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Original Research

A comparative evaluation of tensile bond strength between polycrystalline and mono crystalline ceramic brackets on maxillary anterior teeth: An *in vitro* Study

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***ABSTRACT*:**
Background: Polycrystalline or alumina polycrystalline brackets are made of aluminum oxide crystals fused at high temperatures (near 1950°C).Monocrystalline brackets are made of a single crystal produced from the combination of particles of aluminum oxide fused at a higher temperature (2100°C) and cooled slowly, thus enabling thorough control of crystallization. **Aim of the study:** Tocompare tensile bond strength between polycrystalline and mono crystalline ceramic brackets on maxillary anterior teeth. **Materials and methods:** The present study was conducted in the Department of Dentofacial Orthopedics and Orthodontics of the Dental institution. For the study, 10 sound extracted maxillary anterior teeth each type (maxillary central incisor, lateral incisor and canine) were selected. The teeth were distributed into 2 groups, each containing 30 teeth with 10 teeth of each type. Fracture analyses were performed using an optical stereomicroscope. **Results:** We used 20 each of maxillary central incisor, lateral incisor and canines for the study. Each type of teeth was grouped into 10 for each group for monocrystalline brackets and polycrystalline brackets. We observed that the mean tensile strength of both the groups was comparatively similar. The results on comparison were seen to be statistically non- significant. **Conclusion**: Within the limitations of the present study, it can be concluded that tensile strength of polycrystalline ceramic brackets and monocrystalline ceramic brackets are similar for anterior teeth.
Keywords: Ceramic brackets, Monocrystalline, Polycrystalline

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INTRODUCTION:

Orthodontic tooth movement is frequently carried out by bonding a bracket to the tooth surface and placing an archwire in the bracket slot. Under tension, this archwire applies a gentle force to the tooth that moves it in the desired direction. During this process, sliding friction is generated between the archwires and brackets as the wires guide the brackets during mesiodistal movement of an individual tooth or when archwires are passed through posterior crown attachments.[1] Polycrystalline or alumina polycrystalline brackets are made of aluminum oxide crystals fused at high temperatures (near 1950°C).[2] Monocrystalline brackets are made of a single crystal produced from the combination of particles of aluminum oxide fused at a higher temperature (2100°C) and cooled slowly, thus enabling thorough control of crystallization.[3,4] Thus, the manufacturing process produces translucent and nontranslucent ceramic brackets. Monocrystalline brackets are included in the translucent brackets group while polycrystalline brackets are nontranslucent.[5] The translucency of monocrystalline brackets is due to the structure of a single crystal that provides passage of light. Polycrystalline brackets are not translucent because their structure presents lack of boundaries between the crystals and impurities incorporated during the manufacturing process, thereby hindering passage of light. [6] To have a good esthetic appearance, nontranslucent brackets need to be similar in color and fluorescence to the underlying tooth, whereas translucent brackets need to have sufficient translucency so as to allow the color and fluorescence of the tooth to pass through them. However, it is essential that both have good color stability.[5] Hence, the present study was planned to compare tensile bond strength between polycrystalline and mono crystalline ceramic brackets on maxillary anterior teeth.

MATERIALS AND METHODS:

The present study was conducted in the Department of Dentofacial Orthopedics and Orthodontics of the Dental institution. The ethical clearance for the study was approved from the ethical committee of the hospital. For the study, 10 sound extracted maxillary anterior teeth each type (maxillary central incisor, lateral incisor and canine) were selected. The teeth were stored at +4°C in a physiological saline solution until use. Teeth with hypoplastic areas, cracks, or gross irregularities of the enamel structure were excluded from the study. The criterion for tooth selection was no pre-treatment with a chemical agent such as alcohol, formalin, hydrogen peroxide, etc. Soft tissue remnants and calculus were removed from the teeth, following which they were cleaned with fluoride-free pumice and a rubber cup. The roots of the teeth were cut off with a water-cooled diamond disk. The crowns were mounted in a 3cm diameter circular mould using chemically cured acrylic resin. The labial of the tooth surfaces were perpendicular to the long axes of the moulds. Prior to bonding, the labial surface of each tooth was polished for 1 minute with a combination of a polishing agent and a brush at a low speed (3000 rpm) using a micro motor.

