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Evaluation of Shear Bond Strength at Ceramo Metal Interface of Metal Ceramic Restorations Fabricated With 'Press on Metal' And 'Conventional Layering Techniques' – An Invitro Study

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I. Introduction

There has been extensive development in the field of dental implants and metal free ceramics in the recent years[1,2,3].Despite this, metal ceramics still remains a good option for fixed restorations due to many factors including its mechanical properties[4,5].Dental laboratory procedures used for many decades involves sintering of several dental porcelain layers on metal coping substrate to achieve excellent esthetic results. But this procedure is time consuming . Several studies investigating an alternative approach resulted in the evolution of more rapidly hot pressing ceramic [6].The press on metal technique enhances cohesion of porcelain[7]. This technique allows for full contour ceramic wax up as opposed to more technique sensitive layering method[8]. The marginal fit was comparable with conventional layering technique. Hence the purpose of this study was to compare the efficacy of the new press on metal method of ceramic application with the conventional sintering method .

II. Methodology

PROCEDURE

Thirty two Co-Cr alloy specimens were fabricated with the dimensions 30 mm in length, 10 mm in width, and 2 mm thickness. Thirty two blocks of casting wax (RenfertCrowax) as per above mentioned dimensions were prepared (fig 1). They were sprued and placed inside crucible former . Wax patterns were then invested with phosphate bonded investment (Dentaurum) which was thoroughly mixed in a vacuum mixer(renfert).Casting ring was placed in the furnace at 850 degree Celsius for 1 hr 15 minutes . During this time wax melts creating a space on to which cobalt chromium alloy millets can be filled. The mold is then removed from the furnace and placed onto the casting machine. The cobalt chromium millets were kept in the ceramic crucible which is then placed in the casting machine (fig 2)and rotated so that the cobalt chromium millets melt under heat and flow from the crucible into the mold space .The casting machine is set at 3.5 bar pressure at 1200 degree Celsius. Mold was then divested and the sprue were cut and metal strips were polished (fig3).

CONVENTIONAL LAYERING

From the 32 specimens 16 cobalt chromium strips of prescribed dimension were layered and remaining 16 specimens were pressed with ceramics.The polished metal strips were sand blasted with 110 micron alumina at 4 bar pressure in a sand blaster.110 micron sand blasting was preferred in this study because 110 micron sand blasting provided a better shear bond strength than that with 50 microns. After sand blasting, the metal strips were steam cleaned (reitel steamy mini) for removing the residues . Two layers of wash opaque is then added on the metal strips. Wash opaque layer is added first so that the opaque porcelain bonds very well and flows well on to the metal and prevents space for air entrapment. Then it was placed in furnace and then a second layer of wash opaque is added so that no more air bubbles entrap inside the opaque porcelain. First opaque porcelain is over fired at temperature of 980 degree Celsius so that it fuses to each depression in the metal . The second layer of wash opaque is fired at 970 degree Celsius as per recommendations by the manufacturer. Ivoclar vivadent programat-P200(fig4), starts at temperature of 403 degree celsius and it has a dry time of 6 minutes so that entire water content evaporates Then the temperature rises at a heat rate of 80 degree celsius per minute. Vacuum will be at 550 degree celsius so that no more air gets entraped . Then temperature rises to 980 degree celsius at a holding time of 1 minute. After the coating of opaque porcelain and furnacing body porcelain is to be added layer by layer (IPS CLASSIC DENTIN). It was kept in the furnace at starting temperature of 400 degree celsius for 6 minutes and vacuum is on at 580 degree

celsius . Temperature rises to 925 degree celsius at heat rate of 50 degree per minute and holding time was 1 minute. After furnacing, the layered ceramic is finished and glazed and then furnace again at 855 degree celsius .

PRESSING CERAMIC ONTO METAL

The polished metal strips are sand blasted with 110 micron alumina at 4 bar pressure in (Renfert basic master sand blaster). After sand blasting , the metal strips are steam cleaned (Reitel steamy mini) for removing the residue particles.The first layer of wash opaque is added onto metal strips and furnaced as previously mentioned in layering technique . The second wash opaque is added and furnaced.

Now wax pattern of 1 mm thickness was made using (al- dente) wax . Wax pattern was made in prescribed thickness and measured using wax guage (fig 5).Wax pattern is then sprued using sprue wax . Plastic ring was used and investing was done. Then the mold is placed in pre heating furnace and heated at 850 degree celsius for 1 hour 15 mins. The wax melts creating space for pressable ceramic. The ceramic ingots (ivoclar press on metal small ingots) were used to fill the wax space (fig 6). They are placed on to mold (fig7) and then the plunger is placed over the ingots in the space of mold (fig8) . Then the plunger and mold with ingots are placed in pressable furnace (fig 9) so that pressable furnace presses the plunger on to the ingots and fills the space of wax pattern. The plunger and mold was placed onto the pressable furnace at starting temperature of 700 degree celsius and then temperature is rised at heat rate of 60 degree per minute to 940 degree celsius .Holding time is 20 minutes (fig 10). The mold is then divested and the sprue is cut off .The press on ceramics are finished and finally glazed and again placed in furnace at 855 degree celsius .

SHEAR BOND STRENGTH EVALUATION

The universal instron machine is considered standard equipment for evaluating shear bond strength of two dissimilar materials which are conjoined together. A total of 32 specimens shall be loaded on the assembly, at a crosshead speed of 0.5 mm/min. Shear force will be applied at the junction of metal and porcelain. The force application will continue until adhesive fracture occurs, and the readings of the load applied to that particular specimen will be recorded. The same process will be repeated for all the 32 specimens, and all the readings of the load applications are expressed in Mega Pascal.

