BioCore Exploring Scientific Community

International Journal of Dentistry and Oral Health

Experimental study ISSN 2471-657X

Evaluation of Two Surface Smoothing Techniques Used on Various Glass Ionomer Cements

Manayer Alsalamah[1], Maram Alhenaky[2], turki Almayman[3], Ahmed Alqahtani[4], Abdullah alsirhani[5]

[1]*Dental Department /Alfarabi hospital / manayer933@hotmail.com*
[2]*Dental Department / Alfarabi hospital/ mash_4u@hotmail.com*
[3]*Dental Department / king saud university hospital*
[4]*Dental Department / CONSULTANT OF ENDODONTIC at Alyamamah hospital, MOH, Riyadh, KSA, Email :dentistmail@gmail.com*
[5]*Dental Department /CONSULTANT OF RESTORATIVE AND ESTHATIC DENTSTRY AT MILITARY HOSPITAL, Riyadh, KSA*

Abstract

Aims: To evaluate surface roughness of different glass ionomer cements using two different methods of smoothening techniques.

Methods and Material: Four different types of Glass Ionomer Cements (Conventional GIC, Resin modified GIC (RMGIC), Silver reinforced GIC and Nanofiller GIC) 15 samples of each material, so total =60. Then sub group has been divided as following: 5 controls, 5 finishing with Sof-lex and 5 swabs with alcohol. The surface roughness measured by Profilometer machine (Fig.1), all samples have been measured before and after polishing with Sof-lex discs and swabbed with alcohol swab, then Scanning Electronic microscope (SEM) has been used to measure and exam surface area.

Statistical analysis used: Two-way ANOVA in surface roughness, using spss20. analysis of variance to see the effect of materials and finishing.

Results: All tested GICs showed lower surface roughness values after finishing with soflex disc, which give smoother surface than alcohol swabbed surface. When compared between the materials by using Sof-lex disc, Silver GIC give smooth surface but not significantly different than others. Conventional and RMGICs give smooth surfaces with significantly different. The smoothest surface was the Nanofiller GIC with significantly different than other materials.

Conclusions: We compared the effectiveness of Sof-Lex disc polishing and alcohol swab treatment to achieve surface smoothing. Use of Sof-Lex discs resulted in smoother surfaces than those of the control group and the alcohol swab group, with fewer cracks and voids observed on SEM, although these results were not significant. Both conventional GIC and nanofiller GIC had higher surface roughness values after alcohol swabbing; use of this method is not recommended.

Keywords: Alcohol, Glass ionomer cement, Polishing, Surface roughness

Corresponding author: **Manayer Alsalamah**
Dental Department /*Alfarabi hospital*, Riyadh, KSA .
E-mail: manayer933@hotmail.com

Citation: Manayer Alsalamah (2018), Evaluation of Two Surface Smoothing Techniques Used on Various Glass Ionomer Cements. Int J Dent & Oral Heal. 4:6, 84-88.

Received: May 26, 2018
Accepted: June 05, 2018
Published: June 23, 2018

Introduction:

Many materials are used for dental restoration, including amalgam, composites, and glass ionomers. Glass ionomer cements (GICs) are being used for a wide range of applications in dentistry to replace lost or damaged tissue [1, 2]. Several types of GIC have been introduced since they were first produced by Wilson and Kent in 1969–1970, including conventional GICs, resin-modified GIC (RMGICs), metal (silver)-reinforced GICs, and nanofiller GICs [3]. The main advantages of GICs are fluoride release, good color matching capability, translucency, radioopacity, ability to set quickly, and early resistance to water uptake [4].

Conventional GICs set via an acid-base reaction between the polyacrylic acid and the fluoroaluminosilicate glass particles [5]. Advantages include a coefficient of thermal expansion close to that of the tooth structure and biocompatibility[6]. Disadvantages include long setting time, high surface roughness, poor wear resistance, shrinkage, and difficulties in improving the mechanical properties [7].

