ORIGINAL RESEARCH PAPER

Agricultural Science

COMPARSION OF THE SHEAR BOND STRENGTH OF CERAMIC BRACKETS BONDED TO PORCELAIN FUSED METAL CROWNS AND METAL FREE CERAMIC CROWNS WITH AND WITHOUT SILANE COUPLING AGENT- AN IN VITRO STUDY.

KEY WORDS: porcelain fused metal, shear bond strength, ceramic brackets, megapascals.

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ABSTRACT

Aim-The aim of this study is to evaluate and compare the shear bond strength of ceramic brackets bonded to porcelain fused metal crowns and metal free ceramic crowns with and without silane coupling agent. **Material and Method:** 40 metal free zirconia crowns and 40 PFM crowns were fabricated with glazed surfaces according to the manufacturer's instructions for the study purpose.The samples were divided in two groups A and B and each group was subdivided into two subgroups (A1, A2) and (B1, B2) **Sub-Group A1 and A2:** Twenty metal free ceramic crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was applied to the treated surface. **Subgroup B1 and B2:** 20 porcelain fused metal crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was applied to the treated surface. The shear bond strength of ceramic brackets bonded to porcelain fused metal crowns and metal free ceramic crowns with and without silane coupling agent. **Statistical Analysis:** ANOVA and Post hoc Tukey's test (HSD) tests were used for statistical analysis. **Result:** The result showed that group B1 demonstrate the maximum shear bond strength among all groups which is 9%HF +Relyx ceramic primer application on porcelain fused metal crowns (10.27+1.31Mpa) and has highly significant value. Whereas lowest shear bond strength belongs to group B2which is 9%HF and primer is not applied(5.4+0.73 Mpa). **Conclusion:** Hence it can be concluded that Relyx ceramic primer is more apropriate choice for bonding orthodontic metal brackets on PFM and zirconia surfaces with conventional bonding system.

INTRODUCTION:

The number of patients seeking orthodontic treatment is constantly increasing, with a increase in the need to bond brackets to porcelain restorations[1]. Recently, more esthetic and nearly invisible brackets have gained popularity in orthodontics .These brackets are generally either polycarbonate or ceramic,and the latter are either monocrystalline or polycrystalline.Ceramic brackets can have an epoxy or a polycarbonate base[2]. Porcelain surfaces are considered relatively inert in nature , and clinicians are often faced with the problem of bonding fixed orthodontic brackets to teeth that have different types of restorations, including fixed porcelain prosthesis and veneer laminates[3]. Successful direct bonding of brackets on etched enamel surfaces have been widely documented in orthodontic literature , after the introduction of acid etch bonding technique by buonocore in 1955[4]. Patients are increasingly demanding dental restorations that are both aesthetic and functional. Manufacturers have introduced numerous all-ceramic alternatives like silica-based ceramics, zirconium oxide ceramics etc. Therefore, the orthodontist is often confronted with the challenge of effectively bonding orthodontic brackets to different ceramic restorations[5].

Silanes are also known as adhesion promoters and function by adsorbing onto, and altering, the surface of a solid material (in this case porcelain), by either a chemical or physical process, to increase its interaction with other materials The portion of the silane molecule that is not adsorbed presents a free surface that is wetted easily by adhesive materials. Silanes increases the wettability of the porcelain surface [7]. In this study we evaluate and compare the shear bond strength of ceramic brackets bonded to porcelain fused crowns and metal free ceramic crowns using light cure bonding materials when bonded with and without silane containg coupling agent.

MATERIAL AND METHOD:

Forty metal free zirconia crowns and forty PFM crowns were fabricated with glazed surfaces according to the manufacturer's instructions for the study purpose. The samples were divided in two groups A and B and each group was subdivided into two subgroups (A1,A2) and (B1,B2)

GROUP A : It is divided into two subgroups

Sub-Group A1: Twenty metal free ceramic crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was applied to the treated surface.

Sub-Group A2: Twenty metal free ceramic crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was not applied to the treated surface.

GROUP B :

Subgroup B1: 20 porcelain fused metal crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was applied to the treated surface.

Sub-Group B2: Twenty porcelain fused metal crowns were etched with 9% buffered HF acid gel for 2 minutes, thoroughly washed and air dried. Relyx ceramic primer (silane coupling agent) was not applied to the treated surface .

Bonding Procedure For Groups A and B

Brackets were bonded to each subgroup according to the following protocol.

1 .Composite was placed at bracket base.

2. Bracket was placed onto the crown surface at long axis point on buccal surface and excess composite was removed before the resin had set.

3. Light polymerization done for forty seconds on each bracket.

After bonding procedure done, all samples were stored in artificial saliva.

