



Comparison of the Effect of Different Surface Treatments on the Bond Strength of Different Cements with Nickel Chromium Metal Alloy: An In-Vitro Study

Saumya Kapoor BDS, Fei Liu DDS PhD, Berna Saglik DDS MS, Nayana Prabhu MDS University of Michigan School of Dentistry

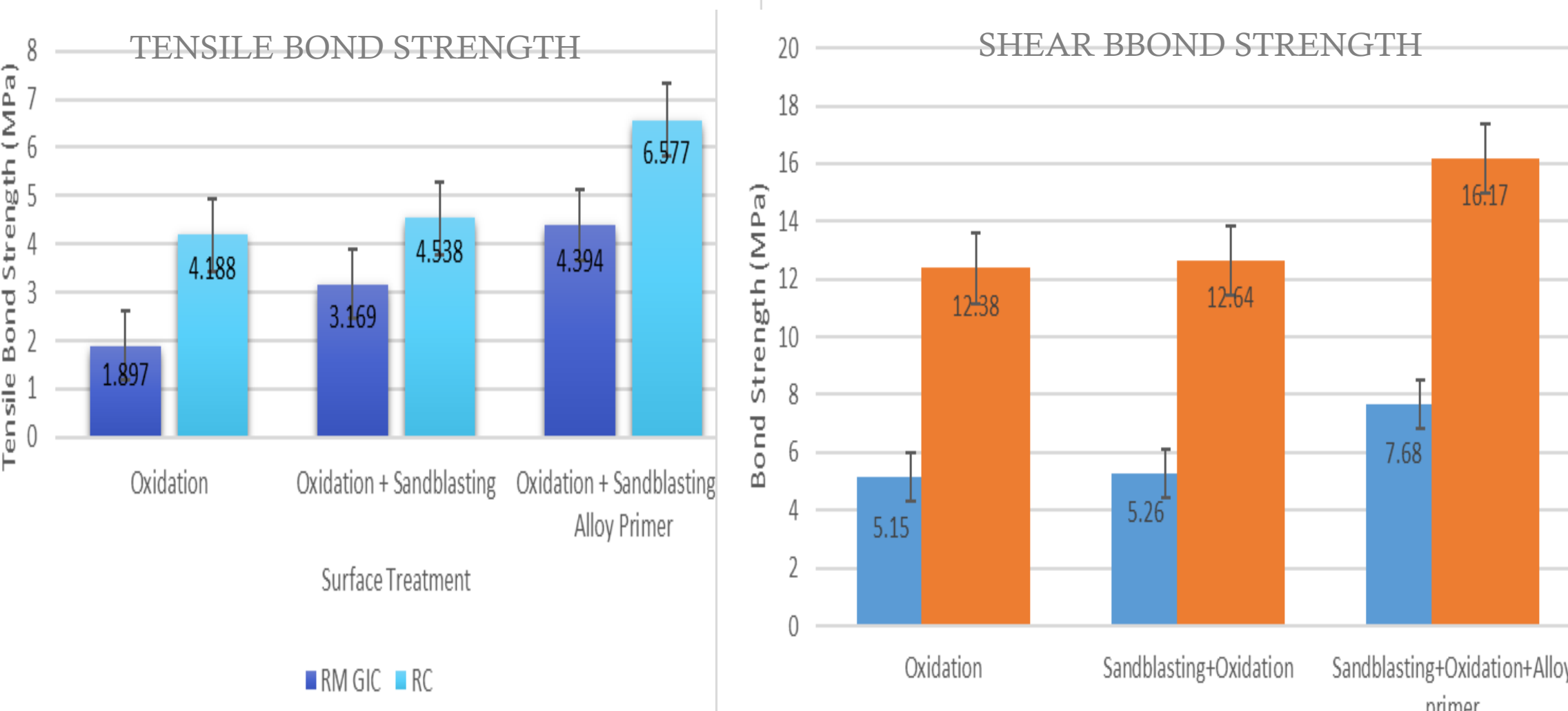
Poster code:
acp2022.04b013a

INTRODUCTION

- Choice of correct luting cement and surface condition of the intaglio surface of the fixed prosthesis important. Adhesion of the cements to the intaglio surface of indirect restorations is imperative to durability of the restoration
- Numerous superficial conditioning methods are present which alter the alloys surface and modify their morphological characteristics (ex:sandblasting, chemical substances such as acid, electrolytic deposition of ions chemically more reactive) promoting a greater affinity between the alloys and the cements, thereby increasing the retention and longevity of the fixed prosthesis.
- High solubility associated with conventional cements has shifted the focus to resin based luting agents. Self-adhesive resin cements offer high fracture strength, adequate bond to the dental structure and low solubility when exposed to oral fluids
