



# Giomers in dentistry – at the boundary between dental composites and glass-ionomers

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## Abstract

**Introduction.** From the variety of direct restorative dental materials, composite resins are considered as having the most esthetic and functional properties. The conservative preparation, esthetic results, good mechanical qualities and surface finishing properties of dental composites, combined with the protective properties of fluoride from glass-ionomers, led to a new generation of dental materials: the giomers.

**Objective.** The purpose is to review the available literature about the giomers, regarding the chemical composition, handling properties and esthetics, adhesion and microleakage, fluoride releasing and protection offered, clinical indications.

**Method.** The search was carried out using ScienceDirect and PubMed databases with the following keywords: giomer, esthetic properties giomers and fluoride releasing giomers. A total of 232 articles were initially selected, with the following inclusion criteria: full text articles, written in English, with topics on the properties and the clinical implications of giomers. Papers presented as abstract were not included. In the next step, review articles, duplicates, and articles in other languages were removed; as a result, a total of 44 sources published between 2004 and 2017 were selected.

**Results.** The selected articles referred to the following aspects about the giomers: chemical composition (8 articles), adhesion and microleakage (10 articles), fluoride releasing and pulp protection (15 articles), clinical indications (6 articles), effects of additional treatments and dietary habits (11 articles).

**Keywords:** giomer, fluoride, dental composites

## Introduction

From the variety of direct restorative dental materials, composite resins are considered as having the most esthetic and functional properties, which explains the high frequency of their use [1,2].

S.R. Schricker [1] describes composite resins as a mixture of organic and inorganic particles: the resin, the fillers, the initiator of the chemical reaction and the coupling agent. This is a versatile combination, the properties and indication of a new material being determined by the proportion of the mixed components [1].

Composite resins allow for a conservative preparation of the tooth structure and esthetic results, enabling to build a restoration without the intervention of the dental laboratory. Other advantages include: wear-resistance close to the natural tooth structure, good marginal integrity, they can be repaired intraorally and/or replaced by ceramic or composite indirect restorations and they have low costs [3].

Due to the differences in filler content, composite resins can be used for specific purposes. Low viscosity composites have a much greater contraction and cannot be applied in areas with high functional stress. However the flowing properties make them easy to handle. Conventional composites have lower setting contraction and can be used to restore the posterior teeth. Composites can also be used for core building. Orthodontic devices can be applied using a chemical setting system of two components. For cementation of restorative appliances, a low viscosity composite, with chemical and/or photo-activated curing mechanism is used. Sealing materials have low viscosity, which enable their penetration into the deep pits and fissures and contain a high percentage of activator to be properly light cured [4].

The marginal fit of direct composites might be improved by heating them before application [5]. With modern composites and adequate technique,

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adhesion to enamel is excellent and to dentine it is increasingly good. The optical properties allow for a close reproduction of color and translucency of natural teeth [6]. According to Rajan [2], all esthetic restorative materials interact with the light, responsible for the intrinsic color; in addition: the optical outcome of the composite restorations is influenced by the thickness of the material, background color, and composition of the materials: matrix component and filler particles, pigments and coupling agents. Titanium oxides, zirconium, aluminum are known as being opaque with refraction indices different from the matrix. They are added in minimal quantities with the purpose of masking discolorations [2].

Another group of direct restorative materials that are known to offer high protection against the development of new carious lesions, by releasing fluoride, are the glass ionomers [3].

Fluoride releasing dental materials benefit from the constant interaction with the oral fluids, which influence the protective properties by release and recharge [7].

The glass-ionomers adhere chemically to the tooth structure and arrest the marginal micro-leakage of the fluids and microorganisms towards the restored surface. However, the mechanical resistance of the glass-ionomers is very weak [8].

Fluoride has the capacity to inhibit the bacterial metabolism of *Streptococcus mutans* and *Streptococcus sobrinus*, species associated with carious lesion debut. Glass-ionomers and resin modified glass-ionomers (RMGIC) are highly recommended for direct restorations and sealers for young patients, as well as for orthodontic brackets bonding [9].

For efficient distribution of fluoride, a bioactive nanoparticle is needed. Systemic effects are minimal and this method allows for a higher local concentration of fluoride, and therefor anti-cariou effect [10].

By combining the characteristics of the composite resins and glass-ionomers, hybrid products known as giomers have been obtained; giomers represent a special class of composites that offer both protection against caries and functional and esthetic results, by incorporating particles of pre-reacted glass filler in the matrix of the composite material.

The objective of this review is to analyze the available literature about the properties, indications, composition of giomers: fluoride-releasing, resin-based, adhesive materials that contain pre-reacted glass fillers.

## Materials and method

The search was carried out using ScienceDirect and PubMed databases with the following keywords: giomer, esthetic properties giomers and fluoride releasing giomers. A total of 232 articles were initially selected, with the following inclusion criteria: full text articles, written in English, with topics on the properties and the clinical

implications of giomers. Papers presented as abstract were not included. In the next step, review articles, duplicates, and articles in other languages were removed; as result, a total of 44 sources published between 2004 and 2017 were selected. The flowchart of the research is presented in Figure 1.

