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Effects of different surface conditioning protocols on shear strength of orthodontic brackets bonded to CAD/CAM materials

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Abstract

Aim: The aim of this study was to evaluate the effects of different surface conditioning method combinations on the shear strength of orthodontic brackets bonded various temporary crown materials used in computer aided design and computer aided manufacturing systems.

Materials and Methods: 100 polymethyl methacrylate, 100 bis-acrylic composite and 100 polyetherketoneketone surfaces were prepared from provisional temporary crown blocks. Five different conditioning protocols (etching with 9.6 % hydrofluoric acid, sandblasting with 50 µm Al_2O_3 particles, roughening with ultrafine diamond bur, Er,Cr:YSGG laser irradiating and priming with methylmethacrylate monomer were applied to the surfaces for each material group. Shear test was performed to half of the bonded samples after 24 hours while the other half 14 days later. The share strengths of the bonded brackets were measured in Newton and Megapascals.

Results: In all material groups, the highest share strength values were found in samples sandblasted with Al2O3 particles. For bis-acrylic composite and polymethyl methacrylate groups, the lowest bond strength value were found in samples irradiated with Er,Cr:YSGG laser.

Conclusion: The shear bond strengths of the orthodontic brackets bonded to the temporary crown materials produced in CAD/CAM systems vary according to the structure of the material and surface conditioning processes.

Introduction

With the increasing number of adult patients applying for orthodontic treatment, the variety of materials encountered by orthodontists in the mouth increases and the attachment of brackets to these materials becomes more important. Provisional restorations used before permanent prosthetic rehabilitation are a type of prosthetic treatment applied to protect the support teeth, to observe the prognosis of the teeth, and to provide the patient with a temporary solution that is aesthetic, functional, phonetic and provides tissue harmony. These restorations are often used to improve the therapeutic efficacy of the treatment plan and to evaluate the form and function of the planned permanent restoration. In such a clinical situation, orthodontic attachments are bonded to provisional crown materials.

The chemical, physical and clinical properties of the most commonly used resins for provisional crowns vary. Bis-acryl composite resins, polymethyl methacrylate resins and ethyl methyl methacrylate resins are among the most frequently used materials for this purpose. Provisional crowns can be produced directly with various materials available in powder liquid form or prefabricated as polycarbonate crowns. There are studies reporting that provisional crowns produced with the Computer Aided Design and Computer Aided Manufacturing (CAD/CAM) system, which has been successfully used in dentistry for a long time, give better results in terms of durability and marginal fit [1]. In many studies in the literature, provisional restorations produced with CAD/CAM systems and conventional methods have been compared in terms of marginal edge matching, color stability and mechanical properties. There are studies indicating that provisional restorations produced with CAD/CAM systems have better color stability and marginal edge matching than those

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produced with conventional methods [2-4]. High density polymer blocks produced for use in CAD/CAM systems have high mechanical properties and smoother surfaces because they are polymerized under special conditions (high temperature and pressure) [2, 4-6]. Various ready-made blocks have been used in different studies on provisional restoration materials produced in CAD/CAM systems. Polymethyl methacrylate (PMMA) (Telio CAD, artBloc Temp,), bis-acryl composite (Vita CAD-temp, Ambarino high-class, Everest C- temp), polyetheretherketone (PEEK), and UDMA (Lava Ultimate) are the most commonly used blocks [7-10].

Brackets bonded to provisional crown materials must have adequate bonding resistance against orthodontic forces. Although both physical and chemical forces play a role in the bonding process, the basic principle is based on mechanical interlocking between the treated surface and the low-density polymer bonding agent [11, 12]. Inadequate bonding resistance of brackets causes high failure rates and negative results in orthodontic treatment in terms of cost and effectiveness. The bond strength between the bracket and the provisional material is influenced by factors such as surface preparation, adhesive material, waiting period after bonding, and thermal cycling [13]. In order to ensure direct adhesion to the restoration surfaces, various surface roughening methods should be applied. In addition to mechanical methods such as green stone, emery, diamond milling, sandblasting with aluminum oxide, chemical agents such as hydrofluoric acid, phosphoric acid, acidulated phosphate fluoride and laser applications such as Er:YAG, Nd:YAG, CO2 have also been studied in the literature [14-19].