The teeth were distributed into 2 groups, each containing 30 teeth with 10 teeth of each type. The teeth were etched with 37 per cent orthophosphoric acid gel for 30 seconds, rinsed with water for 15 seconds, and dried with oil-free air for 10 seconds until a frosty white appearance of the etched enamel was observed. For each group, an orthodontic adhesive primer was used and light cured in all groups. An orthodontic composite resin was added to the surface by packing the material into cylindrical-shaped plastic matrices with an internal diameter of 2.34 mm and a height of 3 mm. Excess composite was carefully removed from the periphery of the matrices with an explorer. The composite was cured with a curing light for 20 seconds. The intensity of light was at least 400 mW/cm2.

Zwick universal testing machine (Z/100, Germany) was used to determine the tensile bond strength of the ceramic specimens in different groups. For this purpose, acrylic specimens were positioned in the lower part of the device and a steel wire which was connected to the upper part of the device was placed beneath the bracket wings (Fig 2). The device was calibrated to apply tensile force with 0.5 mm/min crosshead speed on the brackets until debonding occurred. Tensile bond strength was calculated by Newton being converted into mega-pascal (MPa) by dividing the force to the bracket base area (mm2) (MPa=N/mm2).

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student's t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

RESULTS:

Table 1 shows number of teeth of different types used in the study. We used 20 each of maxillary central incisor, lateral incisor and canines for the study. Each type of teeth was grouped into 10 for each group for monocrystalline brackets and polycrystalline brackets. Table 2 shows the comparison of mean tensile strength of monocrystalline brackets and polycrystalline brackets for different tooth types. We observed that the mean tensile strength of both the groups was comparatively similar. The results on comparison were seen to be statistically non-significant. ($p>0.05$)

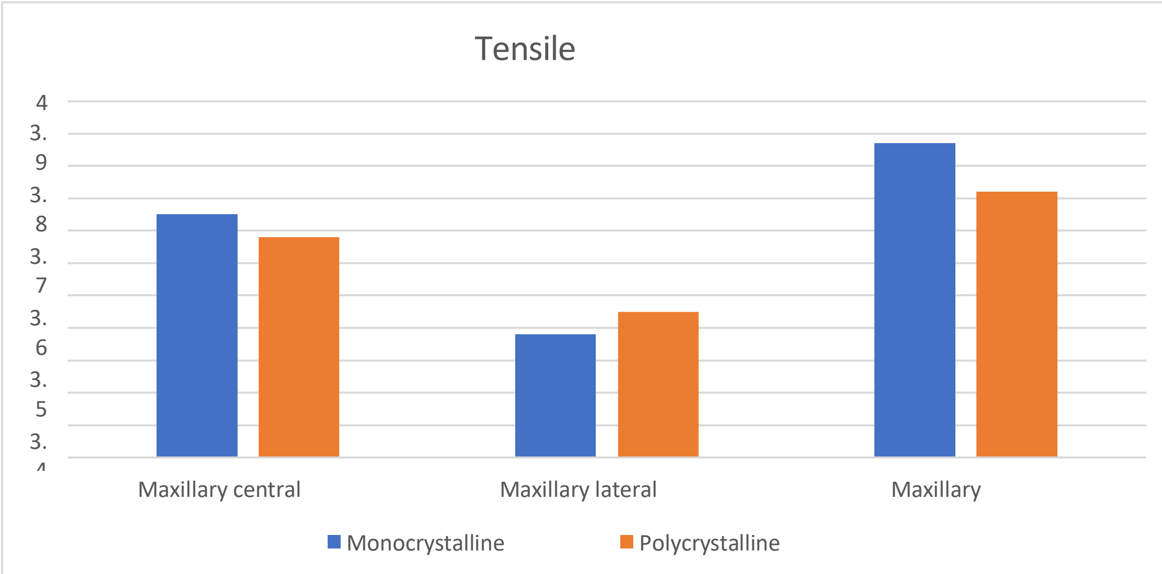
Table 1: Number of teeth of different types used in the study

