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Effect of Simulated Intraoral Conditions on Mode Of Failure Of Different Pretreatment Methods for the Repair of Lithium Silicate Ceramic Restorations

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ABSTRACT: Objective: The purpose of this clinical study was to evaluate the mode offailure between repair composite and different lithium silicate ceramics by using different surface pretreatments under different oral conditions.

Materials and Methods: Rectangular glass-ceramic bars of three types of ceramic (Lithium-disilicate glass ceramic (L2) (IPS e.max Press), Zirconia-reinforced lithium silicate (ZLS1) (Celtra Duo Press), Zirconia-reinforced lithium silicate (ZLS2) (Vita Ambria Press) were manufactured. Specimen preparation was performed to simulate three different environmental settings: laboratory conditions (LC, 23 ±1°C, RH 50 ±5%), rubber-dam conditions (RC, 30 ±1°C, RH 50 ±5%) or oral conditions (OC, 32 ±1°C, RH 95 ±5%). Each group material was divided into three parts. One third of them is the control group without any surface pretreatment. The second third was treated by air abrasionthen application of thin layer of Monobond N. The last third was treated with Monobond Etch and Prime.

Conclusions: Intraoral ceramic restoration repair is the best option since it is the least intrusive and the most economical.The ceramic restoration can be temporarily but effectively repaired intraorally.

Keywords: Glass ceramics, Mode of failure, IPS e.max Press, Monobond N.

I. INTRODUCTION

Dental ceramics are used for the restoration of damaged teeth, replacement of missing teeth and improvement of esthetics. Because of their superior estheticsand mechanicalproperties, the ceramic restorative dental materials are increasingly usednowadays.

One strategy to optimize the mechanical performance of a restorative material, is to use a ceramic with a higher flexural strength and a higher fracture toughness in comparison to the conventional glass ceramics.In order to reinforce lithium disilicate glass ceramics (IPS e.max Press) with about 20 weight percent zirconia, zirconia reinforced lithium disilicate (Celtra Duo Press, Vita Ambria Press) was developed.

Several causes have been associated with fracture and chipping of ceramics, such as inadequate design of the infrastructure, irregular preparation, mismatch between the thermal expansion coefficient of veneering ceramic and infrastructure, inadequate laboratory procedures, porosity and Surface defects after laboratory processing

inappropriate occlusal adjustment, trauma and para functional habits.

In addition to the adhesive failures, ceramic restorations showed some cohesive failures which are affected by the bond strength values and stress levels. In such situations, cracks that started at the interface could be diverted into the ceramic surface and resulted in a cohesive failure of the ceramic region in contact with the bonded composite surface.

II. MATERIALS AND METHODS

The materials used in this study are listed in **(Table 1)**.

Product name	Material type	Basic components	Batch number	Manufacturer
IPS e.max Press A2 (Figure 1)	Lithium disilicate glass ceramic	• SiO_2 (Silicon Dioxide) 57-80 wt% • Li_2O (Lithium Oxide) 11-19 wt% • K_2O (Potassium Oxide) 13 wt% • P_2O_5 (Phosphorous pentoxide) 11 wt%	Z010WC	Ivoclar Vivadent, Liechtenstein, Germany

		• ZrO_2 (Zirconium Dioxide) 0-8 wt% • ZnO 8 wt% • ceramic pigments 8 wt% • other oxides		
Celtra Duo Press A2 (Figure 2)	Zirconia-reinforced lithium disilicate ceramic	• Silica, lithium-metasilicate 55 vol% • lithium-disilicate, phosphate crystals, zirconia crystals 20 wt%	16003308	Dentsply, Sirona, USA
Vita Ambria Press A2 (Figure 3)	Zirconia-reinforced lithium disilicate press ceramic	• SiO_2 (Silicon Dioxide) 58-66 wt% • Li_2O (Lithium Oxide) 12-16 wt% • ZrO_2(Zirconium Dioxide) 8-12 wt% • Pigment < 10 wt% • Various > 10 wt%	78900	Vita Zahnfabrik, Bad Säckingen, Germany
3M™ Filtek™ Z250 XT nano hybrid composite A2 (Figure 4)	Nano-hybrid composite filling Material	• BIS-GMA (Bisphenol A diglycidyl ether dimethacrylate) • UDMA (urethane dimethacrylate) • Bis-EMA (Bisphenol A polyethylene glycol diether dimethacrylate) • Fillers: 60% (volume) silica/zirconia	NF29240	3M ESPE, Minnesota, United States
Monobond N (Figure 5)	Universal Bonding agent (Non-etching glass ceramic primer)	Alcohol solution of • silane methacrylate • phosphoric acid methacrylate • Sulphide methacrylate	Z03V76	Ivoclar Vivadent, Liechtenstein, Germany
Monobond Etch and Prime (Figure 6)	Self-etching glass-ceramic primer	Alcoholic-aqueous solution of • ammonium polyfluoride • silane methacrylate • colourant	Z023RN	Ivoclar Vivadent, Liechtenstein, Germany

