CASE REPORT

Giomer S-PRG Technology as an Alternative Restoration in Early Childhood Caries

Masayu Sesiliana[1], Eriska Riyanti[2]

Abstract

Aim: As a reference for restorative materials that can be used in early childhood caries (ECC) cases.

Background: The term ECC is used to describe any form of caries in infants and preschool children. Treatment of ECC should be adjusted depending on the clinical condition of pediatric patients, which is to restore teeth function by restoring cavity and also to give esthetic aspect. Application of correct restorative material could prevent secondary caries and extensive damage to the tooth layer while maintaining primary teeth until exfoliation. Giomer is a real hybrid restorative material from glass ionomer and resin composites with fluoride-releasing and fluoride-recharging properties, with the main composition based on prereacted glass ionomer (PRG) technology.

Case description: A 5-year-old boy accompanied by his mother to Dental Hospital Universitas Padjadjaran with a cavity on the right and left front upper teeth, absence of throbbing pain. Intraoral clinical examination showed caries on teeth 51, 52, 61, 62, 63, 64, 84, and composite fillings and secondary caries on teeth 74. The restoration was performed on the anterior teeth using giomer technology surface prereacted glass (S-PRG) material with different techniques (bulk-fill using strip crown, bulk-fill without using strip crown and layering). Pulpotomy treatment was lads performed on teeth 64, 74, and 84, then restored using bulk-fill giomer material. The restoration was evaluated for 1 month using modified USPHS criteria and assessments. The results showed Alfa (A) criteria for all teeth restored using giomer material.

Conclusion: Based on the characteristics of the giomer S-PRG technology, this material can be considered as an alternative for restoration in cases of ECC.

Clinical significance: Giomer S-PRG technology releases ions that can play a role in tooth mineralization, antibacterial activity, improvement of acid resistance, and prevention of bacterial adhesion.

Keywords: Early childhood caries, Fluoride recharge, Fluoride release, Giomer, S-prereacted glass ionomer.

World Journal of Dentistry (2021): 10.5005/jp-journals-10015-1826

Background

Dental caries is described as signs, symptoms, and the result of the tooth surface's substance disintegration caused by metabolic events occurring in the biofilm covering the affected area.[1] In contrast to maxillary incisors that are prone to caries, mandibular incisors are less vulnerable because they are shielded by the tongue and saliva from the submandibular and sublingual glands.[1] This pattern of dental caries has been labeled variously as "bottle caries", "nursing caries", or "baby bottle tooth decay".[1] From these terms, we can conclude that one of the causes of early childhood dental caries is improper bottle feeding.[1] Using nursing bottles and "sippy cups" expose to more risk of dental caries.[2] Feeding behavior during sleep increases the risk of caries due to oral cleansing and decreased salivary flow during sleep.[2] Not only increasing the risk of dental caries but feeding behavior is also great in the risk of the dental reservoirs against *Streptococcus mutants*.[2] In regards to this information, it is advised to use early childhood caries (ECC) for any form of caries in infants and preschool children.[1]

Early childhood caries described by the American Academy of Pediatric Dentistry (AAPD) as children (71 months or younger) with the presence of decayed (non-cavitated or cavitated) teeth, missing teeth (because of caries), or a tooth surface that is filled with filling.[3] While any sign of smooth-surface caries in a child younger than 5 years old, one or more cavitated, missing (because of caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of ≥4 (age 3), ≥5 (age 4), or ≥6 (age 5) is being described as severe ECC.[4]

[1,2]Pediatric Dentistry Department, Faculty of Dentistry-Universitas Padjadjaran, Indonesia

Corresponding Author: Masayu Sesiliana, Pediatric Dentistry Department, Faculty of Dentistry-Universitas Padjadjaran, Indonesia, Phone: +62 22 2504985, e-mail: masayusesilianadrg@gmail.com

How to cite this article: Sesiliana M, Riyanti E. Giomer S-PRG Technology as an Alternative Restoration in Early Childhood Caries. World J Dent 2021;12(3):241–246.