- Bonding between resins and metals is a physicochemical phenomenon, resulting in mechanical interlocking of the cement with the metal surface and chemical interactions between the oxides present on the surface of metals and the carboxylic or phosphoric acid derivatives present in the cements.
- The purpose of this study was to evaluate and compare the effect of different surface treatment on the tensile and shear bond strength of different cements with nickel–chromium metal alloy.
- The Null hypothesis tested is that different luting agents and various surface treatments of the nickel chromium alloy have no effect on in vitro tensile and shear bond strength values.**

RESULTS

Mean and standard deviation were used to summarize tensile bond strength and shear bond strength. Two-way analyses of variance (ANOVA) was performed to compare bond strength across type of surface treatment and cement used followed by post hoc parametric analysis.



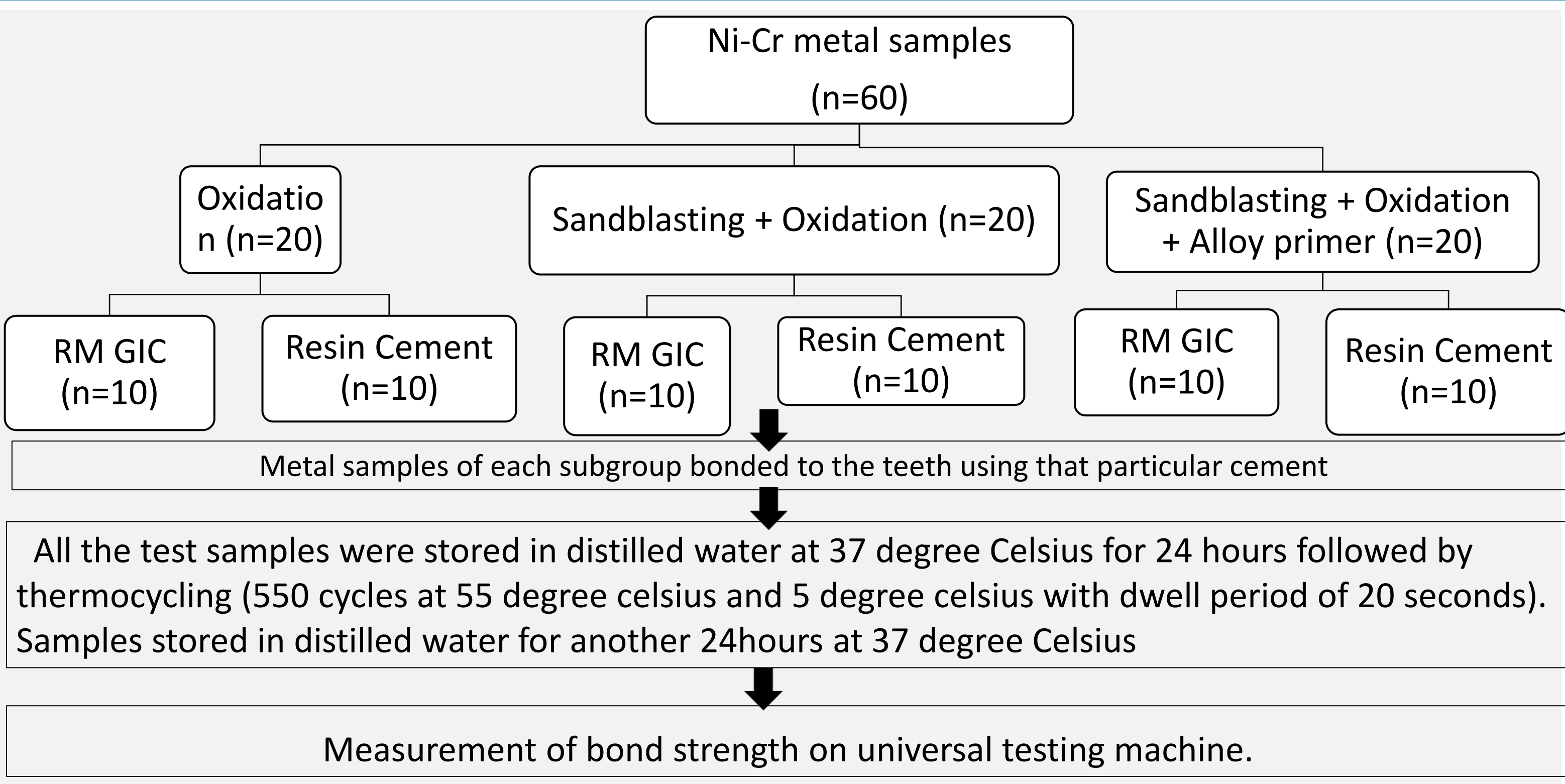
= Reference group Group A = oxidation
Group B = oxidation + sandblasting Group C = oxidation + sandblasting + alloy primer