Although there are many studies in the literature investigating the bond strength between the bracket and various restorative materials, there are limited studies investigating the bond strength between provisional crown materials and the bracket. Based on this information, the aim of this study was to evaluate the bonding resistance of orthodontic attachments that underwent different roughening techniques to the surfaces obtained by CAD/CAM from polymethyl methacrylate, polyetherketoneketone and bis-acryl composite blocks and to determine the most appropriate method to ensure acceptable bonding on these surfaces.

Materials and Methods

Preparation of samples

Three types of provisional crown materials used in CAD/CAM systems were included in the study: bis-acryl composite (Vita CAD-temp Zahnfabrik, Bad Säckingen, Germany), polymethyl methacrylate (Tempo CAD, On-Dent, Izmir, Türkiye) and polyetherketoneketone (Pekkton Ivory, Cendres+Métaux, Biel Bienne, Switzerland). Provisional crown blocks were milled on the "Coritec 550i imes-icore" device with dimensions of 10 mm x 20 mm x 20 mm and 10 samples were prepared for each group. Each sample was designed to contain 12 surfaces for double-sided use (Figure 1a, 1b). Each of the 30 samples containing a total of 300 surfaces was divided into 30 separate groups (n: 10 surfaces) (Table 1). Five different surface roughening procedures were planned for the samples obtained (Table 2).

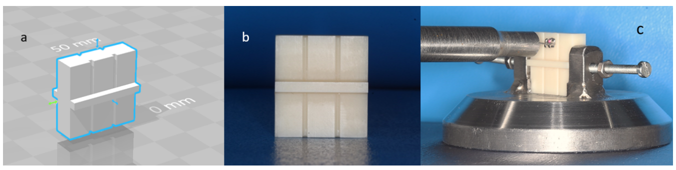

Figure 1. a) Digital design of the samples b) Producted samples containing surfaces c) A custom-made device for the orthodontic brackets to place vertically.

*Group 1-6 (9.6% HF + Silane): 9.6% Hydrofluoric acid gel (Pulpdent, MA, USA), Silane (Ultradent, South Jordan, Utah, USA)

*Group 7-12 Sandblasting with (Al2O3 + Silane): (Hagen Werker, Duisburg, Germany), Silane (Ultradent, South Jordan, Utah, USA)

*Group 13-18 (Roughening with diamond milling + Silane): Komet, Brasseler, Germany, (Ultradent, South Jordan, Utah, USA)

*Group 19-24 (Er,Cr:YSGG laser roughening + Silane): (Biolase, Waterlase MD), (Ultradent, South Jordan, Utah, USA)

*Group 25-30 (Methylmethacrylate Monomer application + Silane): (Imicryl, Konya, Türkiye).

Bonding of brackets

In our study, a total of 300 upper premolar brackets with 0.018 metal slots (Ormco mini 2000, Ormco Cop., CA, USA) were used for the treated sample surfaces. Transbond XT Light Cure Adhesive (3M/Unitek, Monrovia, California) was applied to the base of the orthodontic brackets and the brackets were placed on the surfaces with the help of holders. At this stage, a setup was used so that the bracket base could be parallel to the vertical plane on which the shearing force would be applied (Figure 1c).

Storage of samples

Half of the samples were kept in 10 separate containers with distilled water in an incubator for 24 hours. The other half were kept in the same conditions for 14 days. The temperature of the incubator was fixed at 37 °C to mimic the intraoral environment.

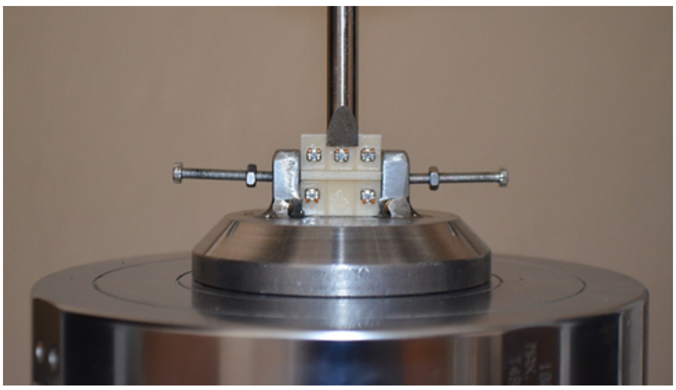

Figure 2. A custom-made device for shearing test.

