In Vivo Longevity of Giomer as Compared to other Adhesive Restorative Materials: A Systematic Review

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ABSTRACT

In vivo longevity of Giomer as compared to other adhesive restorative materials. A systematic search was conducted using MEDLINE PubMed, EbscoHost, Scopus, Google Scholar, and manual search using College library resources were searched from January 2005 up to and including September 30, 2018, to identify appropriate studies. A total of 277 articles were identified through the database. Full-text thorough reading of 5 articles were selected and were assessed for eligibility. Further, these five articles were included in the study. At 1-year Ketac Nano and resin-modified glass ionomer cement restorations were better retained in noncarious cervical lesions, while superior color match and surface finish were observed with Giomer restorations. At 6 years, the HEMA-containing Self Etch adhesive Giomer restorations showed a rather high failure frequency.

KEYWORDS: *Adhesive restorative, Giomer, in vivo, longevity, systematic review*

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INTRODUCTION

Untreated cavitated dentine carious lesions in deciduous teeth constituted the 10th most prevalent health condition, affecting 621 million children worldwide.[1] No significant differences between both genders are seen, and disease prevalence reaches its peak at the age of 25 years, with a second peak later in life at around 70 years of age. No appreciable change in age pattern is observed.[2]

These lesions range from white spot lesions (early caries lesions with the appearance of white chalky areas on enamel) to cavities in dentin. Consequently, the control of dental caries diseases is traditionally centered on mechanical or nonspecific control of the dental plaque, because this is the causative factor.[3]

Significant progress has been made in reducing and controlling dental caries using fluoride. Fluoride can inhibit demineralization and promote remineralization of hard dental tissues. Nevertheless, the limited penetration of fluoride in dental plaque may restrict its inhibitory effects in residual plaque deposits in inaccessible stagnation sites.[4] Consequently, the prevention and management of carious lesions at proximal surfaces and around restorations are still challenges for dental caries research.[5] Composite is the most widely used and versatile dental material used for restoring dental cavities, especially because of its capacity to mimic natural tooth appearance. It is a multiphase substance composed of four major components: resin (organic polymer matrix); filler (inorganic) particles; coupling agent (silane); and the initiator-accelerator of polymerization. Despite its significant improvement over the years, drawbacks related to mechanical properties (low strength, fracture toughness, and wear), microleakage (bacterial penetration along the tooth-restoration interface), and shrinkage during the process of reacting monomer molecules to form polymer chains (polymerization) still remain. These conditions

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are closely related to the primary reasons given for the replacement of dental composites: recurrent caries and fractures.[6]

The use of adhesive materials in dentistry, particularly in the restoration of decayed teeth, is growing. The term "adhesive dentistry" refers to dental procedures and techniques that do not depend on traditional mechanical factors for retention but rather "adhere" to tooth structure. The success of adhesive dental techniques depends on establishing some form of a "bond" or "adhesion" between the restorative material and the underlying tooth substrate.

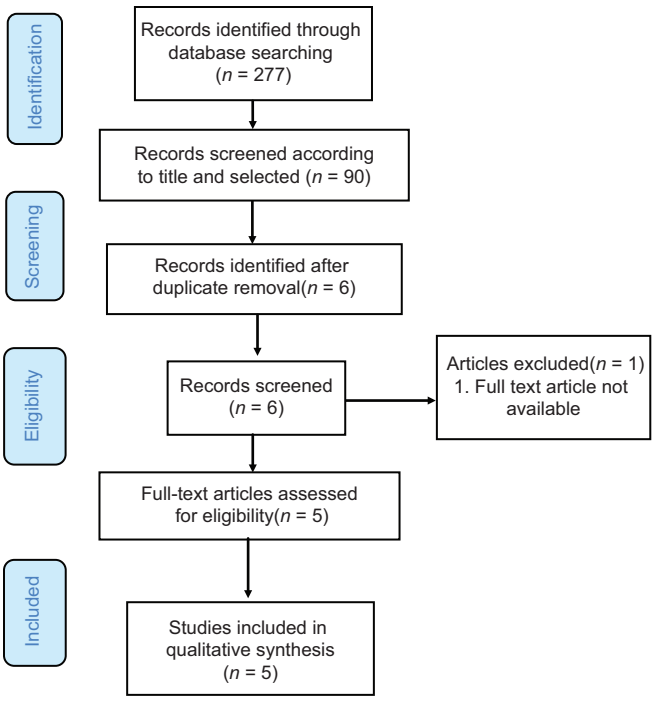
Adhesive materials show two important advantages over traditional materials, such as silver amalgam, namely: (i) That marginal leakage is prevented, thereby eliminating the development of secondary caries; and (ii) that adhesive materials are more clinically conservative since they allow the dentist to repair the tooth without removing excessive amounts of healthy tissue. Teeth repaired in this way are stronger and more likely to last than those treated with silver amalgam fillings.[7] Adhesive dental techniques are ideally suited for patients with minimal dental caries, intact teeth, and a controlled diet. Adhesive dental techniques are not suitable for patients with uncontrolled dental caries, or a sugar-rich diet, as the chances of the restorations failing due to caries are significant.[8]