RMGICs were introduced in 1990 to overcome the limitations of conventional GICs. Key modifications include the combination of GICs with autocured or photocured resin systems [8]. Setting of the cement starts when an acid-base reaction is completed, and polishing should be performed after curing [9].

Metal-reinforced GICs were introduced into the dental market in 1977. The first product, marketed under the name Miracle Mix (GC Corporation, Tokyo, Japan), combined amalgam alloy powders with conventional cement material to improve the physical properties and strength [10]. Metal-reinforced GICs can be used to restore deciduous teeth and core build up; however, poor aesthetics limit their use [11].

Nanofiller GIC materials range in size from 1–100 nm. Nanotechnology involves the use of systems of matter [12]. Studies have suggested that incorporation of nano-sized particles can improve mechanical properties, including improved aesthetics and smooth surface. Similar approaches have been used in attempts to improve the mechanical properties of GICs using nanotechnology [3, 13].

GICs have been used for multiple purposes in dentistry, and it is crucial to have knowledge of the physical and mechanical properties of different brands and new products when choosing a GIC for a particular restoration. Surface roughness may result in the accumulation of different types of bacteria, so some dental practitioners use alcohol swabs to both smooth the GIC surface and kill bacteria. The alcohol swab is a small cotton pad that has been impregnated with medical alcohol, usually used to clean an area of a patient's skin prior to injection or to clean around a wound prior to applying a dressing. The amount of alcohol present in the swab may affect the swabbed surface The aim of this study was to compare the effectiveness of alcohol swabs and Sof-Lex discs (3M ESPE, St Paul, MN, USA) as smoothing techniques.

Materials and Methods:

GIC materials used in this experimental in vitro study are presented in Table 1.

Product name	Type of material	Manufacturer
Ketac Molar Quick Aplicap	Conventional GIC, self-curing, shade A2	3M ESPE, St. Paul, MN, USA
Fuji II LC Capsule	Resin-modified GIC, light-curing, shade A2	GC Corporation, Tokyo, Japan
Miracle Mix Capsule	Silver-reinforced GIC, self-curing	GC Corporation, Tokyo, Japan
Ketac Nano	Nanofiller GIC, light-curing, shade A2	3M ESPE, St. Paul, MN, USA