Source of support: Nil

Conflict of interest: None

One of the known methods to prevent ECC is the prevention of cariogenic food behavior.[1] While an expectant approach, primary prevention of ECC is developing strategies that target the infectious components of the disease (e.g., preventing and delaying primary acquisition of *Streptococcus mutans* in early childhood through decreasing the reservoir of organisms confer in the mother).[2] Other methods used to prevent the accumulation of *S. mutans* to the pathological level are topical application of antimicrobial agents, administration of fluoride, and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) administration.[1,2]

Treatment in cases of ECC depends on the condition to the conditions and complaints of the pediatric patient.[5] The goal of this treatment is to relieving pain, reducing bacterial activity to stop caries, and preventing rapid spread to the pulp with oral prophylaxis, brushing teeth properly, impregnating caries given

to newly formed caries, or enamel caries and dentin caries, e.g., by topical fluoride.[5] Furthermore, the treatment could sometimes be consisting of restoration or the surgical removal of carious teeth.[2] Cavity restoration is the main goal so that oral health and function, and esthetics can be returned.[5]

One of the most challenging dentistry issues in modern days is finding the ideal restorative materials.[6] Fluoride release is one of the features that has enhance resin-based restorative materials.[7] It is a significant property of the restorative material and helps to prevent secondary caries.[7] Now, several materials conceiving fluoride have been promoted, such as compomer, resin-modified glass ionomer, and giomer.[7]

A true hybridized restorative material of glass ionomer and resin composites is known as giomer.[8] It has the fluoride release and fluoride recharge properties of glass ionomer cement, has excellent esthetics, is easy to polish, has strength, has physical properties, and resin composite handling.[8,9] Giomer has a composition based on prereacted glass ionomer (PRG) technology.[8] This technology implicates prereacting a fluoro-aluminosilicate glass filler with polyacrylic acid, shaping a steady phase glass ionomer known as a "wet siliceous hydrogel".[8] Then, these fillers are fused into the resin matrix as the final product.[8] The presence of the prereaction hydrogel was thought to be responsible for fluoride release and recharge in the giomer.[8] Prereacted glass ionomer technology is classified in two categories: (1) FPRG (full prereacted glass), where all filler particles contain polyacrylic acid, the filler will release a large amount of fluoride because the particle core reacts completely, (2) S-PRG (surface prereacted glass), where only the surface of glass filler containing polyacrylic acid, the glass core remains and releases sodium, borate, aluminum, silicate, strontium ions in addition to fluoride ions.[8,10]

Giomer S-PRG technology is a true hybridized restorative material of glass ionomer and resin composites, which has fluoride release and fluoride recharge properties. This case report discussed the restoration using the materials previously mentioned for patients with ECC. The restorations were evaluated within 1 month. To sum up, giomer S-PRG technology can be used as a suitable restorative material for practitioners.

Case Description

A-5-year-old male patient accompanied by his mother to Dental Hospital Universitas Padjadjaran with a cavity on the right and left front upper teeth, absence of throbbing pain. These right and left front upper teeth had been restored but fell off within 1 month. The patient drank milk twice a day. Occasionally, the patient used a bottle to drink the milk until he falls asleep. Intraoral clinical examination showed caries in teeth 51, 52, 61, 62, 63, 64, 84, and composite fillings and secondary caries on teeth 74 (Fig. 1). On extraoral and physical examination did not show any abnormalities.

Vitality tests on teeth 51, 52, 61, 62, 63, 64, 74, and 84 were positive. Palpation, percussion, and press tests showed negative values. Panoramic radiographs were performed to assess caries' depth, root resorption of primary teeth, and the eruption of permanent teeth (Fig. 2).

