

The Influence of Two Different Luting Cement on Shear Bond Strength of Zirconia and Hybrid Ceramic Crowns

Assist. Lect. Dr. Zainab Shaker Al-Taii
B.D.S, M.Sc.

drzainabamory@gmail.com

Al-Rafidain University College – Department of Dentistry

Prof. Dr. Inas I. Al-Rawi
B.D.S, M.Sc.

Inas_arawi@yahoo.com

Al Israa University College – Department of Dentistry

Abstract: *The development of the new restorative materials was overwhelming during the last years. However the focus was on the bonding of these materials to the tooth structure that effected its successfulness. In this study two types of restorative materials are used (Ips e-max.zircad (ivoclar, vivadent) and Vita enamic (vita,sirona), and two type of cement using for bonding (breeze self-adhesive and metacem adhesive resin cement).*

Materials and method: *Forty freshly maxillary premolars extracted for orthodontic purpose divided into four groups, **Group A:** vita enamic cylinders were cemented with breeze self-adhesive resin cement. **Group B:** vita enamic cylinders were cemented with metacem adhesive resin cement, **Group C:** Ips.e-max zircad cylinders were cemented with breeze self-adhesive resin cement. **Group D:** Ips.e-max zircad cylinders were cemented with metacem adhesive resin cement. Statistical analysis was performed by using two-way ANOVA test to see if there were any significant difference among the means of experimental groups for shear bond strength, and independent sample. T-test was used to detect the difference*

between two resin cement within each type of material or between the two types of material within each type of resin cement.

Result: *Showed that Group D has the highest mean shear bond strength, and group C has the lowest mean shear bond strength as compared with other groups. The two ways ANOVA test show that the p value between restorative materials is a high significant difference, also we can see that there is a high significant difference between the cement type materials.*

Conclusion: *The surface treatment for the restorative material with sandblast enhance the shear bond strength, the use of total adhesive cement get higher shear bond strength than self-adhesive cement, The mean shear bond strength of Vitaenamic restorative material is higher than Ips.e-maxzircad*

Keywords: *Zirconia, Vitaenamic, Self-adhesive cement, Total adhesive cement, Shear bond strength.*

1. Introduction

The greater demand for esthetic and improvement of smile for the people led to the introduction of wide brand of metal free restorative [1] material. Ceramic, composite and zircon are used for their esthetic, improved biocompatibility and optical properties in comparison with other metallic restoration.

Zirconia (zirconium oxide) which is the oxide ceramic from zirconium (the shiny silvery metal) that is partially stabilized by adding yttrium oxide to form γ -t-zp (yttrium tetragonal zirconia polycrystals) [2] at room temperature, have excellent esthetic, high strength with better fracture toughness but the bonding of zirconia to the resin and the tooth structure is questionable.[3]

The good adhesion is the primordial for the success of any material. Ceramic material have high esthetic appearance, color stability, wear resistance and compatibility in oral cavity but its brittleness and the formation of flaw and defects made them more

susceptible to fracture in the intaglio surface ,beside causing excessive wear to the opposing dentition[4]

Indirect composite have less wear effect on the opposing dentition and are conducive to make add on adjustment and easier to finish and polish but its softness and its high wear make it less preferable and led to the introduction of new material, vita enamic, that combine the advantages of ceramic and composite to enhance the longevity and make balance between the strength and elasticity and provide high absorption of masticatory force so enhance the property of indirect esthetic restoration[4].

This new material based on strengthening the dominant fine structure ceramic network (86% by wt.) by an acrylic polymer network, (with both networks fully ingrated with one another [5].

For successful restoration an adequate adhesion between tooth structure and the restorative material is achieved, which depend primarily on the production of the hybrid layer, mechanical and chemical adhesion so a lot of types of adhesion material have been produced for long lasting restoration.

2. Materials and methods

Two type of restoration material has been used in this study (Ips e-max.zircad (ivoclar, vivadent) and Vita enamic (vita,sirona).