Bond strength testing

The shear bond test was performed with a universal testing device .In order to maintain a consistent debonding force in a controlled direction, all crowns are mounted in acrylic blocks.In these blocks facial surface of the crowns was kept exactly parallel to the debonding force or perpendicular to the floor .Blade was then used to debond the brackets .blade was then directed parallel to the long axis of the crowns.

The force to debond the brackets was recorded with a universal testing machine at a crosshead speed of 5mm/min.

As the universal testing machine simply records the force to debond , the bond strength was calculated by dividing the figure (in newton) by the area of the bracket base(10.65 mm^2).This gives the debonding force in megapascal.

Statistical Analysis

The statistical analysis was performed to find out the correlation among the various parameters. Data collected by the investigator were first entered to Microsoft excel (2007).All data were visually screened for any missing data or outliners and for validity of distribution assumptions .The data were collected, tabulated and statistically analysed using the S.P.S.S 10 statistical analysis package software.

The data wrer analysed using statistical package for social sciences version (SPSS)17.0 for windows .The level of statistical significance was set at 95%(p=0.05).

The result of the present study wrer subjected to statistical analysis to interpret the differences and the significance between them .Unpaired or independent T test was performed for statistical analysis in the present study.

For the result descriptive Mean,Standard deviation , Minimum ,Maximum values were calculated.

Statistical significance was tested at p level:
Highly significant - pValue<0.01
Significant pValue<0.05
Non-significant p value >0.05

Statistical methods

Mean

This measure implies arithmetic mean which is the simple measures of central tendency, obtained by summing up all the observations and dividing the total by the number of observation.

$$X = \frac{X_1 + X_2 + \ldots\ldots\ldots\ldots X_n}{n} = \frac{\sum x}{n}$$

X=Given variable (x1 +x2+……Xn)

N=number of observations
Σ=sum of xi
Xi=Value of each observation in the data.

Range

Define as the difference between the value of the smallest item and the value of the largest item.This measure gives no information about the values that lies between the extreme values.It is not based on all the items and is subjected to fluctuations of considerable magnitudefrom sample to sample.

Standard Deviation

The standard deviation is a summary measure of the difference of each of each observation from the mean of all the observations.A small standard deviationmeans a higher degree of uniformity of the observations.

Standard deviation is calculated using the formula,

$$SD = \sqrt{\frac{\sum (x_1 - \bar{x})^2}{n-1}}$$

Where X1 is the is the indivisual observation in the class interval, X is the mean and n is the total of all frequencies.

The results of the present study were subjected to statistical analysis to interpret differences and the significance between Groups A (ceramic crowns)and group B(PFM crowns) and the subgroups A1 ,A2 and B1,B2 in with and without the application of ceramic primer.

Independent or unpaired T Test was used for statistical analysis in the present study for inter group comparisions.

RESULTS:

The present study was conducted in the department of Orthodontics and Dentofacial orthopaedics of K.D Dental College and Hospital, Mathura with the objective of determining the shear bond strength of orthodontic ceramic brackets bonded to all ceramic (Zirconia) crowns and Porcelain fused metal crown surface with different surface treatment methods.

Table 1: Group Wise Conditioning And Bond Enhancing Methods

Group	Tooth Surface	Etchant/other method	Primer	Adhesive
Group A1	Zirconia	9%HF	Relyx	Enlight
Group A2	Zirconia	9%HF	Not applied	Enlight
Group B1	PFM	9%HF	Relyx	Enlight
Group B2	PFM	9%HF	Not applied	Enlight

Shear bond strength and in megapascals (MPa) and standard deviation (±SD) for bracket bonded to both zirconia and PFM crowns are represented by tables for easy observation.

Table II: Descriptive statistical data in megapascals(MPa) of the 4 groups

	Type	N	Mean	Std. Deviation	Minimum	Maximum
Group A	A1	20	8.86	0.73	7.25	10.10
	A2	20	5.66	0.52	4.98	6.39
Group B	B1	20	10.27	1.31	7.98	12.45
	B2	20	5.40	0.73	3.95	7.00
Group	A	20	7.26	0.37	6.56	7.82
	B	20	7.83	0.72	6.55	8.78

Table III: Independent T-Test

Variable	Type	N	Mean	S.D.	T-test	P-Value	Inferences
Group A	A1	20	8.86	0.73	16.019	0.000	S
	A2	20	5.66	0.52			
Group B	B1	20	10.27	1.31	14.537	0.000	S
	B2	20	5.40	0.73			
Group	A	20	7.26	0.37	3.141	0.003	S
	B	20	7.83	0.72			

- The result showed that group B1 demonstrate the maximum shear bond strength among all groups which is 9%HF +Relyx ceramic primer application on porcelain fused metal crowns (10.27±1.31Mpa) and has highly significant value.
- Whereas lowest shear bond strength belongs to group B2which is 9%HF and primer is not applied(5.4±0.73 MPa)

DISCUSSION:

The invention of acid etch technique by Bounocore (1955) heralded a new era in adhesive dentistry. Direct bonding of orthodontic appliance to enamel with composite resin was first performed by Newman in 1965 which revolutionized the process of adhesion of orthodontic brackets to teeth I orthodontics.

