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*RESEARCH ARTICLE*

# COMPARISON OF SHEAR BOND STRENGTH OF THREE COMPOSITE RESIN REPAIR MATERIAL WITH CERAMIC AND COBALT CHROMIUM SURFACES AFTER VARIOUS SURFACE TREATMENTS - AN INVITRO STUDY

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## Abstract

**Aim:**The objective of this study was to evaluate the shear bond strength of composite resin repair material with ceramic and cobalt chromium surfaces after various surface treatments and the mode of bond failures by stereo microscope.

**Materials An Methods:** Thirty Ceramic and thirty Cobalt chromium samples (10x10x2mm) were prepared **.**The samples were divided into three groups for ceramic -CI,CII,CIII and for metal -M1,MII and MIII .Three composite resin repair materials were used (1) Restorative composite (control)- [C Group **]** ,(2)SHOFU P & R Ceramic repair kit-[S Group**]** (3) Ivoclar Ceramic Repair System intro pack after surface modification withintraoral sandblaster – [I Group**]**.The composite material was added 6x4mm using a metal holder .All specimens were subjected to a standard shear load in the universal testing machine until fracture occurred. All debonded samples were examined under stereomicroscope to determine the type of failure .The data was analyzed using one-way ANOVA test of variance and Post hoc comparison was applied at 95 % confidence level.

**Results:** Igroup showed the highest shear bond strength followed by S group in ceramic and metal samples. The C group showed least shear bond strength. The predominant mode of failure among the C group in ceramic and Co Cr metal samples was adhesive failure , S Group showed 50% adhesive and 50% mixed type of failure in ceramic samples (CII) ;in cobalt chromium samples(MII),it showed 70 % adhesive and 30% mixed failure . I group showed 100% mixed failure in ceramic samples(CIII) group ,and 80% mixed and 20% adhesive failure in cobalt chromium samples(MIII).

**Conclusion:**The surface modified with intra oral sandblaster and repaired with Ivoclar ceramic repair kit showed the most favorable results in ceramic and cobalt chromium samples.



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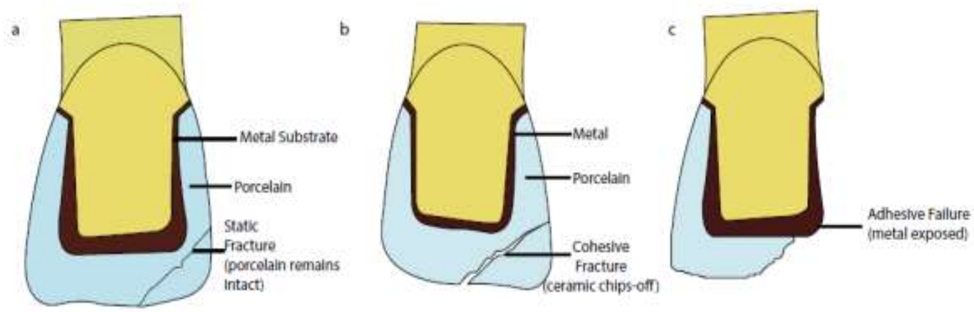
## Introduction:-

Metal ceramic restorations have been one of the most common restoration used in fixed prosthodontics because of the superior mechanical properties of the metal combined with durability and added cosmetic appearance of porcelain .One of the most frequently encountered complications in metal-ceramic restoration is the fracture of veneering porcelain, becoming a dental emergency especially when located in the anterior region. Fracture of the metal ceramic restorations may occur due to trauma , occlusal interference, para functional habits , flexural fatigue of the underlying metal framework , incompatibility between the modulus of thermal expansion of porcelain and metal , inadequate tooth preparation , voids in the porcelain and inappropriate coping design etc.[2] Feldspathic porcelain ,which is used most often, has a compressive strength 2.5times less than enamel.

Friedman classified porcelain fracture into three types namely (Fig 1)
1. Static fracture : where a segment of porcelain fractures but remains intact.
2.Cohesive fracture : that occurs within the body of porcelain due to tensile loads .
3.Adhesive fracture :where failure of the bonding interface between the porcelain and the substrate seen. [6]




(Fig 1)Pictorial representation of friedman classification (a) static fracture(b)cohesive fracture(c)Adhesive fracture

Heintz and Rousson classified ceramic fracture as three grades based on treatment need and the severity of the situation:
Grade 1: Fractures requiring polishing only
Grade 2: Fractures requiring repair
Grade 3: Fractures requiring replacement [7]

Clinical studies indicate that the prevalence of metal ceramic crown fractures ranged between 5 and 10% over 10 years of use and are said to be the second greatest cause of failure after caries[1].The fracture may involve only the ceramic or in some cases ceramic with a significant surface of metal exposed ,new porcelain cannot be added to an existing restoration intra- orally .

