Review Article

SUCCESS OF RESIN MODIFIED VS. CONVENTIONAL GLASS IONOMER CEMENT AS LUTING AGENTS; A SYSTEMATIC REVIEW

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ABSTRACT

It is crucial to emphasize that using these permanent luting cement, especially those reinforced with resin (such as resin-modified glass ionomer cement and resin-based types of cement), can have several clinical benefits. In particular, the low cement solubility can reduce the risk of pulp damage and reduce secondary caries. A systematic literature review from 2000 to 2023 was performed using PubMed, Medline, and ScienceDirect databases. All adhesives exhibited a substantial decline in SBS during TC aging ($p<0.05$), although PAN demonstrated the highest SBS. As an alternative to glass ionomer cement for luting alloy substrates, specific universal resin-luting cement may produce a consistent binding strength to prosthetic substrates. The findings suggest that RMGI cement may offer advantages over conventional GIC as a luting agent in terms of improved surface protection, reduced microleakage, and enhanced mechanical properties. However, further research is needed to assess the long-term clinical success and durability of RMGI in various prosthodontic applications.

Key words: Resin modified GIC, Conventional GIC, Luting agents, Systematic review.

Introduction

Polycrystalline silica-free ceramics (like zirconia and alumina) and silica-based ceramics (like feldspathic, leucite-reinforced, and lithium disilicate ceramics) are only two examples of the many options available for prosthetics today. Cast restorations (such as porcelain-fused-to-metal or full metal crowns and bridges) often use noble metal alloys based on Ag-Pd-Cu-Au as an alternative to ISO type-III or type-IV alloys containing gold; in some countries, such as Japan, insurances cover the cost of such alloys for restorative and prosthetic treatments [1].

Restorative dentistry relies heavily on luting procedures to guarantee the durability of indirect restorations. Various luting cement and prosthetic substrate options are now available, each with its own set of desirable biological, physicochemical, and esthetic properties [1]. It's debatable if luting cement is a temporary or permanent substance. The first category includes two distinct "provisional luting cement types," sometimes known as "temporary cement."Provisional luting cement refers to the first category of materials, among which calcium hydroxide cement and zinc oxide cement are the most common. Permanent luting cement, on the other hand, is any compound with adhesive properties toward various dental and/or prosthetic substrates [2]. Zinc phosphate and silicate cement are examples of luting materials with low strength, whereas polycarboxylate cement and glass ionomer are examples of luting materials with medium strength. The present investigation zeroed attention on high-strength luting cement, which may be cured by chemical/self-activation, light curing, or a combination [3, 4]. When it comes to bonding, however, high-strength resin cement is subdivided into subcategories like luting resin cement and self-adhesive resin cement. Using luting resin cement has traditionally required priming or surface preparation of the binding substrates.

Direct bonding to surfaces is best accomplished using self-adhesive resin cement, which has silanes and particularly sticky functional monomers (such as 10-MDP) that guarantee retention. They immediately surpassed all other resin cements in popularity due to their innovative but simple construction and potential therapeutic uses [5]. Using such materials would eliminate the need for substrate pretreatments such as acid etching and adhesive primers, albeit general practitioners still need to be made aware of the bonding procedures [3, 4].

It is crucial to emphasize that using these permanent luting cement, especially those reinforced with resin (such as resin-modified glass ionomer cement and resin-based types of cement), can have several clinical benefits. In particular, the low cement solubility can reduce the risk of pulp damage and reduce secondary caries [6]. Employing such

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materials to cement cast posts and core build-ups may significantly reduce the risk of root fractures. Further, adhesive resin-based types of cement were said to boost indirect cosmetic ceramic and composite restorations' longevity and resistance to fracture [7].

However, it is well-accepted that certain pretreatments should be used to bond the tooth and prosthetic surfaces perfectly. The quality of the particular equipment and the operators' deft use are just as important to the success of surface pretreatments as the operators' training and expertise. In the last 10 years, novel resin cement with particular qualities has rapidly advanced, which may enable doctors to give enough bonding force while using user-friendly and simpler surface treatments. However, there needs to be more information on the bonding ability of more recent self-sticking resin cement when attached to a range of prosthetic substrates compared to traditional or self-adhesive resin-based and resin-modified glass ionomer cement (RMGICs) [8].