Shear test

Instron Universal Tester (Instron 3382, Istanbul, Türkiye) was used for the shear test. A special set-up was prepared to keep the specimens stationary during the application of the shear force (Figure 2). The maximum force that the moving arm can apply was set to 500 Newton and the speed was set to 1 mm/min. Shear force was applied at the bracket-sample surface junction by means of a fine-tipped stainless steel blade fixed to the movable upper part of the device. The values obtained in N (Newton) were converted to megapascals using the equation Mpa=N/mm2. The base area of the brackets used in the study was calculated as 9.63 mm^2 and this value was used in the equation.

Statistical analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Sciences) for Windows 17.0 (SPSS, Inc., Chicago, IL USA) program. Descriptive statistics were presented as mean and standard deviation. In the data evaluation stage, the Kolmogorov–Smirnov test was used to assess the normality of the data. Two-way ANOVA test was applied to the data showing normal distribution in the shear bond strength test. The results were evaluated at 95% confidence interval and $p<0.05$ significance level.

Results

The calculated MPa values were analyzed by two-way ANOVA and interaction data were obtained. According to these results, material used and method applied had statistically significant effects when evaluated individually and together ($p<0.05$). Waiting time was found to be statistically significant when evaluated separately by material and method ($p<0.05$).

The mean bracket rupture values and standard deviations in MPa (megapascals) for the Vita CAD-temp material after 24 hours and 14 days of shear testing are given in Table 3. The binding value in Group 1 (9.6% HF acid) was significantly lower than Group 7 (50 μm Al_2O_3) and significantly higher than Group 19 (Er,Cr:YSGG laser); while no statistically significant difference was found when compared to Group 13 (Ultrafine milling cutter) and Group 25 MMA (Methyl Methacrylate monomer). The binding value in group 7 (50 μm Al_2O_3) was significantly higher compared to the other groups. There was no significant difference between Group 13 (Ultrafine drill), Group 19 (Er,Cr:YSGG laser), and Group 25 (MMA). The binding strength in Group 4 (9.6% HF acid) was significantly higher than Group 16 (Ultrafine bur) and Group 22 (Er,Cr:YSGG laser). The value in Group 10 (50 μm Al_2O_3) was found to be significantly higher compared to Group 4 (9.6% HF acid), Group 16 (Ultrafine bur), Group 22 (Er,Cr:YSGG laser), and Group 28 (MMA). The value in Group 28 was significantly higher compared to Group 22 (Er,Cr:YSGG laser), but no difference was found between Group 28 and Group 16 (Ultrafine bur).

The average bracket rupture values and standard deviations of Tempo CAD material after 24 hours and 14 days of shear testing are given in MPa (megapascal) in Table 4. Shear test results of Tempo CAD material were also compared and statistically significant differences were found between some groups ($p<0.05$). The value in Group 2 (9.6% HF acid) was significantly lower compared to Group 8 (50 μm Al2O3), Group 14 (Ultrafine bur), and Group 26. There was no statistically significant difference between Group 2 (9.6% HF acid) and Group 20 (Er,Cr:YSGG laser). Group 8 (50 μm Al_2O_3) showed the highest value among the groups. The value in Group 14 (Ultrafine bur) was significantly higher compared to Group 20 (Er,Cr:YSGG laser) and the value in Group 20 (Er,Cr:YSGG laser) was significantly higher compared to Group 26. The value in Group 11 (50 μm Al_2O_3) was significantly higher compared to Group 5 (9.6% HF acid) and Group 23 (Er,Cr:YSGG laser). The value in Group 17 (Ultrafine bur) and Group 29 (MMA) was significantly higher compared to Group 23 (Er,Cr:YSGG laser). The mean bracket rupture values and standard deviations of the Pekkton Ivory material after 24 hours and 14 days of shear testing are given in MPa (megapascals) in Table 5. Shear test results of Pekkton Ivory material were also compared and statistically significant differences were found between some groups ($p<0.05$). The value in Group 9 (50 μm Al_2O_3) was significantly higher than the values in Group 3 (9.6% HF acid), Group 15 (Ultrafine bur), and Group 27 (Methyl Methacrylate monomer). There was no statistically significant difference between the values in Group 15 (Ultrafine bur), Group 21 (Er,Cr:YSGG laser), and Group 27 (MMA). The value in Group 12 (50 μm Al_2O_3) was significantly higher than the values in Group 6 (9.6% HF acid), Group 18 (Ultrafine bur), Group 24 (Er,Cr:YSGG laser) and Group 30 (MMA). There was no statistically significant difference between the values in Group 6 (9.6% HF acid), Group 18 (Ultrafine bur), Group 24 (Er,Cr:YSGG laser), and Group 30 (MMA).

