Wang, S.C., Galvan, S. I. - Yemeni J Med Sci. 2025; 19(3):28 -41
https://doi.org/10.20428/yjms.v19i3.2679
https://journals.ust.edu/index.php/yjms

OPEN ACCESS ORIGINAL ARTICLE

Comparison between Micro Sandblaster and Direct Flame Technique for Removing Adhesive Remnants from Debonded Orthodontic Metal Bracket Bases

Sally C. Wang[1*], Shirchie I. Galvan[2]

[1] *Department of Dentistry, MSD Orthodontics, Manila Central University, Caloocan City, Philippines*
[2] *Department of Dentistry, Faculty of Orthodontics, Manila Central University, Caloocan City, Philippines*

ABSTRACT

Background: The removal methods of adhesive resin remain a subject of debate among researchers regarding the most effective approach for reconditioning debonded brackets from the tooth.
Objectives: The aim of this study was to evaluate the micro sandblaster and direct flame technique for removing adhesive remnants from debonded orthodontic metal bracket bases.
Method: The research design was experimental and involved comparing the micro sandblaster and direct flame technique in removing adhesive remnant using purposive sampling. Thirty (30) metal brackets were divided into two groups and soaked for 24 hours in an incubator before applying the two methods of removal. The samples were examined in optical microscopy, and the areas of adhesive remnants were analyzed and measured as a percentage of the digital images using the ImageJ analysis software function. Pixels were converted into millimeters (mm). Statistical analyses, including Shapiro-Wilk Test, Levene's Test, and T-Test for Independent samples were conducted.
Results: The micro sandblaster group exhibited the lowest mean value at 1.518 mm +1.159 (mean + standard deviation), while the direct flame group showed the highest value at 2.264 mm +1.262. The Levene's Test result was 0.079, and the T-Test for Independent Samples yielded a p-value of 0.103 which exceeded the predetermined significance level of 0.05.
Conclusion: The results of this study indicate that the micro sandblaster and direct flame techniques for removing adhesive residues from debonded metal brackets showed statistically insignificant differences. Either of these methods may be a viable approach for operators to use when reconditioning dislodged brackets.

Keywords: Sandblaster, Direct Flame, Adhesive Remnants, Metal Brackets, Mesh, Percentage, Debonded, Orthodontic Treatment

**** Corresponding author address:*** *drasallywang@gmail.com*

INTRODUCTION

Bracket dislodgement continues to be a problem for orthodontists and causes unwanted delays and excessive costs in treatment. Recycling or reusing orthodontic brackets offers a significant ecological conservation advantage and cost reduction [1]. The most used adhesive material in modern orthodontic practice is light-cured composite. When the composite resin is combined with phosphoric acid etching, it results in a strong bond strength [2]. However, the removal of any remnant resin is difficult and time-consuming. The remnants exhibit high elastic coefficients and high hardness values due to the inclusion of inorganic fillers [3]. Stainless steel brackets are the most frequently used bracket type in the studies [4]. Adhesive remnants of the dislodged brackets can be removed conveniently in-office or chairside setting by using mechanical and thermal methods like direct flame, dental burs, sandblasting (air abrasion) laser applications [5]. The introduction of air abrasion (sandblasting) technology to orthodontics may allow for immediate use of these failed brackets. Air abrasion removes residual bonding material from the failed bracket base and results in a roughened and irregular surface of the mesh [6]. On the other hand, Direct Flame technique of removing remnants of adhesive is also usually use by most clinicians because it is handy and well available in the market in the form of refillable butane torch. The researcher aims to compare and assess the effectiveness of which method that can encourage clinicians to adopt these techniques instead of resorting to less effective options for removing adhesive resin remnants prior to rebonding with a new adhesive to debonded orthodontic metal brackets. This study focuses on evaluating the adhesive remnants on bracket mesh using both a micro sandblaster and a direct flame technique. Working null hypothesis was set as there is no significant difference between micro sandblaster and direct Flame technique for removing adhesive remnants of debonded orthodontic metal brackets bases.

METHODS

Research Design

The research design utilized was experimental which involved scientific approach [7] and quantitative research type with measuring the numerical values in percentage millimeter to evaluate the Adhesive Remnants on bracket bases mesh using a micro sandblaster and direct flame technique.

Sample and Sampling Technique

A purposive sampling technique was used in this study. A total sample of thirty (30) pieces of traditional size premolar orthodontic metal brackets of .022 slot with 80-gauge fine mesh design were selected and assigned into two (2) groups:

Group SB = 15 brackets for Micro sandblaster Method
Group DF = 15 brackets for Direct Flame Method

Research Instruments

This study utilized the following research instruments that are necessary to collect the data. Thirty (30) Metal Brackets - .022 slot Roth system Traditional Size Master Series Metal Twin Brackets 80-gauge fine mesh design (American Orthodontics/ USA).