The primary and ideal treatment option involves removing the prosthesis and re fabricating a new one. Replacement of a failed restoration is not necessarily the most practical solution because of the associated cost and the complex nature of the restoration [1]. Nowadays there are various ceramic repair system available. Intra -oral repair options provide the possibility of intra oral repairing of the restoration in the patient's mouth thereby avoiding replacement of the complete restoration.

It was reported in many studies that combined use of mechanical roughening (acid etching , sandblasting ) and chemical agents ( silane coupling agent)improves the bond between composite and ceramic surfaces [11]. The objective of this study was to evaluate and compare the shear bond strength of two composite repair systems and one commercial dental composite (control) on two surfaces -, ceramic and cobalt -chromium base metal alloy following surface treatments. The procedure involved the evaluation of the shear bond strength and evaluating the mode of failure using a stereo microscope .

## Materials And Methods:-

This in vitro study was conducted in the Department of Prosthodontics and Department of Orthodontics in Government Dental College, Kottayam, Kerala, India to compare the shear bond strength of composite resin with ceramic and cobalt chromium metal surface using two different ceramic repair kits . Testing part of study was conducted at Physical Testing Laboratory and Department of Germplasm, Rubber Research Institute of India, Kottayam.

In this study 30metal ceramic samples (Fig 2) and 30 Cobalt chromium metal samples (Fig 3) were used . Wax patterns for the samples were prepared with casting wax of standardized dimensions. Spruing and investing done according to manufacturer's recommendations. Ringless casting technique was followed in this study. The samples were fabricated in vacuum pressure induction casting machine (Argon caster AE, Shofu Inc,Japan) .The alloy was Co-Cr dental alloy (Colado CC, Ivoclar Vivadent).The castings were then divested, and the sprues were separated.A sandblaster with 50 µm aluminium oxide ($Al_2 0_3$) was used to remove any remaining investment.

The samples were divided into 2groups 30 cobalt chromium metal samples in one group and ceramic was added to the second group of 30 cobalt-chromium samples.Theceramic surface blocks were prepared by theconventional layering technique on cobalt chromium metal surfaces as per ISO standard 6872:2015(E). Porcelain (IPS Classic- Ivoclar Vivadent) build up was done by layering on cobalt chromium samples to a uniform thickness of 1.5mm so that the final sample thickness will 2mm**.**The samples were then subjected to firing according to the specification given by manufacturer.All samples were placed in the centre of silicon mould of 12x12x12 mm and self cure acrylic was poured into the mould .The sample embedded blocks were then trimmed and polished . Embedded samples were mounted in auto polymerizing resin with aluminium holders.

The 30 metal ceramic samples were further grouped into -CI,CII and CIII (Fig.4 )and 30 Cobalt chromium alloy samples into -MI,MII,MIII with each sub group containing 10 samples (Fig.5) . All specimens were grounded using a fine-grit diamond rotary cutting instrument in a high-speed hand piece with water irrigation for 10 seconds. The composite resin material was added 6x4mm using a Teflon coated metal holder (Fig6).

Table 1 and 2 show the composition of the repair materials and the mode of application respectively.

**Table 1:-** Composition of repair materials and ode of application on the specimens.

| | Brand name of material | Content | Composition |
|---|---|---|---|
| 1 | **C Group**<br>Control - Restorative composite- Anabond Stedman | 1.Restofill composite<br>2.Stedbond-S<br>3.Eazetch gel | 1.BisGMA,TEGDMA,Barium boroalumino silicate glass<br>2.Acetone based 5$^{th}$ generation bonding agent<br>3.37% phosphoric acid |
| 2 | **S Group**<br>SHOFU P & R Ceramic repair kit- | 1.CRB1<br>2.CRB2<br>3.ML Primer | 1.Ethanol and silane coupling<br>2.Acetone,4-AET,UDMA and polymerisation initiators<br>3.Aceton , phosphonic acid monomer ,thioctic acid monomer |
| 3 | **I Group**<br>Ivoclar Ceramic Repair System intro pack | 1. Metal zirconia primer ,<br>2. Monobond -S ,<br>3. Heliobond ,<br>4.Tetric Evoceram<br>5.37% Phosphoric acid | 1.Phosphonic acid methacrylate and methacrylate cross linking agent<br>2.1% Methacryloxypropyltrimethoxy silane(MPS) and ethanol<br>3.Bis GMA, Triethylene glycol dimethacrylate<br>4.Bis-GMA , Urethane dimethacrylate ,Ytterbium trifluoride ,Ethyoxylated bisphenol A dimethacrylate . |