Table 1: Glass ionomer cements used in the study

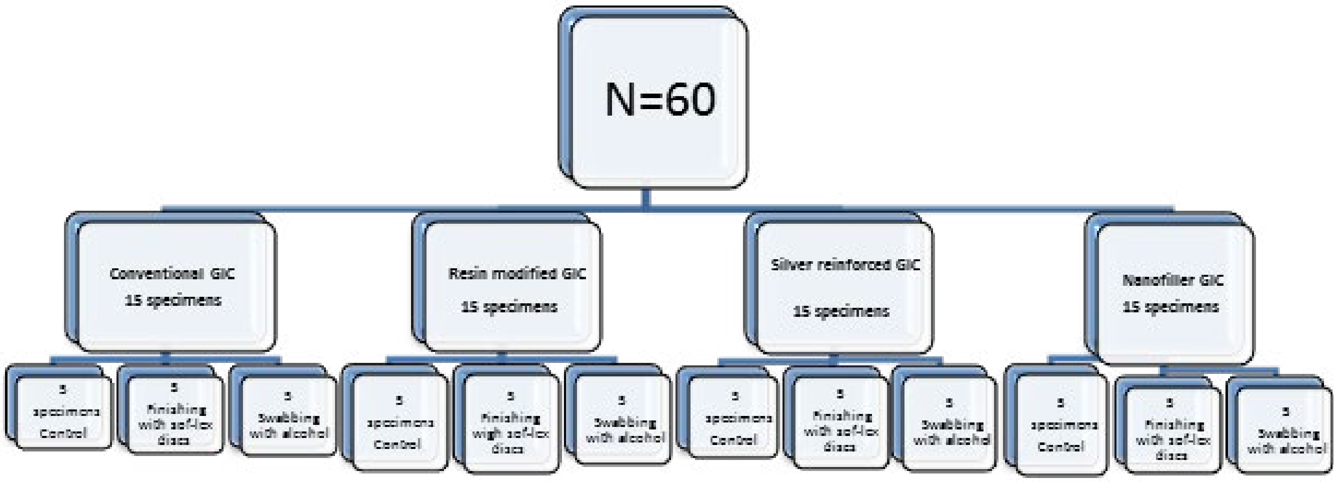
Specimen preparation

All specimen preparation was conducted according to instructions from the manufacturer in order to reduce variability. Specimens were prepared using plastic bounding molds (8 mm diameter × 2 mm thickness). The uncured glass ionomers were inserted into molds and intentionally overfilled. Light pressure with glass was applied to expel excess material from the mold. Each specimen was light cured (CICADA dental LED curing light radiometer, Foshan CICADA Dental Instruments Co, Ltd, Foshan City, China) through the top and bottom for the 20-s period recommended by the manufacturers. The intensity (200–400 mW/cm2) of the light-curing unit was checked before each sample. The specimens were stored in distilled water at 37°C for 24 hours.

Experimental design

Fifteen specimens of each of four types of glass ionomer materials were constructed: conventional GIC (Ketac Molar Quick Aplicap), resin modified GIC (Fuji II LC Capsule), nanofiller GIC (Ketac Nano), and silver reinforced GIC (Miracle Mix Capsule). There was a total of 60 specimens.

The 15 specimens for each material type were divided into three groups as follows: five control samples, five Sof-Lex disc samples, and five alcohol swab samples. Sof-Lex samples were polished using an air-driven slow-low handpiece (CA111, Bien Air Dental, Bienne, Switzerland) rotating at approximately 20000 rpm. Alcohol swab samples were wiped with alcohol swabs. Each step of the finishing-polishing process was applied for 20 s. Each procedure was conducted using light pressure in one direction.



Measurement of surface roughness

The surface was evaluated using a profilometer (Contour GT and Vision 64 software; Bruker Company, Billerica, MA). Parameters of the system were as follows: measurement type, vertical scan interferometry (VSI); objective, 5x; measurement area, x=1.261 mm and y=0.946 mm; height (amplitude mean in the height direction), and arithmetic mean height (Sa). Sa is a three-dimensional (3D) parameter derived from the roughness (two-dimensional) parameter Ra. It expresses the average of the absolute values of Z (x, y) in the measured area. Sa is equivalent to the arithmetic mean of the measured region on the 3D display diagram when valleys have been changed to peaks by conversion to absolute values and surface profile tracing. Each sample was rotated 120°, relative to the center, for each of three readings and averaged to generate average roughness value.

Scanning electron microscope

A scanning electronic microscope (SEM) (JEOL JSM-6360 LV, JEOL USA, Inc., Peabody, MA, USA) was used in this study to examine surface characteristics, including cracks and voids. Magnifications of 2000x and 1000x were used, with voltage set at 20 k 100. Samples were coated with gold to a thickness of approximately 60 nm. Three images were taken of each sample in different positions.

Statistical analysis

Two-way analysis of variance (ANOVA) was conducted. A Tukey post hoc multiple-range test was used to determine whether there were significant differences in surface roughness among the materials in each test group. Significance was set at $p<0.05$. SPSS version 20 (SPSS Inc., Chicago, IL, USA) statistical software was used for analyses

Results And Discussion:

Means and standard deviations (SDs) of surface roughness (presented as Sa) are presented in Table 2.