Adhesive – light cure (Reliance Orthodontic Products, Inc. USA)
Aluminum oxide powder – 90 microns (Deldent/Israel)
Bonding agent - Reliance Orthodontic Products
Bracket holder – stainless steel (USDontics)
Orthodontic tweezer – stainless steel (USdontics)
Distilled water – deionized within 24 hours
Flame – micro torch, 271Jet,1300 /2500 degrees Celsius, butane power piezo ignition, BS-271b Flame gun P.R.C
ImageJ Software Analysis - National Institute of Health, Bethesda, Maryland USA
Light cure -Dental curing light UV lamp LED (Cicada, PRC) 1s-20s

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Sandblaster – Mini blaster (Deldent /Israel) using 50-90 µm Aluminum oxide particle powder, 80-100 psi, weight 75g, 175mm Length,70mm height tungsten carbide nozzle with 360 degrees rotation.
Scaler – universal (USdontics)
Polytetrafluoroethylene flat white sheet (PTFE) Teflon plate – 5 mm thick 25mm (height) 25mm (width) online supplier P.R.C
Optical Microscopy - Ateneo De Manila University Physics Laboratory Quezon City.

Data Gathering

The study used a quantitative data analysis, wherein metal brackets bases were examined under an Optical Microscope and ImageJ Analysis Software, and evaluated the Adhesive Remnants of debonded metal brackets bases after applying the methods of removing remnants of adhesives.

Preparation of Samples

Thirty (30) Metal Brackets - .022 slot Roth system Traditional Size Master Series Metal Twin Brackets 80-gauge fine mesh design (American Orthodontics/. USA). Specimens for experiment bond into white PTFE plate size 25mm height x 25mm width using a light-cure highly filled orthodontic adhesive in strict accordance with the manufacturer's instructions. This step was carried out without the benefit of etching. Both the plastic sheet and the bracket bases were coated with a thin layer of primer, which is thinned with a gentle stream of oil- and moisture-free air, then light-cured for 10 seconds. All the bonded brackets were placed in an incubator at 37 degrees for 24 hours soaked with distilled water. Before debonding, the samples were divided into 2 groups: Group SB for micro sandblaster and Group DF for Direct Flame. After debonding, the bases of 30 brackets proceeded to the micro-sandblasting method and direct Flaming method, respectively. After the removal of the adhesive, the brackets base of 30 test brackets was evaluated by Optical Microscopy and processed with ImageJ Analysis software to get adhesive remnants. Data was collected using a computer that was linked to the microscope.

- **Bonding Protocol –** metal brackets were adhered to a white flat PTFE plate using a light-cure highly filled orthodontic adhesive in strict accordance with the manufacturer's instructions. This step was carried out without the benefit of etching. Bonding of the brackets was not done in the human tooth because we will evaluate the Adhesive Remnants with the consistent amount of adhesive left in the bracket to evaluate using micro sandblaster and direct flame technique. The researcher chose this method based on the studies of Basudan et al., [16] on their bonding technique in their study. Both the plastic sheet and the bracket bases were coated with a thin layer of primer, which is thinned with a gentle stream of oil- and moisture-free air, then light-cured for 10 seconds. The mini mold was filled with adhesive then scooped and transferred to the bracket base to maintain the same amount of material. The bracket was placed on the Teflon properly positioned. Any extra resin eliminated using scaler. Subsequently, light curing was conducted for both sides for 10 seconds to solidify the adhesive. Aadhesives was cured using LED (Cicada, PRC) (2.5 secs each Mesiodistal, 2.5 secs each occlusogingival). This procedure followed the manufacturer instruction. All the samples were kept in an incubator to control the temperature of 37 degrees throughout the experiment.
- **Debonding Protocol** – brackets clipped in tweezer. After the brackets were removed, two distinct techniques were used in two groups to eliminate adhesive adhered to the bracket base to assess adhesive remnants.
- **Flaming Protocol -** The tweezers grasped the brackets as the base was warmed using a micro torch. The flame tip pointed 10 seconds until debonded bracket began to glow cherry red, burning off any leftover resin. Afterwards, the

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bracket was promptly cooled in room temperature water and dried with an air stream.

- **Micro Sandblasting Protocol** - micro sandblaster instrument in a stable position with the bracket mesh stable position in an improvised container or box to avoid human error. Aluminum oxide particles with a size of 90 micrometers were utilized and sprayed onto the bracket bases, positioned 5 mm from the air abrasion machine nozzle with 45 degrees angulation. Each bracket base underwent air abrasion for 20 to 40 seconds at a pressure of 90 psi. The composite was eliminated until the bracket base was smooth and glossy under the dental lamp's light, or until the bonding resin was no longer visible to the naked eye and the bracket base took on a frosted appearance. Finally, it was washed with air and water before being dried with compressed air.

RESULTS

The data collected during the research was analyzed and interpreted in the tables below. The adhesive remnants on bracket bases mesh were scanned using optical microscopy analyzed by ImageJ analysis software and summed up to the adhesive remnant's average and percentage.

