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Aesthetic-chemical properties and clinical indications of giomers: literature review

Propriedades estético-químicas e indicações clínicas dos giômeros: revisão de literatura

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ABSTRACT

Giomer is a hybrid restorative material, developed in the 2000s, which presents a combination of characteristics and properties of both composite resin and ionomeric cement, but whose clinical indications are still unclear. The present review aims to evaluate the literature that addresses these indications, as well as the aesthetic and chemical properties, compared to traditional non-hybrid restorative materials. The bibliographic search was carried out in PubMed, LILACS and SciELO databases, from 2016 to 2022. It included articles published in English, Portuguese and Spanish, and used strategies adapted to each database and descriptors compatible with the objective. Publications whose full versions were duplicated and/or unavailable for free access were excluded. From an initial total of 137 articles, 14 were selected. It was observed that there are still doubts about the amount of fluoride released over the time and about the possibility of a burst effect, which means the initial explosion effect that occurs in the first 24 hours and decreases with time, similar to what occurs with glass ionomer cement and does not with conventional resins. In the light of the consulted literature, it is possible to conclude that giomers, as well as composite resins, can be widely indicated for restorative procedures, as they have satisfactory resistance and aesthetics, in addition to releasing enough fluoride to prevent caries, making it possible to recharge them with this ion, as in glass ionomer cements.

Keywords: Dentistry. Esthetics. Materials.

RESUMO

O giômero é um material restaurador híbrido, desenvolvido nos anos 2000, que apresenta uma combinação de características e propriedades, tanto da resina composta, quanto do cimento ionomérico, mas cujas indicações clínicas ainda não estão claras. A presente revisão tem como objetivo avaliar a literatura que aborda essas indicações, bem como as propriedades estéticas e químicas, comparativamente aos materiais restauradores tradicionais não híbridos. A busca bibliográfica foi realizada nas bases de dados PubMed, LILACS e SciELO, de 2016 a 2022. Ela incluiu artigos publicados em inglês, português e espanhol, e utilizou estratégias adaptadas a cada base e descritores compatíveis com o objetivo. Foram excluídas as publicações cujas versões completas estivessem duplicadas e/ou indisponíveis para acesso gratuito. De um total inicial de 137 artigos, foram selecionados 14. Observou-se que ainda existem dúvidas sobre a quantidade de flúor liberada ao longo do tempo e quanto à possibilidade de efeito *burst*, ou seja, o efeito de explosão inicial que acontece nas primeiras 24 horas e diminui com o tempo, semelhante ao que ocorre no cimento de ionômero de vidro e não acontece nas resinas convencionais. À luz da literatura consultada, é possível concluir que os giômeros, assim como as resinas compostas, podem ser amplamente indicados para procedimentos restauradores, por possuírem resistência e estética satisfatórias, além de liberarem quantidade de flúor suficiente para prevenção da doença cárie, sendo possível recarregá-los deste íon, como ocorre nos cimentos de ionômero de vidro.

Palavras-chave: Estética. Materiais. Odontologia.

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INTRODUCTION

Currently, in Dentistry, composite resins are widely used in direct restorations, as they offer a good aesthetic result and allow more conservative approach. In addition, they present satisfactory marginal integrity, resistance similar to the tooth structure, besides a fast and low-cost treatment, compared to indirect restorations (Rusnac et al., 2019).

In contrast, the glass ionomer cement (GIC) has a striking feature: its ability to release fluoride (Bollu et al., 2016). Fluoride ion is known to prevent demineralization and increase remineralization of tooth enamel, thus hindering caries formation. Fluoride also acts by inhibiting the metabolism of *Streptococcus mutans and Streptococcus sobrinus* bacteria, species involved in the etiology of the disease (Rusnac et al., 2019). GICs also exhibit the "burst" effect, which is the release of a large amount of fluoride in the first 24 hours (Kelić, P ar, Peroš, Šutej, & Tarle, 2020). Despite these qualities, the ionomer has low wear resistance (Spajic et al. 2019), and less satisfactory aesthetics when compared to composite resins (Rusnac et al., 2019).

For the purpose of combine the aesthetic and physical properties of composite resin with the benefits of glass ionomer, the japanese company SHOFU launched, in 2000, the giomers. They are a new class of hybrid materials, in which the pre-reacted glass ionomer is immersed in a resin matrix (Burtea et al., 2019; Rusnac et al., 2019).