Solution	Materials	Mean	SD	ANOVA P-value	95% Confidence Interval		Tukey Multiple comperison test			
					Bound	Bound	GIC	NANOGIC	SILVER	RMGIC
CONTROL	GIC	2.083	0.224	0.010	1.334	2.832	1.000	0.441	0.008	0.830
	NANOGIC	2.966	1.173		2.217	3.715		1.000	0.150	0.901
	SILVER GIC	4.264	1.287		3.515	5.013			1.000	0.043
	RMGIC	2.572	0.474		1.823	3.321				1.000
FINISHING	GIC	1.670	0.118	0.132	0.922	2.419	1.000	0.909	0.314	0.939
	NANOGIC	1.366	0.355		0.617	2.115		1.000	0.107	0.615
	SILVER GIC	2.490	1.347		1.741	3.239			1.000	0.625
	RMGIC	1.932	0.383		1.183	2.681				1.000
ALCOHOL	GIC	2.236	0.274	0.028	1.487	2.984	1.000	0.021	0.148	0.565
	NANOGIC	4.016	1.456		3.267	4.765		1.000	0.733	0.237
	SILVER GIC	3.459	0.410		2.710	4.207			1.000	0.781
	RMGIC	2.948	0.744		2.199	3.697				1.000

Table 2: Surface roughness measurements (Sa), by treatment and material

All tested GICs exhibited lower surface roughness values after smoothing. When surface roughness values for each GIC materials were compared before and after polishing with Sof-Lex discs, conventional GIC, RMGIC, silver-reinforced GIC, and nanofiller GIC all demonstrated statistically significant decreases ($p<0.05$). There were no statistically significant differences in surface roughness values before and after polishing for nanofiller GIC or conventional GIC ($p>0.005$). Nanofiller GIC had the smoothest surface before polishing.

Figure 1: Surface roughness (Sa) of materials tested, by treatment and material

RMGIC there is significant difference p value of finishing was less than the other p=0.040. There were significance differences in surface roughness within the control group (p=0.010). Silver GIC had the highest Sa measurement, and the surface roughness of silver GIC was significantly higher than those of both conventional GIC and MRGIC.

After polishing with Sof-Lex discs, nanofiller GIC exhibited the lowest surface roughness at 1.366±0.355. This value was not significantly different from those of others in the Sof-Lex group (p=0.132). The SEM photomicrographs obtained in this study showed that, regardless of commercial brand, all conventional GICs presented voids and cracks on their surfaces. SEM photomicrographs were obtained for each sample. Alcohol swabbing did not appear to promote significant changes in surface roughness when compared with controls, although alcohol swabbed surfaces were the roughest of those examined. The lines and cracks in GICs appeared to increase after swabbing with alcohol. Conversely, polishing with Sof-Lex discs appeared to decreased voids and cracks, with polished materials exhibiting the smoothest surfaces on SEM. Conventional GICs appeared to have more voids and cracks than other surfaces, and silver GICs appeared to have smoother surfaces after Sof-Lex polishing. Our results suggest that alcohol swabs should not be used to achieve smooth GIC material surfaces.

Use of alcohol swabs is popular in clinical practice, but there is no literature addressing this procedure. Surface features play a key role in the clinical longevity of restorative materials [14]. High surface roughness can increase bacterial adhesion, dental plaque accumulation, and acidity, thus increasing risk of caries [11]. Therefore, this study evaluated the surface roughness of conventional GICs, metal-reinforces GICs, RMGICs, and nanofiller GICs after use of two different smoothing techniques. In vitro investigations have employed profilometers to measure surface roughness. The results of the present investigation showed significant differences in surface roughness among different groups. Bollen et al. reported surface values for all GICs before and after polishing, and suggested that materials compositions may be responsible for the differences observed [15].

Surface roughness of GIC specimens can be affected by the storage media. In the present study, the prepared GIC specimens were stored in distilled water at 37°C for 24 h to mimic clinic conditions. The chemical dissolution process can produce an increase in surface roughness [16]. One study evaluated the effects of storage media upon the surface micromorphology of resin-based materials and revealed no statistically significant differences in surface roughness between specimens exposed to distilled deionized water and those exposed to artificial saliva [17].

Several techniques can be used for finishing and polishing. The literature suggests that the surface characteristics of GICs can be improved through polishing with aluminum-oxide discs (Sof-Lex) [18, 19]. Therefore, the present study compared the effectiveness of polishing various GICs with aluminum oxide discs to smoothing using an alcohol swab.

