient[3.] For teeth that are to be restored, the decision concerning which procedure and material to use is traditionally one in which patients have been involved less fully. It should be ultimately the dentist choice based on the clinical requirements and various other influencing factors on restoration longevity. FIG 1 summarizes the various influencing factors on the success of a posterior restoration[1].

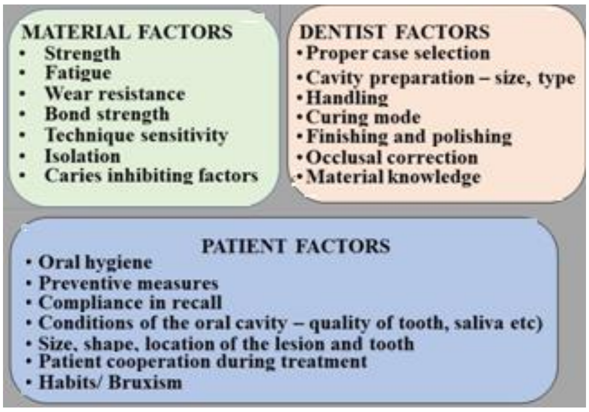

Figure 1: Factors Influencing Dental Restorations' Longevity

Properties of Ideal Direct Posterior Restorations

The ideal posterior restorative material should exhibit certain important features.

Physical/Mechanical Properties

- Stability in the acid/base oral fluids
- Low thermal conductivity, as similar to the tooth substance as possible
- Ability to resist permanent deformation or fracture under the forces of mastication
- Ability to achieve and maintain a highly polished or homogeneous surface
- Tooth-colored
- Resistance to fracture and marginal breakdown
- Wear rate similar to enamel
- Resistance to corrosion
- Adhesive to or chemically bonded to the tooth structure
- Capability to adapt well to the cavity walls, if not an adhesive material
- Nonconductive of electrical currents in the oral cavity
- Not sensitive to moisture contamination during placement

- Minimal thermal and dimensional changes during setting and at the "set" phase.

Technical Features for the Provider

- Easy to manipulate, place, and shape
- Safe to handle
- Requires minimal preparation of the tooth for placement
- Able to be repaired in the mouth
- When warranted, easy to diagnose the need for replacement, and then easy to replace or repair
- Relatively insensitive to the technique of the provider.

Patient Acceptability

- Reasonable cost to the patient
- Functional
- Long-lasting (ideally, a lifetime)
- Esthetic
- Safe.

Clinical Aspects

- Biocompatible with oral tissues and normal metabolic and physiological processes
- Anticariogenic
- Not disposed to the accumulation of dental plaque
- Long-lasting (e.g., 95 percent survive at least 10 years)
- Able to determine when replacement is necessary based on recognizable clinical measurements such as clinical examination and/or X-ray

Dental Materials for Restoring Posterior Teeth

The restorative materials available for posterior restorations are described briefly below and summarized according to their relative advantages, disadvantages, clinical indications, and contraindications. Table 1 provides a quick summary of the most frequently used materials for restoring posterior teeth[1,4].

Table 1: Properties of Frequently Used Materials in Direct Posterior Restoration

Critical Parameters	Amalgam	Composite	GIC	Gold Foil
Median Longevity Estimate[1]	8-12 years	6-8 years	No data:[1] 5 years predicted	No data: 10-15 years estimated
Relative Surface Wear	Wears slightly faster than enamel	Excessive wear in stress-bearing situations	Excessive wear in stress-bearing situations	Excessive wear in stress-bearing situations
Resistance to Fracture	Fair to excellent	Poor to excellent	Poor	Fair to good
Marginal Integrity (leakage)	Fair to excellent. Self-sealing through corrosion products	Poor to excellent. Polymerization shrinkage can cause poor margins	Poor to excellent	Poor to excellent
Conservation of Tooth Structure	Good	Excellent	Excellent if initial restoration, not if replacement	Good
Esthetics	Poor	Excellent	Good	Poor
Indications:	All ages	All ages	All ages	Adult
Age range	Moderate stress	Low-stress-bearing	Adult-Class V and low-stress primary teeth	Class III and V and crown repair
Occlusal stress			Class I and II child	Incipient to moderate size cavity
	Incipient to moderate size cavity	Incipient to moderate size cavity	Incipient to moderate size cavity	
Extent of caries				
Cost to Patient[2]	1X	1.5X	1.4X	4X

1) Direct Filling Gold

For centuries, gold foil has been applied to various surfaces for ornamentation or utility. Early use of foil also included adaptation to teeth where defects existed. With time, as new instruments became available and better skills were developed, more and more uses were found for this material in dentistry. Ironically, gold alloy and pure gold restorations are often found to be the oldest and least carious in the oral cavity. Newer forms of the gold appeared and made easier the meticulous task of condensation, first with powdered gold (Baum, 1965), then with other forms of electrolytic-formed gold (mat gold)[5].