Forty cylinders (5mm in diameter, 6mm in height) were milled. Twenty zirconia cylinder were milled from zirconium oxide blocks (with dimensions of 19mm, 15.5mm, 55mm) (Ips e. max zircad, ivoclar vivadent as shown in figure (1a), each cylinder was milled up to 6.25 mm in diameter and 7.5 mm in height as shown in figure (1b), and then sintered in a vacuum furnace (infire htc speed sintered furnace, sirona) at 1500°C for 8 hours including cooling, (according to manufacture instruction). A 3 dimensional volumetric shrinkage of the milled cylinder of approximately 20%took place to have the dimensions of approximately 5mm in diameter and 6mm in height, as shown in figure (1c)



(a)



(b)



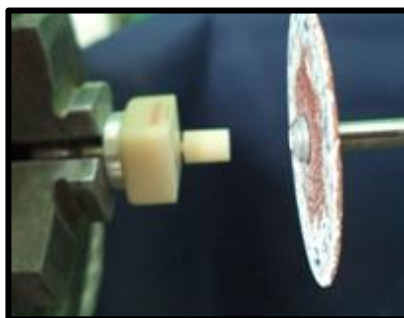
(c)

Figure (1): (a) IPs e-max zircad block (b) Milling and cutting the zirconia block (c) Final shape of the zirconia cylinder

The other Twenty cylinder were cutted from vita enamic blocks as shown in (2a) with dimensions of 5mm in diameter and 6 mm in height.



(a)



(b)

Figure (2): (a) Vitaenamic block. (b) Cutting cylindrical blank with diamond disk

Samples grouping

Each type of restorative material were divided into 2 sub-groups ten groups each:

Group A: vita Enamic cylinders were cemented with breeze self-adhesive resin cement.

Group B: vita Enamic cylinders were cemented with metacem adhesive resin cement.

Group C: Ips.e-max zircad cylinders were cemented with breeze self-adhesive resin cement.

Group D: Ips.e-max zircad cylinders were cemented with metacem adhesive resin cement.

Tooth preparation

Forty freshly maxillary premolars extracted for orthodontic purposes, sound and free from caries or cracks were collected and cleaned from debris by using slurry of pumice and a rubber cup. The teeth were stored in normal saline which is changed each 10 days at room temperature.

The teeth were mounted in auto polymerized acrylic block up to the level of cemento-enamel junction, the mounting was parallel with the long axis of the tooth using dental surveyor, all the teeth were subjected to cusp cutting (reduction) to 3.0mm from the buccal cusp by the aid of specialized machine (low speed diamond

machine), the cutting were done under running water as in figure (3a and b)

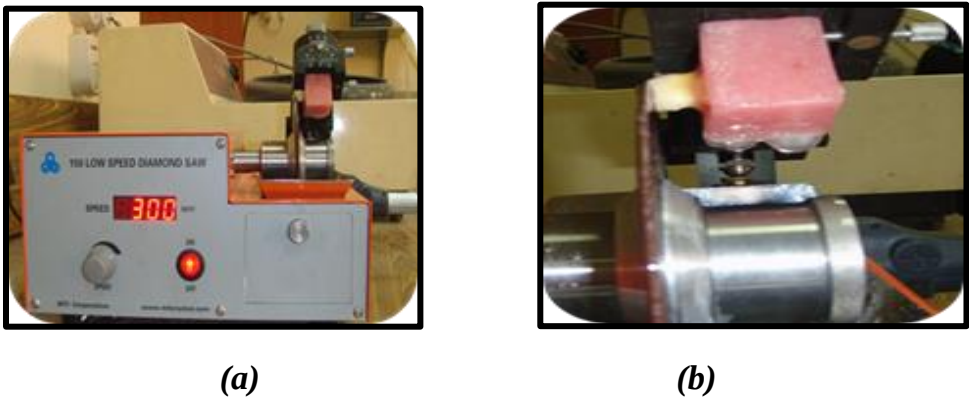


Figure (3): (a) Cutting machine. (b) Cutting the cusp under running water

For the vita enamic rods the adherent surface were subjected to sandblasting with Al₂O₃ max 50µm and a pressure 1 bar to remove any residue (according to manufacturer instruction) as in figure (4) then all rods were cleaned with ultrasonic cleaner. All the cylinders were silanated with mono bond for 1 min on the side to be cemented as in figure (5)



Figure (4) Sandblasting to Vita enamic cylinders **Figure (5) Silanization with mono bond**

6a) on the dentine surface and apply the vita enamic rod on it with

surface that is sandblasted and cure for 3 sec then remove the access and continue curing for 20 sec for each side (figure 7a and b).