Differences in particle sizes of GICs influence physical properties such as fracture toughness, compressive strength, abrasion resistance, and surface microhardness [20]. Moreover, the surface roughness of GICs is partially dependent on their particle size ranges [21]. According to Gladys and van Meerbeek [22], conventional GICs have larger mean particle sizes than other types of GIC. In this study, conventional GICs were shown to have a higher surface roughness than other materials tested. There was no significant difference in surface roughness between conventional GICs in the control group and those treated with alcohol swabs. Polishing the conventional GICs with Sof-Lex discs resulted in a smoother surface than controls, but the difference was not significant.

In comparing RMGICs with conventional GICs, some studies have reported that the surface roughness of conventional GICs is higher than the surface roughness of RMGICs +. In this study, the surface roughness of the RMGIC tested was significantly lower than that of silver, but it was not significantly different from that of the conventional GIC tested. This finding suggests that the insertion of resin particles in Fuji II LC or insertion of nanoparticles into the nanofiller GIC Ketac did not significantly improve the surface roughness of these materials. In evaluating the effectiveness of the two smoothing technique on RMGICs, we found that a significant difference after polishing with Sof-Lex discs (p=0.040). The resulting surface was smoother than those of either control or swabbed alcohol surfaces.

Silver-reinforced GIC had the highest surface roughness value (4.264±1.287), followed by nanofiller GIC. There was a significant difference (p=0.074) between the surface roughness values of RMGIC and conventional GIC. Some investigators have reported significant differences between the strengths of conventional GICs and RMGICs due to the effects of adding metal to the glass ionomer [25, 26]. In using two different smoothing techniques on silver-reinforced GIC, we observed no significant difference in surface roughness between polishing with Sof-Lex discs and smoothing with an alcohol swab.

In the present study, materials with smaller average particle sizes (e.g., nanofiller GIC Ketac) had lower surface roughness median values after polishing with Sof-Lex discs than did other materials. Some in vitro studies have shown that the addition of nanofillers provides enhanced polish and surface wear relative to some other available dental materials [27]. This study showed that polishing with Sof-Lex discs resulted in nanofiller GIC having the smoothest surface, although the surface roughness values for all materials after polishing were not significantly different. After alcohol swabbing, nanofiller GIC had the highest surface roughness value among materials tested; the nanofiller GIC Sa value was significantly higher than that of conventional GIC after alcohol swabbing ($p=0.021$). Silver GIC had the highest surface roughness value in the control group at 4.264±1.287; this value was significantly higher than those of both conventional GIC and RMGIC ($p=0.043$).

