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ORIGINAL ARTICLE

COMPARISON OF SHEAR BOND STRENGTH OF FIFTH AND SEVENTH GENERATION ADHESIVE SYSTEMS FOR CERAMIC ORTHODONTIC BRACKETS

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ABSTRACT

Debonding forces can cause a fracture of ceramic brackets or adhesive system at tooth / resin interface, because, ceramic brackets have no bending ability. This in turn can create cracks in susceptible enamel. Therefore, safe debonding is considered to be one of the biggest concerns while using ceramic brackets. Aim of this study was to compare mean shear bond strength of ceramic brackets bonded with fifth generation {Transbond XT (3M UNITEK) bonding agent} versus seventh generation bonding agents {ADPER Prompt-L-pop (3M ESPE)}.

This randomized control trial was done at the department of orthodontics, Lahore Medical and Dental College, Lahore, For six months i.e: 30th August 2019 to 29th February 2020.

Sixty untreated maxillary & mandibular extracted premolars of age 12-35 years and both genders were collected from the Department of Orthodontics, Lahore Medical and Dental College (LMDC), Lahore. Defective, restorative and anomalous premolars were excluded. In group A, 5th generation bonding material (Conventional system) was applied. In group B, 7th generation bonding material (Self Etch Primer) was applied. Universal testing machine (Instron) was used to measure shear bond strength.

The mean shear bond strength of brackets was 16.40 ± 3.47 MPa in fifth generation group while 11.40 ± 1.40 MPa in seventh generation group (p-value = 0.0001).

This study concluded that mean shear bond strength of brackets bonded with fifth generation bonding agent is greater than brackets bonded with seventh generation adhesive.

Keywords: *Comparison, Shear bond strength, Adhesive systems*

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INTRODUCTION

Acid-etch technique was introduced in 1955 by Buonocore, which is now used in all the fields of dentistry. This technique is mostly applied in orthodontics for bonding the brackets; adhesion occurs between the bracket base and the adhesive through microscopic interlocking. Conventional adhesive (bonding) system uses three separate agents i.e. an etchant, primer and an adhesive.[1-9]

Stainless steel (metallic) brackets are mostly used in orthodontic treatment, but metallic color of these brackets is not widely accepted by patients. Consequently, the patients wish to have the brackets that are tooth colored (ceramic brackets). Since introduction, the design of the ceramic brackets have been improved which eventually enhanced clinical efficiency. Superior aesthetics and the resistance to discoloration are two noticeable strengths of ceramic brackets, however, increased frictional resistance and greater risk of enamel

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fracture during debonding are their shortcomings.[3,9]

The debonding forces can fracture the ceramic brackets or bonding system at the tooth / resin interface, because, ceramic brackets have no bending ability. This in turn can create cracks in susceptible enamel. Therefore safe debonding is considered to be one of the biggest concerns while using ceramic brackets.[9]

Bracket bonding with conventional system (fifth generation) requires clean enamel surface that has been etched by using the 37% phosphoric acid for about thirty seconds, then washed and dried up, later on the bonding agent is applied and bracket with composite resin is placed.[4]

Self-etching primers (seventh generation) have simplified the bracket bonding procedure by reducing the number of steps and clinical chairside time. This one-step adhesive system (seventh generation) has gained attention among practitioners. Its active component is Methacrylated phosphoric acid ester that etches and primes the enamel surface simultaneously.[1,2,4-6]

Shear bond strength is an important characteristic of bonding agents. It is defined as an adhesive's ability to resist forces that attempt to cause the bracket to slide against the tooth, calculated in terms of mega pascals (MPA).According to Reynolds, shear bond strength of about 5.9-7.8 MPa is adequate to tolerate the masticatory forces.[7]

Literature shows that there are numerous bonding systems with different shear bond strengths. Shear bond strength of fifth generation adhesive system is 15.49±2.55 MPa. Seventh generation system which is mixed immediately prior to use as a single application procedure has SBS of 13.51±2.45 MPa which is less than fifth generation bonding system.[1,7]

It is claimed that in seventh generation bonding system, concurrent demineralization and resin infiltration results in a hybrid layer that doesn't collapse as it happens in fifth generation. [8] Limited data is available regarding the bonding efficacy of seventh generation bonding system with ceramic orthodontic brackets in Pakistan.

There is very limited literature published on shear bond strength of adhesive systems with ceramic orthodontic brackets in national studies, so, The purpose of this study was to compare the shear bond strength of ceramic orthodontic bracket bonded with fifth generation system and seventh generation system. The results of this study will help orthodontists to identify and utilize an appropriate adhesive system in local settings in order to avoid untoward sequelae of enamel fracture on debonding and improve our knowledge and practice.

