ID Design 2012/DOOEL Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2016 Dec 15; 4(4):695-699.
https://doi.org/10.3889/oamjms.2016.116
eISSN: 1857-9655
Stomatology

A Twofold Comparison between Dual Cure Resin Modified Cement and Glass Ionomer Cement for Orthodontic Band Cementation

Hanaa El Attar[1*], Omnia Elhiny[2], Ghada Salem[3], Ahmed Abdelrahman[4], Mazen Attia[5]

[1]Suez Canal University, Faculty of Dentistry, Orthodontics, Faculty of Dentistry, Umm al Qura University, Orthodontics, Ismailia - el Gamaa street, Ismailia 0000, Egypt; [2]National Research Center, El Bohouth str., Cairo 12622, Egypt; [3]Faculty of Dentistry Fayoum University, Paedoodontics, Fayoum, Egypt; [4]Faculty of Dentistry, MTI University, Cairo, Egypt; [5]Faculty of Dentistry, Beni Suef University, Fixed Prosthodontics, Cairo, Egypt

Citation: El Attar H, Elhiny O, Salem G, Abdelrahman A, Attia M. A Twofold Comparison between Dual Cure Resin Modified Cement and Glass Ionomer Cement for Orthodontic Band Cementation. Open Access Maced J Med Sci. 2016 Dec 15; 4(4):695-699. https://doi.org/10.3889/oamjms.2016.116

Keywords: dual cure resin; glass Ionomer; orthodontic band; band cementation; solubility.

***Correspondence:** Dr Hanaa Mohamed Samir El Attar. Suez Canal University Faculty of Dentistry, Orthodontics, Ismailia- el Gamaa street, Ismailia 0000, Egypt. E-Mail: hanaaelattarr@yahoo.com

Received: 27-Sep-2016; **Revised:** 04-Oct-2016; **Accepted:** 05-Oct-2016; **Online first:** 21-Oct-2016

Funding: This research did not receive any financial support.

Competing Interests: The authors have declared that no competing interests exist.

Abstract

AIM: To test the solubility of dual cure resin modified resin cement in a food simulating solution and the shear bond strength compared to conventional Glass ionomer cement.

MATERIALS AND METHOD: The materials tested were self-adhesive dual cure resin modified cement and Glass Ionomer (GIC). Twenty Teflon moulds were divided into two groups of tens. The first group was injected and packed with the modified resin cement, the second group was packed with GIC. To test the solubility, each mould was weighed before and after being placed in an analytical reagent for 30 days. The solubility was measured as the difference between the initial and final drying mass. To measure the Shear bond strength, 20 freshly extracted wisdom teeth were equally divided into two groups and embedded in self-cure acrylic resin. Four mm sections of stainless steel bands were cemented to the exposed buccal surfaces of teeth under a constant load of 500 g. Shear bond strength was measured using a computer controlled materials testing machine and the load required to deband the samples was recorded in Newtons.

RESULTS: GIC showed significantly higher mean weight loss and an insignificant lower Shear bond strength, compared to dual cure resin Cement.

CONCLUSION: It was found that dual cure resin modified cement was less soluble than glass ionomer cement and of comparable bond strength rendering it more useful clinically for orthodontic band cementation.

Introduction

Traditional systems for bonding orthodontic brackets and bands require multiple steps including etching, rinsing, drying and application of primer before using adhesive resin. This was time-consuming and may affect the bond strength of the brackets or bands [1]. Self-adhesive resin cements were introduced to the dental market in 2002. They did not require pre-treatment of the tooth surface, and they are fluoride releasing cements similar to glass ionomer [2], hence they were thought to be easier to handle, had shorter chair-time and decreased technique sensitivity [3].

Self-adhesive resin cements have better mechanical properties than resin modified glass ionomer [4]. This may render it as a good candidate for cementing orthodontic bands which are subjected to a great number of forces in the mouth and adequate bond strength is important for the long treatment period needed with the bands in the patient's mouth [5].

The importance of cements lies in their versatility in clinical use; not only they are used in cementing orthodontic bands, but as luting agents, and for cementing different fixed partial prostheses as well. However, this variability requires the presence of different physical properties and manipulative characteristics [6].