Table 1: The Means and Standard Deviation of the Adhesive Remnants of debonded orthodontic metal brackets bases

	N		Mean	
	15	1.518	1.159	15
Micro Sandblaster	15	2.264	1.262	15
Direct Flame	N	Mean	SD	N

Table 1 displays the statistical characteristics of the mean value of micro sandblaster and Direct Flame in Adhesive Remnants of debonded brackets bases. It was expressed in terms of counts (N), mean, and standard deviation. The mean value of the micro sandblaster in Adhesive Remnants of debonded brackets was 1.518, SD 1.159, (N=15). The mean value of the Direct Flame in Adhesive remnants of debonded brackets was 2.264, SD 1.262 mm (N=15). Note: N: number of specimens in sandblaster group.

Table 2: Micro Sandblaster Sample's Value Highest to Lowest

Samples	Adhesive Remnants (mm.)	%
SB15	4.363	43.43022
SB5	3.179	32.15659
SB11	2.726	27.05707
SB13	2.045	20.60453
SB10	1.809	17.95712
SB9	1.782	18.09504
SB7	1.138	11.26175
SB3	1.298	12.95409
SB2	0.989	9.7979
SB14	0.839	8.427079
SB6	0.72	7.083825
SB8	0.68	6.796602
SB1	0.505	5.106168
SB12	0.414	4.141657
SB4	0.278	2.744053

samples	AR mm.	%
DF10	4.82	47.88872
DF9	4.039	40.36982
DF5	3.611	35.67477
DF3	3.287	33.23895
DF12	2.804	28.0008
DF4	2.365	23.75452
DF13	2.274	22.82674
DF1	2.01	20.10603
DF14	1.922	19.05801
DF2	1.673	16.9865
DF15	1.605	16.09184
DF7	1.423	14.3332
DF8	1.26	12.77502
DF11	0.635	6.280289
DF6	0.234	2.367463

Figure 1. Direct Flame sample's value highest to lowest

Table 2 displays the adhesive remnants of samples for Micro Sandblaster and Direct Flame Technique after removal methods of orthodontic resin.

Table 3: T- Test for Independent Sample of the micro sandblasting and direct flame in Adhesive Remnants of debonded brackets bases

t-test for Independent Sample						
	Mean	SD	t	df	Sig. (2-Tailed)	Decision
Micro Sandblaster	1.518	1.159	-1.687	28	0.103	Fail to Reject H_o
Direct Flame Technique	2.264	1.262				

Table 3 shows that a 2-tailed test for independent samples value was p=0.103, above the significant level of 0.05, statistically no significant, t (28) = -1.687. Therefore, there is no significant difference between sandblasting and direct flame in AR of debonded brackets. This implies that the Null hypothesis that there is no significant difference between micro sandblaster and direct flame technique for removal of adhesive resin from debonded orthodontic metal brackets is retained.

Table 4: Test for Normality of Distributions of the micro sandblasting and direct flame in AR of debonded brackets

Normality Test						
AR	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Micro Sandblaster	.175	15	.200	.882	15	.051
Direct Flame Technique	.135	15	.200	.975	15	.921

Table 4 presents the Normality test (Shapiro-Wilk), and Kolmogorov-Smirnova nonparametric goodness-of-fit test to see if data is normally distributed. This was done to test the comparability of the data for a parametric statistical treatment.

Shapiro-Wilk Test: The p-values of all the micro sandblasters in Adhesive Remnants of debonded brackets were above the $p > 0.05$, the value was 0.051 which meant that data was normally distributed. Likewise, the p-value for the direct flame in Adhesive Remnants of debonded brackets was 0.921 $p > 0.05$ which meant that data was normally distributed. Thus, a parametric test was applied, specifically an independent t-test, which compared the mean value of the sandblasting and direct flame in Adhesive Remnants of debonded brackets using ImageJ analysis software.

Table 5: Levene's Test for equality of variances of the micro sandblasting and direct flame in Adhesive Remnants of debonded brackets.

Levene's Test for Equality of Variances				
	F	df_1	df_2	p
Total	0.079	1	28	0.780

Table 5 shows that test of equality of variance yields p = 0.780, above the 5% ($P>0.05$) significant level. The Levene's F-test value was 0.079 and the degree of freedom (df1 is 1 and df2 is 28). The Levene's test therefore was insignificant, then the variances are equal across groups of samples and variances are not significantly different from each other. The study compared between micro sandblaster and direct flame technique for removing Adhesive Remnants from debonded orthodontic metal brackets bases. The adhesive remnants on bracket mesh were scanned using optical microscopy analyzed by ImageJ analysis software and summed up to the adhesive remnant's average and percentage [8]. The mean and standard deviation of the Direct Flame group was higher than the Micro sandblaster group in Table 1.