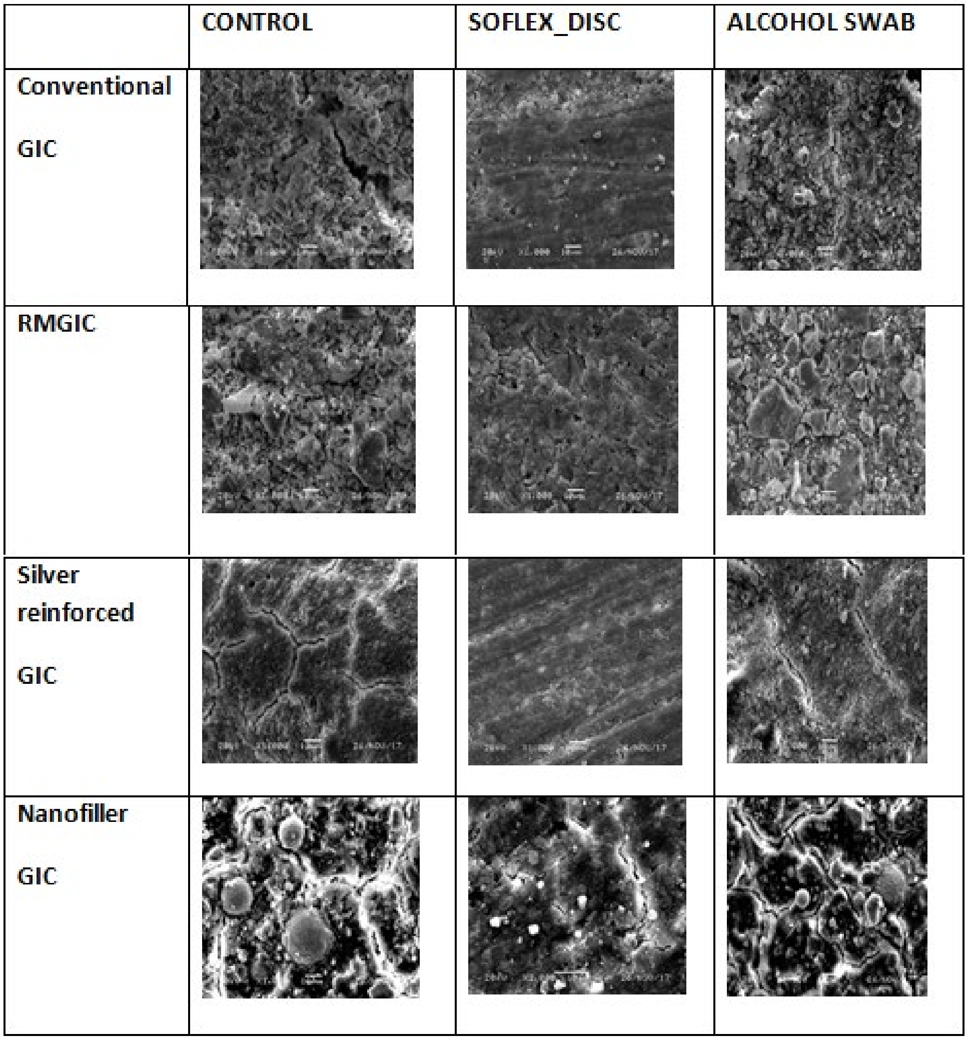


Figure 2: Surface roughness of material by scanning electronic microscope (SEM)

Conclusions

We compared the effectiveness of Sof-Lex disc polishing and alcohol swab treatment to achieve surface smoothing. Use of Sof-Lex discs resulted in smoother surfaces than those of the control group and the alcohol swab group, with fewer cracks and voids observed on SEM, although these results were not significant. Both conventional GIC and nanofiller GIC had higher surface roughness values after alcohol swabbing; use of this method is not recommended.

References

1. Sakaguchi, R. L. & Powers, J. M. Restorative Dental Materials. SciencesNew York 135, (2002).

2. McCabe, J. Applied dental materials ninth edition. American Journal of Orthodontics 64, (2013).

3. Najeeb, S. et al. Modifications in Glass Ionomer Cements: Nano-Sized Fillers and Bioactive Nanoceramics. Int. J. Mol. Sci. 17, (2016).

4. Sidhu, S. K. & Nicholson, J. W. A Review of Glass-Ionomer Cements for Clinical Dentistry. J. Funct. Biomater. 7, (2016).

5. Costato, M. Acid-base cements. Their biomedical and industrial

applications. Il Nuovo Cimento D 17, (1995).

6. Modena, K. C. da S. et al. Cytotoxicity and biocompatibility of direct and indirect pulp capping materials. J. Appl. Oral Sci. 17, 544–554 (2009).

7. Pereira, L. C. et al. Mechanical properties and bond strength of glass-ionomer cements. J. Adhes. Dent. 4, 73–80 (2002).

8. Wilson, A. D. Developments in glass-ionomer cements. Int J Prosthodont 2, 438–446 (1989).

9. Di Lenarda, R., Cadenaro, M. & De Stefano Dorigo, E. Cervical compomer restorations: the role of cavity etching in a 48-month clinical evaluation. Oper. Dent. 25, 382–387 (2000).