MATERIALS & METHODS

This Randomized controlled trial was done at the Department of Orthodontics, Lahore Medical and Dental College, Lahore. Duration of study was 6 months i.e: from 30th August 2019 to 29th February 2020. A total of 60 premolars; 30 premolars in each group was calculated with 95% confidence interval, 80% power of study and taking magnitude of mean shear bond strength i.e. 15.49±2.55 MPa 5th generation adhesive system and 13.51±2.45 MPa of 7th generation bonding agents. [7]

The sample was collected using Non-probability, Consecutive sampling technique. The healthy maxillary and mandibular premolars extracted for orthodontic treatment (Therapeutic extractions) were collected from patients falling in the age range of 12-35 years. Teeth with restorations, anamolies or calcification defects were excluded from the sample.

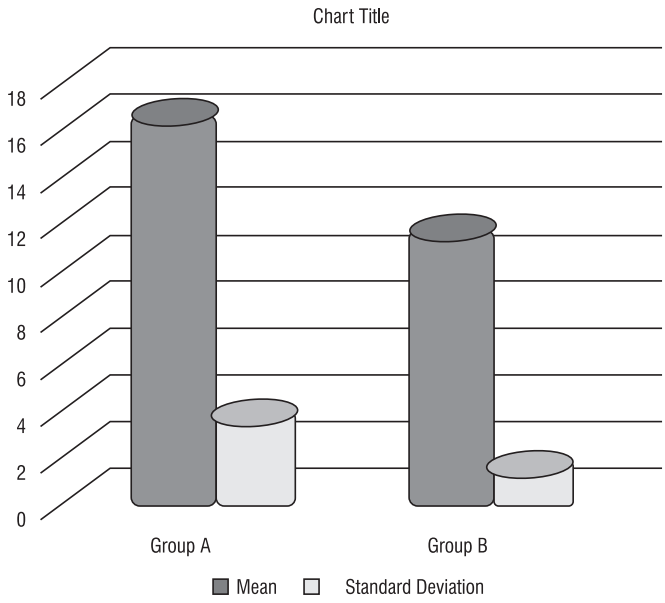
Premolars were randomly divided in two groups. Roots of sample teeth were removed 5-7mm below the cemento-enamel junction and crowns were embedded separately in acrylic resin in a way that facial surface of each tooth is above the acrylic and is parallel to acrylic base. Ceramic brackets were placed on the facial surface and then light cured for 20 seconds. In group A, ceramic orthodontic brackets were bonded with 5th generation bonding material {Transbond XT (3M UNITEK)}. In group B, 7th generation bonding material {ADPER Prompt-Lpop (3M ESPE ADPER PROMPT L-POP ADHESIVE)} was applied. Shear bond strength was measured with the help of Instron Universal testing machine in COMSATS university. The specimen was placed in the machine between the grips. Once the machine starts it begins to apply an increasing load on the orthodontic bracket till it breaks off from the tooth. The SBS was noted as an adhesive's ability to resist forces that attempt to cause the bracket to slide against the tooth, in terms of mega pascals (MPa) using Universal Testing Machine. All this information was recorded on proforma.

All the gathered information (data) was entered and analyzed by using the SPSS v. 21. Mean and standard deviation were estimated for quantitative variables like age, shear bond strength and number of premolars involved. Percentage and Frequency were estimated for qualitative variables like gender. Independent samples t-test was applied to compare the mean shear bond strength in both groups. P-value ≤ 0.05 was kept as significant.

RESULTS

According to calculated sample size, there were total sixty individuals enrolled in this study. The mean age of individuals was 21.77 ± 5.71 years with the age range from 12 to 35 years. The mean age of individuals in group A was 22.87 ± 6.08 years and 20.67 ± 5.20 years in group B. Out of 60 individuals, 34 (56.7%) were male and 26 (43.3%) were female with male to female ratio of 1.3:1. In group A, there were 13 (43.3%) female and 17 (56.7%) male. In group B, there were 13 (43.3%) female and 17 (56.7%) male. Table 1

The mean shear bond strength of brackets was 16.40 ± 3.47 MPa in Group A (fifth generation) while 11.40 ± 1.40 MPa in Group B (seventh generation) (p-value = 0.0001). Figure 1



P-value = 0.0001 which is statistically significant
Fig 1: Mean shear bond strength of brackets in both groups.