**Table 2:-** Mode of application of the repair material.

| | | |
|---|---|---|
| C Group | CI | • Etching with H3PO4 for 30 secs<br>• Bonding agent-(Stedbond-S) applied<br>• Repair material added and cured |

| | | |
|---|---|---|
| | | |
| | MI | • Same as CI |
| S Group<br>( Fig 7) | CII | • CRB1 followed by CRB2 added and left for 10 secs<br>• Light curing for 10 secs<br>• Repair material added - cured |
| | MII | • ML Primer added<br>• Left for 10 secs<br>• Repair material added-cured |
| I Group<br>(Fig 8) | CIII | • Sample Surface sample modified with intraoral sandblaster-50µ kept at a distance of 5-19mm distance from needle tip to the blasting surface with a compression air pressure at 60~ 80 lbf/pol2 (4-5,5Kgf/cm2 Al2O3-15 secs(Fig 9).<br>• Etched with H3PO4 for 30 secs<br>• Silanating agent-Monobond S -60 secs<br>• Heliobond applied-10 secs<br>• Repair material added - cured |
| | MIII | • (Sample surface modification and etching with H3PO4as above)<br>• Metal zirconia primer applied- waited for 3 mts<br>• Heliobond applied- 10 secs<br>• Repair material added-cured |

All the sixty repaired samples were stored for 24 hours in distilled water at 37°C before shear loading.

**Testing of the samples**

The shear bond strength of the specimens was tested on Universal Testing Machine (Fig.10)(Zwick 1120; Zwick GmbH & Co KG, Ulm, Germany)] using a cross head speed of 0.5 mm per minute with a cell load of 2kN. They were first blot dried with a blotting paper and then placed on the machine for testing.The machine has two arms which move in same directions during shear bond testing at a specified cross head speed. On one arm a blunt ended shear device was fixed to apply the shear stress. The opposing platform had a shear jig (customized mounting apparatus) for holding the sample . For testing, this specimen was locked with the fixture to align it parallel to the long axis of the machine.

The specimens were placed under shear stress until bonding failure occured at the interface and the maximum shear stress before failure was recorded for each sample.The values were calibrated and the shear bond strength (SBS) was calculated using the following formula .

Shear bond strength = load in Newton /Surface area.The shear bond strength was represented in MPa units.

**Evaluating Mode Of Failure**
A stereomicroscope (LEICA DMLM with Watec WAT 2020 Digital Camera, Japan) was used to analyse the trend of bond failure after shear bond testing at 12X magnification.

Bond failure was classified into three types as-
Type 1: adhesive –composite absent/covering <25%.
Type 2: mixed mode –composite covering 25 - 75% of the surface .
Type 3: cohesive failure – composite covering >75% of the surface .
The composite – ceramic interfaces and composite –cobalt chromium interfaces were individually evaluated to assess the failure mode.