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III. RESULT

Table (2) Comparison of mode of failure between different materials with different surface treatment under different oral conditions.

Materials	Surface treatment	Condition	Mode of failure				
			Adhesive	Cohesive		Mixed	Total
				Within ceramic	Within composite		
IPS e.max Press	Monobond Etch and Prime	LC	1	1	1	7	10
		RC	1	1	0	8	10
		OC	1	1	1	7	10
	Between different conditions		P=0.982				
	Air abrasion + Monobond N	LC	1	2	1	6	10
		RC	1	1	1	7	10
		OC	0	1	1	8	10
	Between different conditions		P=938				
	No treatment	LC	8	1	1	0	10
		RC	7	2	1	0	10
		OC	8	1	1	0	10
	Between different conditions		P=0.965				
Celtra Duo Press	Monobond Etch and Prime	LC	0	2	0	8	10
		RC	0	2	0	8	10
		OC	0	2	0	8	10
	Between different conditions		P=1.0				
	Air abrasion + Monobond N	LC	0	1	1	8	10
		RC	0	2	1	7	10
		OC	1	2	2	5	10
	Between different conditions		P=0.731				
	No treatment	LC	8	1	1	0	10
		RC	8	0	2	0	10
		OC	8	2	0	0	10
	Between different conditions		P=0.406				
Vita Ambria Press	Monobond Etch and Prime	LC	0	1	0	9	10
		RC	1	1	0	8	10
		OC	0	1	1	8	10
	Between different conditions		P=0.666				
	Air abrasion + Monobond N	LC	2	2	1	5	10
		RC	2	2	0	6	10
		OC	0	1	0	9	10
	Between different conditions		P=0.458				
	No treatment	LC	7	2	1	0	10
		RC	8	2	0	0	10
		OC	7	3	0	0	10
	Between different conditions		P=0.667				
Between different surface treatment		Monobond Etch and Prime	$P_{LC=0.982}$ $P_{RC=1.0}$ $P_{OC=0.666}$				
		Air abrasion + Monobond N	$P_{LC=0.938}$ $P_{RC=0.731}$ $P_{OC=0.458}$				
		No treatment	$P_{LC=0.965}$ $P_{RC=0.406}$ $P_{OC=0.667}$				

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Between different Materials	FOR LC	P_M=0.576 P_A=0.791 P_N=0.965
	FOR RC	P_M=0.827 P_A=0.744 P_N=0.394
	FOR OC	P_M=0.732 P_A=0.460 P_N=0.543

PLC: comparison between different surface treatment for LC group, PRC comparison between different surface treatment for RC group, POC: comparison between different surface treatment for OC group, PM: comparison between different materials for Monobond Etch and Prime group, PA: comparison between different materials for air abrasion and Monobond N group, PN: comparison between different materials for no treatment group.

IV. DISCUSSION

Ceramic restorations have been utilized extensively due to its various benefits, which include color stability, low heat conductivity, wear resistance and biocompatibility.[1] Lithium glass-ceramics have a greater aesthetic impact due to their higher translucency and range of color tones. Additionally, they are able to form strong, sticky resin connections by employing standard acid etching and silanization techniques.[2]

In this study, Ceramic bars of each martial were heat pressed and finished in accordance with the manufacturer's instructions. Since heat pressing created glass ceramic with improved marginal fit, reduced porosity and higher flexural strength, it became a popular and efficient method of fabricating glass ceramic restorations.[3,4]

A new generation of ceramics that purport to combine glass-ceramic esthetic performance and zirconia improved mechanical properties was brought about by the introduction of hybrid ceramic materials.[5,6]