The giomers present, in their storage, fluoroaluminosilicate, a filler endowed with reactive charges that are normally activated by acids. They also have the "Surface Pre-reacted Glass Ionomer" (S-PRG) technology, as they present the surface in a situation of previous partial reaction and also already treated with silane, in addition to a non-reactive filler and a mixture of monomers and camphorquinone in its composition. When in contact with the oral environment, this material sorbs water, and S-PRG fillers are capable of releasing ions such as calcium, fluorine and aluminum, as well as strontium borate and silicate. This water absorption happens at the periphery of the material. This system presents itself more reactive than conventional FAS filling of other materials; therefore, there is no need for an acid to cause the ionic release activation, unlike the compomers (Francois, Fouquet, Attal, & Dursun, 2020). The material is a hybridization of two well-established materials, which behaves mainly like composite resins, characteristics that raise doubts if the SPR-G incorporation really makes a significant difference in this material or if it is just a modified version of elements that already exist (Condò et al., 2017).

For Rusnac et al. (2019), working with giomers is considered relatively easy as it has high flexibility and less propensity to move from areas with high functional stress. It seems to be suitable for different types of procedures, from restorations to bonding orthodontic brackets. The cost is similar to the composite resins, but its characteristics are little known by clinicians.

This review aims to evaluate the available literature on the clinical indications, as well as the aesthetic and physicochemical properties of giomers, compared to composite resins and ionomeric cements.

MATERIAL AND METHODS

A bibliographic search was carried out, using advanced strategies, in the *Pubmed*, *Lilacs and SciELO* databases, covering the last five years (2016 to 2022), in English, Portuguese and Spanish. *"Giomer"* and "*S-PRG"* were used as well as "clinical indications", "aesthetic properties", "physicochemical properties", "composite resin", "glass ionomer" and their respective translations into Portuguese and Spanish (Giômero, giomero, ionômero de vidro pré-reagido de superfície, ionómero de vidrio prerreaccionado superficialmente, indicações clínicas, indicaciones clínicas, propriedades estéticas, propiedades estéticas, propriedades físico-químicas, propiedades fisicoquímicas, resina composta, resina compuesta, ionômero de vidro, ionómero de vidrio). To optimize and, at the same time, increase the specificity of the results, the Boolean operators "AND" and "OR" crossed and combined complementary and similar terms, respectively.

The work was based on the following guiding question: "Do giomers present aesthetic and physicochemical properties favorable to their clinical indication in Dentistry?" For this, the use of the acronym PICo was established, in which the P (Population/Patient or Problem) would be the hybrid giomer, the I (Interest) its aesthetic, physical-chemical and clinical properties, and the Co (Context) the comparison of this material with those already well known, such as composite resin and glass ionomer (Araújo, 2020).

Thus, publications addressing the aforementioned properties of the giomer were included and articles whose full versions were unavailable for free access were excluded.

The selection process was carried out in three stages. The first was based on reading the titles, which also allowed the identification and removal of duplicate articles. In the second stage, the abstracts were analyzed and, in the third, the full texts were analyzed.

RESULTS AND DISCUSSION

Initially, it was found 137 articles. Of these, only fourteen met the inclusion and exclusion criteria and were selected. Giomeres have been described as an “smart material”, which emerged with the aim of combining the aesthetics and strength of composite resin with Civ`s ability of releasing fluoride (Rusnac et al., 2019). They feature glass ionomer technology with S-PRG pre-activated surface (Spinola et al., 2020). When in contact with polyacrylic acid, the fluoroaminosilicate particles react and are incorporated into the resin, resulting in a continuous release of fluorine.

Table 1
Selected articles.

Authors, year/method	**Title**	**Objective**
Bollu et al. (2016) Search	Comparative Evaluation of Microleakage Between Nano-Ionomer, Giomer and Resin Modified Glass Ionomer Cement in Class V Cavities - CLSM Study.	To evaluate microleakage in Class V cavities that were restored with Resin-Modified Glass Ionomer Cement (RMGIC), Giomer and Nano-Ionomer.
Burtea et al. (2019) Search	New Pre-reacted Glass Containing Dental Composites (giomers) with Improved Fluoride Release and Biocompatibility.	Investigate the morphology, physicochemical properties (residual monomer, fluoride release) and cytotoxicity of Giomers.
Condò et al. (2017) Search	A Deep Morphological Characterization and Comparison of Different Dental Restorative.	General investigation of the morphological and structural characteristics of Giomeres.
Francois et al., (2020) Literature review	Commercially Available Fluoride-Releasing Restorative Materials: A Review and a Proposal for Classification. materials.	Review the literature on the chemical reactions responsible for the initial configuration and ion release of materials found on the market to better understand their chemical and physical properties, their ion release capabilities and indications for use.
Harhash, ElSayad, Zaghloul (2017) Search	A comparative in vitro study on fluoride release and water sorption of different flowable esthetic restorative materials.	To evaluate fluoride release and water sorption of three fluid aesthetic restorative materials