DISCUSSION

The outcome of the study after the samples were bonded with adhesives and stored in distilled water for incubation of 24 hours at 37 degrees Celsius before debonding and removing the remaining adhesives using a micro sandblaster and direct flame techniques. The results were p-value > 0.05 implied there is no significant difference between micro sandblasting and direct flame in the AR of debonded brackets bases in Table 3. This result of our study conformed to the findings of [9] on their study about assessing the effects of three resin removal methods that No significant difference was found between resin removal methods. The Adhesive Remnant of debonded brackets with 80-gauge design fine mesh using the micro sandblasting technique for removal of orthodontic adhesive resin arithmetic mean is 1.518

and the standard deviation is 1.159. It is less than the direct flame technique. Direct Flame technique for removal of orthodontic adhesive resin arithmetic mean is 2.264 and the standard deviation is 1.262. It is greater than the micro sandblasting technique. The results of this study were consistent with the findings of [10], on their study Comparison of Two Different Orthodontic Bracket Recycling Techniques noticed that the aluminum oxide particles had removed adhesive residue to a greater extent compared to Group A (Heating/ Flaming) and the samples of Direct Flame after being recycled with heat still had considerable amount of adhesive residues. Based on the result and findings of the study, the two methods yielded values to confirm their differences. No significant difference between the micro sandblaster and direct flame in Adhesive Remnants of debonded brackets. The results of the aforementioned studies conformed with the previous findings of [11] on their study about Residual Adhesive Removal Methods for Rebonding of Debonded Orthodontic Metal Brackets that no consensus as to which is the best method to remove adhesive remnants from the bracket base. Defining the exact mechanism of how adhesive remnants on bracket mesh using a micro sandblaster and direct flame technique was not part of the study. This aspect requires further exploration. Sandblasting technique is my preferred method because it is faster and convenient to use, and the outcome is clean. Based on the study during experimentation, direct flaming, it causes bracket discoloration, and this was same with observation of [12] on their study about Evaluation of the re-bond strength of debonded metal and ceramic brackets that Flame removal is the most common adhesive removal strategy. However, it can lead to the discoloration of the brackets. The disadvantage of burning off the composite is that the bracket discolors according to [13] on their study of office reconditioning. Likewise, to the results of the study by [14, 15] on 105 orthodontic brackets, the heating method caused structural discoloration.

CONCLUSION

Statistically the results and findings had different values that were considered acceptable and within limits. As a clinician either of these methods can be applied in our practice to recondition the brackets.

Recommendations

Based on these results, the application of direct flame or micro sandblasting techniques can be considered a viable option for the elimination of residual adhesive from orthodontic bracket bases. Further investigations explore the effectiveness of applying these methods without compromising the valuable properties with no distortion of the bracket base and maintain the integrity of the wire mesh for the retention and proper adhesion and the resin prior to rebonding of the orthodontic brackets. Need to consider the well-being of the operator during sandblasting technique. Individuals who have respiratory problems may use preventive measures on how to handle this technique well.

Conflict of Interest

The authors declare that no conflict of interest.

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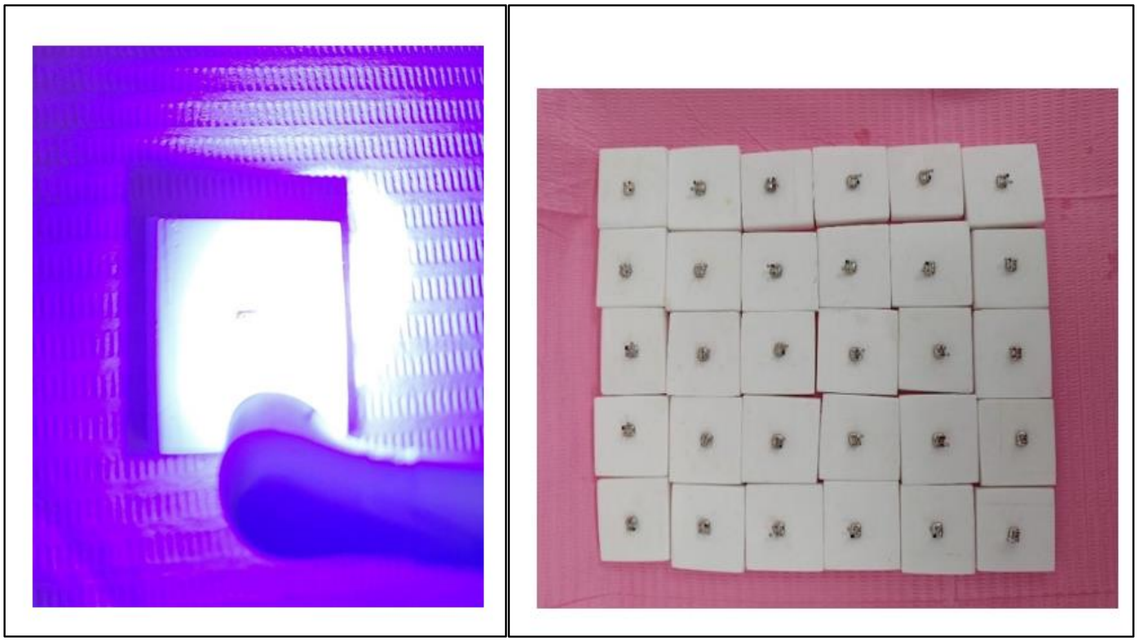
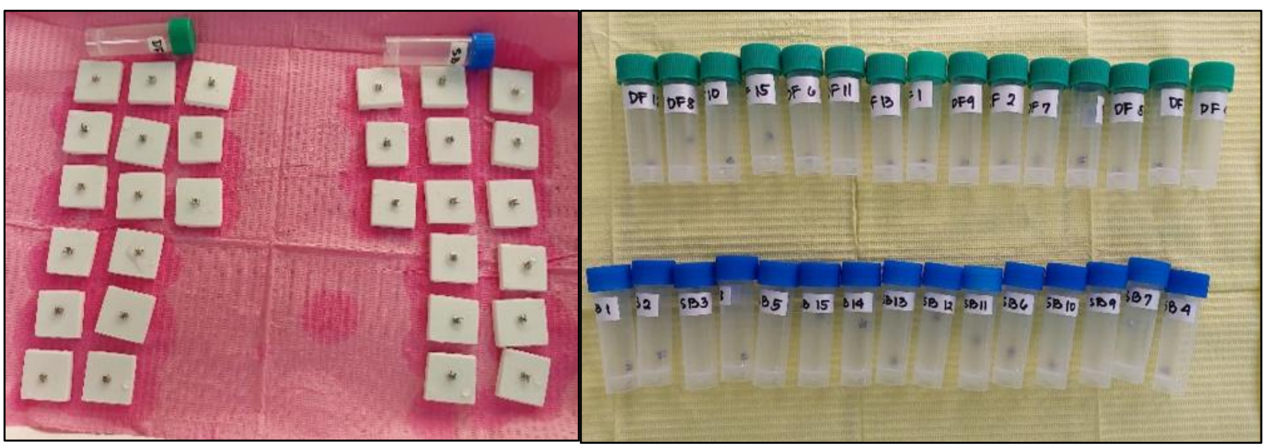
APPENDICES