Group B: the dentine surface of the tooth were etched with phosphoric acid 37% for 15 sec followed by irrigation for the same duration then with slight dryness, add the metacem total etch dual cure resin cement (figure 6b) on dentine surface then apply the vita enamic rod and cure for 3 sec then remove the access and complete the curing for 20 sec for each side



(a)



(b)

Figure (6): (a) Breeze self-adhesive resin. (b) Metacem dual cure resin cement

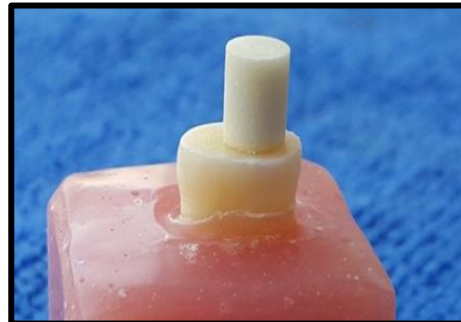
Group C: add a layer of breeze, self-adhesive resin cement on the dentine surface and apply the ips.e-max zircad rod on it and cure for 3 sec then remove the access and continue curing for 20 sec for each side.

Group D: the dentine surface of the tooth were etched with phosphoric acid 37% for 15 sec followed by irrigation for the same duration then with slight dryness, add the metacem total etch dual cure resin cement then apply the ips.e-max zircad rod and cure for 3 sec then remove the access and complete the curing for 20 sec for each side.

The entire specimens are loaded with a static load of 1 kg



(a)



(b)

Figure (7): (a) Specimen before removal of excess.

(b) Removing cement excess

After 1 hr. after cementation, specimens were stored in distilled water in dark container at room temperature for 24 h before the test.

Using universal testing machine (wdw-200e, 200kn) a shear force were applied using stainless steel chiseled rod with cross head speed of 1mm/min until failure occurred and data collected.

Statistical analysis was performed by using two-way ANOVA test to see if there were any significant difference among the means of experimental groups for shear bond strength, and independent sample.

T-test was used to detect the difference between two resin cement within each type of material or between the two types of material within each type of resin cement.

3. Result

Descriptive statistic: The means and standard deviations of shear bond strength of all experimental groups are shown in table (1).

Table (1) Descriptive statistic: means, standard deviation, minimum and maximum values for each group.

groups	Means	S.D.	MIN	MAX
A	11.82	0.97	10.3	13.5
B	20.89	2.04	18.8	24.7
C	4.41	1.46	2.1	6.1
D	21.59	2.00	18.6	24.5

From table (1) we see that the highest mean shear bond strength denoted at group (D) compared with other groups. And group (C) has the lowest mean shear bond strength as compared with other groups

Two-way ANOVA test was used to detect whether there were significant effects of the material of fabrication and the type of luting cement used and their interaction on the shear bond strength to dentin for the all experimental groups table (2).

Table (2) Group difference using two way ANOVA test

Source	Type III sum of square	Df	Mean of square	f- test	p-value
Materials	112.594	1	112.594	40.155	0.000
Type of adhesion	1722	1	1722	614.133	0.000
Material*types of adhesion	164.471	1	164.133	58.657	0.000
Error	100.942	36	58.657		
Total	10717.461	40			

From table (2) the type of the material of fabrication (vita enamic and ips.e-max zircad) had a highly significant effect on shear bond strength ($p < 0.000$), the type of luting cement (adhesive system) was also a highly significant factor ($p < 0.000$).

Further analysis were conducted and two- independent samples t-test was used to detect the difference in shear bond strength between the two luting cements (breeze and unicem) within each type of material or between the two type of materials (vita enamic and ips.e-max zircad) within each type of adhesive system table (3).

Table (3) Groups difference using independent sample t- test

Groups	t-test	d.f.	p-value
A vs. B	-12.710	18	0.000 (hs)
A vs. C	13.343	18	0.000 (hs)
B vs. D	-0.776	18	0.448 (ns)
C vs. D	-21.947	18	0.000 (hs)

From table (3) a highly significant difference between groups A and B, A and C and between group C and D, while a non-significant difference was found between group B and D.