The solubility of the dental cement in saliva may be a serious cause of the development of enamel demineralization and even caries under orthodontic bands and fixed prostheses [7]. Furthermore, it results in debanding of orthodontic bands as it affects the flexural strength, Vichers hardness and mechanical stability [7]. However, cements are not only exposed to saliva in the oral environment, there are multiple other media in food and beverages that can seriously affect the degradation process of the cement [8].

Hence, this study was conducted to test the solubility of dual cure resin modified resin cement in a food simulating solution and the shear bond strength compared to conventional Glass ionomer cement.

Materials and Methods

Materials

The materials tested were self-adhesive dual cure resin modified cement (G-CEM capsule, GC corporation, Tokyo, Japan), Table 1, and Glass Ionomer (Ketac^{TM} cem, 3M ESPE, Deutschland GmbH Germany), Table 2.

Table 1: G-CEM capsule chemical composition

4-Methacryloxyethyltrimellitate anhydride (4- META)	6 - 10%
Urethane Dimethacrylate (UDMA)	1.5 - 3%
Alumino-silicate glass	65 - 70%
Pigment	< 1%
Dime thacrylate	15 - 20%
Distilled water	1.5 - 3%
Phosphoric ester monomer	1-2%
Initiator	<1%
Camphorquinone	< 1%

Table 2: Ketac^{TM}-cem powder/liquid composition

Powder	Liquid
Glass powder	Water
Polycarboxylic acid	Tartaric acid
Pigments	Conservation agents

Methods

The study was a twofold study that investigated and compared the solubility of the materials as well as the shear bond strength and failure mode.

The solubility investigation

Twenty cylindrical Teflon moulds of size 1.2 mm (diameter) x 5 mm (height); measured using a digital calliper to the nearest 0.01 mm, were used. The moulds were divided into two groups; in the first group ten moulds were injected with the modified resin cement and packed using 1mm diameter condenser (Thomson, Tactile Tone SS, OREGON # 2). The specimens were left to set for 5 minutes according to the manufacturer's instructions. In the second group, Glass Ionomer cement powder and liquid were mixed and packed in 10 moulds and left to set for 5 minutes according to the manufacturer's instructions. Glass slabs lined with Mylar strips were used to cover the moulds in both groups until they completely set.

Each mould was weighed using an analytical balance to an accuracy of ± 0.1 mg and inserted in numbered light-proof sealed tubes containing 10 ml n-heptane 95% analytical reagent, (chosen according to the FDA Food and Drug Administration guide lines 1976, USA) [9], at 37^{0}C. The reagent was changed on daily basis, and it simulated butter, fatty meats, and vegetable oils. The specimens were aged in the solution for 30 days [9] then they were removed from the solution, washed in running water, wiped with a soft absorbent paper [10] and reweighed. The solubility was measured as the difference between the initial and final drying mass.

Shear bond strength

For this part of the study, 20 wisdom teeth freshly extracted for surgical reasons were used. The teeth were embedded in self-cure acrylic resin moulds, the buccal surface directed upwards to allow cementation and testing. The teeth were scaled and polished.

The study consisted of two groups each comprised of 10 teeth. The tooth blocks were randomly distributed in dark numbered envelopes. Using the online computer program Random sequence generator; random.org, each tooth was assigned to one of the two groups. This randomization was performed by a researcher who didn't participate in the rest of the study.

The stainless steel bands were sectioned into equal 4mm sections for the sake of standardisation. In group one; the study group, the band sections were cemented to the tooth surface under a constant load of 500 g [4] using dual cure modified resin cement and left to set for 5 minutes according to the manufacturer's instructions. In group two, the control group, the sectioned bands were cemented to the teeth using Glass Ionomer cements under a constant load of 500 g [4] for 5 minutes according to manufacturer's instructions.

The shear test was designed to evaluate the bond strength. All samples were individually and horizontally mounted on a computer controlled materials testing machine (Model LRX-plus; Lloyd Instruments Ltd., Fareham, UK) with a loadcell of 5 kN and data were recorded using computer software

(Nexygen-MT; Lloyd Instruments). Samples were secured to the lower fixed compartment of the testing machine by tightening screws. Shearing test was done by compressive mode of the load applied at the band-tooth interface using a mono-beveled chisel shaped metallic rod attached to the upper movable compartment of testing machine travelling at a cross-head speed of 0.5 mm/min. The load required to deband the samples was recorded in Newtons [11]. The load at failure was divided by bonding area to express the bond strength in MPa: τ = P/ A; where τ = shear bond strength (MPa), P = load at failure (N) and A = interfacial area (mm^2).