Therefore, this systematic review aimed to compare the effectiveness of ordinary glass ionomer cement and resin-modified glass ionomer as luting agents.

Materials and Methods

This study used PubMed, Medline, and ScienceDirect to conduct a comprehensive literature search spanning 1998–2021. Search terms included "resin-modified GIC," "conventional GIC," and "luting agent." To illustrate how we chose which papers to search, we used the PRISMA flowchart **(Figure 1)**.

Inclusion criteria
Case-control and randomized-control trials
published in English between 1998 and 2021 were included as well as the in-vivo (humans).

Exclusion criteria
Expert opinion, narrative reviews, systematic reviews
research conducted outside the given time frame,
studies conducted in languages other than English
studies conducted in vitro were excluded.

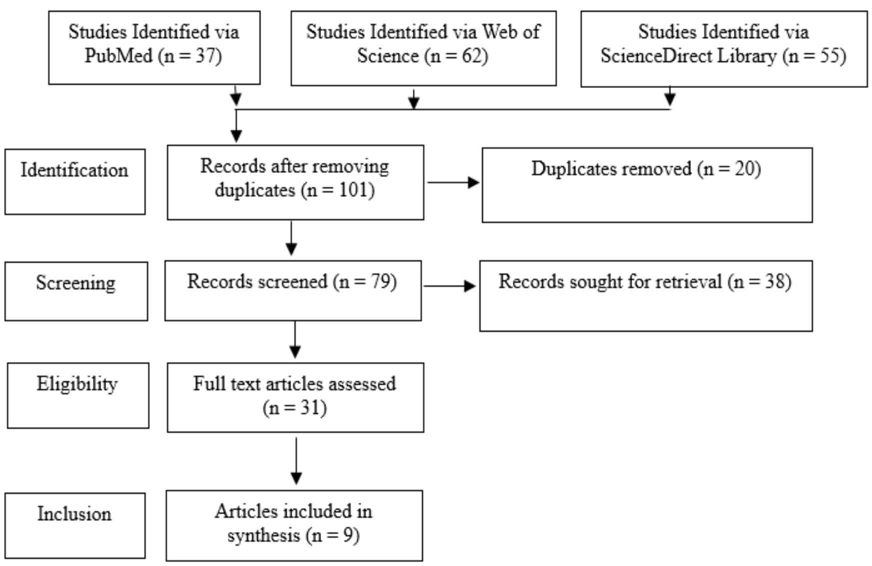

Figure 1. PRISMA Flow Diagram

Risk of bias assessment
Cochrane risk of bias assessment method was used to assess the quality of the studies included **(Table 1)**.

Table 1. Summary of Cochrane Risk of Bias Assessment

Study	Selection Bias/Appropriate control selection/baseline characteristics similarity	Selection bias in randomization	Selection bias in allocation concealment	Performance-related bias in blinding	Reporting bias/Selective reporting of outcomes	Detection bias Blinding outcome assessors	Accounting for confounding bias

Sabatini *et al*., (2013) [9]	+	+	+	+	+	+	+
Karaoglanoglu *et al*., (2009) [10]	+	+	+	+	+	+	+
Millett *et al*., (2003) [11]	+	+	-	+	+	+	+
Maño *et al*., (2020) [1]	+	+	+	+	+	+	+
Rekha *et al*., (2012) [12]	+	+	+	+	+	-	+
Pameijer *et al*., (2015) [13]	+	+	+	+	+	+	+
Sreeramulu *et al*., (2015) [14]	+	-	+	+	+	+	+
Leevailoj *et al*., (1998) [15]	+	+	+	+	+	+	+
Mitchell *et al*., (1999) [16]	+	+	+	+	+	-	+