Appendix A: Bonding of Brackets to Teflon Plates



Appendix B: Grouping of samples into two; Group SB (Micro Sandblaster) blue vials and Group DF (Direct Flame) green vials



https://doi.org/10.20428/yjms.v19i3.2679
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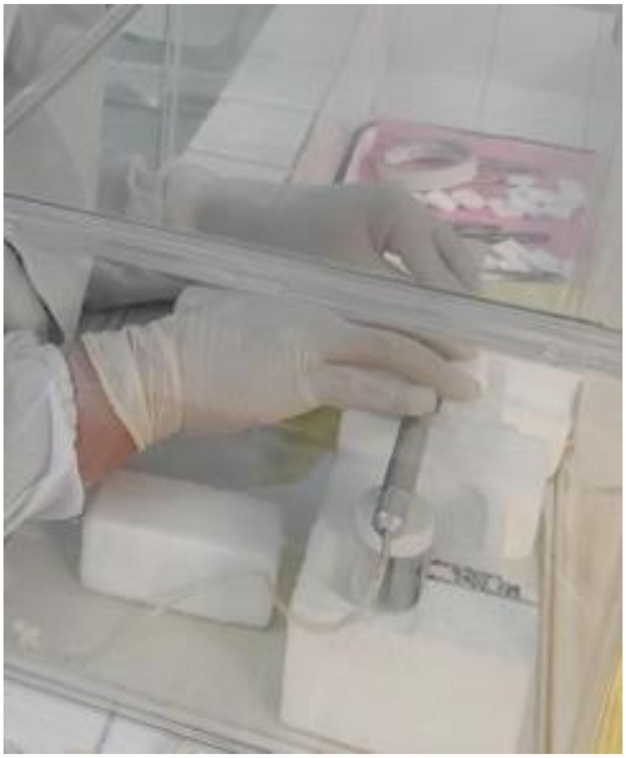
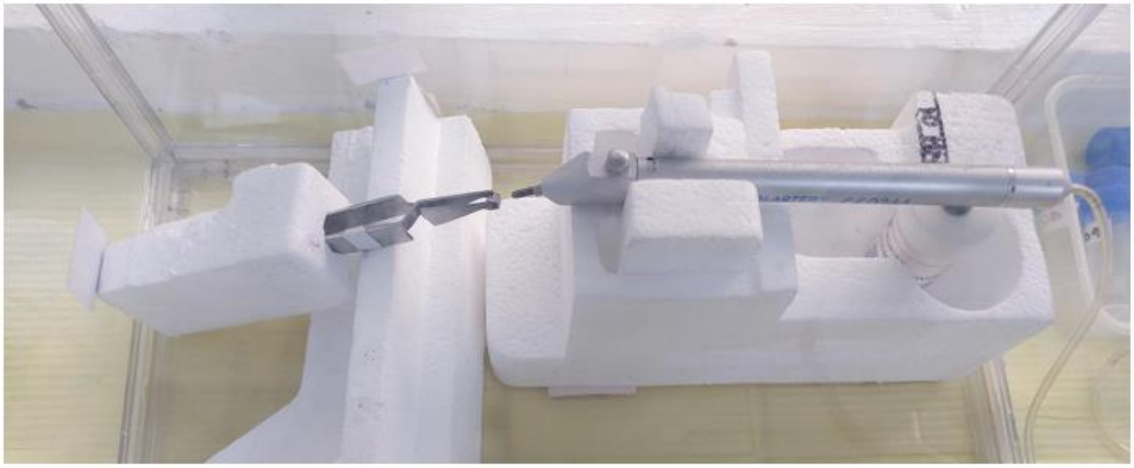
Appendix C: Micro sandblasting method the debonded brackets to remove adhesive