Discussion

Provisional crowns can be produced directly with various materials available in powdered liquid form or prefabricated in the form of polycarbonate crowns. Studies in the literature examined many parameters such as surface roughening methods, waiting times of specimens, bonded orthodontic attachments, and bonding agents [13, 20-27].

There are studies indicating that provisional restorations produced with CAD/CAM systems have better color stability and marginal accuracy than those produced with conventional methods [2-4]. Rayyan et al. compared PMMA blocks with conventional resin materials and reported that PMMA blocks gave better results in terms of color stability, less water absorption, higher abrasion resistance, surface hardness, and fracture strength [28]. Therefore, it is beneficial to use CAD/CAM systems in cases where provisional restorations need to be used for a long period of time [10]. There are many studies in the literature on the bonding dynamics of orthodontic attachments to provisional crown materials obtained by conventional methods [13, 20-27]. However, there are no studies on the bonding dynamics of orthodontic attachments to provisional restorations produced in CAD/CAM systems. Based on this information, the aim of the present study was to evaluate the bonding resistance of orthodontic attachments undergoing different roughening processes to the surfaces obtained by CAD/CAM from

Table 1. Study design.

	HF		Al_2O_3		Bur		Laser		MMA	
	24 hours	14 days	24 hours	14 days	24 hours	14 days	24 hours	14 days	24 hours	14 days
Vita CAD	Group1	Group4	Group7	Group10	Group13	Group16	Group19	Group22	Group25	Group28
Tempo CAD	Group2	Group5	Group8	Group11	Group14	Group17	Group20	Group23	Group26	Group29
PEKK	Group3	Group6	Group9	Group12	Group15	Group18	Group21	Group24	Group27	Group30

HF: Hydrofluoric acid gel, MMA: methylmethacrylate monomer,PEKK: polyetherketoneketone, Al_2O_3 :Aliminum Oxide.

Table 2. Groups and surface conditioning protocols.

Groups (n:10)	Surface conditioning protocols	
Group 1-6	HF Silane Transbond XT Primer Transbond XT Adesive	%9.6, 2 minutes 60 seconds
Group 7-12	Al_2O_3 Silane Transbond XT Primer Transbond XT Adesive	50µm, 2.5 bar, 10 sec, 10 mm 60 seconds
Group 13-18	Diamond Bur Silane Transbond XT Primer Transbond XT Adesive	Ultrafine, 30µm, 10 sec. 60 seconds
Group 19-24	Er,Cr:YSGG Laser Silane Transbond XT Primer Transbond XT Adesive	3 W, 8 mm, 10 Hz, 20 sec. 60 seconds
Group 25-30	Metil Metakrilat Monomer Silane Transbond XT Primer Transbond XT Adesive	180 seconds 60 seconds

HF: Hydrofluoric acid gel, Al2O3 :Aliminum Oxide, W:Watt, sec:Second, µm:Micrometer, mm:Milimeter, Hz:Hertz.

Table 3. The comparison of shear bond strength values (Mpa) of Vita CAD-temp material after different surface conditioning protocols.