Table 2. Summary of the findings from included studies

Author's name	Objective	Specimens	Results
Sabatini *et al*., (2013) [9]	To assess the shear bond strength (SBS) between several prosthodontic substrates, three self-adhesive resin cement, and a resin-modified glass ionomer cement (RMGIC).	12	Compared to the three further self-adhesive resin cement, FujiCEM showed considerably reduced SBS overall (p<0.05).
Karaoglanoglu *et al*., (2009) [10]	This study aimed to determine dye uptake spectrophotometrically to assess the efficacy of various surface protectors for a glass-ionomer, a resin-modified glass-ionomer, and a polyacid-modified resin cement.	378	The Vitremer group did not show any statistically significant changes.
Millett *et al*., (2003) [11]	This research compared micro-etched orthodontic bands glued using resin-modified glass ionomer cement in terms of mean shear-peel bond strength and the most common location of bond failure.	120	the conventional GIC's fatigue characteristics under simulated mechanical stress appear to be worse than those of the other cement for band cementation.
Maño *et al*.,, (2020) [1]	This research aimed to assess the shear bond strength (SBS) of contemporary resin-modified glass ionomer cement and self-adhesive resin cement used on various prosthetic substrates.	10	All adhesives exhibited a substantial decline in SBS during TC aging (p<0.05).
Rekha *et al*., (2012) [12]	In this research, the tensile bond strength and microleakage of compo glass, Fuji IX GP, and Fuji II LC were evaluated and compared.	96	Tensile strength and microleakage levels varied significantly amongst the three groups.
Pameijer *et al*., (2015) [13]	Flexural strength and flexural fatigue tests were used to ascertain the physical characteristics of several resin-modified glass ionomers (RMGIs) and to compare them to flowable composite resins and traditional glass ionomer cement (GICs).		Activa-enhanced RMGIs and flowable composites showed much higher flexural fatigue than all other materials (p=0.001).
Sreeramulu *et al*., (2015) [14]	To analyze and assess the tensile bond strength of four commercially available luting agents.	40	The glass ionomer fuji 1 (GC), zinc phosphate cement, and resin-modified glass ionomerRely XTMLuting 2 (3M ESPE) were the materials with the greatest retentive strength, followed by adhesive resin multilink speed cement.
Leevailoj *et al*., (1998) [15]	In-Ceram and VitaDur Alpha porcelain jackets, all ceramic crowns cemented with 5 luting agents over 2 months of storage in 0.8% NaCl solution, were the subjects of this research, which assessed the fracture incidence.	50	Results for the genuine resin-modified glass ionomer cement do not corroborate anecdotal claims that these materials caused all-ceramic crowns to shatter after being cemented.
Mitchell *et al*., (1999) [16]	This research looked at the fracture toughness of three different kinds of luting cement to see if there were any notable changes between them.	11	The resin composite cement is evaluated to see whether it can withstand clinical failure brought on by cement cohesive failure.

Results and Discussion

Table 2 shows that the study done by Sabatini *et al*. (2013) [9] assessed the shear bond strength (SBS) between several prosthodontic substrates, three self-adhesive resin cement, and a resin-modified glass ionomer cement (RMGIC). The LP and 24-hour modes showed significantly greater mean SBS than the SP modes . Compared to the three further self-adhesive resin cement, FujiCEM showed considerably reduced SBS overall ($p<0.05$).

The research done by Karaoglanoglu *et al*. (2009) [10] aimed to determine dye uptake spectrophotometrically to assess the efficacy of various cements. The variance analysis was used to examine the results. The Vitremer group did not show any statistically significant changes, nevertheless.

Millett *et al*. (2003) [11] revealed that the enamel/cement contact was where conventional GIC specimens generally failed. The results show that while the band cement' mean shear-peel bond strengths seem to be equivalent, the conventional GIC's fatigue characteristics under simulated mechanical stress appear to be worse than those of the other cement for band cementation.

The research done by Maño *et al*. (2020) [1] reported that tthere was no change in SBS between GC-GIC and 3M-RES. All adhesives exhibited a substantial decline in SBS during TC aging ($p <0.05$), although PAN demonstrated the highest SBS. Specific universal resin-luting cement may produce a reliable binding strength to prosthetic substrates and may be an alternative to glass ionomer cement for luting alloy substrates.

In the research done by Rekha *et al*. (2012) [12], the tensile bond strength and microleakage of compoglass, Fuji IX GP, and Fuji II LC were evaluated and compared, as well as the bond strength.. The tensile strength of Compoglass was the greatest, while the microleakage of Fuji II LC was the least. Between the three groups, there were substantial differences in tensile strength and microleakage levels.