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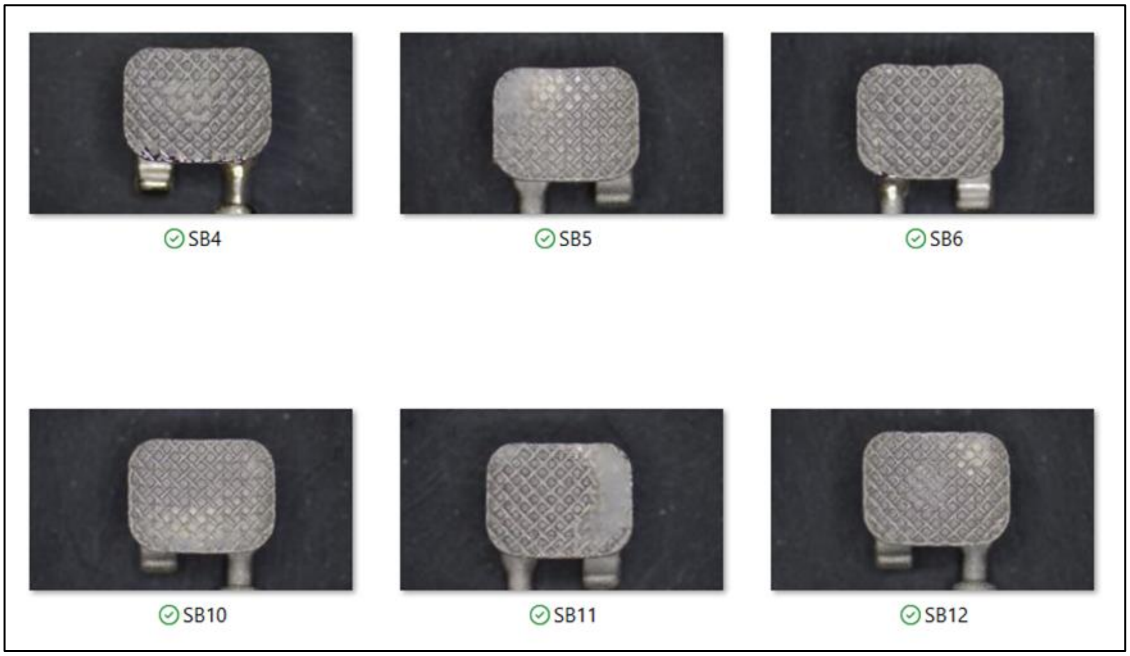
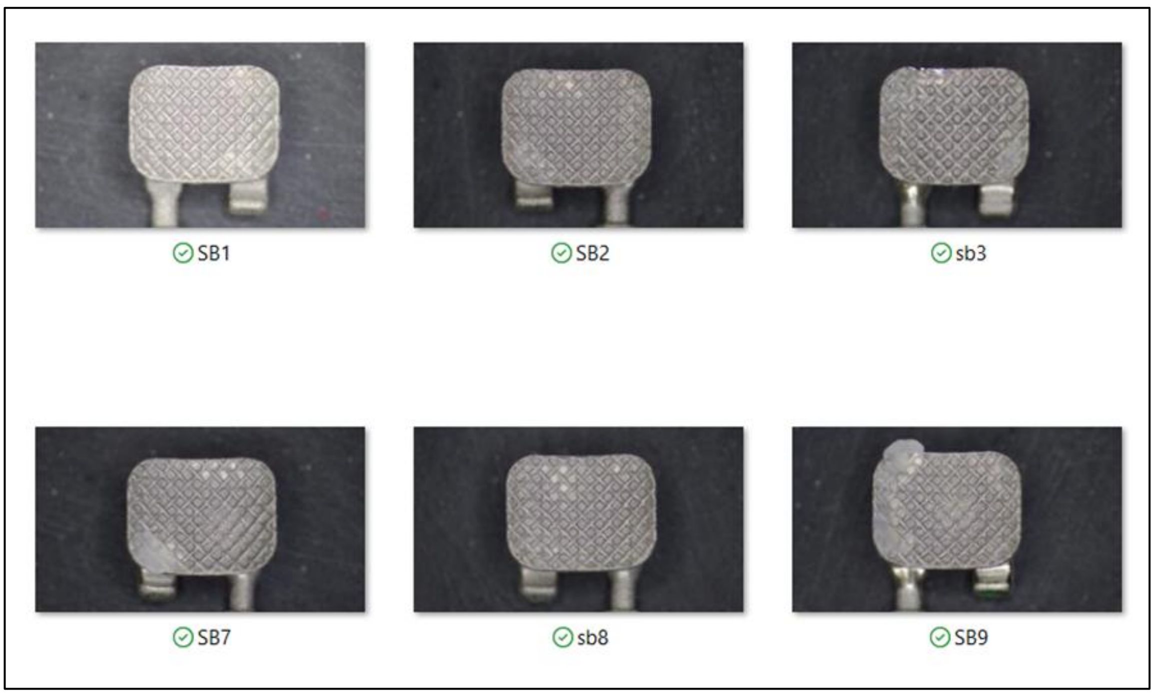
Appendix D: Microscopic Images Of Micro Sandblaster Method