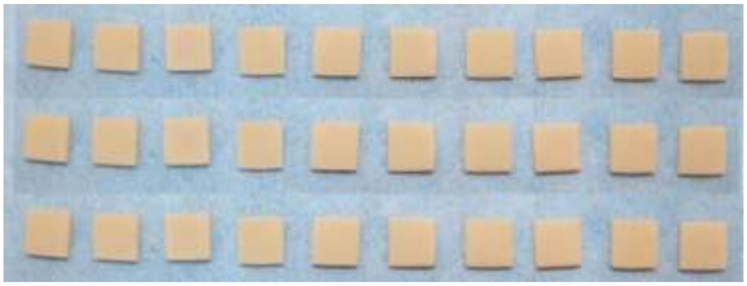


**Fig. 2:-** Thirty metal ceramic samples.

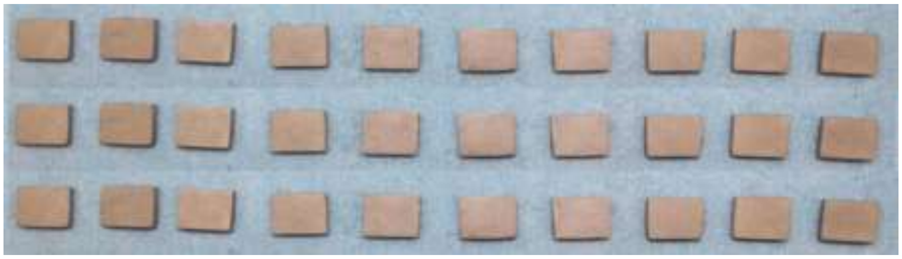


**Fig 3:-** Cobalt chromium metal samples.

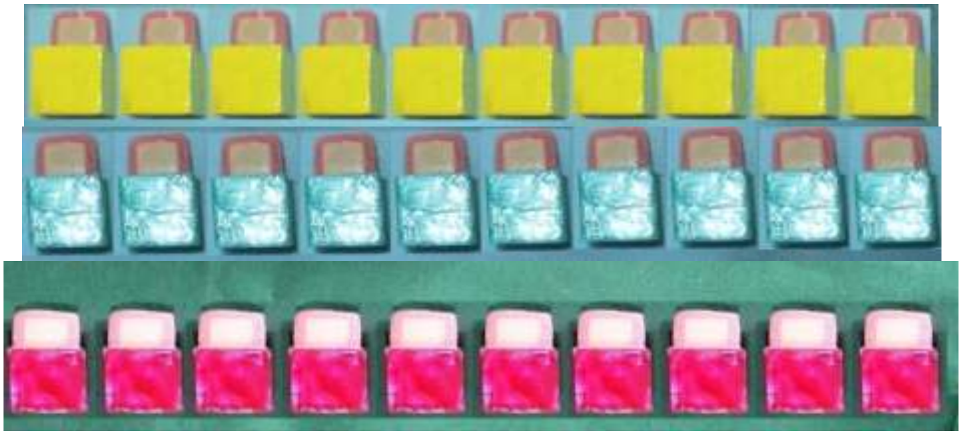


**Fig.4:-** Metal ceramic group- CI,CII,CIII.

**Fig. 5:-** Cobalt chromium metal group- MI,MII,MIII.

**Fig 6:-** Metal holder for application of material and composite resin applied surface.

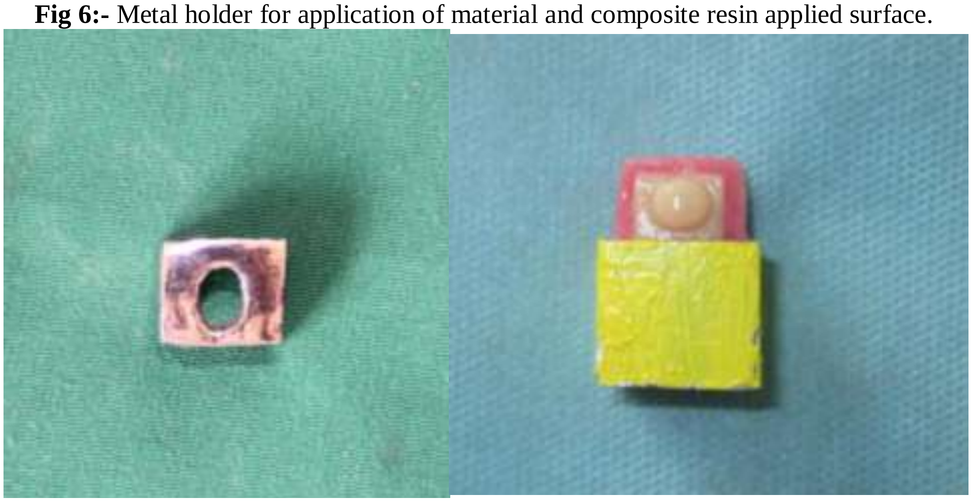


**Fig 7:-** P and R Repair kit.


**Fig 8:-** Ivoclar ceramic repair kit and component.


**Fig 9:-** Intraoral sandblaster.

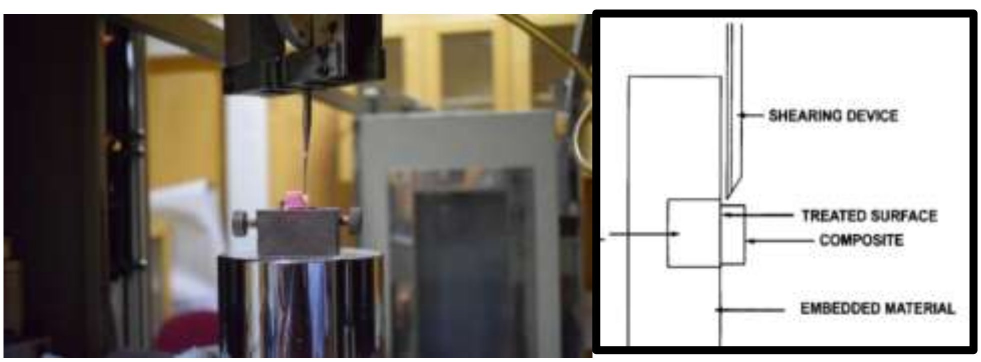



**Fig. 10:-** Shear bond strength testing on Universal Testing machine.

## Results:-

In the present in-vitro study , one way ANOVA test and post hoc comparison using the Tukey HSD test was used to find out significance of difference between and with in the groups. The test showed a P value <0.001 and the difference between the three groups are statistically significant.

**Descriptive Statistics Of Ceramic Group**

Individual group comparison of shear bond strength is shown in (Table 3 and 4 ). Post hoc analysis by Tukey HSD test showed that significant differences existed among the pairs, C Group vs S Group (MD=-3.394; p<0.01); C Group v/s I Group (MD=-12.506; p<0.01), and S Group v/s I Group (MD=-1.17; p<0.001).

**Table 3:-** One way ANOVA has been done .There is a significant difference among groups (F=1577.19,P<0.01).

| CERAMIC | N | MEAN | SD |
|---|---|---|---|

| | | | |
|---|---|---|---|
| C Group( CI) | 10 | 6.849 | .663 |
| S Group (CII) | 10 | 10.243 | .265 |
| I Group(CIII) | 10 | 19.355 | .534 |

**Table 4:-** Post hoc comparison using the Tukey HSD test.

| CERAMIC | Mean diff | 95%CI | p-value |