At the first dental visit, an introduction to the patient and the parents was carried out, followed by anamnesis, physical examination, body profile and posture, extraoral and intraoral examination, caries risk assessment, and dental health education, oral hygiene index, and panoramic radiographic examination. The patient's mother has explained the oral cavity condition and the treatment plan to be carried out. Caries risk assessment based on AAPD in this patient is in the high-risk category. The patient was rescheduled to restore the anterior maxillary teeth using giomer S-PRG technology material and different filling techniques, and pulpotomy treatment on the teeth 64, 74, and 84 then performed restorations. The specifications of the dental material used in this case are described in Table 1. All restoration procedures were performed by the author using different restoration techniques as described in Table 1, and the restoration results can be seen in Figures 3A to C. At each visit, a plaque index was checked. The plaque index results are depicted in Figure 4.

The restorations were evaluated within one month clinically using the modified USPHS criteria and scoring, evaluated using visual and tactile inspection. USPHS criteria consist of anatomic form, color match, marginal discoloration, marginal adaptation, postoperative sensitivity, and secondary caries (Table 2). The evaluation results showed Alfa (A) criteria for all teeth restored using giomer material (Table 2 and Figs 3D to F)

Discussion

Children suffering from ECC need to be treated as soon as possible to prevent more severe conditions.[5] The performed treatment would relieve complaints of pain and maintain mental and stomatognathic growth.[5] The main goal of ECC's dental management is cavity restoration so that oral health and function, and esthetics can be restored.[5]

One of the resin-based restorations that have fluoride release and recharge properties is giomer.[8] Giomer is a hybrid material manufactured by adding prereaction glass filler particles in a resin matrix.[12] Zafar stated in his research comparing fluoride release between giomer and RMGI (Beautifil® and Fuji II™ LC), that the two ingredients showed a similar fluoride release pattern, first the initial fluoride release followed by a continuous fluoride release for 4 weeks.[12] Research by Naoum et al. stated that the three composites studied showed fluoride release (Beautifil II > Gradia Direct X > Tetric EvoCeram) and fluoride recharge (Beautifil II > Gradia Direct X > Tetric EvoCeram).[13] The mechanical properties of every composite did not decrease with aging and fluoride release during the test period.[13] This ability increase the likelihood that fluoride-containing composites show a lower occurrence of recurrent caries than non-fluoride-containing composite.[13] The results of a 1-month evaluation of restoration using giomer materials in this case report, all the restored teeth did not show recurrent caries (Table 2).

S-PRG releases six types of ions, namely Na^+, BO^{3-}, Al^{3+}, F^-, Sr^{2+}, and SiO^{2-}.[10] Table 3 summarizes the functions of these ions.[10,14] The results of research by Fujimoto et al. regarding the clinical implications of S-PRG fillers showed that S-PRG fillers capable of releasing ions that play a role in tooth mineralization and have a modulation impact on acidic conditions produced by oral cariogenic microorganisms.[15] Hence, there is a beneficial effect of S-PRG fillers to provide a sustainable clinical advantage after long-term application in the oral environment.[15]

Giomer product from Shofu (e.g., Beautifil® II, Beautifil-Bulk Restorative, and Flowable) has fluoride release properties using a S-PRG filler.[16] The S-PRG filler has a glass core that pre-reacts with a solution of polyacrylic acid.[16] The glass ionomer phase in the giomer filler is shielded from water absorption and material reduction by the surface-modified layer.[16] Accordingly, ion exchange of composite materials using this technology contributes to the mineralization of teeth and can help neutralize acids that

Figs 1A to E: Intraoral view: (A) Anterior view; (B, D) Lateral view; (C) Upper teeth; (E) Lower teeth

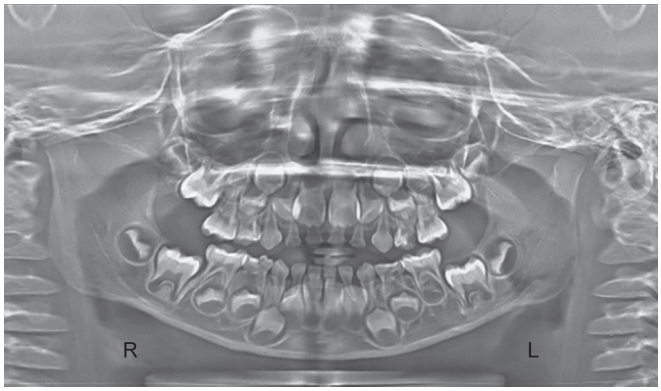


Fig. 2: Panoramic radiographic view

result from bacterial metabolism and which are a direct cause of demineralization and long-term tooth decay.[15,16] Giomers can provide ion-exchange benefits similar to glass ionomers, so they are especially important in caries-prone individuals.[16]