 Online ISSN: 2227-961X.

https://doi.org/10.20428/yjms.v19i3.2679
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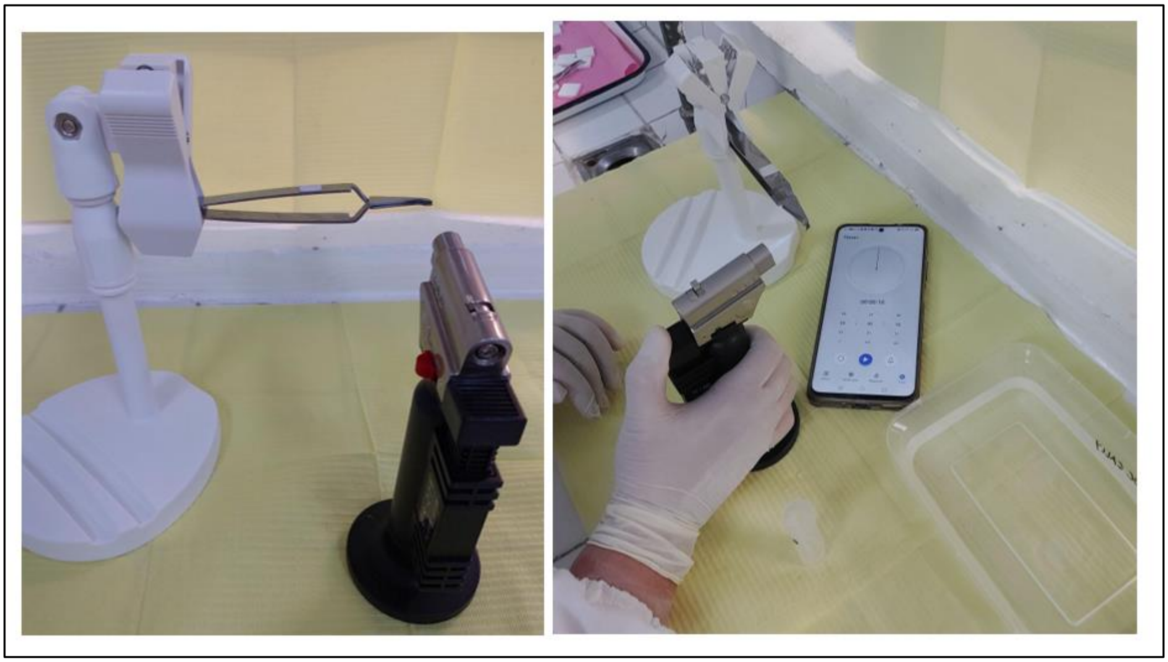
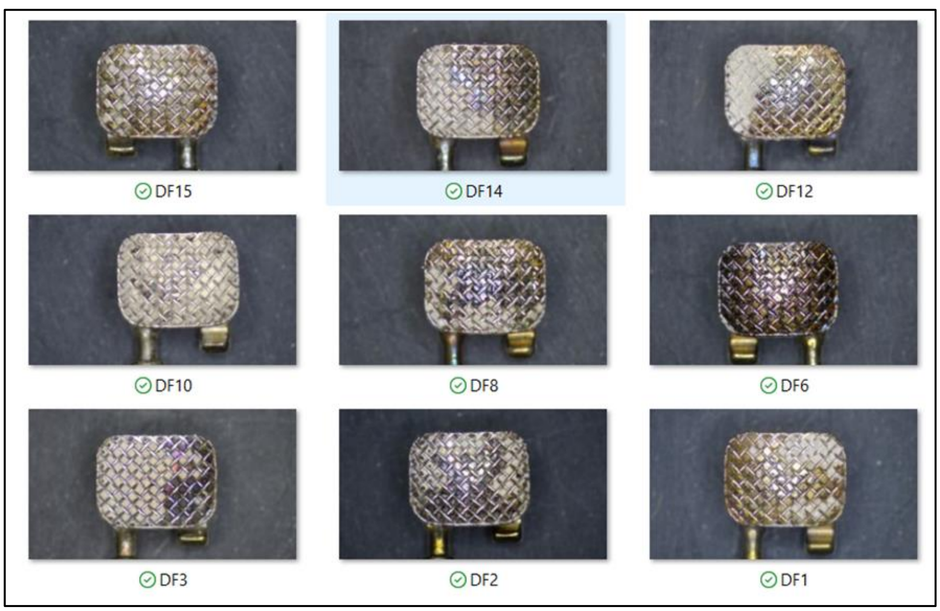
Appendix E: Direct Flaming of debonded brackets to remove adhesives