Pameijer *et al*. (2015) [13] conducted the research in which flexural strength and flexural fatigue tests were used to ascertain the physical characteristics of several resin-modified glass ionomers (RMGIs) and to compare them to flowable composite resins and traditional glass ionomer cement (GICs). Statistics were used to compare the data (ANOVA, SNK, $p<0.05$). The least frequent occurrences approach (failures against non-failures) was used to analyze statistical data for flexural fatigue. Compared to all other RMGIs and GICs, Activa-enhanced RMGIs' flexural strength was statistically considerably higher (p 0.001). Activa-enhanced RMGIs and flowable composites showed much higher flexural fatigue than all other materials ($p=0.001$). The two flowable composites put to the test and the Activa-enhanced RMGIs' flexural fatigue were equivalent.

In the investigation done by Sreeramulu *et al*. (2015) [14] reported thatThe glass ionomer fuji 1 (GC), zinc phosphate cement, and resin-modified glass ionomerRely XTMLuting 2 (3M ESPE) were the materials with the greatest retentive strength, followed by adhesive resin multilink speed cement.

Leevailoj *et al*., (1998) [15] assessed the fracture incidence. For each ceramic system, fifty human maxillary premolar teeth were manufactured, separated into five groups of ten teeth each, and then bonded using five different luting types of cement. As the amount of storage time grew, cracks started around the edge of the crown, and many fracture lines were discovered. Porcelain jacket crowns were substantially weaker (98.6 17.8 kg) than in-ceramic crowns (140 21.5 kilograms), according to $p<0.05$.

The research done by Mitchell *et al*. (1999) [16] looked at the fracture toughness of three different kinds of luting cement to see if there were any notable changes between them and whether the value achieved varied depending on whether typical glass-ionomer luting adhesives were mechanically mixed or mixed by hand. Eleven specimens of each of the six types of cement were created for the chevron notch short rod procedure to measure the plane strain fracture toughness. The specimens were loaded in a water bath at a crosshead speed of 4 mm/s after seven days, and the results for fracture toughness were computed. The Fisher's PSLD test was used to compare each cement to all others after the ANOVA revealed significant differences between the cement ($p<0.0001$).

The studies analyzed the properties and success of resin-modified glass ionomer (RMGI) cement compared to conventional glass ionomer cement (GIC) as luting agents. Several factors were evaluated, including shear bond strength, surface protection efficacy, bond failure location, tensile bond strength, microleakage, flexural strength, fatigue resistance, retentive strength, fracture incidence, and fracture toughness. Compared to SBS values obtained when the cement was left to self-polymerize, those obtained when the specimens were exposed to light were much greater. Similar findings are reported in the literature. After light polymerization, improvements in SBS were observed for all three self-adhesive resin cements. However, it was discovered that this effect was cement-specific [17]. The qualities and quantities of resin, particularly hydrophilic resin, may account for these divergent results [18].

The average shear-peel bond strength did not vary noticeably amongst cement types in the current investigation. Both RMGICs were similarly strong in terms of bond strength measurements. This corroborates the results seen with this specific cement brand's products. According to these findings, the conventional GIC had a similar shear-peel bond strength to the other cement tested. For band cementation on molar teeth, there seems to be no prior laboratory investigation comparing the novel cement to a standard GIC [19, 20].

The glass ionomer setting process and the chemical polymerization of the resin follow. Cement's wear resistance and physical strength are greatly improved by adding the resin component, shortening the cement's initial hardening period, and easing its handling. Group 2 resin-modified glass ionomer cement, as opposed to group 1, has a 20% resin component, which may explain its better tensile bond strength. The tensile bond strength for resin-modified glass ionomer cement was higher than chemically cured cement [21, 22]. The results suggest that employing certain RMGIs for Class I, II, III, and V restorations may be perfect [23, 24].

Dental luting agents connect the restoration and the prepared tooth by forming a surface connection (mechanical, micro-mechanical, chemical, or combination) [25]. Several elements contribute to the long-term clinical effectiveness of fixed prosthodontic and cast restorations, including the preparation design, oral hygiene and microflora, mechanical pressures, and restorative materials. But picking the right luting chemical and cementation technique is crucial to success. Numerous studies have looked into the preservation of cast restorations using various types of cement. These experiments' results are mixed, but they do demonstrate that no cement is clearly superior to the others. There was a statistically significant difference in retention between the four luting agents in this trial. The adhesive strength of zinc phosphate cement (Harvard cement) was the lowest of the four luting types of cement tested [26, 27]. Water absorption and strength may vary greatly among methyl methacrylate-based proprietary composites in resin cement due to variations in the filler matrix bond. They enhanced the filler matrix binding using coupling agents like silane. And 4-META may slow water absorption by decreasing interfacial water diffusion. Low water absorption and expansion may be partly due to the coupling agents used to handle the filler component in Panavia. The expansion and water absorption processes of advanced cement are mysterious. The exact chemical makeup of this substance remained unknown. All-ceramic crowns cemented with Advance may crack under extreme tensile stress if the filler matrix does not adhere well and the filler is hydrophilic (like fluoride-releasing glass). The setting process, material characteristics, water sorption, and expansion behaviors of fluoride-releasing resin cement need further study [28-30].