Properly placed, direct-filling gold restorations are excellent replacements and can be expected to last for 20 years or more. Their clinical indications, however, are limited. Most frequently, they are placed into small cavities in nonstress-bearing situations, or to repair defective margins of cast gold inlays, onlays, and crowns. Large restorations of foil are difficult to place. In addition, pure gold is too soft and ductile to withstand the forces that are exerted on most posterior restorations. Furthermore, larger restorations in the anterior of the mouth are not esthetic.

The major difficulties with direct gold restorations are the technique sensitivity of placement, the skill and meticulous attention required of the dentist, the potential damage to the pulp and/or periodontal tissues because of trauma during placement, and the overall cost to the patient in time and money.

In spite of many favourable properties, the placement of gold foil restorations is at decline, both in the university -based practice and in private practice. In India, it is almost none. Gerald .D. Stibbs (1987) critically evaluated the reasons for this decline. The reasons stated are:

1) Lack of emphasis of direct gold restoration in dental curriculum.
2) Lack of trained staff in direct gold restorations.
3) Change in overall attitude to settle for less than the best restoration.

He further states that the same decline in private practice is because of the change in the current philosophy of practice. The olden days practice was based on more value- based treatment with the concept of "need based practice" as the pivotal point[6].

Although many dentists still believe that this material should continue to be placed and that the technique should be taught, the use of gold foil is limited and diminishing. Its use is declining primarily because of the high cost associated with this technique, the limited number of applications for its use, and the availability of acceptable alternative materials, primarily composite, glass ionomer, or amalgam.

2) Silver Amalgam

Dentists have more than a century of experience using amalgam as a direct filling material. Amalgam is strong and durable enough to withstand the pressures of chewing; it is relatively inexpensive and easy to place; and it has properties that may help prevent recurrent caries (Phillips, 1984; 0rstavik, 1985). Dental amalgam is widely considered to be unaesthetic, however, and questions regarding its safety have been raised virtually from the time of its first use[8]. Although amalgam has a range of defined optimal uses, its low cost to patients, ease of manipulation and durability allow it to be used in areas where a stronger or more esthetic material ideally would be placed. Incipient caries lesions are restored with amalgam when a preventive resin and sealant would conserve tooth structure and function[7].

Dental amalgam is this the end?

The classic Norway Study followed 27 dentists in Norway by looking at all of their class II restorations (4030 in total), for over 4 years. 13 amalgams failed = 7.1% of the amalgams placed (lower than composite failure rate). The mean annual failure rate for Amalgam (1.6%).According to Soares et al (2010) stated in his review on Amalgam and Composite Longevity of Posterior Restorations, the mean survival time for amalgam restorations was 22.5 years[1].In 1997, the World Health Organization (WHO) issued a consensus statement on dental amalgam, which stated, "No controlled studies have been published demonstrating systemic adverse effects from amalgam restorations[11]. In May 2008, the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR)- dental amalgam is an effective restorative material safe, both for patients and dental personnel. SCENIHR state that the half-life of mercury in the body is only "20-90 days"[12].SCENIHR disregarded the toxicology of mercury and did not include most important scientific studies in their review[7]. Most studies cited by SCENIHR which conclude that amalgam fillings are safe and have no severe methodical flaws. Amalgam is a versatile material that needs years to be eradicated completely from the world of dentistry.

3) Glass Ionomer Cement

It was developed by Wilson & Kent in1971. The mechanism is based on the reaction of silicate glass powder with polyalkenoic acid in the presence of water and referred as Polyalkeonate cement. It involves ionic bonds and consist of aqueous polymeric acids such as Polyacrylic acid, plus basic glass powder such as Calciumaluminosilicate. GIC sets by a neutralization reaction of Aluminosilicate which is chelated with Carboxylate groups to cross link the polyacids. A substantial amount of glass remains unreacted & acts as reinforcing fillers. For a few important reasons, glass ionomers recently have gained wider acceptance as a restorative material for defined situations. They bond chemically to tooth structure and release fluoride. Patient response to glass ionomers is usually excellent because the placement technique can be extremely conservative and requires little, if any, drilling (Hunt 1990); the procedure is usually quick and painless and often does not require local anesthesia; and the resulting restoration is fairly esthetic[17].