4. Discussion

According to the result above, from table (1) the difference in mean of the shear bond strength between group A&B is due to the difference in the composition of the cement types that are used in the 2 groups which are in group A breeze self-adhesive resin cement that had mean shear bond strength is 11.82MPa and group B metacem adhesive resin cement which had mean shear bond strength 20.89MPa, this is may be due to the difference in the mechanism of cementation, in the metacem adhesive resin we use acid etching for the dentine surface that lead to remove the smear layer and smear tags and widened the dentinal tubules and making their orfices funnel shape that act as a micro retentive network for micromechanical inter locking [6] this is agree with [6,7,8], a hybrid layer and resin tags are created to provide micro mechanical retention [6]

In group A (vita enamic cemented with breeze self-adhesive resin cement) shear bond strength is 11.82 MPa which is lower as

compared with group B (vitaenamic with metacem adhesive resin cement) which is 20.89MPa due to the fact that priming and adhesion were done in the same step so the smear layer is still in its place and prevent the opening of dentinal tubules and the smear plug is not completely removed from dentinal tubules and a shallow hybrid layer is formed with submicron measures [6], and this result was supported by the data that was achieved from two way ANOVA test between the adhesive material which is appeared as a high significant value. Also the result that obtained from the t-test show the high significant p-value between the group A and B (this is agree [6, 9, 10].

The difference in mean shear bond strength value between group C that had 4.41MPa and group D that had 21.59 MPa is due the same reasons that had mentioned above and also improved by the obtained data from two way ANOVA between adhesive material which is shown a high significant p- value, and the t- test value between group C and D.

And group A (vita enamic cemented with breeze self-adhesive resin cement) shear bond strength 11.82 is higher than group C (zirconium with breeze self-adhesive resin cement) is 4.41 that's because resin based ceramic is the best material for luting ceramic restoration that's because composite cement have the same composition of composite restoration which is inorganic filler embedded in organic matrix [11] also the fine structure of feldspar ceramic and the acrylate polymer network make this material abrasion, flexural strength and elasticity close to dentine [12] the sandblasting process that been carried out on the vita enamic cylinders made their surface clean without any contaminant and also increase the surface roughness that will lead to increase the surface area of the cylinder which lead to increase the surface area for adhesion so shear bond strength increased. These results agree with [13, 14, 15] while it is disagree with [2-14].

5. Conclusions

From the above result and discussion we can conclude that:

1. The surface treatment for the restorative material with sandblast enhance the shear bond strength
2. The use of total adhesive cement get higher shear bond strength than self-adhesive cement
3. The mean shear bond strength of vitaenamic restorative material is higher than ips.e-maxzircad

References

- [1] Graiff L., Piovan C., Vigolo P. and Mason P., "Shear Bond Strength between Feldspathic CAD/CAM Ceramic and Human Dentine for Two Adhesive Cement", Journal of prosthodontics, 2008:294-299.
- [2] Piconi C., Maccauro G., "Zirconia as A Ceramic Biomaterial", Biomaterial, 1999; 20(1):1-25
- [3] Reddy S., Vijitha D., Deepak T., Satish A., "Evaluation of Shear Bond Strength of Zirconia Bonded to Dentine after Various Surface Treatments of Zirconia", J Indian Prosthodontics Soc., 2014; 14(1):38-41.
- [4] Elaska Sh. "Bond Strength of Novel CAD/CAM Restorative Materials to Self-Adhesive Resin Cement: the Effect of Surface Treatment", J. Adhesive Dent., 2014; 16:531-540.
- [5] Scientific documentations of vita enamic for cercer/inlab
- [6] Eliades G., Watts D. Eliades, T., "Dental Hard Tissues and Bonding", Springer, 2005:103-109.
- [7] Kolker J., Vargas M., Armstrong SR., Dawson D., "Effect of Desensitizing Agents on Dentin Permeability and Dentin Tubule Occlusion", J. Adhesive Dent., 2002; 4:211–221
- [8] Tay FR., Pashley DH. "Dental Adhesives of the Future", J. Adhesive Dent., 2002; 4:91–103