Conclusion

The findings suggest that RMGI cement may offer advantages over conventional GIC as a luting agent in terms of improved surface protection, reduced microleakage, and enhanced mechanical properties. However, more investigation is required to evaluate the endurance and long-term clinical performance of RMGI in a variety of prosthodontic applications.

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References

1. Maño EP, Algarra RM, Fawzy A, Leitune VC, Collares FM, Feitosa V, et al. In vitro bonding performance of modern self-adhesive resin cements and conventional resin-modified glass ionomer cements to prosthetic substrates. Appl Sci. 2020;10(22):8157.
2. Alaghemandan H, Ferdosi M, Savabi O, Yarmohammadian MH. Proposing a Framework for Accreditation of Dental Clinics in Iran. J Organ Behav Res. 2022;7(2):161-70.
3. Bandarra S, Neves J, Paraíso A, Mascarenhas P, Ribeiro AC, Barahona I. Biocompatibility of self-adhesive resin cement with fibroblast cells. J Prosthet Dent. 2021;125(4):705-e1.
4. Balaji A, Jei JB, Muthukumar B. Comparison and evaluation of the effect of polymerization of resin modified glass ionomer cement and dual cure resin cement on the crystalline structure of dentin using synchrotron X ray diffraction and its clinical correlation with postoperative sensitivity. J Indian Prosthodont Soc. 2023;23(2):119-26.
5. Ashurko I, Esayan A, Magdalyanova M, Tarasenko S. Current concepts of surgical methods to increase mucosal thickness during dental implantation. J Adv Pharm Educ Res. 2021;11(3):37-41.
6. Mekereș GM, Buhaș CL, Tudoran C, Csep AN, Tudoran M, Manole F, et al. The practical utility of psychometric scales for the assessment of the impact of posttraumatic scars on mental health. Front Public Health. 2023;11:1103714.
7. Calheiros-Lobo MJ, Vieira T, Carbas R, da Silva LF, Pinho T. Effectiveness of Self-Adhesive Resin Luting Cement in CAD-CAM Blocks—A Systematic Review and Meta-Analysis. Materials. 2023;16(8):2996.
8. Kheur M, Kantharia N, Iakha T, Kheur S, Husain NA, Özcan M. Evaluation of mechanical and adhesion