The original glass ionomers had a number of clinical drawbacks that limited their acceptance. Clinical failings were related to manipulation, setting sequence, early moisture sensitivity, esthetics, and surface texture. Consequently, glass ionomer, as restorative materials, did not gain the acceptance of dentists to the same extent as Composites which proved to have a competitive edge over glass ionomers as restorative materials because of their higher strength. Development in the formulation of glass ionomers have made them useful as a cavity-lining material and for cementation and preventive applications, as well as for their original intended use as a direct filling material. As a filling material, glass ionomers are perhaps best used in restoring deciduous teeth and in Class V restorations involving gingival erosion and abrasion defects in adults. The use of glass ionomer may play an increasingly important role in the growing geriatric population which is retaining their teeth longer, but facing a concomitant increased risk of root caries. While glass ionomer appears to be satisfactory in many anterior applications and primary teeth, their use continues to be limited in permanent posterior teeth, particularly with stress-bearing restorations. Limitations include low tensile strength, low impact and fracture resistance (brittleness), and degradation[16].

Glass ionomers are not recommended for restorations where toughness and resistance to wear are major considerations (Sulong and Aziz, 1990). It has been recognized, generally, that the wear resistance of glass ionomer is inadequate in areas of occlusal contact. Clinical studies have shown that a gradual loss of contour can be expected because of chemical degradation and surface wear (McLean, 1980). One study of a glass ionomer product, using a commercial composite resin as a control, reported that the glass ionomer abraded about three times more rapidly, by volume, than the composite[17] (Smales and Joyce, 1978).In the early to mid-1980's, it was found that the introduction of metal fibers or powder in the glass ionomer system (glass-cermet cements) significantly improved abrasion resistance (McLean, 1984). The addition of silver alloy powder to glass ionomer, in particular, resulted in a number of improvements in its physical properties (Simmons, 1990). The silver cermet material has a light gray color, which is no more unaesthetic than silver amalgam, but it has a major disadvantage in that it has a low fracture toughness, making it of limited value in regions subjected to the stresses of mastication (Croll, 1990; McLean and Gasser, 1985)[17].

Glass ionomers, including cements, are technique sensitive (Knibb and Plant, 1989; Mount, 1990b; Smales et al., 1990; Smales and Gerke, 1990; Watson, 1990). The setting reaction and maturation of glass ionomer restorations are relatively slow. Even with the most skilful placement technique, however, the success of a glass ionomer restoration may hinge on the composition of commercial glass ionomer materials, which may vary widely from manufacturer to manufacturer (Smith, 1990).Although glass ionomers exhibit significantly less polymerization shrinkage than composites, some curing contraction generally occurs, leading to the formation of marginal gaps (Feilzer et al., 1988; Saunders et al., 1990). Marginal leakage associated with glass ionomer can be reduced still further if the restoration is covered with a thin layer of posterior composite resin[17] (Guelmann et al., 1989).

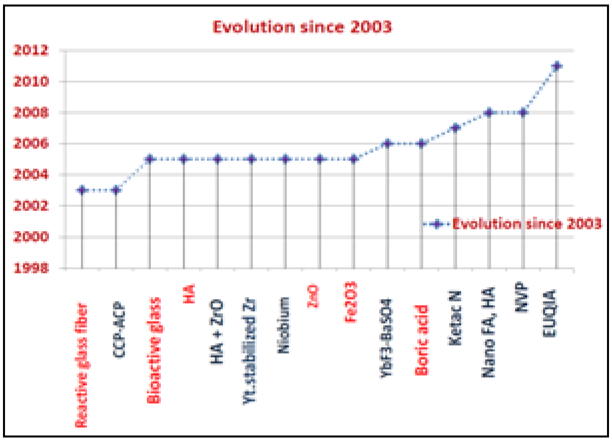

Figure 2: Evolution of Glass Ionomer Cements

Clinical experience has defined the practical advantages and disadvantages of glass ionomer cement system. This has led to improved formulations and more controlled techniques. Since it is difficult to produce an ideal material, but with the current level of intensive research on glass ionomer cements, the deficiencies that exist can be eliminated, or reduced, resulting in an ever – improving, biocompatible materials of this type.