- [9] Loguercio A, Reis A., Ballester R., "Polymerization Shrinkage: Effects of Constraint and Filling Technique in Composite Restorations". *Dental Material*, 2004; 20:236–243
- [10] Chen H, Manhart J., Kunzelmann K-H, Hickel R., "Polymerization Contraction Stress in Light-Cured Compomer Restorative Materials". *Dent. Mater.*, 2003; 19:597–602
- [11] Blatz M., Sadan A., Kern M., "Resin Ceramic Bonding: A Review of Literature". *Journal of Prosthetic Dentistry*, 2003; 89:268-74.
- [12] Dirxen C., Blunck U., Preissner S., "Clinical Performance of A New Biomimetic Double Network Material", *Open Dentistry Journal*, 2013; 7:118-122.
- [13] Amaral R., Ozcan M., Bottino MA. Valandro LF., "Micro Tensile Bond Strength of A Resin Cement to Glass Infiltrated Zirconia-Reinforced Ceramic: the Effect of Surface Conditioning". *Dental Material*, 2006; 22:283–290.
- [14] Kim S., Cho H., Lee Y., Choi SH., Moon H. "Bond Strength Y-TZP Zirconia Ceramic Subjected to Various Surface Roughening Method and Layering Porcelain". *Surface and Interface Analysis*, 2010; 42:576-580.
- [15] De oyague R., Monticelli F, Toledano M., Osorio E., Ferrari M., "Influence of Surface Treatments and Resin Cement Selection on Bonding to Densely – Sintered Zirconium – Oxide Ceramic", *Dental Material*, 2009; 25:172-179.
- [16] Torres SM., Borges GA., Spohr AM., "The Effect of Surface Treatments on the Micro-Shear Bond Strength of A Resin Luting Agent and Four All-Ceramic Systems". *Oper. Dent.* 2009; 34(4):399–407.

تأثير نوعين مختلفين من السمنت اللاصق على قوه لصق التيجان المصنوعة من الزركون والسيراميك المهجن

م.م.د. زينب شاكر الطائي

drzainabamory@gmail.com

كلية الرافدين الجامعة – قسم طب الأسنان

أ.د. إيناس عيسى الراوي

Inas_arawi@yahoo.com

كلية الإسراء الجامعة – قسم طب الأسنان

المستخلص

التطور السريع لمواد بناء الاسنان ازداد في السنوات الاخيره ولكن التركيز في نجاح هذه المواد هو قابلية الالتصاق بسطح السن الذي اثر تأثيرا مباشرا على فعاليتها.

استعملت في هذه الدراسة نوعين من مواد بناء الاسنان vitaenamic و Ips zircad e-max كما واستخدمت نوعين من المواد اللاصقة breeze self-adhesive و metacem adhesive resin cement.

تم تقسيم ضواحك الاسنان العلويه الاربعين المستخدمه ذات الاحجام المتماثله الى اربعة مجموعات :

مجموعه ا: عشره اسنان مقطوعه السطح ملصق عليها ماده vitaenamic بعد تقطيعها على شكل اسطوانه وباستخدام اللاصق breeze self-adhesive.

مجموعه ب: عشره اسنان مقطوعه السطح وملصق عليها ماده vitaenamic بعد تقطيعها على شكل اسطوانه وباستخدام اللاصق metacem adhesive resin cement

مجموعه ج: عشره اسنان مقطوعه ملصق عليها اسطوانه من ماده ال ips e-max zircad واستخدام اللاصق breeze self-adhesive.

مجموعه د: عشرة اسنان مقطوعه السطح وملصق عليها اسطوانه من ماده ips e-max zircad واستخدام اللاصق metacem adhesive resin cement وتم قياس قابليه الالتصاق باستخدام universal testing machine وبعد اجراء الحسابات احصائيا اظهرت النتائج ان المجموعه د تمتلك اعلى قوه التصاق والمجموعه ج تمتلك قوه الالتصاق الاقل بالمقارنه مع المجاميع الاخرى كما اظهرت الحسابات الاحصائيه وجود اختلاف كبير بالنتائج باختلاف ماده الحشوه واختلاف كبير باختلاف ماده اللاصقه. **وكاستنتاج:** لوحظ ان معامله السطوح بالعصف الرملى ساعد كثيرا في قوه اللصق وان استخدام ماده اللاصقه breeze adhesive resin كان لديه قوه التصاق اعلى من self-adhesive resin cement بالاضافه الى ان قوه التصاق Vitaenmic اعلى من Ips e-max zircad.

الكلمات الرئيسية: زركونيا، فيتا اينامك، سمنت ذاتي اللصق، مقاومة الالتصاق القصي.