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Factors that influence the clinical application of composite resins: Literature review

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Abstract
Introduction: The importance of this research lies in providing the professionals with the bases they can consider when selecting the composite based on the therapeutic requirements.
Objective: Analyze the factors that influence the clinical application of resins. Among them: are the material, photopolymerization, placement technique, color stability, and preheating.
Methodology: A compilation of articles published in the last 5 years was carried out using PubMed's electronic database. Summaries and full texts were identified that included information on factors that influence the resin application: “material”, “light”, “curing”, “placement”, “techniques”, “color” and “preheating”.
Results: Knowledge of the material allows its proper application and greater longevity. Insufficient polymerization causes a decrease in physical and mechanical properties. The block technique is faster and there is adequate light curing. Extrinsic and intrinsic factors must be considered in their placement since these will determine the success or failure of mimicry. Preheating reduces its viscosity, due to better wetting of the cavity walls, increasing marginal adaptation, and decreasing micro-leakage.
Conclusions: There is a need for minimally invasive treatments such as the use of resins which provide advantages such as aesthetics, excellent surface finish, and resistance to wear, therefore it is necessary to know the factors that help us promote their manipulation, such as; the material it is composed of, its polymerization, its placement technique, its color, and preheating.

Keywords: Material, light, curing, placement, techniques, color, preheating

Introduction

Currently, the most common dental problem is dental caries. For its treatment, the decayed dental tissue is removed and the cavity is filled with restoration materials [1]. Currently, resins are good restoration materials due to their physical, mechanical, thermal, and tribological [2].

Resin-based composites have been used in the oral cavity since their introduction in the 1950s [3]. The growing demand for tooth-colored, mercury-free aesthetic restorations has driven an increase in the use of resin-based composite dental materials 1, which have been improving at an accelerated rate [4].

Composite resins constitute a group of materials that allow the conservation of healthy dental tissue and are easy to handle [1] for the reduction of microleakage [5], prevention of postoperative sensitivity [6], reinforcement of the tooth structure, and the transmission/distribution of masticatory forces through the adhesive interface of the tooth [7].

Although they are one of the most used materials today, one of the most common problems with them is poor adaptation [5], and the formation of spaces between the restorative material and the dental structure [8], which generates some problems, such as microleakage of oral fluids, postoperative sensitivity, and recurrent caries [9]. This may be due mainly to factors specific to its material, photopolymerization, placement technique [6], color stability, and preheating [8].

One of the most used aesthetic restoration materials today is light-polymerizable resin composites due to their easy handling and high aesthetic grade, which is why it is necessary for the dentist to know all the bases that can provide the criteria to consider. To select a resin based on therapeutic requirements.

Therefore, this article analyzes the literature on the factors that influence the clinical application of resins. These include the material itself, photopolymerization, placement technique, color stability, and preheating.

Methodology

A compilation of articles published in the last 5 years (2018-2022) was carried out using the electronic database PubMed. Abstracts and full texts were identified that included information on factors that affect resin application: material, polymerization, placement technique, color stability, and preheating. The implementation of the search using AND, OR, and NOT operators. Within the keywords used for the search “resin”, “material”, “light curing”, “techniques”, “color”, and “preheating”.

Results

Material: Clinical behavior depends on the structure of the material [2]. Dental composites are composed of three chemically different materials: the organic matrix or organic phase which is composed of the Bis-GMA/TEGDMA monomer [5] or the Bis-GMA association [10]; the inorganic matrix, filler material or dispersed phase [11] in which silicon dioxide stands out, as well as lithium borosilicates and aluminosilicates. Currently, materials are being sought, such as calcium metaphosphate, that have a lower hardness than glass so that they are less abrasive to the opposing tooth [12]; and lastly, an organo-silane or binding agent between the organic resin and the filler whose molecule has silane groups at one end (binding ionic with SiO2) [13] and methacrylate groups at the other end (covalent bond with the resin) [5].