|---|---|---|---|
| C Group-S Group | -3.394 | (-3.981,-2.806) | <0.01 |
| C Group-Group | -12.506 | (-13.093,-11.918) | <0.01 |
| S Group –I Group | -9.112 | (-9.699,-8.534) | <0.01 |

It indicate that the difference between group (C-S),(C- I )and (S -I ) is statistically significant .

**Descriptive Statistics Of Cobalt Chromium Group**

In cobalt chromium metal samples the Ivoclar group (MIII) had highest shear bond strength of (13,33 ± 0.55) followed by P and R repair kit (M II)(8.206 ± 0.23). The control group (MI) had least shear bond strength of (5.14± 0.66).

Individual group comparison of shear bond strength is shown in (Table5 and 6) . Post hoc analysis by Tukey HSD test showed that significant differences existed among the pairs, control restorative composite vs P and R repair kit (MD=--3.059; p<0.01); control restorative composite v/s Ivoclar repair kit (MD=-8.191; p<0.01), and P and R repair kit v/s Ivoclar repair kit (MD=-5.132; p<0.001).

**Table 5:-** Oneway ANOVA has been done .There is a significant difference among groups(F=225.94,P<0.01).

| Cobalt chromium samples | N | MEAN | SD |
|---|---|---|---|
| C Group | 10 | 5.147 | .665 |
| S Group | 10 | 8.206 | 1.235 |
| I Group | 10 | 13.338 | .552 |

**Table 6:-** Post hoc comparison using the Tukey HSD test.

| Cobalt Chromium | Mean diff | 95%CI | P-value |
|---|---|---|---|
| C Group-S Group | -3.059 | -4.053,-2.064 | <0.01 |
| C Group-I Group | -8.191 | -9.185,-7.196 | <0.01 |
| S Group – I Group | -5.132 | -6.12,-4.13 | <0.01 |

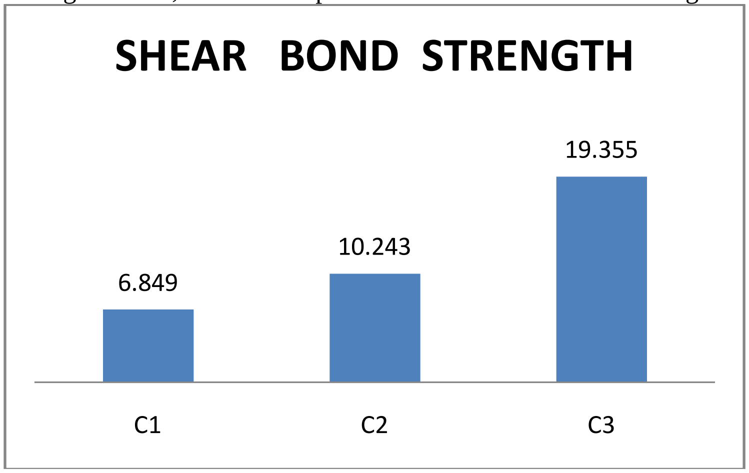
Post hoc comparison using the Tukey HSD test indicate that the difference between group (C-S),(C-I )and (S-I) is statistically significant.