The increased demand of orthodontic treatment in adult patient has resulted in the [problem of bonding brackets to porcelain.One problem in vivo when bonding brackets to porcelain crown and veneers is the multitude of dental porcelain varieties.The demand for better restoration hs caused the development of more advanced porcelain system.According to Sevinc Karan there are several types of porcelain for ceramic restorations. Silica based ceramics,glass infiltered or densely sintered aluminium oxide ceramics and zirconium oxide ceramics.From a clinical [prospective he sugested that if the clinician does not know the ceramic type , silane combined with silica coating or HF

acid after sand blasting can be used for bonding to porcelain surfaces and gives almost similar results in all ceramic types, In our study we have used porcelain fused metal based crowns which are feldspathic ceramic with low to medium aluminium oxide content .

Laboratory bond testing is designrd to evaluate the bond strength of adhesives to provide an indication of the risk of clinical bracket bond failure.The approach used should be simple enough to be reproducible but sophisticated enough to be valid.The methodology used in this study was largely based upon a protocol design to increase the reproducibility of bond strength.One area of this protocol that was not consistently reproducible in previous studies was the exact direction of force used to debond the brackets as this may significantly influence the measurement of SBS.This indicates the need for control and standerdisation of this testing parameter in orthodontic shear bond strength testing.This problem was addressed by using jigs to mount and debond the brackets.This effort was made to restrict the debonding force to pure shear minimizing the unwanted and unpredictable effects of peel.

In the present study sample was divided into 2 groups and 2subgroups according to surface preparation methods in order to obtain more specific and useful SBS values.

The results demonstrated that the group bonded with 9%HF +Relyx ceramic primer gave significant results which indicates that this combination is effective in bonding orthodontic brackets to ceramic surfaces.

According to study conducted by Zachrisson demonstrated results in accordance with this study in which silane application after sand blasting the ceramic surface significantlyincreased the bond strengthof metal bracketas bonded to ceramic surface .

In a research conducted by kocadereli et al evaluate that the shear bond strength of various zirconia blocks were measured to determine whether arecently comerciallised zirconia primer or a conventional porcelain primer was more suitable for bonding orthodontic brackets to full contour zirconia crowns .there results were in accordance with this study and the previous studies which demonstrated that porcelain primer successfully increases the shear bond strength of bracket resin cement complex bonded to glaze porcelain surface that has been etched and sand blasted.

It was also supported by Newman that the strength of bond between the resin and the porcelain attained with the use of a silane coupler was sufficient to cause the fracture of porcelain such an occurance is undesirable when associated with the removal of orthodontic brackts from porcelain crowns on restored teeth.

So, in this present study surface treatment with 9%HF and then silane application showed the maximum SBS values in case of the group B1,(PFM crowns)i.e of 10.37+1.31 Mpa rather than the metal free ceramic (Zirconia) crowns(Group A1) that were also treated with silane application (8.86+0.73 MPa).In a study conducted by Zachrisson ,reported that silane application to sandblasted porcelain did not provide clinically acceptable bond strength and suggested abandoning this technique.

It was also suggested by calamia JR in his pioneering article that the bond strength of porcelain laminate veneer was greater when etched as compared to sandblasting if it was performed lightly.

According to this study the weakest bond strength obtained was when the silane coupling agent was not applied that is in group A2 (5.66+0.73MPa) and the weakest bond strength obtained in group B2 that is (5.40+0.73MPa).The results were found to be significant and therefore clinical use of silane (Relyx primer) is suggested in bonding orthodontic ceramic brackets to metal free ceramic crowns.

CONCLUSION :

This study made us reach the conclusion that even though there is not much difference between the SBS of PFM and Zirconia crowns after (9%HF) +Relyx primer application ,but the obtained SBS values of PFM and Zirconia crowns where primer application was not done showed the lowest SBS values which is clinically non acceptable.

Hence it can be concluded that Relyx ceramic primer is more appropriate choice for bonding orthodontic metal brackets on PFM and zirconia surfaces with conventional bonding system. The study carries scope to explore the newly available Relyx ceramic primer.