Statistical analysis

Statistical analysis was performed with IBM® SPSS® (SPSS Inc., IBM Corporation, NY, USA) Statistics Version 22 for Windows. The significance level was set at P ≤ 0.05.

Results

Data was explored for normality using D'Agostino-Pearson test for the Normal distribution. Shear bond strength (MPa) and Weight loss (%) showed nonparametric distribution, hence Mann-Whitney U-test was used to compare between different tested cement.

Means and standard deviations (SD) of weight loss (%) and Shear bond strength (MPa) for different Types of cement were presented in Table 3 and Figures 1 & 2.

Table 3: Mean and standard deviation (SD) of Shear bond strength (MPa) and weight loss (%) for different Types of cement

	Cements								p-value
	Glass ionomer				Dual-cure resin				
	Mean	SD	Min.	Max.	Mean	SD	Min.	Max.	
Shear Bond Strength (MPa)	1.15	.36	.57	1.43	2.44	1.42	1.21	4.58	0.056
Weight loss (%)	13.21	5.83	7.84	22.64	6.36	1.72	3.85	8.00	0.016*

** = Statistically significant.*

Weight loss (%)

Glass-ionomer Cement (13.21 ± 5.83 %) showed the highest significant mean weight Loss (%) Compared to dual cure resin Cement (6.36 ± 1.72 MPa), p = 0.016 (Table 3, Figure 1).

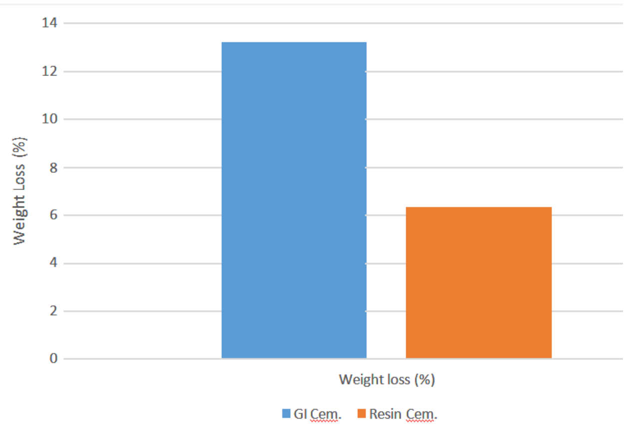

Figure 1: Histogram showing the mean Weight loss (%) for Different Types of cement

Shear Bond Strength (MPa)

Glass-ionomer Cement (1.15 ± 0.36 MPa) showed the lowest insignificant mean Shear bond strength (MPa) Compared to dual cure resin Cement (2.44 ± 1.42 MPa) p=0.056. (Table3, Figure 2).

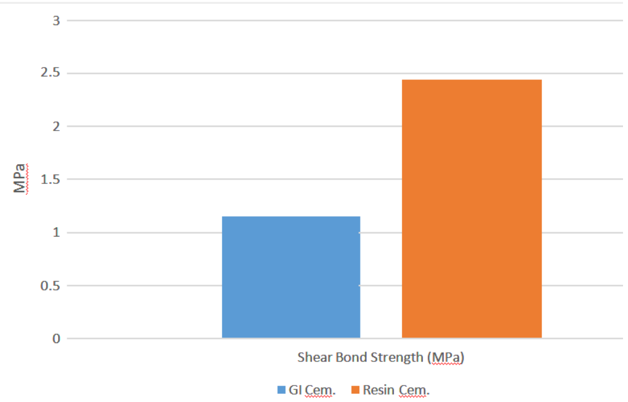

Figure 2: Histogram showing the mean Shear bond strength (MPa) for Different Types of cement

Discussion

The current research was a twofold study to assess the solubility and the shear bond strength of Glass Ionomer cement and Dual-cure resin modified cement. It was argued that resin modified cement had better mechanical properties and less water sorption [3] than conventional cement and that its bond strength to dentin was equivalent to conventional resin cement [12, 13]. Since Glass Ionomer cement are conventionally used in orthodontic banding, it was necessary to test their sustainability in the oral environment and whether there was a more superior material or not. This is important to ensure clinical efficiency as orthodontic treatment, normally and unlike any dental treatment, takes a long time.