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Kelic et al. (2020) Search	Fluoride-Releasing Restorative Materials: The Effect of a Resinous Coat on Ion Release.	To determine the effect of two adhesive systems and a glass ionomer coating resin on fluoride release and concomitant pH changes over a period of 168 days.
Komalsingsakul, Srisatjaluk, Senawongse, (2022) Search	Effect of brushing on surface roughness, fluoride release, and biofilm formation with different tooth-colored materials	To investigate surface roughness, fluoride release and *S. mutans* biofilm formation on various tooth-colored restorative materials before and after toothbrushing.
Miki et al. (2016) Search	Antibacterial activity of resin composites containing surface pre-reacted glass-ionomer (S-PRG) filler.	To evaluate the inhibitory effects on bacterial growth on the surface of a giomer material and the association of ions released from the S-PRG filler with antibacterial activity.
Okamoto et al. (2019) Search	Surface Pre-Reacted Glass Filler Contributes to Tertiary Dentin Formation through a Mechanism Different Than That of Hydraulic Calcium-Silicate Cement.	To evaluate the formation of tertiary dentin induced by S-PRG cement in vivo and its effect on the healing process of pulp cells in vitro.
Rusnac et al. (2019) Literature review	Giomers in dentistry - at the boundary between dental composites and glass-ionomers.	Review the available literature on giomers, regarding chemical composition, handling and aesthetic properties, adhesion and microleakage, fluoride release and protection offered, in addition to clinical indications.
Shimizubata M. (2020) Search	Basic properties of novel S-PRG filler-containing cement.	To evaluate the effect of a new surface pre-reacted glass ionomer cement (S- PRG) for root caries.
Şişmanoğlu (2019) Search	Fluoride Release of Giomer and Resin Based Fissure Sealants. Odovtos International	To evaluate the time-dependent release of fluoride ions from giomer and resin-based crack sealants.
Spajic et al. (2019) Search	Effects of Curing Modes on the Microhardness of Resin-modified Glass Ionomer Cements.	To evaluate the effects of polymerization modes on the surface microhardness of a giomer after different storage periods compared to self-curing resin-modified glass ionomer cements.
Spinola et al. (2020) Search	Efficacy of S-PRG filler containing varnishes on enamel demineralization prevention.	To evaluate the effect of varnishes containing different concentrations of S-PRG filler in protecting against enamel demineralization.

Source: Pubmed, Lilacs e SciELO.

This happens as soon as there is interaction with the saliva from the oral environment (Burtea et al., 2019; Francois et al., 2020; Harhash, ElSayad & Zaghloul 2020). In addition to fluoride release, the S-PRG load releases other substances with a cumulative effect against caries formation (Miki et al., 2016; Okamoto et al., 2019; Spinola et al., 2020), such as borate and fluoride which, together with silicate and aluminum, have antimicrobial/bacteriostatic action against *S. mutans* (Miki et al., 2016).

There are studies, such as the one by Okamoto et al. (2019), that also demonstrates an important role of strontium in bone augmentation. These elements would act in, preventing demineralization and favoring remineralization (Miki et al., 2016; Okamoto et al., 2019; Spinola et al., 2020). In addition to hindering bacterial adhesion to the tooth (Shimizubata, Inokoshi, Wada,

Takahashi & Minakuchi, 2020), the ions would act as a buffer, neutralizing the acids produced by these microorganisms (Spinola et al., 2020).

Some of the factors that make composite resins widely used in direct restorations are aesthetics and the tooth-like expansion coefficient (Rusnac et al., 2019). Studies show that restorations with giomers have morphology, postoperative sensitivity, marginal adaptation and initial aesthetic and mechanical properties very similar to those of a composite resin, but have a lower longevity (Francois et al., 2020). When compared to restorations with materials such as GICs and resin-modified glass ionomer cements (RMGICs), they have a smoother surface and can be compared to compomers (Condò et al., 2017). Long-term studies report satisfactory visual texture and roughness (Burtea et al., 2019; Condò et al., 2019), and there are also authors pointing giomer restorations with preserved esthetics even after two years (Rusnac et al., 2019).

An *in vitro* study on fluoride release (Harhash et al., 2020) compared three materials, being a giomer, a nanohybrid with fluoride releasing and a non-fluoridated nanohybrid composite. Measurements were taken after one day, one week and four weeks of immersion in deionized water. It could be observed that, throughout the evaluation period, although the release has decreased for all materials studied, the giomer presented a statistically superior result. This finding corroborates to those of Şişmanoğlu (2019), in which there was a burst effect, followed by a gradual reduction in release (Şişmanoğlu, 2019; Komalsingsakul, Srisatjaluk & Senawongse, 2022).