Knowledge of the material that makes up the composite resins allows us to have an adequate placement of the resins, since with this we have knowledge of the passage of light, the changes in the inorganic phase, and how all its components influence the adaptation marginal.

Polymerization

Photopolymerization is a method that allows the transformation of a liquid polymerizable composition into a solid through its exposure to electromagnetic radiation most often UV [14]. Quartz Tungsten Halogen (QTH) lights [15] and light-emitting diodes (LEDs) are the most used light sources in dentistry [16]. A minimum intensity (400 mW /cm^2) in the appropriate spectral distribution is needed for complete polymerization of the photopolymerizable resin composite [17]. Adequate photopolymerization of composite resins is essential to achieve mechanical properties [18] and optimal optics [19]. For sufficient polymerization[3], essential conditions for the light source are required: appropriate wavelength range of the light, adequate light output, and curing time [17].

Insufficient polymerization can lead to a decrease in the physical and mechanical properties of the composite resins, causing future failure in the restoration, producing in turn a contraction of the polymerization, thus affecting the marginal adaptation.

Placement technique

There are two resin placement techniques, one is incremental and the other is block [20]. Incremental layering allows placement of composite resin in increments of up to 2 mm horizontally, vertically, and obliquely [21], ensuring adequate curing of the composite resin [22]. This is used to reduce polymerization shrinkage stress [23]. The block-filling technique allows the clinician to place restorations up to 4 mm thick [6] without negatively affecting the adaptation of the cavity, the contraction, and the efficiency of polymerization [5], this allows for shortening the clinical procedure and facilitating management [1].

The incremental technique requires more time, especially in deep cavities, and can cause air to become trapped between layers. In addition, the depth of the photocuring is not wide. However, the block technique is faster and there is adequate polymerization.

Color stability

The color stability of the composite resin can occur due to intrinsic or extrinsic factors [24]. Among the intrinsic factors, we can point out the restoration's color change due to the oxidation of tertiary amines, the polymer matrix, or the oxidation of residual methacrylate groups [25]. These factors depend on the formulation and light activation quality of the resin-based material. The organic matrix content is also related to the possibility of staining [24] and Bis-EMA (bisphenol A polyethylene glycol dimethacrylate) tends to react less favorably to pigment incorporation than UDMA (urethane dimethacrylate) and Bis-GMA (bisphenol-A glycidyl methacrylate) [10], which have a greater water absorption capacity because they are hydrophilic. The inorganic filler content may be influenced since the possible spaces between the filler particles favor the deposition of pigment [11]. Causes related to extrinsic factors include color change due to the adsorption of dyes [26] as a result of contact with exogenous sources, such as an individual's diet [27] or drinks with coloring [28].

Intrinsic factors are always linked to the material's own knowledge, while extrinsic factors are generally combined with factors other than the material; knowledge of both would anticipate a future color change in our restorations.

Preheating

Preheating the composite resin decreases its viscosity [8] and thickness [29], increasing its fluidity and adaptation with the cavity walls [30]. Furthermore, this technique increases the polymerization speed and microhardness of the composite resin [31], improving its physical-mechanical properties [32], which increases the durability of the restoration [33]. The effect of heat, due to a preheated composite resin, on the increase in pulp temperature is minimal [9]. The polymerization rate of the composite resin could increase the polymerization shrinkage and the resulting stress [8].

Preheating composite resins before light activation reduces their viscosity, thanks to better wetting of the cavity walls, increases marginal adaptation, and decreases microleakage.

Conclusion

Currently, dentistry has taken giant steps in the development of restorative materials. Every day there is a need to propose innovative and minimally invasive treatments such as the use of composite resins that provide advantages such as high-quality aesthetics, excellent surface finish, and wear resistance, which is why it is necessary that all those factors are known. That help us promote their proper handling, such as; the material they are composed of, their polymerization, their placement technique, their color and their preheating.

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