The solubility of the Glass Ionomer cement was significantly more than that of the dual cure resin cement as was shown by the weight loss percentage. This may favour rapid degradation of the cement [10] under the orthodontic bands predisposing to their mechanical debanding, and hence delays or interferes with orthodontic treatment mechanics, alongside with the possibility of the occurrence of secondary caries [14, 15]. Those findings were similar to other studies which also reported that the solubility of cements had a potential effect on their mechanical stability [10, 14, 15]. The increased solubility of Glass Ionomer could be attributed to the plasticizing effect of the solvent used which resulted in erosion and degradation of the material [14-16]. On the other hand, the presence of resin network in the resin modified cement reduced the solvent diffusion into the cement [17], which reduced the dissolution of the cement.

Multiple factors affect the rate and amount of dissolution of materials like time, concentration and pH of the dissolving medium, specimen thickness, and powder/liquid ratio of the cement [18]. Ideally, the solutions used must simulate the oral environment complexity, however, static solubility tests are only made because it's impossible to simulate the oral environment as it varies from person to person and within the same person [19]. The organic solution n-heptane, used in this study, simulated butter, fatty meats, and vegetable oils [20], which are materials that accelerate the chemical ageing process [9].

To be able to evaluate the full mechanical performance of the cement in a clinical setting, it was also necessary to investigate their bond strength in which the bonding was done under a constant load of 500 g [4]. Hattar et al [2] reported that adhesive cements should set under pressure [21, 22] to facilitate the intimate adaptation of the relatively highly viscous cement [23]. The results of the study revealed an insignificantly lower bond strength of the Glass Ionomer cement than the Dual-cure resin modified cement. Nakamura et al [4] reported that dual cure resin modified cement had both physical properties and chemical composition similar to resin modified glass ionomer; which could offer a possible explanation for this insignificant difference. Furthermore, when the dual cure resin modified cement was compared to other resin adhesive systems used for bracket adhesion; the bond strength was found to be significantly less [11, 24] which further highlighted that it's more comparable to resin modified glass ionomer cement than to other resin adhesives. On the other hand, bands cemented with dual cure resin modified cement showed superior tensile strength when compared to those cemented with glass ionomer cement [5]. These literature reports showed that the results obtained were not only influenced by the type of the material, but also the various types of the tests used, indicating that further evidence-based studies unifying the variables should be conducted to obtain more comparable results.

In conclusion, within the limitations of this in-vitro study, it was found that dual cure resin modified cement was less soluble than glass ionomer cement and of comparable bond strength rendering it more useful clinically for orthodontic band cementation.

References

1. Ramazanzadeh B A, Merati M, Shafaee H, Dogon L, Sohrabi K. In vitro evaluation of an experimental method for bonding of orthodontic brackets with self-adhesive resin cements. European J Gen Dent. 2013; 2 (3): 264-269. http://dx.doi.org/10.4103/2278-9626.116018 PMid:24163808 PMCid:PMC3806483

2. Hattar S, Hatamleh M M, Sawair F, Al-Rabab'ahl M. Bond strength of self-adhesive resin cements to tooth structure. The Saudi Dental Journal. (2015) in press. http://dx.doi.org/10.1016/j.sdentj.2014.11.006 PMid:26082572 PMCid:PMC4459118

3. Türker S A, Uzunoğlu E, Yılmaz Z. Effects of dentin moisture on the push-out bond strength of a fiber post luted with different self-adhesive resin cements. Restorative dentistry and endodontic. 2013; 38(4) 234-240.

4. Nakamura T, Wakabayashi K, Kinuta S, Nishida H, Miyamae M, Yatani H. Mechanical properties of new self-adhesive resin-based cement. Journal of Prosthodontic Research. 2010; 54: 59–64. http://dx.doi.org/10.1016/j.jpor.2009.09.004 PMid:19879828

5. Millet DT, Kamahli K, McColl J. Comparative laboratory investigation of dual-cured vs. conventional glass ionomer cements for band cementation. Angle Orthod. 1998;68(4):345-350.

6. Ghanim A. Water sorption and solubility of different commercially available dental cements. (An in vitro study). Babylon medical journal. 2010; 7(4).

7. Manish A, Timothy FF, Douglas R. A Comparison of Shear-Peel Band Strengths of 5 Orthodontic Cements. The Angle Orthodontist. 2000; 70(4): 308-316.

8. Yap AUJ, Tan DTT, Goh BKC, Kuah HG, Goh M. Effect of food simulating liquids on the flexure strength of composite and polyacid-modified composite restoratives. J Oper Dent. 2000;25: 202-208.