METHODS

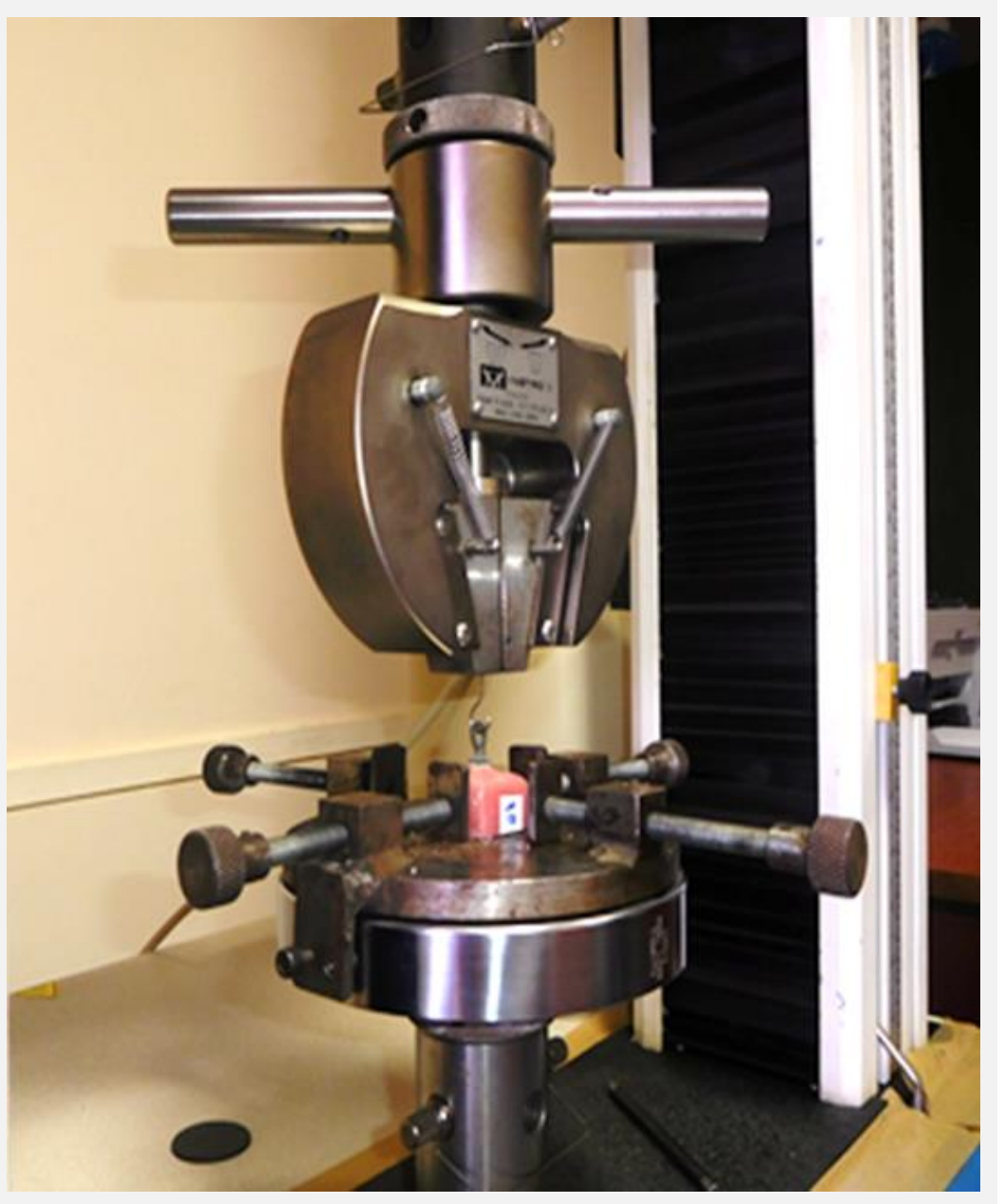
- 120 extracted, caries free, unrestored human maxillary first premolar (Stored in 0.05% thymol)
- Divided randomly into 12 experimental groups with 10 teeth in each group. All procedures were carried out by one operator.
- Teeth were embedded 1mm above the cemento-enamel junction in an aluminium die with auto polymerizing acrylic resin.
- Block dimensions for tensile bond strength was 3x5cm & for shear bond strength was 3x8cm.
- A flat occlusal surface with dentin exposed was created at right angles to the straight-line axis of the tooth using a diamond abrasive impregnated disk in micromotor hand piece under copious water lubrication.
- A dental surveyor was modified and customized to receive the hand piece with the bur, to ensure a flat occlusal surface which is parallel to the horizontal plane.
- The hand piece was fixed at that position moved back and forth across the occlusal surface of each tooth 20 times.
- Wax patterns were made with casting wax (Star Wax CB) directly on the tooth surface. Dimensions: 7x5mm.