STATISTICAL ANALYSIS

The shear bond strength were measured in Mega Pascal . The mean value and standard deviation of the groups were calculated and used for describing the shear bond strength. The comparison between the groups were done by using ‘student t test’.

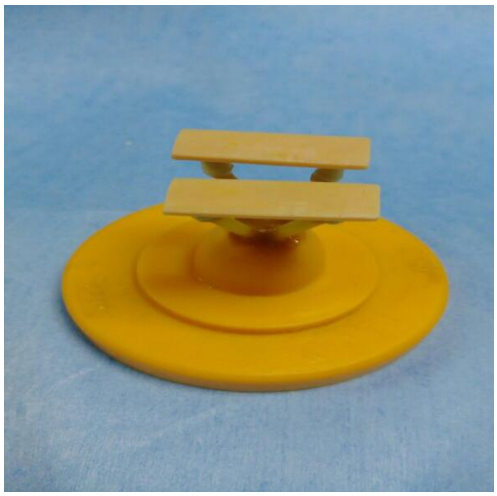

Figure 1. Wax pattern fabricated in desired dimension

Figure 2. Crucible and mold placed in casting machine

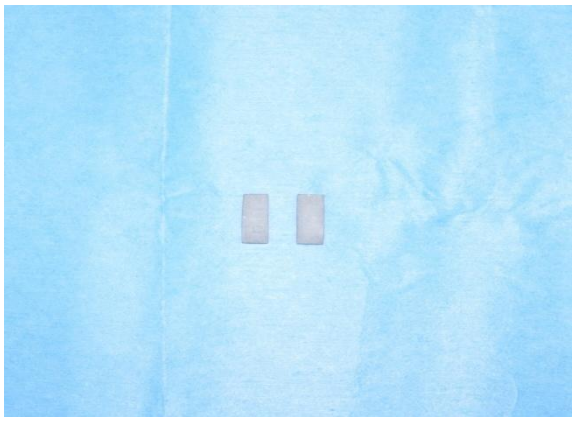

Figure 3 Cobalt chromium metal strips

Figure 4.Metal strips place in furnace after adding opaque porcelain

Fig 5 Wax pattern fabrication for pressing ceramic

Fig 6 Mold placed in pre heating furnace

Fig 7 Press on metal ingots

Fig 8 Ceramic ingots being placed in mold after preheating in furnace

Fig 9 Plunger placed into mold for pressing in the pressable furnace

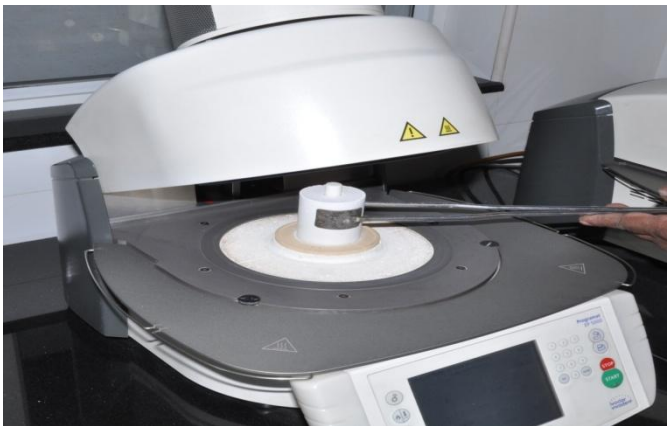

Fig 10 Plunger with mold placed in pressable furnace

III. Result

Comparison of shear bond strength at ceramo metal interface in metal ceramic restorations made with Press on Metal and conventional layering techniques

	Mean	SD	N	t	p
Press on metal	28.9	2.1	16	17.47**	0.000
Conventional layering	40.3	1.6	16		

Table 2

IV. Discussion

In this study ,the shear bond strength of metal ceramic samples made by conventional layering method and press on metal were studied and both the techniques were compared . Cobalt chromium base metal alloy was used because it is compatible with ceramic used with 'conventional layering' (IPS inline) and 'press on metal' (IPS Inline POM) techniques. Coefficient of thermal expansion of metal should be greater than that of porcelain in metal ceramic samples in order to create a compressive stress on ceramic on cooling and to increase the longevity of restorations[9]. . The coefficient of thermal expansion of alloy was 1 4.2x10-6/K (25 – 500°C).The ips inline and ips inline POM had coefficient of thermal expansion of 13.8 x 10-6/K (25 – 500°C) .

In this study same alloy was used in both techniques . Same heating cycles were employed in furnace and same cooling procedures were followed to avoid any probable influence in metal ceramic bond strengths [10].The material composition, firing rate , operator skills cooling rate and fabrication process affect the metal ceramic bond strengths. Metal ceramic samples made with conventional layering technique had a greater mean shear bond strength (40.3MPa)than pressed metal ceramic samples(29.3MPa).

In previous studies by Venkatachalam et al[11] and Schweitzer et al [12] no significant differences were found in bond strength of metal ceramic samples with conventional layering and press on metal techniques. In their studies the samples studied with press on metal showed a larger standard deviation. More over the samples used for conventional layering had different firing rate and different coefficient of thermal expansion .This may have definitely affected the bond strength [29]

Farzin et al [13] compared the effects of pressed metal ceramics and conventional layered ceramics on nickel chromium alloys. According to their study pressed metal ceramics have an increase tensile bond strength than conventional layered ceramics .This result is contradictory to the results of the current study .This may be due to the difference in the type of base metal alloy used . There was an increased standard deviation in the mean tensile bond strength of conventional layering samples .

V. Conclusion

Within the limitations of the study, the following conclusions were drawn.

1. Mean shear bond strength of conventional layering technique was greater than that of metal ceramic samples made by press on technique
2. There is adequate shear bond strength for metal ceramic samples made by press on metal technique.

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