Tooth type	Monocrystalline brackets	Polycrystalline brackets
Maxillary central incisor	10	10
Maxillary lateral incisor	10	10
Maxillary canine	10	10

Table 2: Comparison of mean tensile strength (MPa) of monocrystalline brackets and polycrystalline brackets for different tooth types

Tooth type	Monocrystalline brackets	Polycrystalline brackets	p-value
Maxillary central incisor	3.65	3.58	0.4
Maxillary lateral incisor	3.28	3.35	0.09
Maxillary canine	3.87	3.72	0.2

Fig 1: Comparison of tensile strength



DISCUSSION:

In the present study, we compared monocrystalline and polycrystalline ceramic brackets. Extracted maxillary teeth were used for comparison. We observed that tensile strength of both the types of brackets was similar for all the teeth. The results were statistically non-significant. de Oliveira CB et al analyzed color stability of monocrystalline and polycrystalline ceramic brackets after immersion in dye solutions. Seven ceramic brackets of four commercial brands were tested: Two monocrystalline and two polycrystalline. The brackets were immersed in four dye solutions (coffee, red wine, Coke and black tea) and in artificial saliva for the following times: 24 hours, 7, 14 and 21 days, respectively. Color changes were measured by a spectrophotometer. There was a perceptible change of color in all ceramic brackets immersed in coffee, black tea and red wine, but no change was noticed in Coke and artificial saliva. It was concluded that ceramic brackets undergo color change when exposed to solutions of coffee, black tea and red wine. However, the same crystalline structure, either monocrystalline or polycrystalline, do not follow the same or a similar pattern in color change, varying according to the bracket fabrication, which shows a lack of standardization in the manufacturing process. Ansari MY et al evaluated and compared the effect of base designs of different ceramic brackets on SBS, and to determine the fracture site after debonding. Four groups of ceramic brackets and one group of metal brackets with different base designs were used. Adhesive precoated base of Clarity Advanced (APC Flash-free) (Unitek/3M, Monrovia, California), microcrystalline base of Clarity Advanced (Unitek/3M, Monrovia, California), polymer mesh base of InVu (TP Orthodontics, Inc., La Porte, IN, United States), patented bead ball base of Inspire Ice (Ormco, Glendora, California), and a mechanical mesh base of Gemini Metal bracket (Unitek/3M, Monrovia, California). Ten brackets of each type were bonded to 50 maxillary premolars with Transbond XT (Unitek/3M). Samples were stored in distilled water at room temperature for 24 hours and subsequently tested in shear mode on a universal testing machine (Model 3382; Instron Corp., Canton, Massachusetts, USA) at a cross head speed of 1mm/minute with the help of a chisel. The debonded interface was recorded and analyzed to determine the predominant bond failure site under an optical microscope (Stereomicroscope) at 10X magnification. Mean SBS of microcrystalline base, was the highest followed by bead ball base, adhesive precoated base, polymer mesh base, and mechanical mesh base the least. Comparing the frequency (%) of ARI Score among the groups, chi-square test showed significantly different ARI scores among the groups. They concluded that different base designs of metal and ceramic brackets influence SBS to enamel and all were clinically acceptable.[7, 8]