- An inverted 'U' shaped loop using sprue wax of diameter 2mm (Bego, USA) was attached to the external surface of the patterns.
- Wax patterns were then invested and casted in nickel–chromium metal alloy (Wiron 99, Bego, USA) using an induction casting machine (OKAY PLUS, Galoni, USA).



- Oxidation treatment: metal samples exposed to 600° - 980°C under vacuum, in the Multimat NTX press unit for 6 minutes 30 seconds to form an oxide layer (4).
- Sandblasting or airborne particle abrasion treatment: aluminum oxide was inundated on the bonding surface of metal castings at 0.3 MPa pressure (70 psi) for 10 seconds at the distance of 10 mm (4). Samples were then cleaned under running tap water followed by ultrasonic cleaning in distilled water for 2 min.
- Chemical surface treatment: application of metal primer (Alloy Primer) on the metal surface using applicator brush. Air dried for 20-30 seconds.
- Resin modified Glass Ionomer Cement (RM GIC) (RelyX Luting 2) and a self-adhesive, resin- cement (RelyX U 200).



Post hoc comparisons of mean difference through Two Way ANOVA for tensile bond strength

Parameter	Mean Diff	Std. Error	t	Sig. (p value)	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	15.773	.592	26.638	<0.001	14.587	16.960
(Group A) – (Group C)	-3.163	.725	-4.361	<0.001	-4.616	-1.710
(Group B) – (Group C)	-2.978	.725	-4.106	<0.001	-4.431	-1.525
Group C	0#	.	.	.	.	.
RM GIC Cement	-7.698	.592	-13.000	<0.001	-8.884	-6.511
Resin Cement	0#	.	.	.	.	.