S-PRG-filled particles in giomers are reported to have fluoride-recharging properties by brushing or rinsing with fluoridated products.[9] Giomer forms an acid-resistant film, preventing biofilm as it inhibits bacterial adhesion.[9] Suzuki et al. stated that S-PRG interferes with the mature salivary polymicrobial biofilm and inhibits biofilm formation.[14] Giomers have a better surface finish than glass ionomers and RMGI due to resin composites' basic properties.[9] Several studies on the first-generation Beautifil® and the second-generation Beautifil II® (Shofu, Kyoto, Japan) reported acceptable clinical performance over 1 to 8 years period in class V, I, and II restorations.[9]

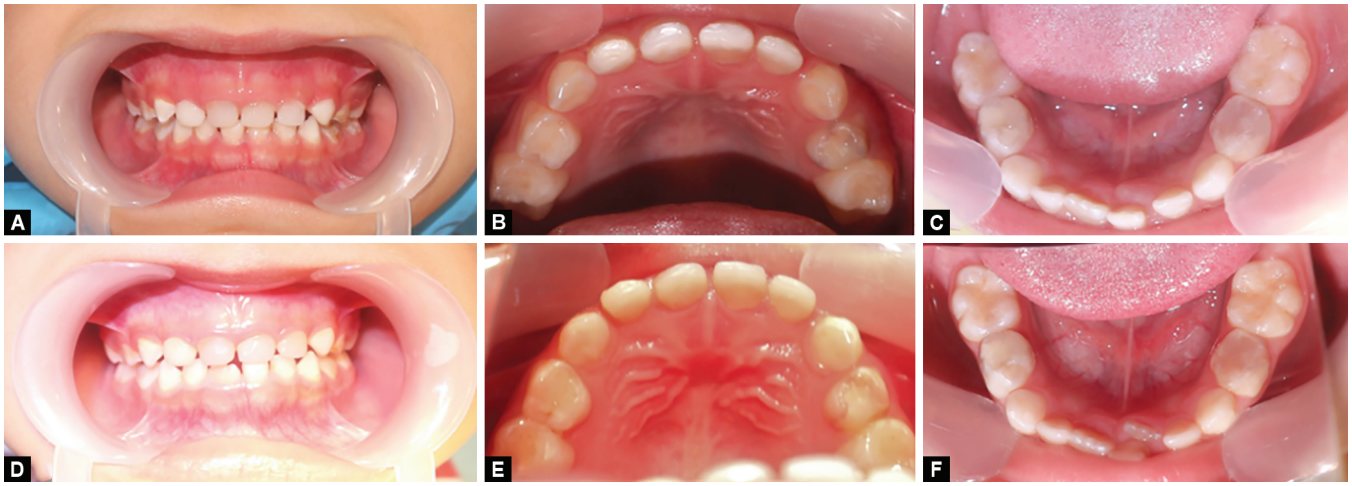
Giomer is a new material being developed to improve physical, mechanical, and esthetic properties.[12] The giomer manufacturers have claimed that these materials exhibit better physical and mechanical properties as well as better esthetic properties and are easy to polish.[12] Marginal damage has been reported as one of the features of resin composite restorations that can induce secondary caries.[7] In this case report, the marginal adaptation and marginal discoloration of the teeth indicated Alfa criteria (A).