Direct repair, using a composite resin is less expensive, can be completed quickly and preserves supporting structures, seems like a good option for treatment of fractured glass ceramics intraorally. If the conditions and methods of treatment are appropriate, intraoral repair has lately been proposed as a possible therapeutic substitute which is the least intrusive and the most economical.[7]

Nanohybrid composites were used in this study with a finer filler particle size distribution. This provides superior strength and superior fracture resistance.[8,9] This nanoscale filler particles are also contributed to enhancing the wear resistance and ensuring more durable restorations that withstand functional forces.[10, 11]

This study was based on testing the mode of failure of ceramic bars. Both temperature and humidity tested by **Bicalho etal.**[12] significantly affected the tensile bond strength and rubber dam enhanced the bonding strength of posterior composite restorations with avoiding the high humidity.

Additionally, rubber dam is essential for increasing bonding strength as stated by **Rau etal.**[13] who clinically measured the influence of rubber dam on the proximal contact strength after its reconstruction with tooth-colored restorations. The study concluded that rubber dam is recommended for adhesive restorations.

Hence, the bonding mechanisms between ceramic material and composite must be investigated in order to ascertain the effectiveness of a repair, in addition to the particular performance of each material.[14]Numerous bond strength tests have been devised in order to assess lasting bonding in a laboratory setting.[15]

V. CONCLUSION

Intraoral ceramic restoration repair is the best option since it is the least intrusive and the most economical. Furthermore, if the conditions and methods of treatment are appropriate, the ceramic restoration can be temporarily but effectively repaired intraorally.

REFERENCES

[1]. Rekow ED, Silva NRFA, Coelho PG, Zhang Y, Guess P, Thompson VP. Performance of dental ceramics: challenges for improvements. J Dent Res. 2011;90(8):937-952.
[2]. Zarone F, Di Mauro MI, Ausiello P, Ruggiero G, Sorrentino R. Current status on lithium disilicate and zirconia: a narrative review. BMC oral health. 2019;19(1):134-134.
[3]. Lubauer J, Belli R, Peterlik H, Hurle K, Lohbauer U. Grasping the Lithium hype:

Insights into modern dental Lithium Silicate glass-ceramics. Dent Mater. 2022;38(2):318-332.

[4]. Matinlinna JP. Handbook of oral biomaterials: CRC press; 2014.

[5]. Dentsply Sirona. Celtra Press Directions for use Revesion 2019:10.

[6]. Zhang Y, Lawn BR. Novel Zirconia Materials in Dentistry. J Dent Res. 2018;97(2):140-147.

[7]. Reston EG, Filho SC, Arossi G, Cogo RB, Rocha CS, Closs LQ. Repairing Ceramic Restorations: Final Solution or Alternative Procedure? Oper Dent. 2008;33(4):461-466.

[8]. Van Ende A, De Munck J, Lise DP, Van Meerbeek B. Bulk-Fill Composites: A Review of the Current Literature. J Adhes Dent. 2017;19(2):95-109.

[9]. Ilie N, Hickel R. Macro-, micro- and nano-mechanical investigations on silorane and methacrylate-based composites. Dent Mater. 2009;25(6):810-819.

[10]. Van Ende A, De Munck J, Lise DP, Van Meerbeek B. Bulk-Fill Composites: A Review of the Current Literature. J Adhes Dent. 2017;19(2):95-109.

[11]. Wu H. Toughening and strengthening mechanisms in ceramic nanocomposites. Residual Stresses in Composite Materials: Elsevier; 2021. p. 279-311.

[12]. Bicalho AA, de Souza SJ, de Rosatto CM, Tantbirojn D, Versluis A, Soares CJ. Effect of temperature and humidity on post-gel shrinkage, cusp deformation, bond strength and shrinkage stress - Construction of a chamber to simulate the oral environment. Dent Mater. 2015;31(12):1523-1532.

[13]. Rau PJ, Pioch T, Staehle HJ, Dörfer CE. Influence of the Rubber Dam on Proximal Contact Strengths. Oper Dent. 2006;31(2):171-175.

[14]. Romanini- Junior JC, Kumagai RY, Ortega LF, Rodrigues JA, Cassoni A, Hirata R, et al. Adhesive/silane application effects on bond strength durability to a lithium disilicate ceramic. J Esthet Restor Dent 2018;30(4):346-351.

[15]. Darvell BW. Adhesion Strength Testing — Time to Fail or a Waste of Time? J Adhes Sci Technol 2009;23(7-8):935-944.