10. Williams, J. A., Billington, R. W. & Pearson, G. J. The comparative strengths of commercial glass-ionomer cements with and without metal additions. Br. Dent. J. 172, 279–282 (1992).

11. Bala, O., Arisu, H. D., Yikilgan, I., Arslan, S. & Gullu, A. Evaluation of surface roughness and hardness of different glass ionomer cements. Eur. J. Dent. 6, 79–86 (2012).

12. Khurshid, Z. et al. Advances in Nanotechnology for Restorative Dentistry. Mater. (Basel, Switzerland) 8, 717–731 (2015).

13. Moshaverinia, A. et al. Effects of incorporation of hydroxyapatite and fluoroapatite nanobioceramics into conventional glass ionomer cements (GIC). Acta Biomater. 4, 432–440 (2008).

14. Rocha, A. C. D. C., Lima, C. S. A. De, Santos, M. D. C. M. D. S. & Montes, M. A. J. R. Evaluation of surface roughness of a nanofill resin composite after simulated brushing and immersion in mouthrinses, alcohol and water. Mater. Res. 13, 77–80 (2010).

15. Bollen, C. M. et al. The influence of abutment surface roughness on plaque accumulation and peri-implant mucositis. Clinical oral implants research 7, 201–211 (1996).

16. Roulet, J. F.,ois & Wälti, C. Influence of oral fluid on composite resin and glass-ionomer cement. J. Prosthet. Dent. 52, 182–189 (1984).

17. Turssi, C. P., Hara, A. T., Serra, M. C. & Rodrigues, A. L. Effect of storage media upon the surface micromorphology of resin-based restorative materials. J. Oral Rehabil. 29, 864–871 (2002).

18. Pedrini, D., Candido, M. S. M. & Rodrigues, A. L. Analysis of surface roughness of glass-ionomer cements and compomer. J. Oral Rehabil. 30, 714–719 (2003).

19. Tate, W. H. & Powers, J. M. Surface roughness of composites and hybrid ionomers. Oper. Dent. 21, 53–8 (1996).

20. Yli-Urpo, H., Lassila, L. V. J., Närhi, T. & Vallittu, P. K. Compressive strength and surface characterization of glass ionomer cements modified by particles of bioactive glass. Dent. Mater. 21, 201–209 (2005).

21. Yap, A. U. J., Tan, W. S., Yeo, J. C., Yap, W. Y. & Ong, S. B. Surface texture of resin-modified glass ionomer cements: effects of finishing/polishing systems. Oper. Dent. 27, 381–386 (2002).

22. Gladys, S., Van Meerbeek, B., Braem, M., Lambrechts, P. & Vanherle, G. Comparative physico-mechanical characterization of new hybrid restorative materials with conventional glass-ionomer and resin composite restorative materials. Journal of Dental Research 76, 883–894 (1997).

23. Xie, D., Brantley, W. a, Culbertson, B. M. & Wang, G. Mechanical properties and microstructures of glass-ionomer cements. Dent. Mater. 16, 129–138 (2000).

24. Aliping-Mckenzie, M., Linden, R. W. A. & Nicholson, J. W. The effect of saliva on surface hardness and water sorption of glass-ionomers and 'compomers'. J. Mater. Sci. Mater. Med. 14, 869–873 (2003).

25. Kerby, R. E. & Bleiholder, R. F. Physical Properties of Stainless-steel and Silver-reinforced Glass-ionomer Cements. J. Dent. Res. 70, 1358–1361 (1991).

26. WILLIAMS, J. A. & BILLINGTON, R. W. Changes in compressive strength of glass ionomer restorative materials with respect to time periods of 24 h to 4 months. J. Oral Rehabil. 18, 163–168 (1991).

27. Pitkethy, M. J. Nanoparticles as building blocks? Mater. Today 6, 36–42 (2003).

Citation: Manayer Alsalamah (2018), Evaluation of Two Surface Smoothing Techniques Used on Various Glass Ionomer Cements. Int J Dent & Oral Heal. 4:6, 84-88.