To compare the difference in shear bond strength between ceramic and cobalt chromium metal surfaces . Independent t-test was done. There is a significant difference between values in ceramic and cobalt chromium group(Table 7)

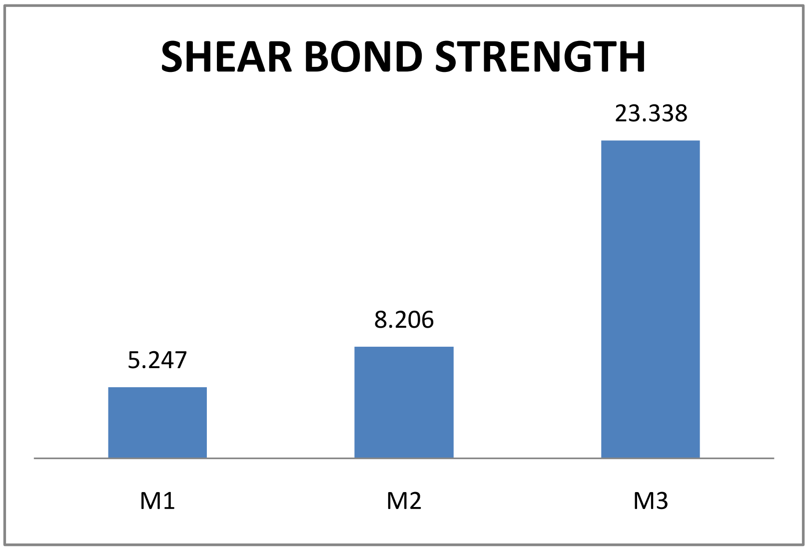
**Table 7:-** Comparison of difference in Shear bond strength between Ceramic and Cobalt chromium metal surfaces.

| Samples | N | Mean | SD | Mean-diff(95% CI) | p-value |
|---|---|---|---|---|---|
| Ceramic samples | 30 | 12.14 | 5.39 | 3.25(.894-5.609) | 0.008 |
| Cobalt chromium samples | 30 | 8.89 | 3.53 | | |

**Graph I:-** Shear bond strength values, and the comparison of Mean Shear Bond Strength Of Ceramic Surfaces.




**Graph II:-** Shear bond strength values and the comparison of Mean shear bond strength of Cobalt Chromium Metal Surfaces.




**Failure Mode Analysis**

Varying types of failure were observed in the groups at the ceramic-composite interface and cobalt chromium – composite interface(Table-8). .Failure type in the ceramic groups and the cobalt-chromium groups were tested by Chi-square test. It was found that significant differences were there in failure proportions among the three ceramic groups ($p<0.01$)(Table- 9).

**Table 8:-** Comparison Of Type Of Failure Among Control Group, Pand R Group And Ivoclar Repair Kit Group In Ceramic Samples.

| **Group** | **Sub group** | **Mode of Failure** |
|---|---|---|
| C Group | CI | 100% Adhesive |
| | MI | 100% Adhesive |
| S GROUP | CII | 50% Adhesive+ 50% Mixed |
| | MII | 70% Adhesive+ 30% Mixed |
| I Group | CIII | 100 % Mixed |

| | | |
|---|---|---|
| | MIII | 20% Adhesive+ 80% Mixed |

| Groups | | Type of Failure | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | $X^2$-Value | p-value |
| 1 | N (%) | 9(100.0) | 0 (0.0) | 18.98 | <0.01 |
| 2 | N (%) | 5 (50.0) | 5 (50.0) | | |
| 3 | N (%) | 0 (0.0) | 10 (100.0) | | |

Ceramic Group (P-value derived from one-way chi-square test, †significant at $p < 0.05$)

**Table 9:-** Comparison Of Type Of Failure Among C-Group, S-Group And I- Group In Cobalt Chromium Samples Co-Cr metal samples ( P-value derived from one-way chi-square test, †significant at $p < 0.05$).

| Groups | | Type of Failure | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | $X^2$-Value | p-value |
| 1 | N (%) | 9(100.0) | 0 (0.0) | 13.28 | <0.01 |
| 2 | N (%) | 7(70.0) | 3 (30.0) | | |
| 3 | N (%) | 2(20.0) | 8 (80.0) | | |

## Discussion:-

The metal-ceramic restorations still remain the 'gold standard' in prosthodontics since their introduction in the 1960s. The main disadvantages of metal ceramic restorations is the brittle nature ,weak in tension and less aesthetics compared to all ceramic restorations. The majority of failures are observed in the anterior region and mainly in the maxilla predominantly at the labial surface. Repairing the ceramic restoration fractures with composite resins has some major advantages as it preserves the main body of the restoration and making the treatment inexpensive and easy with no replacement or re fabrication of prosthesis[2].