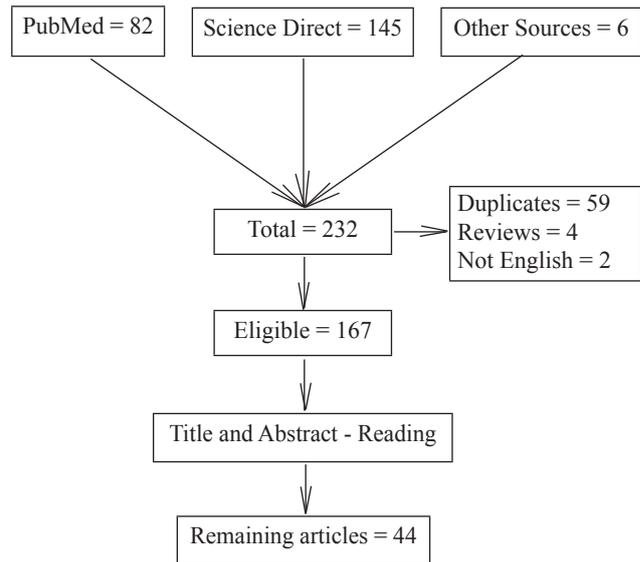


Figure 1. Flowchart of the selection.

## Results

The selected articles referred to the following aspects about the giomers: chemical composition (8 articles), adhesion and microleakage (10 articles), fluoride releasing and pulp protection (15 articles), clinical indications (6 articles), effects of additional treatments and dietary habits (11 articles).

## Discussion

### *Chemical composition of the giomers*

New classes of hybrid materials widely used in dentistry are: resin modified glass ionomers (RMGIC), compomers (resin based materials, modified by adding polyacid), ormocers (the matrix is a mix of organic and inorganic polymers), zircomers (composites modified with zirconium particles).

A new class of materials – Giomers - aims to incorporate the best properties of composite resins and glass-ionomers: protection against carious lesion, good mechanical resistance and esthetics. Giomers represent one of the most recent developments in the field of fluoride releasing dental materials, combining esthetics with the possibility to have a finished surface and good mechanical resistance. Clinical studies suggested that the morphology, marginal adaptation and post-operative sensitivity are similar for resin composites and giomers. For giomers, Itota [7], Abdel-Karim [11] and Cury [12] have found that

secondary caries are less frequent [7,11,12].

Giomers have a conventional bis-GMA matrix and bioactive glass fillers. The setting reaction is light activated. The consistency is either flow or conventional; the amount of fluoride released is sufficient for antibacterial protection [13].

#### ***Handling properties and esthetics***

Working with giomers is considered easy in comparison to composite resins. They have high flexibility and are less likely to be dislocated from areas with high functional stress. Color, fluorescence (property to absorb light and spontaneously emit a higher wavelength, bringing vitality to a restoration) and translucency (property that allows the passage of light), together, essentially contribute to the esthetical integration of a new restoration. Therefore, new materials should imitate the color of natural teeth and all other optical properties [14-17]. Nakamura [13] found esthetic appearance of the fillings at two years after application [13].

#### ***Adhesion and micro-leakage***

When referring to adhesion in the field of restorative dentistry, a material should ideally achieve an impenetrable bond to the tooth structure. This way, the pulp chamber is sealed from negative stimuli such as bacterial infiltration or chemical injuries. For giomers, a self-etch system is mainly used to obtain the adhesion of the material to the tooth structure.

With the purpose of increasing the antimicrobial protection, the effect of topical fluoridated solutions on the surface of giomers restorations is being tested. The effect of these applications might negatively influence the bond strength between giomer and tooth structure and increase the microleakage [18-21].

Comparative micro-leakage studies have shown that this phenomenon is higher for giomers and lower for glass-ionomers and zircomers (other fluoride releasing dental materials). However, the force necessary to displace a giomer filling is higher than for the other two materials [22-24].

A method of avoiding secondary decays is the use of chlorhexidine as disinfectant of the cavity. However, in the case of giomers, when used with a self-etch adhesive system, the supplementary disinfection might negatively influence adhesion quality and therefore increase the risk for micro-leakage [25].

With the purpose of reducing the increase in size for cavities as a consequence of micro-leakage, the possibility to repair a filling is investigated using giomer materials. To accomplish this, a strong bond between the old and the new material is enforced by removing the surface layers of the old filling [8,26].

#### ***Fluoride releasing and protection offered by giomers***

There is no ideal formula for a dental material that is applicable to all clinical cases [1]. Bioactive glass included in the composition of giomers, dissolves upon contact with biological fluids, allowing for a therapeutic ion release like phosphate, fluoride, calcium, influencing the capacity

to form apatite. This approach is a rather new one for the dentistry field. In the field of orthodontics it helps prevent white spots lesions [27].