Adhesive materials such as a hybrid composite resin (HCR), resin-modified glass ionomer cement (RMGIC), and glass ionomer cement (GIC) have been used for many years. Factors such as fracture resistance, fatigue resistance, degradation, erosion resistance, bonding strength, polymerization shrinkage, postoperative sensitivity, biological compatibility, technical accuracy, and anti-cariogenic effects are significant in the clinical success of restorative materials.[9]

HCR is recommended in the low caries risk group patients, compomer in the moderate caries risk group patients, and GIC with high fluoride content in the high caries risk group patients.[10] Furthermore, along with the developments in fluoride-releasing materials, giomer restorative materials are available.[11] Total and free fluoride release from Giomer was found to be higher than the compomer and lower than RMGIC.

In 2000, Shofu Inc. (Kyoto, Japan) developed an innovative filler technology of resin composite that created a stable glass-ionomer phase on a glass core in which they induced an acid-base reaction between acid reactive fluoride containing glass and polycarboxylic acid in the presence of water – developed as a prereacted

Table 1: PRISMA flow chart



glass-ionomer (PRG) filler. This PRG technology was applied to the filler component of resin composite materials to provide a bioactive result that released and was recharged with fluoride – like a traditional glass-ionomer cement, all the while maintaining the original physical properties of the resin composite system. This resin composite material with PRG filler technology is totally different from other compomers or resin-modified glass-ionomer cements – consequently these new PRG filler containing products are categorized as a Giomer. This concept is based on hybridized technology between PRG filler and resin composite material.

When the PRG technology was first developed, two PRG filler types were available: A fully PRG (F-PRG) filler and a surface PRG (S-PRG) filler. Each F-PRG and S-PRG filler technology has been applied to the self-etch adhesive system and resin composite materials. Recently, an improvement on the PRG technology has been developed that resulted in the development of modified "S-PRG filler" which consists of a three-layered structure with an original glass core of multifunctional fluoro-boro alumino-silicate glass and two-surface layers that form a PRG phase on the surface of a glass core and a reinforced modified layer that covers the surface of PRG phase – it is important to recognize the modified S-PRG filler is reinforced.[12]

Reliable bonding of resin composites to the tooth substrate has long been desired in restorative dentistry

because it reduces postoperative sensitivity and increases the longevity of restorations. Advances in adhesive technology have facilitated the restoration of tooth defects by direct resin composite placement. Recently, single-step self-etch adhesives, which combine the functions of the conditioner, primer, and bonding resin, have been developed to simplify and shorten this clinical procedure. The single-step self-etch adhesive is applied to the tooth surface and improves adhesion by enhancing monomer penetration of the tooth substrate. Although self-etch adhesives are user-friendly adhesive systems, careful management of each product is required to achieve optimal results. Most single-step self-etch adhesives have a moderately acidic pH: They dissolve the smear layer but do not demineralize the deeper portion of the dentin. Self-etch adhesives do not etch enamel as deeply as phosphoric acid; thus, bond strength with the enamel is lower. The moderate pH results in lower enamel bond strength as compared with adhesives utilizing phosphoric acid for pretreatment. The clinical performance of composite restorations is likely to be affected by carious dentin, lesion location, size, and shape, operator variability, and occlusal forces.[13]

Dentists need to consider various factors when choosing restorative materials, with the longevity of restorations being one of the most important criteria. Replacement of failed restorations constitutes over 60% of operative procedures, leading to high annual costs. The longevity of restorations depends on many factors, including materials used, type of restorative procedure, patient parameters, operator variables, and local factors.[14]

Materials and Methods

The methodology used in this systematic review includes:

- A literature search strategy,
- Selection criteria,
- Screening and data extraction.

The PRISMA 2009 flow chart was followed in this systematic review.

PICO:

- P: Human Teeth
- I: Giomer
- C: Other Adhesive Restorative Materials
- O: *In vivo* Longevity.