The present study compared the efficacy of two different commercially available ceramic repair system (P and R repair kit and Ivoclar Ceramic Repair System) with a restorative composite resin as control .The control group (C I and MI) had least shear bond strength. In the control group, 37% phosphoric acid was used as etchant and the bonding agent in the restorative composite is not able to form a stable bond between the ceramic and composite[3] .This proves that the restorative composite that is available in the dental office will not give a successful outcome when it is used to repair metal ceramic restoration. So the composite material kits that are meant for ceramic repair purpose should be our choice in the management of ceramic fracture[4].

The Ceramic Group CIII (Intraoral sandblasting + Ivoclar ceramic repair kit group ) had the highest shear bond strength of followed by P and R repair kit.The comparison between the ceramic groups also shows significant difference among the pairs **.**In cobalt- chromium metal samples, the Ivoclar group (M III) had highest shear bond strength followed by P and R repair kit (M II).

The better performance of SHOFU P & R Ceramic repair kit is due to the presence of ethanol and silane coupling agent in Cera Resin Bond 1or CRB 1. The role of ethanol has an important role in recent adhesive systems . Researchers confirmed that ethanol wet- bonding enhances resin infiltration- promoting higher quality hybrid layers in comparison with conventional water wet- bonding. Conventional water wet-bonding technique has been advocated by many scientists, but the excess water will induce sub optimal polymerization of dental adhesives, phase separation and nano leakage, which will influence the longevity of resin-dentin interfaces[15]. Ethanol also act as a dehydrating agent and a solvent for resin monomers and improves the bond strength.The silane coupling agents are mainly used as adhesion promotions in ceramic restorations and their repairs with resin composites , glass fiber reinforced polymer composites , glassy fillers in resin composite and to form durable bond between resin composite to silica-coated metal and metal alloys . Muhammad Zakir et al explained the role of silanes . Silanes are one of the mostly broadly and widely studied coupling agents and have a very wide range of applications .Dental applications of silanes are mainly related to hydroxylated(−OH) surfaces, in particular using 3methacryloxypropyltrimethoxysilane (MPS or y-MPS) to coupling reactions[8]. It is one of the most commonly used silane due to its reactivity and ability to yield good, durable adhesion between the relevant substrates . The CRB2 contains high-vapor pressure organic solvents acetone and ethanol. These chemical agents, known as "water-chases", increase dentin wettability and help replace the water on the acid etched and rinsed dentin surface with hydrophilic resin monomers when used in dentine bonding agents .Unfilled or lightly-filled monomers in CRB2 , UDMA stabilize the hybrid layer –fills up remaining pores and resin tags and links primer to composite resin . The role of metal primer is to form a bond between composite and metal surface. The M L primer contains phosphonic acid monomer . Sasiwimol Sanohkan explained that the experimental phosphonic acid monomers［R-P（=O)（OH）2］ should possess adhesion-promoting functions. The phosphonic acid monomers 6-MHPP, 6-AHPP and 10-MDPP which can react with metal oxides and create strong adhesion to both unetched enamel and sandblasted metal alloy[10]. The CRB1, CRB2 and ML primer modifies ceramic and cobalt chromium metal surfaces . The manufacturer does not specify the composite material to be used ,hence the same material used to repair CI and MI was used to repair C2 andM2 . There is an improvement in the bond strength of composite repair material when compared to the control group ( Mean difference -3.394).