Initial postoperative sensitivity is a matter with resin-based materials.[7] Studies have discovered that postoperative sensitivity decreases during the first few weeks after restorations are placed but can keep going for a more extended period.[7] A study conducted by Abdel-Karim et al. showed changes in the Beautifil Flow Plus F00 product (Shofu-Kyoto, Japan), which initially recorded a Charlie score to an Alfa score in the 6 months until the end of the 36 months.[9] This prominent postoperative sensitivity could be associated with baseline hyperemic pulp, which vanished after a 6-month follow-up period.[9] In an examination led by Gordan et al., there was no sensitivity for restorations using self-etching primers (FL-Bond, Shofu) and giomer (Beautifil, Shofu, Kyoto, Japan) 8 years of observation.[7] The same thing was shown in the 1-month evaluation case report of the restoration, which was the absence of a postoperative sensitivity response in all the restored teeth.

Several manufacturers have introduced innovative bulk-fill composites to decrease the time and exertion needed to coat and adapt posterior composites.[17] These materials are professed to have lower polymerization shrinkage and depths of cure of up to 4 mm through the use of new restrictive resins, particular modulators, unique fillers, and filler control.[17] In this case report, the filling technique was done using bulk-fill (Beautifil Bulk® Restorative)

Table 1: Restoration of teeth

Tooth	*Technique*	*Products*	*Color*	*Bonding agent*	*Contouring, finishing, and polishing kit*	*Manufacturer*
51	Bulk fill without using strip crown	Beautifil Bulk® Restorative	A	Beautibond®	Super snap®	Shofu-Kyoto, Japan
52	Layering	Beautifil II®	B1	Beautibond®	Super snap®	Shofu-Kyoto, Japan
61	Bulkfill using strip crown	Beautifil Bulk® Restorative	A	Beautibond®	Super snap®	Shofu-Kyoto, Japan
62	Bulkfill using strip crown	Beautifil Bulk® Restorative	U	Beautibond®	Super snap®	Shofu-Kyoto, Japan
63	Layering	Beautifil II®	B1	Beautibond®	Super snap®	Shofu-Kyoto, Japan
64	Bulkfill	Beautifil Bulk® Restorative	A	Beautibond®	Super snap®	Shofu-Kyoto, Japan
74	Bulkfill	Beautifil Bulk® Restorative	A	Beautibond®	Super snap®	Shofu-Kyoto, Japan
84	Bulkfill	Beautifil Bulk® Restorative	A	Beautibond®	Super snap®	Shofu-Kyoto, Japan



Figs 3A to F: (A to C) Restoration using the giomer S-PRG; (D to F) Control restoration 1 month

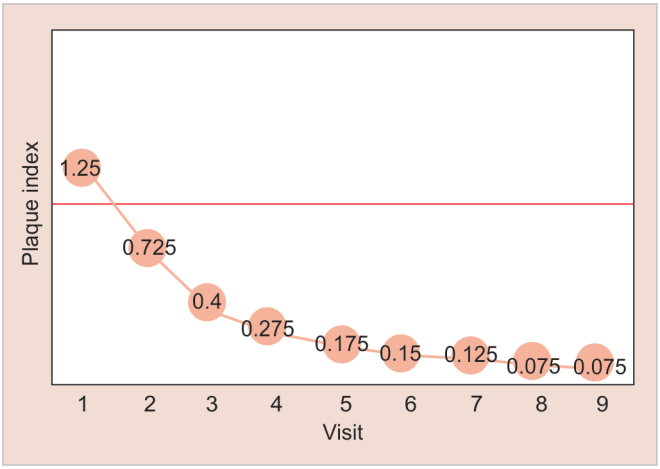


Fig. 4: Plaque index

and layering (Beautifil II ®). The evaluation results between the two patching techniques showed Alfa (A) criteria.