#### ***Clinical indications***

Clinical tests conducted by Jyothy and Gordan (periods of 1 year up to 13 years) have shown that giomers have ideal properties for treating cervical non-carious lesions. These lesions remain a challenge because of the lower adhesion quality at cervical level. Clinical trials also indicated both adequate resistance and esthetically acceptable aspect for giomers, years after application [28-30].

Alsayed [31] and Salmerón-Valdés [32] conducted in vitro studies to highlight the preventative properties of giomers as coating materials and pit and fissure sealants [31,32].

Tests conducted by Kimyai [33] show that contamination with hemostatic agents can increase the microleakage and marginal gaps in giomer restorations [33].

Table I shows the available products based on giomer technologies. Manufacturers recommend the use of giomers for all restorations (class I, II, III, IV, V) especially for patients with a high carious index, for direct veneers because of high esthetic properties and chameleon effect, for the proper restoration of pink esthetics in exposed cervical areas (Gingival shades), as pit and fissure sealants, as base materials or liners, for pediatric use, as varnish for hypersensitive exposed areas, for cementation of restorations, and even for collating orthodontic brackets [34].

#### ***Effects of additional treatments/ dietary habits***

Currently, an often required procedure is teeth whitening. The substances used have the capacity to modify the surface structure of the enamel and of direct restoration materials.

The changes in color after the use of whitening method are clinically acceptable. Microscopically, micro-fissures and a higher bacterial adhesion can be detected. For other materials, such as microfilled composite resins, replacing the filling is imperative after the whitening procedure because of visible color differences [35,36].

Lately an important increase in the number of erosive lesions with both intrinsic and external causes has been observed. A great part of the external erosion is caused by the increased consumption of acidic beverages, which modify also the surface of restorative materials, including giomers [37-39]. Another important factor for surface modifications in giomer restorations is represented by prophylaxis methods like air-powder polishing, pumice and brushes used to remove dental plaque. Increased surface roughness favored staining, bacterial retention and gingival inflammation [14,40,41].

Giomers prove to be useful in the process of collating orthodontic brackets with mechanical properties similar to composite resins. They offer protection against carious lesions, but the orthodontic bond-strength of giomer materials proves to be lower than that of RMGIC [42-44].

**Table I.** Commercial products available, according to the producer [34]

Product	Company	Specifications
FL-BOND II Adhesive System	Shofu Dental Corporation, Japan	self-etching, fluoride releasing bonding system
Beautifil-Bulk Restorative	Shofu Dental Corporation, Japan	For posterior restorations High fill ratio (87.0wt%, 74.5 vol%) reduced polymerization shrinkage increased compressive and flexural strength sustained fluoride release
Beautifil-Bulk Flowable	Shofu Dental Corporation, Japan	High filler ratio (73.wt %) reduced volumetric shrinkage increased compressive and flexural strength fluoride release and recharge Self-leveling and easy adaptation 10 second cure time
Beautifil Flow Plus, Beautifil Flow	Shofu Dental Corporation, Japan	Base, liner and restorative material
Beautifil II	Shofu Dental Corporation, Japan	A fluoride releasing, highly aesthetic dental material for all classes of restorations appropriate for patients with high caries index
Beautifil II LS (Low Shrinkage)	Shofu Dental Corporation, Japan	Low volumetric shrinkage Chameleon effect Easy to handle Sustained fluoride release and recharge
Beautifil II Gingiva Shades	Shofu Dental Corporation, Japan	fluoride-releasing intended for the cervical area, specifically the aesthetic correction of gingival recession, wedge-shaped defects, exposed cervical areas, splinting, and re-balancing of pink aesthetics
Beautifil II Enamen Shades	Shofu Dental Corporation, Japan	chameleon-like optical characteristics for enamel direct veneers
BeautiSealant	Shofu Dental Corporation, Japan	Fluoride Releasing Pit and Fissure Sealant System
PRG Barrier Coat	Shofu Dental Corporation, Japan	light-cured giomer varnish for prolonged hypersensitivity relief Seals and protects exposed dentinal tubules to prevent pain for patients experiencing loss of enamel, gingival recession or temporary sensitivity due to whitening
BeautiCem SA	Shofu Dental Corporation, Japan	Self-etching, self-adhesive resin cement No primer required for all substrates (except porcelain) Low film thickness (12 µm)

### Conclusions

Giomers have been proved to incorporate the mechanical and esthetic qualities of composite resins and carious protection through fluoride release from the glass-ionomers component. They have a wide range of clinical indications and are easily used them for restorations of cervical lesions, where adhesion is less efficient.

Giomers are affected by dietary habits and dental procedures, such as acidic beverage consumption, teeth whitening or prophylaxis methods.

In some cases, other materials have improved performances: RMGIC and Nano-Ionomers have a better marginal adaptation when compared to giomers and RMGIC have a stronger bond-strength than giomer materials when attaching metal brackets to enamel.

New research investigates the usage of giomers in the field of orthodontics, for the prevention and treatment of white spots.

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