The third repair material used was Ivoclar Ceramic Repair System intro pack (37% Phosphoric acid ,Metal zirconia primer ,Monobond s ,Heliobond and Tetric Evo ceram .It was applied after surface modification by intraoral sand blaster. Kwok-hung Chunget al compared the effect of surface treatments on the bonding strength of porcelain fused to metal prosthesis repair. HF acid etching and intraoral sandblasting was compared and found that there was no significant difference in bond strengths between sandblasting and HF etching treatment of porcelain surfaces. [5].HF is one of the most dangerous acids known. HF has two mechanisms that cause tissue damage -corrosive burns from free hydrogen ions and chemical burns from tissue penetration of fluoride. Care should also be observed in the clinic environment, because an unintentional application corrodes metals and ceramic [5.] In this study only phosphoric acid(37% )has been used, as it does not produce any type of alterations on the ceramic morphology,and can used to clean the ceramic surface after mechanical roughening. The surface was abraded using a chair side intraoral sandblaster –Micro blaster ( bio .art , Rua TeotonionVilela,Brasil) for 15 seconds with 50 microns aluminium oxide particles .It will create surface roughness and improve bonding . The airborne particle-abraded porcelain surface was uniformly frosted The Mono bond S is contains 1% Methacryloxy propyl trimethoxy silane(MPS) and ethanol. The former will act as the silane coupling agent . The Helio bond contains Bis GMA, Triethylene glycol dimethacrylate . It can be used as bonding agent for adhesive restoration and will provide a bonding layer for the repair resin.The Metal / zirconia primer is a single component primer promoting an adhesion between luting composite and indirect restoration[14] .It consist of phosphonic acid methacrylate and methacrylate cross linking agent in an organic solvent . The surface modification has a great role in improving composite –ceramic bond and composite –cobalt chromium metal bond .It can also be considered as an alternative to HF etching[5] .Application of opaquer resin which offer opaque and translucent resins should preferably be used to re-establish aesthetics after ceramic repair[10].

The composite resin present in the Ivoclar ceramic repair kit is Tetric Evo Ceram .It is a light-curing, radiopaque nanohybrid composite that is based on the latest technology for direct restorative therapy. It contains Bis-GMA , Urethane dimethacrylate ,Ytterbium trifluoride ,Ethyoxylated bisphenol A dimethacrylate .The well-balanced filler technology combines the advantages of all filler sizes , including nano filler. Therefore it provides excellent polished smooth surface with high wear resistance and extremely low shrinkage[13].The composite material used in the control group and P and R repair group was micro-hybrid composite.Both micro-hybrid and nanohybrid composite in the restoration of occlusal and proximo -occlusal cavities showed acceptable clinical performance.

On comparing the shear bond strength,the predominant mode of failure among the control group in ceramic and Co Cr metal were adhesive failure . The second group in which the Ceramic samples(CII) have undergone repair with P and R repair kit showed 50% adhesive and 50% mixed type of failure and cobalt chromium samples(MII) shows 70 % adhesive and 30% mixed failure . The third group repaired with Ivoclar repair kit 100% mixed failure in ceramic samples(CIII) group showed 80% mixed and 20% adhesive failure.So the type of surface to be repaired , the surface preparation and the role of each and every component in the repair system is important in the bonding .

Earlier studies showed the shear bond strength of composite to ceramic with various ceramic repair system to be in the range of 6-29.9 Mpa[14,9]. According to some authors shear bond strength >10Mpa indicate clinically satisfactory results. The in vitro evaluation is the first step of testing any material to examine the properties and potential that it posses[12].The present study tested the shear bond strength and mode of failure of ceramic repair material to metal and ceramic surface.It is suggested that other aspect of the bond such as the effect of different mechanical test design, micro leakage, etc should be studied for more comprehensive evaluation of these porcelain repair systems. Further in vivo studies are needed to provide additional information about durability of the repair systems.

## Conclusion:-

1.The mean shear bond strength between ceramic and cobalt chromium metal surface specimen surface pre-treated with intraoral sandblasting procedure and repaired with Ivoclar ceramic repair kit showed highest (CIII and MIII) followed by P and R repair kit (CII and MII)( the second group).The Control group with ceramic and cobalt chromium samples (CI and MI) showed the least bond strength.

2.The shear bond strength of the repair resin with ceramic is greater than that with the cobalt-chromium alloy.

3. The predominant mode of failure was adhesive in Control group in both ceramic and cobalt chromium group (CI and MI) . In the second group repaired with P and R repair kit - ceramic showed both adhesive and mixed failure and cobalt chromium metal samples showed predominantly adhesive failure .The third group showed predominant mixed mode of failure .

4.Ceramic repair can be considered as an alternate treatment option in case of fractured metal ceramic restoration and the bond strength will be more if the fracture involve only the ceramic. The surface modification using intra oral sandblaster can be considered as an alternative to the ill effects of HF etching.

5.The nano hybrid composite showed higher bond strength compared to conventional composite, but the role of surface modification and adhesive components cannot be excluded .

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