Giomer consists of Bis-GMA and TEGDMA, so it has a weakness similar to composite resin, absorbing water.[18] TEGDMA maximizes copolymerization with Bis-GMA.[9] This water absorption characteristic occurs because of the space between molecules in the resin matrix.[18] Water will diffuse into the resin matrix; the space between the polymer chains causes the polymer chains' breakdown.[18] The analysis of the polymer chains results in porosity and space between the bonds, making the restoration material easy to enter by the liquid.[18] Water acts as a vehicle for the dye to penetrate the resin matrix. Thus, the giomer can also change color, as occurs in composite resin.[18] The difference in filler composition also affects the color change.[18] An *in vitro* study in 2012 examined the color stability of S-PRG giomer products (Shofu-Kyoto, Japan) with various filler compositions, which are Beautifil II, Beautifil Flow (F02, F10), and Beautifil Flow Plus (F00, F03).[9] The least color change occurs in Beautifil Flow Plus.[9] Giomer contains filler surface-prereacted glass ionomer filled composite (S-PRG).[18] The filler on the surface of this giomer has an osmotic effect: to maintain the pressure between the inside and outside when immersed in a solution, which makes the giomer more absorbent, especially on its surface.[18] Any dissolved resin matrix will cause greater exposure

Table 2: One-month evaluation of restoration

Criteria	*Tooth 52*	*Tooth 51*	*Tooth 61*	*Tooth 62*	*Tooth 63*	*Tooth 64*	*Tooth 74*	*Tooth 84*
Anatomic form	A	A	A	A	A	A	A	A
Color match	A	A	A	A	A	A	A	A
Marginal discoloration	A	A	A	A	A	A	A	A
Marginal adaptation	A	A	A	A	A	A	A	A
Postoperative sensitivity	A	A	A	A	A	A	A	A
Secondary caries	A	A	A	A	A	A	A	A

Modified USPHS criteria and scoring-adapted from Sunico et al.[8] and Gallo et al.[11]
Criteria A Anatomic form: The restoration is continuous with the existing anatomic form
Criteria A Color match: Restoration matches adjacent teeth in color and translucency
Criteria A Marginal discoloration: No discoloration exists anywhere on the margin between restoration and tooth structure
Criteria A Marginal adaptation: There is no visible evidence of a crevice along the margins. An explorer does not catch when drawn across the margins
Criteria A Postoperative sensitivity: Patient reports no postoperative sensitivity
Criteria A Secondary caries: There is no evidence of caries along the margins of the restoration

Table 3: The function of ions in giomer[10,14]

	Ion	*Bioactive properties*
F^-	Ion fluoride	Forming fluoroapatite, antibacterial activity, remineralization in demineralized area
Sr^{2+}	Ion strontium	Improvement of bone tissue formation and mineralization/Improves of acid resistance, the effect of neutralization and acid buffer
Al^{3+}	Ion aluminum	Controlling hypersensitivity
SiO^{2-}	Ion silicate	Remineralization of the tooth, calcification of bone
BO^{3-}	Ion borate	Bactericidal activity/antibacterial effect, promotion of bone formation, prevention of bacterial adhesion, antiplaque properties
Na^+	Ion sodium	Water-soluble/induces the function of 5 other ions

Adapted from Hajira and Meena[10] and Suzuki and Yoneda[14]

to the irregularly arranged filler particles resulting in a rougher surface that is tarnished by mechanical absorption.[9] The results of a 1-month restoration evaluation in this case report did not show any change in the restoration color in all the filled teeth. However, further evaluation in a more extended period is needed to observe the color change. This will disturb the esthetics and increasing the risk of replacing the restoration in the future.

Comprehensive treatment for ECC cases is needed, one of which is by performing restoration as the main goal so that oral health and function, as well as esthetics, can be restored. In this case report, the result of a 1-month evaluation of restoration using the giomer S-PRG technology material showed alfa (A) criteria on all modified USPHS criteria and scoring. Based on a study conducted by Naoum et al., which compared the properties of fluoride release and fluoride recharge in giomer S-PRG technology with two other composites, the results showed that the fluoride-containing composites show a lower incidence of recurrent caries than the composites that not contain fluoride.[13] In line with the results of a 1-month evaluation of a case report that did not show the presence of recurrent caries in teeth restored using giomer S-PRG technology. The properties of this restorative material were required for the treatment of ECC cases. Therefore, giomer S-PRG technology could be recommended as an alternative restorative material in the case of ECC.