4) Resin Composites

The advances in the restorative materials and bonding techniques have changed the concept of "EXTENSION FOR PREVENTION" as "*Restriction with Conviction*" The advent of composite resin restorative materials has led the way towards achieving this goal[8]. Of all the innovative aesthetic materials available today composite restorative materials have assumed a thrust in restorative dentistry. An era in dental restorative materials began in 1955, when Buonocore found that acrylic resin formed acceptable micromechanical adhesion with dry enamel that had been etched with phosphoric acid[21]. Many generations of restorative materials have existed in the last five decades, and the modern clinician may be overwhelmed when attempting to make decisions as which material or technique must be most appropriate in varying clinical situations[12].

Dental composite is defined as a "Highly cross-linked polymeric material reinforced by a dispersion of amorphous silica, glass, crystalline, or Organic resin filler particles or short fibres bonded to the matrix by a Coupling agent."These materials have been the focus of a great deal of research in recent years with the goal of improving restoration performance by changing the initiation system, monomers, fillers, coupling agents, and by developing novel polymerization strategies.

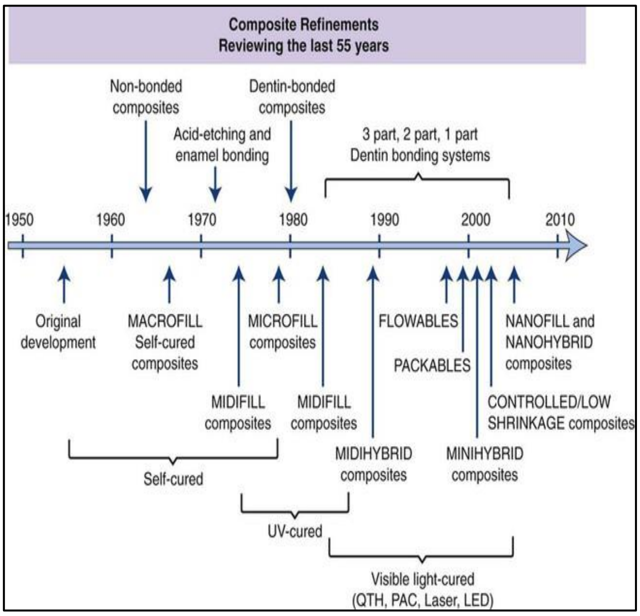

Figure 3: Evolution of Dental Composites

Dental composites are among the synthetic resins used as adhesives or restorative material in dentistry and now represent general alternation to dental amalgam. However, composites have limited uses because of low durability and strength[18].Longevity and survival studies in posterior teeth continue to show that amalgam has better track record than composites. Many attempts have been undertaken to improve the clinical performance of dental resin composites since their development[19].Norway Study followed 27 dentists in Norway – looking at all of their class II restorations (4030 in total), for over 4 years. Mean annual fail rate for: Amalgam (1.6%) & resin composite (2.9%).Correctly performed amalgam restorations in posterior teeth have higher longevity than resin composites. These differences are more pronounced when: -The cavity is larger & -There are multiple surfaces involved[21]. Annual failure rates in posterior stress-bearing restorations are: 0% to 7% for amalgam restorations 0% to 9% for direct a composite which makes to think seriously about the age old techniques and materials.

Contemporary composite materials are being constantly upgraded and have significantly improved physical and mechanical characteristics in comparison with previous generations, especially concerning the hardness, firmness, elasticity, resistance to bending, breaking, torsion and wear. However, since cross linking in net formation during polymerization leads to volumetric shrinkage and, consequently, polymerization stress that can affect the creation of a marginal gap and also compromise the longevity of the restoration, stress compensation represents the biggest scientific and clinical challenge[20].

Conclusion

The word "ideal" and "gold standard" are used in recent days to justify why a dentist should buy another "new and improved" product. However, none of the material has all the ideal characteristics. Providing patients with adequate informed consent for the treatment choice, materials, benefits, risks and limitations is not only ethical, but also realistic and mandatory. Exciting new products will continue to inundate the profession in future with claims of being superior. Providing patients with the most recent material is not a high-revenue procedure for most dentists, yet it is imperative that we improve our techniques to compensate for the limitations of the products until the ideal direct restorative material is introduced. With millions of restorations performed each year, continuing research into practical advances and successful clinical implementation of the restoratives are both critical to oral care, aesthetics, and function.

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