Reddy YG et al compared the Shear Bond Strengths (SBSs) of ceramic brackets and metal brackets. Forty freshly extracted, human maxillary first premolars were selected for bonding. They were equally bonded with ceramic brackets (Transcend series 6000) and metal brackets (Mini Dynalock Straight wire brackets). A no – mix orthodontic adhesive system was used. Their shear bond strengths were measured by using the Instron universal machine. The mean bond strength of the ceramic brackets was 20.68 ± 3.89 Mpa and that of the metal brackets was 12.15 ± 1.32 MPa. They concluded that the shear bond strength of the ceramic brackets was found to be superior than that of the metal brackets. Chauhan V et al investigated the effect of different intracoronal bleaching methods on the shear bond strength and site of failure of ceramic brackets. Sixty freshly extracted human maxillary incisors were randomly divided into four groups (n = 15). Endodontic access cavity was prepared and root canals were filled, root fillings were removed 2mm apical to the cementoenamel junction, and a 2-mmthick layer of glass ionomer cement base was applied. Group 1 served as the control. Intracoronal bleaching was performed with 35% carbamide peroxide in group 2, sodium perborate in group 3, and 37.5% hydrogen peroxide in group 4. The teeth were immersed in artificial saliva for 4 weeks before bracket bonding. Ceramic brackets were bonded with composite resin and cured with LED light. After bonding, the shear bond strength of the brackets was tested with a universal testing machine. The site of bond failure was determined by modified ARI. The highest value of shear bond strength was measured in control group, which was statistically significant from groups 2,3, and 4. There was no significant difference between groups 2 and 4. The lowest shear bond strength was measured in group 3. ARI scores were not significant from each other. They concluded that intracoronal bleaching significantly affected the shear bond strength of ceramic brackets even after 4 weeks of bleaching. Bleaching with sodium perborate affects shear bond strength more adversely than does bleaching with other agents like hydrogen peroxide and carbamide peroxide. [9, 10]

CONCLUSION:

Within the limitations of the present study, it can be concluded that tensile strength of polycrystalline ceramic brackets and monocrystalline ceramic brackets are similar for anterior teeth.

REFERENCES:

1. Frank CA, Nikolai RJ. A comparative study of frictional resistances between orthodontic bracket and arch wire. Am J Orthod. 1980;78:593–609.
2. Ghafari J. Problems associated with ceramic brackets suggest limiting use to selected teeth. Angle Orthod. 1992;62(2):145–152.
3. Maltagliati LA, Feres R, Figueiredo MA, Siqueira DF. Braquetes estéticos: considerações clínicas. Rev Clín Ortod Dental Press. 2006;5(3):89–95.
4. Omana HM, Moore RN, Bagby MD. Frictional properties of metal and ceramic brackets. J Clin Orthod. 1992;26(7):425–432.
5. Lopes Filho H, Maia LEG, Araujo MVA, Ruellas ACO. Influence of optical properties of esthetic brackets (color, translucence, and fluorescence) on visual perception. Am J Orthod Dentofacial Orthop. 2012;141(4):460–467.
6. Jena AK, Duggal R, Mehrotra AK. Physical properties and clinical characteristics of ceramic brackets: a comprehensive review. Trends Biomater Artif Organs. 2007;20(2):101–115.
7. de Oliveira CB, Maia LG, Santos-Pinto A, Gandini Junior LG. In vitro study of color stability of polycrystalline and monocrystalline ceramic brackets. Dental Press J Orthod. 2014;19(4):114-121. doi:10.1590/2176-9451.19.4.114-121.oar
8. Ansari MY, Agarwal DK, Gupta A, Bhattacharya P, Ansar J, Bhandari R. Shear Bond Strength of Ceramic Brackets with Different Base Designs: Comparative In-vitro Study. J Clin Diagn Res. 2016;10(11):ZC64-ZC68. doi:10.7860/JCDR/2016/20624.8910
9. Reddy YG, Sharma R, Singh A, Agrawal V, Agrawal V, Chaturvedi S. The Shear Bond Strengths of Metal and Ceramic Brackets: An in-Vitro Comparative Study. J Clin Diagn Res. 2013;7(7):1495-1497. doi:10.7860/JCDR/2013/5435.3172
10. Chauhan V, Kumar P, Sharma P, Shetty D. Effect of different intracoronal bleaching methods on shear bond strength of ceramic brackets bonded to bleached enamel: An in- vitro study. J Orthod Sci. 2017;6(3):86-90. doi:10.4103/jos.JOS_149_16