Two Internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: Namely the National Library of Medicine (MEDLINE PubMed) and the Cochrane Central Register of Controlled Trials, Google Scholar, Google, Clinical trials registry, and manual search using college library resources. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria. The databases were searched up to and including September 2018 using the search strategy. The following combination of key words were used: Giomer and clinical evaluation and adhesive restorative, Giomer and/or Beautifil and adhesive restorative, Adhesive restorative and Clinical evaluation Giomer or Beautifil and clinical evaluation and adhesive, Giomer and Resin modified glass ionomer and clinical evaluation, Giomer and Composite resin and clinical evaluation, Giomer or Beautifil and RMGIC, Giomer and Beautifil, Giomer and longevity.

Inclusion criteria

1. Articles in English language or those having summary in English
2. Full text articles
3. Case reports published from January 1, 2005 to September 30, 2018
4. *In vivo* studies
5. Studies comparing *in vivo* longevity of Giomer and other adhesive restorative materials.

Exclusion criteria

1. Studies in languages other than English
2. Review, abstract, letter to editorials are excluded
3. Any studies done before January 1, 2005
4. *In vitro* studies.

Results

A total of 277 articles [Table 1] were identified through the database searching. These articles were then screened for titles. After a thorough reading of titles, 185 articles were excluded as they did not match the motive of the study. Further, 90 articles were assessed for any duplicates and 84 articles were removed. Remaining six articles were then screened for abstracts, and no articles were excluded after the screening of abstracts. A thorough reading of the full text of the remaining 6 articles selected were assessed for eligibility. One article was then excluded from the study, since the full text was not accessible. Finally, only 5 articles were included in the study.

Discussion

Summary of evidences

Reliable bonding of restorative materials to the tooth substrate increases the longevity of the restoration, and also it reduces postoperative. Over the years, various adhesive restorative materials have been used, and these include GIC, resin-modified GIC, composite resins, compomer, reinforced materials, etc. Giomer is a relatively new group of restorative resin that has

prereacted glass particles. It was introduced in the year 2000 by Shofu. It has been recommended to be used as an adhesive aesthetic restorative material. This systematic review aims to evaluate the *in-vivo* longevity of Giomer with other adhesive restorative material.

Five studies met the inclusion criteria established for the present systematic review:

1. Van Dijken[13] in 2013 evaluated the clinical effectiveness of a one-step 2-HydroxyEthyl Methacrylate (HEMA)-free self-etching adhesive (SEA) placed with a micro-fine hybrid resin composite in class II restorations. The restorations were compared intra-individually with 2-step HEMA containing SEA-Giomer restorations. Fifty-four patients with at least one pair of two similar Class II cavities participated (30 men, 24 women; mean age 57.1 years). A total of 115 Class II composite restorations were placed with (1) a one-step HEMA-free adhesive and a micro-fine hybrid resin composite (Gbond/Gradia Direct: 60; GG) and (2) a 2-step HEMA-containing SEA and a Giomer (FL Bond/Beautifil: 55; FB). Each participant received in a randomized way at least one restoration with each of the experimental materials. The restorations were evaluated at baseline and yearly during a 6-year follow up using modified USPHS criteria. During the 6 years, Fourteen failed restorations (12.6%) were observed during the follow-up, 5 GG (8.5%; 4 premolar and 1 molar teeth), and 9 FB (17.7%; 1 premolar and 8 molar teeth) ($P < 0.05$). The annual failure rate at 6 years was 1.4% for GB and 3.0% for FB. The main reasons for failure were bulk fracture of resin composite for FB and tooth fracture for GB. The HEMA-free SEA-hybrid RC restorations showed good clinical durability in Class II cavities after 6 years. The HEMA-containing SEA-Giomer restorations showed a rather high failure frequency
2. Matis *et al*.[14] in 2004 conducted a study to determine retention, anatomical form, caries, staining, marginal discoloration, marginal adaptation, surface roughness, and sensitivity of Giomer compared with those of a micro-filled composite. They placed 40 sets of restorations randomly in canines and premolars *in vivo*. They used a Giomer composite and a micro-filled composite in erosion/abrasion/abfraction Class V lesions that were not altered with rotary instruments. They placed the restorations according to the manufacturer's recommendations, and two calibrated examiners evaluated the restorations independently using modified U. S. Public Health Service criteria at baseline and at 6, 18, and 36 months. The lesions receiving the restorations did not differ from each other in the amount of circumferential enamel present, the percentage of the surface area of dentin or lesion type. There were no differences in the restorations at baseline, an evaluation made 2 weeks after placement. At 36 months, the Giomer and micro-filled composite restorations were not significantly different from one another in any of the eight criteria evaluated. The percentage agreement between examiners was at least 83% for each criterion in each evaluation period. Both the Giomer and the micro-filled composite used in this study meet the clinical portion of the Acceptance Program Guidelines for Dentin and Enamel Adhesives Materials established by the American Dental Association
3. Sengul and Gurbuz[9] in 2015 conducted a study to evaluate clinical success of primary teeth class II lesions restored with different restorative materials (HCR, RMGIC, compomer, and Giomer Composite Resin [GCR]) followed up for 24 months. Study design: This study was carried out on 146 primary molars of 41 children in the age range of 5–7 years. The class II lesions in primary molars of a patient were restored using different restorative materials. Restorations were evaluated according to a Foreign Direct Investment criteria, and their survival rates were determined. Data were analyzed with Pearson Chi-square, Kaplan–Meier, and Wilcoxon (Breslow) tests ($\alpha = 0.05$). Results**:** The failure rates of restorative materials were as follows: Compomer 33.3%, RMGIC 28.1%, HCR 22.5%, and GCR 21.1%. Conclusions: While the functional failure was the most important factor in restorative material failure, RMGIC was the most successful material in terms of biological evaluation criterion, and GCR had the longest survival rate
4. Jyothi *et al*.[15] in 2011 conducted a study was to evaluate and compare the clinical performance of Giomer (Beautifil II) and RMGIC (Fuji II LC) in the noncarious cervical lesion (NCCL). Thirty-two subjects with one or two pairs of NCCL with the depth ranging from 1 to 3 mm were included in the study, and written informed consent was obtained. Thus, a total of 80 restorations were performed. The minimum sample size required was 25 in each group. Anticipating the loss to follow-up we selected 40 in each group. The lesions were classified as being saucer-shaped or V-shaped. The presence of sensitivity was recorded by taking the history and clinical examination. The selected pair of lesions in each subject was randomly assigned for either RMGIC or Giomer. The subjects were called at the end of 15 days, 6 months, and 1 year for evaluation of restorations by a single calibrated investigator using mirror and explorer under good operating light using USPHS criteria. None of the restorations, either Giomer or RMGIC showed surface staining, marginal discoloration or postoperative sensitivity

5. Priyadarshini *et al*.[16] in 2017 in 2017 evaluated the clinical performance of Ketac Nano (Ketac™ N100), RMGIC (Fuji Filling™ LC), and Giomer (Beautifil® II) in NCCLs. Materials and Methods: One operator restored 120 NCCLs in 20 subjects, with at least two lesions restored with one of the restorative materials: RMGIC (control group), Giomer and Ketac Nano (experimental groups). Two observers evaluated retention, marginal discoloration, marginal adaptation, color match, surface roughness, and postoperative sensitivity using modified USPHS criteria at baseline, 6, and 12 months. There was a statistically significant difference observed between Giomer, Ketac Nano and RMGIC after 12 months ($P < 0.05$). There was a significant decrease in retention rates for Giomer ($P = 0.0050$), increased marginal discoloration and color mismatch for Ketac Nano ($P = 0.0025$, $P = 0.0053$), increased surface roughness and color mismatch with RMGIC ($P = 0.0022$, $P = 0.0077$) from baseline to 12 months. They concluded that within the limitations of this RCT of 12 months, Ketac Nano and RMGIC restorations were better retained in NCCLs while superior color match and surface finish were observed with Giomer restorations.

Conclusions

From this systematic review it can be concluded that:

i. High HEMA content promotes water uptake and subsequent gradual hydrolytic degradation of the polymers, swelling, and staining. HEMA-free, less hydrophillic have been introduced to overcome the disadvantages of HEMA. These adhesives may show reduced water sorption, higher stability of mechanical properties, the stability of the interfacial bond, improvement in bonding durability and reduced allergenic potential.
ii. The clinical parameters of all the above articles are comparable up to 1 year.
iii. At 1-year Ketac, Nano and RMGIC restorations were better retained in NCCLs while superior color match and surface finish were observed with Giomer restorations.
iv. RMGIC was the most successful material in terms of biological evaluation criterion, and GCR had the longest survival rate in primary teeth.
v. At 6 years, The HEMA-containing SEA-Giomer restorations showed a rather a high frequency of failure.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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