Conclusion

Giomer of S-PRG technology is a restorative material with fluoride-releasing, fluoride-recharging properties, and also esthetic, physical, and handling properties similar to composite resin. S-PRG releases six types of ions, namely Na^+, BO^{3-}, Al^{3+}, F^-, Sr^{2+}, and SiO^{2-}. The effect of S-PRG fillers and ions released on hard tissue is anti-demineralization and remineralization activities. Bioactive properties were also detected while using S-PRG. Based on the properties possessed by the giomer S-PRG technology, this material can be used as an alternative for restoration in cases of ECC.

Clinical Significance

Giomer S-PRG technology can play a role in tooth mineralization, antibacterial activity, improvement of acid resistance, and prevention of bacterial adhesion.

References

1. Kawashita Y, Kitamura M, Saito T. Early childhood caries. Int J Dent 2011. 1–7. DOI: 10.1155/2011/725320.
2. Berkowitz RJ. Causes, treatment and prevention of early childhood caries: a microbiologic perspective. J Can Dent Assoc 2003;69(5):304–307b.
3. McDonald R, Avery D, Dean JA. Dentistry for the Child Aa. Maryland Heights, Missouri: Mosby Elsevier; 2011. pp. 366–402.
4. Council R. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. Pediatr Dent 2017;39(6):59–61.
5. Fajriani F, Handayani H. Penatalaksanaan early childhood caries management of early childhood caries. J Dentomaxillofacial Sci 2011;10(3):179. DOI: 10.15562/jdmfs.v10i3.281.
6. Barceleiro M, Mello J, Mello G, et al. Hybrid layer thickness and morphology: the influence of cavity preparation with Er:YAG laser. Oper Dent 2005;30(3):304–310.
7. Gordan VV, Mondragon E, Watson RE, et al. A clinical evaluation of a self-etching primer and a giomer restorative material: results at eight years. J Am Dent Assoc 2007;138(5):621–627. DOI: 10.14219/jada.archive.2007.0233.
8. Sunico M, Shinkai K, Katoh Y. Two-year clinical performance of occlusal and cervical giomer restorations. Oper Dent 2005;30(3):282–289.
9. Abdel-karim UM, El-Eraky M, Etman WM. Three-year clinical evaluation of two nano-hybrid giomer restorative composites. Tanta Dent J 2014;11(3):213–222. DOI: 10.1016/j.tdj.2014.10.004.
10. Hajira NSWN, Meena N. GIOMER- the intelligent particle (new generation glass ionomer cement). Int J Dent Oral Heal 2016;2(4):1–5.

11. Gallo J, Burgess J, Ripps A, et al. Three-year clinical evaluation of a compomer and a resin composite as class V filling materials. Oper Dent 2005;30(3):275–281.
12. Zafar MS. Effects of surface pre-reacted glass particles on fluoride release of dental restorative materials. World Appl Sci J 2013;28(4):457–462.
13. Naoum S, Ellakwa A, Martin F, et al. Fluoride release, recharge and mechanical property stability of various fluoride-containing resin composites. Oper Dent 2011;36(4):422–432. DOI: 10.2341/10-414-L.
14. Suzuki N, Yoneda M. Antibacterial effect of surface pre-reacted glass ionomer filler and eluate–mini review. Pharm Anal Acta 2015;06(03):3–7. DOI: 10.4172/2153-2435.1000349.
15. Fujimoto Y, Iwasa M, Murayama R, et al. Detection of ions released from S-PRG fillers and their modulation effect. Dent Mater J 2010;29(4):392–397. DOI: 10.4012/dmj.2010-015.
16. Lowe RA. Advances in composite resin materials. Inside Dent 2015;11(12):45–52.
17. Yap AUJ, Pandya M, Toh WS. Depth of cure of contemporary bulk-fill resin-based composites. Dent Mater J 2016;35(3):503–510. DOI: 10.4012/dmj.2015-402.
18. Irwandana PW, Kristanti Y, Daradjati S. Perbedaan perubahan warna pada bahan restorasi giomer dan kompomer pasca aplikasi bahan bleaching berbahan dasar hidrogen peroksida 40% sebagai bahan in office bleaching. J Ked Gi 2016;7(2):145–150.