24 hours			14 days		
Groups	Mean ± SD	p	Groups	Mean ± SD	p
Group 1 (Vita-HF)	8.92 ± 4.43	Group 7-p<0.01 Group13-p>0.05 Group19- p>0.05 Group25- p>0.05	Group 1 (Vita-HF)	8.34±3.59	Group10- p<0.01 Group16- p<0.01 Group22- p<0.01 Group28- p>0.05
Group 7 (Vita-Al_2O_3)	15.85±2.75	Group13- p<0.01 Group19- p<0.01 Group25- p<0.01	Group 10 (Vita-Al_2O_3)	14.08±3.55	Group16- p<0.01 Group22- p<0.01 Group28- p<0.01
Group 16 (Vita-Bur)	8.77±4.78	Group19- p>0.05 Group25-p>0.05	Group 16 (Vita-Bur)	2.41±1.39	Group22- p>0.05 Group28- p>0.05
Group 22 (Vita-Laser)	6.56±4.61	Group25- p>0.05	Group 22 (Vita-Laser)	2.41±1.39	Group28- p<0.01
Group 28 (Vita-MMA)	8.41±6.04		Group 28 (Vita-MMA)	8.06±4.57	

p<0.05, Two-way ANOVA test HF: Hydrofluoric acid gel, MMA: methylmethacrylate monomer, Al_2O_3: Aliminum Oxide.

polymethyl methacrylate, polyetherketoneketone and bis-acryl composite blocks and to determine the most appropriate method to ensure acceptable bonding on these surfaces.

Table 4. The comparison of shear bond strength values (Mpa) of Tempo CAD material after different surface conditioning protocols.

24 hours			14 days		
Groups	Mean ± SD	p	Groups	Mean ± SD	p
Group 2 (Tempo-HF)	4.38 ± 4.10	Group 8-p<0.01 Group14- p<0.01 Group20-p>0.05 Group26- p<0.01	Group 5 (Tempo-HF)	6.65 ± 4.37	Group11- p<0.01 Group17-p<0.05 Group23- p>0.05 Group29- p<0.05 1
Group 8 (Tempo-Al_2O_3)	15.61 ± 3.33	Group14-p<0.05 Group20- p<0.01 Group26- p<0.01	Group 11 (Tempo-Al_2O_3)	14.23 ± 2.35	Group17- p<0.05 Group23- p<0.01 Group29- p<0.05
Group 14 (Tempo-Bur)	12.62 ± 3.01	Group20- p<0.01 Group26-p>0.05	Group 17 (Tempo-Bur)	10.77 ± 3.13	Group23- p<0.01 Group29- p>0.05
Group 20 (Tempo-Laser)	4.05 ± 1.74	Group26- p<0.01	Group 23 (Tempo-Laser)	4.76 ±2.51	Group29- p<0.0
Group 26 (Tempo-MMA)	10.9 ± 2.49		Group 29 (Tempo-MMA)	11.00 ± 3.54	

P<0.05, Two-way ANOVA test HF: Hydrofluoric acid gel, MMA: methylmethacrylate monomer, Al_2O_3 :Aliminum Oxide.

Table 5. The comparison of shear bond strength values (Mpa) of Pekkton Ivory material after different surface conditioning protocols.

24 hours			14 days		
Groups	Mean ± SD	p	Groups	Mean ± SD	p
Group 3 (PEKK-HF)	0.64 ± 0.31	Group 9-p<0.01 Group15-p>0.05 Group21- p>0.05 Group27- p>0.05	Group 6 (PEKK-HF)	1.45 ± 0.77	Group12- p<0.01 Group18- p>0.05 Group24- p>0.05 Group30- p>0.05
Group 9 (PEKK-Al_2O_3)	7.28 ± 4.20	Group15- p<0.01 Group21-p<0.05 Group27- p<0.01	Group 12 (PEKK-Al_2O_3)	11.10 ± 4.77	Group18- p<0.01 Group24- p<0.01 Group30- p<0.01
Group 15 (PEKK-Bur)	2.02 ± 1.18	Group21- p>0.05 Group27- p>0.05	Group 18 (PEKK-Bur)	1.21 ± 0.71	Group24- p>0.05 Group30- p>0.05
Group 21 (PEKK-Laser)	2.39 ± 2.62	Group27- p>0.05	Group 24 (PEKK-Laser)	0.70 ± 0.40	Group30- p>0.05
Group 27 (PEKK-MMA)	0.36 ± 0.13		Group 30 (PEKK-MMA)	1.22 ± 1.17	