Kelić et al., (2020) evaluated four materials, a giomer, an alkasite material, a glass ionomer cement and a conventional composite. Contrary results of the aforementioned study were found. The giomers did not demonstrate the initial explosion effect and released a smaller amount of fluorine, over time, compared to the other materials. Other authors also state that giomers do not have a burst effect and their fluoride release is much lower than that of an GIC (Francois et al., 2020). This could be explained by the higher porosity of ionomeric cements (Kelić et al., 2020).

Apparently, the amount of fluoride ions released decreases over time, until it reaches a plateau and runs out (Harhash et al., 2020). Being "smart" materials (Burtea et al., 2019), giomers could be recharged if fluoride ions are available in the oral environment (Rusnac et al., 2019; Komalsingsakul et al., 2022). The amount released would be sufficient to exert a preventive effect on caries (Şişmanoğlu, 2019), which does not eliminate the importance of mechanical techniques for removing dental biofilm (Komalsingsakul et al., 2022).

Concerning its indication, the authors agree with the use of giomers in pediatric dentistry, both as a varnish in areas with mild demineralization, and also to seal pits and fissures. They would also be indicated in non-carious cervical lesions, as they have ideal characteristics for this type of clinical situation, such as resistance and aesthetic potential (Condò et al., 2017; Francois et al., 2020), as shown by some medium-term studies about its use in class V restorations (Rusnac et al., 2019).

Sealants with materials that release fluoride are indicated for caries prevention, especially in high-risk patients. Although the benefits of GIC are notorious in this sense, its retention is low, which makes giomers a good option, as they remain in the preparation for longer and also continuously release fluoride (Şişmanoğlu, 2019).

The manufacturers of the different commercial brands of giomeres provide, on the packaging, information regarding the indication for clinical use: restoration, varnish, sealant, cementation of crowns, bonding of orthodontic brackets, etc. (Rusnac et al., 2019), as can be seen in Table 2.

Table 2
Giomers available on the market and manufacturers' specifications.

Product	**Company**	**Specifications**
Adhesive System FL-BOND II	Shofu Dental Corporation, Japan	Self-etching, fluoride-releasing adhesion system

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Beautifil-Bulk Restorative	Shofu Dental Corporation, Japan	For posterior restorations, the high fill rate (87.0% by weight, 74.5% by volume) reduced polymerization shrinkage, increased compressive and flexural strength with sustained fluoride release.
Beautifil -Bulk Flowable	Shofu Dental Corporation, Japan	High fill rate (73% by weight) reduced volumetric shrinkage, increased compressive and flexural strength, fluoride release and refill Self-leveling and easy adaptation. 10 second healing time
Beautifil Flow Plus, Beautifil Flow	Shofu Dental Corporation, Japan	Base, lining and restorative material
Beautifil II	Shofu Dental Corporation, Japan	Highly esthetic dental material, with fluoride release for all classes of restorations, suitable for patients with high caries index
Beautifil II LS (low shrinkage)	Shofu Dental Corporation, Japan	Low volumetric shrinkage, chameleon effect, easy to handle and sustained fluoride release and recharge
Beautifil II Gingiva shades	Shofu Dental Corporation, Japan	Fluoride release aimed at the cervical area, specifically for esthetic correction of gingival recession, wedge-shaped defects, exposed cervical areas, immobilization and rebalancing of pink esthetics
Beautifil II Enamen curtains	Shofu Dental Corporation, Japan	Chameleon-like optical characteristics for direct enamel veneers
BeautiSealant	Shofu Dental Corporation, Japan	Fissure and pit sealing system with fluoride release
PRG barrier coating	Shofu Dental Corporation, Japan	Giomer varnish light cured, for prolonged relief of hypersensitivity Seals and protects exposed dentinal tubules to prevent pain in patients experiencing enamel loss, gingival recession or temporary sensitivity due to whitening
BeautiCem SA	Shofu Dental Corporation, Japan	Self-adhesive and self-etching resin cement. Primer is not required for all substrates (except porcelain). Low thickness film (12 µm)

Source: Rusnac (2019), adapted by the authors.

CONCLUSION

According to the literature, giomers have a good spectrum of clinical use, as they are aesthetically pleasing and also release fluoride. More in vitro studies could help to clarify some of its physicochemical characteristics, including the amount of fluoride released. Even so, there are indications that it is sufficient to prevent tooth decay, even because the material is rechargeable in the presence of fluoride sources.

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