9. Abdelrahman AM, Amin AM, Sharawy AM. Effect of food simulating liquids on fracture toughness of nano-hybrid composite with different resin matrix formulations. Cairo: Faculty of Oral and Dental Medicine, Cairo University, 2012. [Dissertation]

10. Malacarne J, Carvalho RM, Mario F, Svizero N, Pashley DH, Tay FR, Yiu CK, de Oliveira Carrilho MR. Water sorption/solubility of dental adhesive resins. Dental Materials. 2006;22(10):973-80. http://dx.doi.org/10.1016/j.dental.2005.11.020 PMid:16405987

11. Vicente A, Bravo LA, Romero M, Ortiz AJ, Canteras M. A Comparison of the Shear Bond Strength of a Resin Cement and Two Orthodontic Resin Adhesive Systems. Angle Orthod. 2004;75:109–113.

12. De Munck J, Vargas M, Van Landuyt K, Hikita K, Lambrechts P, Van Meerbeek B. Bonding of an auto-adhesive material to enamel and dentin. Dent Mater. 2004;20:963–71. http://dx.doi.org/10.1016/j.dental.2004.03.002 PMid:15501325

13. Hikita K, Van Meerbeek B, De Munck J, Ikeda T, Van Landuyt K, Maida T, Lambrechts P, Peumans M. Bonding effectiveness of adhesive luting agents to enamel and dentin. Dent Mater. 2007;23:71–80. http://dx.doi.org/10.1016/j.dental.2005.12.002 PMid:16426673

14. Keyf F, Tuna S H, Sen M, Safrany A. Water Sorption and Solubility of Different Luting and Restorative Dental Cements. Turk J Med Sci. 2007; 37 (1): 47-55.e

15. Al-Shekhli A Abdul Wahab R. Solubility of four dental luting

cements. J Int Dent Med Res. 2010;3: (3), pp. 104-107.

16. Cattani-Lorente MA, Dupuis V, Payan J, Moya F, Meyer JM. Effect of water on the physical properties of resin-modified glass ionomer cements. Dent Mater. 1999; 15: 71- 79. http://dx.doi.org/10.1016/S0109-5641(99)00016-0

17. Toledanoa M, Osorioa R, Osorioa E, Fuentessa V, Pratib C, Garcıa-Godoyc F. Sorption and solubility of resin based restorative dental materials. Journal of Dentistry. 2003;31:43–50. http://dx.doi.org/10.1016/S0300-5712(02)00083-0

18. Wison AD. Specification test for the solubility and disintegration of dental cements: a critical evaluation of its meaning. J Dent Res. 1976;55(5):721-9. http://dx.doi.org/10.1177/00220345760550050401

19. Macorra JC, Praides G. Conventional and adhesive luting cements. Clin Oral Invest. 2002; 6: 198-204. http://dx.doi.org/10.1007/s00784-002-0184-1 PMid:12483233

20. Al-Wahab ZN. An evaluation of the effect of different solutions on the microhardness of aesthetic restoration. MDJ. 2011;8(2).

21. Chieffi N, Chersoni S, Papacchini F, Vano M, Goracci C, Davidson C L, Tay F R, Ferrari M. The effect of application sustained seating pressure on adhesive luting procedure. Dent Mater. 2007;23, 159–164. http://dx.doi.org/10.1016/j.dental.2006.01.006 PMid:16494935

22. Duarte Jr S, Botta AC, Meire M, Sadan A. Microtensile bond strengths and scanning electron microscopic evaluation of self-adhesive and self-etch resin cements to intact and etched enamel. J Prosthet Dent. 2008;100, 203–210. http://dx.doi.org/10.1016/S0022-3913(08)60179-1

23. El-Guindy J, Selim M, El-Agroudi M. Alternative pretreatment modalities with a self-adhesive system to promote dentin/alloy shear bond strength. J Prosthodont. 2010;19, 205–211. http://dx.doi.org/10.1111/j.1532-849X.2009.00541.x PMid:20040029

24. Al-Saleh M, El-Mowafy O. Bond strength of orthodontic brackets with new self-adhesive resin cements. Am J Orthod Dentofacial Orthop. 2010;137:528-33. http://dx.doi.org/10.1016/j.ajodo.2008.04.027 PMid:20362914