P<0.05, Two-way ANOVA test HF: Hydrofluoric acid gel, MMA: methylmethacrylate monomer, Al_2O_3 :Aliminum Oxide.

Various ready-made blocks have been used in different studies on provisional restoration materials produced in CAD/CAM systems. PMMA (Telio CAD, artBloc Temp,), bis-acryl composite (Vita CAD-temp, Ambarino high-class, Everest C- temp), polyetheretherketone (PEEK), and UDMA (Lava Ultimate) are the most commonly used blocks [1, 7-10]. Three types of CAD/CAM temporary blocks, Vita CAD-temp (Bis-acryl composite), Tempo CAD (Polymethyl methacrylate), and Pekkton Ivory (Poly-ether-ketone-ketone), were included in our study.

Although there are many studies in the literature investigating the bond strength between the bracket and various restorative materials, there are limited studies investigating the bond strength between provisional crown materials and the bracket. Jabbari et al. reported that a bracket applied to a provisional crown material with an unroughened surface produces too low bond strength to withstand the forces required for orthodontic tooth movement [20].

The bonding strength should be high enough to prevent unwanted bracket detachment during orthodontic treatment, but not too high to cause enamel-damaging forces during the removal of the brackets at the end of treatment. High values of bonding strength are therefore not essential for good clinical performance [29]. Reynolds reported that the bonding resistance between the bracket and tooth should be at least 5.9-7.8 MPa to suit the orthodontic movement of the teeth [30]. Bowen et al. reported that the average tensile strength of enamel is 14.5 Mpa [31]. The different CAD/CAM provisional materials we used in our study had an effect on the bonding values of the brackets.

After 24 hours of shear testing, the specimens in the Vita CAD-temp material group gave better results than the Tempo CAD material groups in the HF acid, Er,Cr:YSGG laser and, although not significantly, in the sandblasting with Al2O3 powder groups. After 14 days of shear testing, the bonding values of the specimens in the Al_2O_3 powder and Er,Cr:YSGG laser groups were higher in the Tempo CAD material group, but the difference was not statistically significant. The bonding values of the specimens in the Ultrafine bur and MMA groups were higher for the Tempo CAD material both after 24 hours and 14 days of shear testing. In the present study, the groups in which the highest bonding values were recorded in all material groups were the specimens sandblasted with 50 µm Al_2O_3 powder (Group 7 (Vita-24 hours-15.85±2.75), Group 10 (Vita-14 days-14.08±3.55), Group 8 (Tempo-24 hours-12.62±3.01), Group 17 (Tempo-14 days-14.23±2.35), Group 9 (Pekk-24 hours-7.28±4.20), Group 12 (Pekk-14 days-11.10±4.77)). The lowest bonding strength values were recorded in Er,Cr:YSGG laser treated specimens in all material groups (Group 19 (Vita-24 hours-6.56±4.61), Group 22 (Vita-14 days-2.41±1.39), Group 20 (Tempo-24 hours-4.05±1.74), Group 23 (Tempo-14 days-4.76±2.51), Group 21 (Pekk-24 hours-2.39±2.62), Group 24 (Pekk-14 days-0.70±0.40)). No statistically significant difference was observed in each of the material groups between 24 hours and 14 days.

Increasing the waiting time to 14 days resulted in lower values only in the bis-acryl composite (Vita CAD- temp) material group in the milled and laser-treated specimens. No significant change was noted in the PMMA material group. The destructive effect of the thermal cycling process on PMMA material suggested by Jabbari et al. was not observed after the 14-day waiting period applied in our study [20].