DISCUSSION

Increased need of ceramic orthodontic brackets and aesthetic restorations in dentistry has led to the development of different systems to allow sufficient bonding to enamel and dentin with lesser steps.[10] Dentin adhesives available include, one-step, 2-step and 3-step adhesives, based on the process of combining the three major components i.e: etchant, primer and bonding components. Now that adhesives have achieved an appropriate bond strength level, efforts have been made on reducing the application steps because it is challenging and time consuming to use multi-step agents in children. Simultaneous enamel and dentin etching products have demonstrated favourable clinical efficacy.[11] A recent revolutionary advancement in dentin bonding agents is the use of acidic primers which enables simultaneous application of acid and primer together in 6th and 7th generation bonding systems.[12] One-step systems simplify and shorten the process of bonding hence they are beneficial in uncooperative children.[11]

TABLE 1: DEMOGRAPHICS OF PATIENTS IN BOTH GROUPS (N=60).

Age (years)	Group A (n=30)		Group B (n=30)		Total (n=60)	
	F	%age	F	%age	F	%age
12-25	20	66.7%	24	80.0%	44	73.3%
26-35	10	33.3%	06	20.0%	16	26.7%
Mean ± SD	22.87 ± 6.08		20.67 ± 5.20		21.77 ± 5.71	
Gender						
Female	13	43.3	13	43.3	26	43.3
Male	17	56.7%	17	56.7%	34	56.7%
Number of premolars						
≤3	24	80.0%	24	80.0%	48	80.0%
>3	06	20.0%	06	20.0%	12	20.0%

We have conducted this study to compare mean shear bond strength of ceramic brackets bonded with fifth generation versus seventh generation bonding agents. Mean shear bond strength of brackets in Group A (fifth generation) was 16.40 ± 3.47 MPa while in Group B (seventh generation) was 11.40 ± 1.40 MPa (p-value = 0.0001). *Sharma et al* have already established similar results, according to them SBS of fifth generation adhesive system is 15.49±2.55 MPa, whereas, Seventh generation system has SBS of 13.51±2.45 MPa which is less than fifth generation bonding system.[7]

Shekhar et al., noticed that the highest shear bond strength with fifth generation (Prime & Bond NT) than sixth generation (Adper SE plus) and seventh generation (G-Bond) bonding agents. Authors have recognized this difference in bond strength to the less cross linking monomers in 7th generation than previous generations (5th and 6th).[13]

Poptani et al., could not find the significant difference in fifth and seventh generation bonding agents following thermocycling. The authors believe that thermocycling may have destabilized the collagen leading to the reduced bond strength.[14] The results of this study are similar to *Pickett et al* who reported shear bond strength of 11.2 & 9.7 MPa for traditional acid-etch adhesives and newer agents, respectively, their findings are in congruence with my study but with slight differences that may be due to

a difference in testing conditions.[15] Similarly *Verma et al* found shear bond strength of 27.63±12.21MPa traditional acid etch adhesives and 23.77 ± 15.85MPa for Self-etching primers which were in accordance of our results.[18]

Dhawan et al., observed that the greater tensile bond strength with single bonded conditioner (fifth generation) than scotch bond multi-purpose (fourth generation) and Prompt-L-Pop (sixth generation). Self-etching primers offer a great advantage of being relatively simpler to use as compared to 5th generation systems but this simplification has not led to an improvement in bond strengths. Self-etching primers reduce steps in bonding and decrease chair side time evading the adverse effects of the acid etch. It was observed that the etching with phosphoric acid leads to the higher loss of enamel layer. This greater loss of enamel leads to greater bond strength and gentle etching pattern formed by Self-etching primers cause less bond strength.[7,16,17]

The results of this study supports the hypothesis. Small sample size, possible human error and in vitro rather than in-vivo conduction of experiment can attribute to the possible limitations of this study as in-vivo environment may have less SBS. These limitations can be overcome by future researchers by increasing the sample size or by establishing appropriate standards in oral environment to study bond strengths more accurately.[15]

CONCLUSION

This study concluded that mean shear bond strength of ceramic brackets bonded with fifth generation bonding agent (16.40 ± 3.47 MPa) is greater than brackets bonded with seventh generation (11.40 ± 1.40 MPa). So we recommend that seventh generation bonding agent should be used as a primary bonding agent with ceramic brackets to avoid negative sequel of enamel cracks and damage during debonding. This can help us achieve safe debonding alongwith acceptable shear bond strength.

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