properties of glass ionomer cement incorporating nano-sized hydroxyapatite particles. Odontology. 2020;108:66-73.
9. Sabatini C, Patel M, D'Silva E. In vitro shear bond strength of three self-adhesive resin cements and a resin-modified glass ionomer cement to various prosthodontic substrates. Oper Dent. 2013;38(2):186-96.
10. Karaoglanoglu S, Akgül N, Özdabak HN, Akgül HM. Effectiveness of surface protection for glass-ionomer, resin-modified glass-ionomer and polyacid-modified composite resins. Dent Mater J. 2009;28(1):96-101.
11. Millett DT, Cummings A, Letters S, Roger E, Love J. Resin-modified glass ionomer, modified composite or conventional glass ionomer for band cementation?—an in vitro evaluation. Eur J Orthodont. 2003;25(6):609-14.
12. Rekha CV, Varma B. Comparative evaluation of tensile bond strength and microleakage of conventional glass ionomer cement, resin modified glass ionomer cement and compomer: An in vitro study. Contemp Clin Dent. 2012;3(3):282.
13. Pameijer CH, Garcia-Godoy F, Morrow BR, Jefferies SR. Flexural strength and flexural fatigue properties of resin-modified glass ionomers. J Clin Dent. 2015;26(1):23-7.
14. Sreeramulu B, Suman P, Ajay P. A comparison between different luting cements on the retention of complete cast crowns-an in vitro study. Int J Healthc Biomed Res. 2015;3(04):29-35.
15. Leevailoj C, Platt JA, Cochran MA, Moore BK. In vitro study of fracture incidence and compressive fracture load of all-ceramic crowns cemented with resin-modified glass ionomer and other luting agents. J Prosthet Dentist. 1998;80(6):699-707.
16. Mitchell CA, Douglas WH, Cheng YS. Fracture toughness of conventional, resin-modified glass–ionomer and composite luting cements. Dent Mater. 1999;15(1):7-13.
17. Alrefeai MH, Aljamhan AS, Alhabdan A, Alzehiri MH, Naseem M, Alkhudhairy F. Influence of methylene blue, Riboflavin, and indocyanine green on the bond strength of caries affected dentin when bonded to resin-modified glass ionomer cement. Photodiagnosis Photodyn Ther. 2022;38:102792.
18. Thepveera W, Potiprapanpong W, Toneluck A, Channasanon S, Khamsuk C, Monmaturapoj N, et al. Rheological Properties, Surface Microhardness, and Dentin Shear Bond Strength of Resin-Modified Glass Ionomer Cements Containing Methacrylate-Functionalized Polyacids and Spherical Pre-Reacted Glass Fillers. J Funct Biomater. 2021;12(3):42.
19. Panpisut P, Suppapatpong T, Rattanapan A, Wongwarawut P. Monomer conversion, biaxial flexural strength, apatite forming ability of experimental dual-cured and self-adhesive dental composites containing calcium phosphate and nisin. Dent Mater J. 2021;40(2):399-406.
20. Hassan AM. Evaluation of The Microleakage of Polyacid Modified Composite Compared to Hybrid Composite and Resin Modified Glass Ionomer Cement in Primary and Permanent Teeth Restoration (An in vitro study).
21. Nica I, Stoleriu S, Iovan A, Tărăboanță I, Pancu G, Tofan N, et al. Conventional and Resin-Modified Glass Ionomer Cement Surface Characteristics after Acidic Challenges. Biomedicines. 2022;10(7):1755.
22. Ana ID, Anggraeni R. Development of bioactive resin modified glass ionomer cement for dental biomedical applications. Heliyon. 2021;7(1):e05944.
23. Nishanthine C, Miglani R, Indira R, Poorni S, Srinivasan MR, Robaian A, et al. Evaluation of fluoride release in chitosan-modified glass ionomer cements. Int Dent J. 2022;72(6):785-91.
24. Bezerra IM, Brito AC, de Sousa SA, Santiago BM, Cavalcanti YW, de Almeida LD. Glass ionomer cements compared with composite resin in restoration of noncarious cervical lesions: A systematic review and meta-analysis. Heliyon. 2020;6(5):e03969.
25. Aboalshamat K, Alhuzali R, Alalyani A, Alsharif S, Qadhi H, Almatrafi R, et al. Medical and Dental Professionals Readiness for Artificial Intelligence for Saudi Arabia Vision 2030. Int J Pharm Res Allied Sci. 2022;11(4):52-9.
26. Koc Vural U, Kerimova L, Kiremitci A. Clinical comparison of a micro-hybride resin-based composite and resin modified glass ionomer in the treatment of cervical caries lesions: 36-month, split-mouth, randomized clinical trial. Odontology. 2021;109:376-84.
27. Aydın N, Karaoğlanoğlu S, Aybala-Oktay E, Çetinkaya S, Erdem O. Investigation of water sorption and aluminum releases from high viscosity and resin modified glass ionomer. J Clin Exp Dent. 2020;12(9):e844.
28. Sharafeddin F, Jowkar Z, Bahrani S. Comparison between the effect of adding microhydroxyapatite and chitosan on surface roughness and Microhardness of resin modified and conventional glass ionomer cements. J Clin Exp Dent. 2021;13(8):e737.
29. Martínez-Rus F, Rodríguez C, Salido MP, Pradíes G. Influence of different cleaning procedures on the shear bond strength of 10-methacryloyloxydecyl dihydrogen phosphate-containing self-adhesive resin cement to saliva contaminated zirconia. J Prosthodont Res. 2021;65(4):443-8.
30. Manso AP, Chander K, Campbell KM, Palma-Dibb RG, Carvalho RM. Effects of aging on shear bond strength to dentin and mechanical properties of restorative glass ionomer cements. Int J Adhes Adhes. 2020;102:102693.