Post hoc comparisons of mean diff. through Two Way ANOVA for shear bond strength

Parameter	Mean Diff.	Std. Error	T	Sig. (p value)	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	6.459	0.227	28.504	<0.001	6.005	6.913
(Group A) – (Group C)	-2.443	0.278	-8.802	<0.001	-2.999	-1.887
(Group B) – (Group C)	-1.632	0.278	-5.880	<0.001	-2.188	-1.076
Group C	0#	A.	.	.	.	.
RM GIC Cement	-1.948	0.227	-8.595	<0.001	-2.402	-1.494
Resin Cement	0#	.	.	.	.	.

References: 1. Silva BC, Salim MD, Kammer MG, Carvalho W, Gouveia DVC. Influence of surface treatment on bond strength of resin cements to a nickel alloy. RGO, Rev Gaúch Odontol, Porto Alegre. 2014;62:377-82.
2. Alloy Primer, Product brochure, Kuraray Co., Ltd. 3. Stefani A, Brito RB, Kina S, Andrade OS, Ambrosano GMB, Carvalho AA, Giannini M. Bond Strength of Resin Cements to Zirconia Ceramic Using Adhesive Primers. J Prosthodont. 2016;25:380-5.
4. Yoshida K, Sawase T, Watanabe L, Atsuta M. Shear bond strengths of four resin cements to cobalt-chromium alloy. Am J Dent. 1995;8:285-8.
5. Piwowarczyk A, Lauer HC, Sorensen JA. In vitro shear bond strength of cementing agents to fixed prosthodontic restorative materials. J of Prosth Dent. 2004;92:265-73.
6. Dixon DL, Breeding LC, Hughie ML, Brown JS. Comparison of shear bond strengths of two resin luting systems for a base and a high noble metal alloy bonded to enamel. J Prosthet Dent. 1994; 72:457-61.

DISCUSSION

- Adhesive ability of luting agent is evaluated by tensile and shear bond tests
- Ni-Cr alloy is the most commonly used metal for making fixed adhesive prostheses. Base metals have higher free-surface energy and form a thicker oxide layer which provide possible sites for chemical bonding (1)
- The surface treatment which offered the maximum tensile and shear bond strength for both the cements, was oxidation and sandblasting followed by application of alloy primer. Therefore, the null hypothesis was rejected.
- The finding imply that the proposed chemical reaction produced between the NiCr alloy and the metal primer, effectively improves the bond strength of resin cement to base metal alloys. Adherence was offered by both **micromechanical** means (sandblasting) and **chemical bonding** (oxide layer and alloy primer). The airborne-particle abrasion with alumina particles results in improved microtopography and possibly **better wettability and penetration** of the primers into the micro irregularities of the surface. As per the manufacturer, the alloy primer contains MDP (**10-methacroyloyloxydecyl dihydrogen phosphate**), an adhesive compound which contains phosphoric acid monomer components. These phosphoric acid monomers of MDP react with the metal oxides, while the double bonds on the other end of the molecule copolymerize with the resin cement monomers creating an **enhanced metal cement bond** (2,3).
- These results agree with findings of Yoshida K, Taira Y, Matsumura H, Atsuta M (4) who reported significant improvement in bond strength of noble and base metal alloys when these alloys were pre-treated using a metal primer before bonding prosthetic composite resin to metals.
- A significant difference was observed between RM-GIC and resin cement for both tensile and shear bond strength (p value<0.05), with resin cement offering higher bond strength values.
- Piowarczyk *et al.* in 2004 (5) reported that RMGIC provided lower bond strength values with both metal alloy and ceramic than the self-adhesive resin cement which exhibited significantly higher values, as found in the present study. This can attribute to **phosphoric-acid methacrylates** in the self-adhesive resin cement, which provided a strong chemical reaction with MDP component of the metal alloy primer.
- For both the RM-GIC and resin cement, no statistically significant difference for shear bond strength was found between oxidised group and oxidation followed by sandblasting. This is in accordance with a study performed by Dixon *et al.* (6)

SUMMARY

For both RM-GIC and Self-adhesive resin cement, the surface treatment which offered the maximum tensile and shear bond strength values was combination of oxidation, sandblasting and alloy primer. And for this surface treatment, compared to RM-GIC, self-adhesive resin cement offered stronger bond strength values.