In their study, Chay et al. applied various roughening methods on the surfaces of conventional temporary crown materials (Protemp 3/Bis-acryl composite and Temporary Bridge Resin/PMMA) [13]. They found that roughening using green stones was not as effective as sandblasting with 50 µm Al_2O_3 powder. The authors stated that there was a significant decrease in bonding strength in the bis-acryl composite material group, but there was no statistical difference in the PMMA material group, albeit non-significant increases in the values. Although the sandblasting method we used in our study was the same as the method used by Chay et al., the bonding values of the sandblasted samples in the bis-acryl composite material group, more prominently in the PMMA material group, were higher than the values found by the researchers. The fact that CAD/CAM provisional materials are different from conventional provisional materials in terms of mechanical properties, the application of silane after sandblasting method in our study, different waiting times and different application of shear force are thought to be the reasons for these differences in the values obtained.

Blakey et al. investigated the effects of diamond milling, 9.6% HF acid, and sandblasting with 50 µm aluminum oxide on bonding strength of polycarbonate crowns [21]. They reported that polycarbonate crowns, which are structurally similar to PMMA, were resistant to acid applications. The highest bonding values were measured in the sandblasted group and then in the milled group. Similarly, in the present study, in the PMMA (Tempo CAD) material group, the bonding strengths of the samples treated with 9.6% hydrofluoric acid were found to be lower than the groups treated with Ultrafine bur, MMA monomer, and sandblasting (Group 2 (HF-24 hours-4.38±4.10), Group 5 (HF-14 days-6.65±4.37)).

Goymen et al. applied different roughening methods on five different conventional provisional crown materials, namely PMMA (Dentalon Plus), PEMA (Trim II), bis-acryl composite (Structur Premium, Protemp 4), UDMA (Revotec LC), and measured the highest bonding strength values in the shear tests after thermal cycling in all material groups in the Er:YAG laser treated samples [24]. The authors stated that more successful results were obtained in bis-acryl composite material groups compared to other material groups. They reported that higher values were obtained in the group roughened with 50 µm Al_2O_3 sandblasting and similar values were obtained in the group treated with 37% phosphoric acid. However, since these values were lower than the accepted minimum bonding values, the authors argued that sandblasting and acid application methods would not give successful results, especially in the PMMA material group In the present study, the bonding values obtained in the bis-acryl composite and PMMA material groups treated with Er,Cr:YSGG were similar to the results reported by Goymen et al. Laser application gave results above the minimum accepted bonding values only in the bis-acryl composite group.

In the PEKK (Pekkton Ivory) material group, the effects of different surface roughening treatments and shear tests applied for different time periods on the bonding strength of orthodontic brackets were examined and all methods except for sandblasting with 50 µm Al_2O_3 yielded results below the minimum bonding value. The failure of bonding between the PEKK material and the adhesive resin was attributed to the lack of PEKK primer. PEKK material was used for the first time in the literature to examine bonding strength, and only Al_2O_3sandblasting was effective among the surface roughening procedures applied on the PEKK material used. Due to its high mechanical properties, PEKK material is used in many areas of dentistry; however, further studies are needed before it can be used as a provisional crown material.

Conclusion

1. The bonding strength of brackets bonded to provisional CAD/CAM materials varies depending on the type of material and the roughening method used.
2. Sandblasting with 50 µm Al_2O_3 powder yielded the highest bonding strength values in all material groups.
3. Er,Cr:YSGG laser treatment yielded the lowest bonding strength values in all material groups.
4. Bis-acryl composite material group gave more successful results compared to other material groups. This material can be preferred in orthodontic treatments that require long-term use of a provisional restoration.
5. In the PMMA material group, the application of methyl methacrylate monomer gave results above the minimum bonding values. This method, which is easy to apply in clinical settings, can be preferred in the surface preparation of provisional crowns made of polymethyl methacrylate.

6. In the PEKK material group, all surface roughening procedures except sandblasting with 50 µm Al_2O_3 powder resulted in low bonding strength values of orthodontic brackets.
7. Waiting period before the shear test had no significant effect on the bonding strength values of the brackets.

Ethical approval

It is a study that does not require ethical approval.

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