Appendix F: Microscopic Images Of Direct Flame Method



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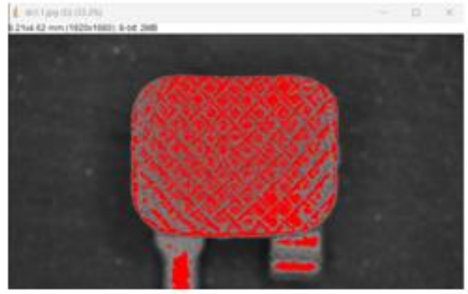
Appendix G: Micro sandblaster sample and Image J software Analysis for adhesive remnants



8 BIT grayscale Format

Threshold

Binary

Total Base area and Adhesive Areas

Results

File Edit Font Results

	Area
1	0.036
2	0.035
3	0.030
4	0.034
5	0.034
6	0.025
7	0.043
8	0.045
9	0.037
10	0.041
11	9.890

RESULTS areas with adhesive in mm.

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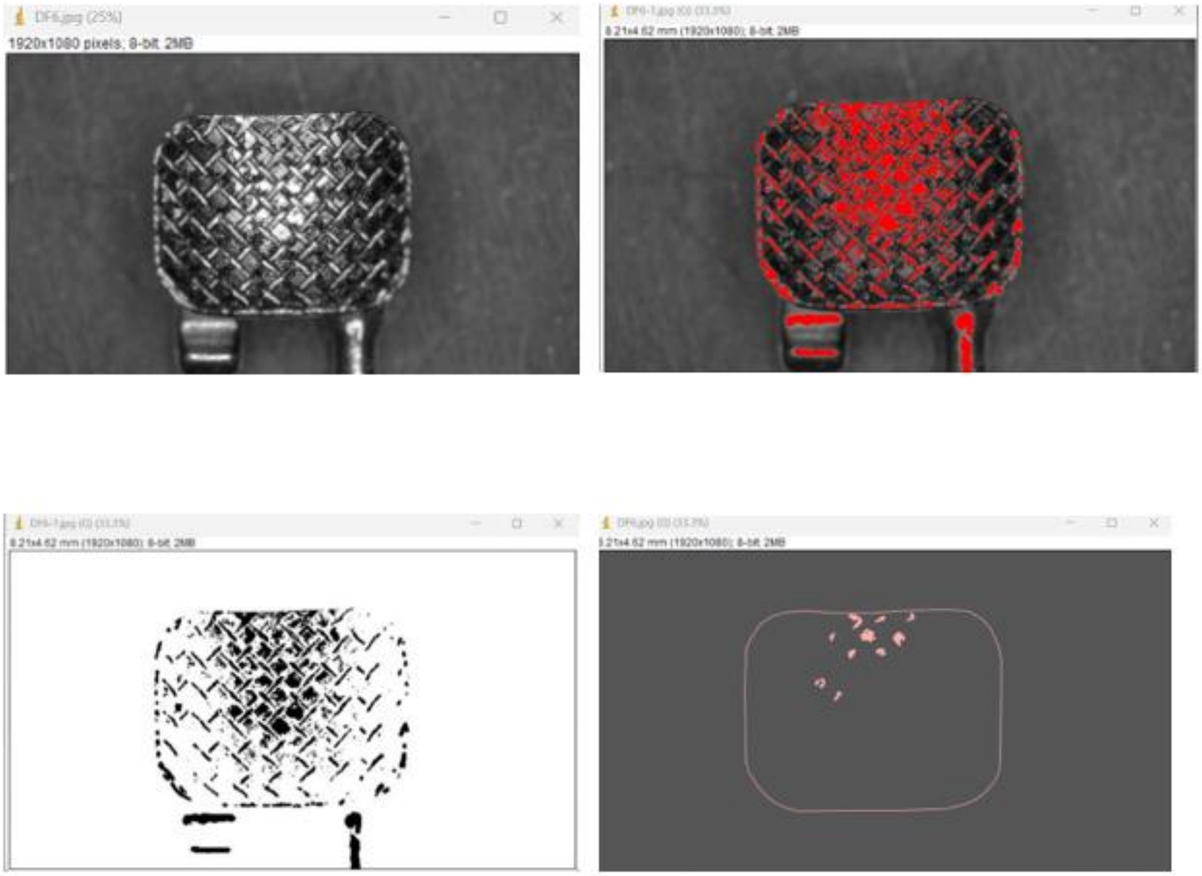
Appendix H: Direct Flame sample and Image J software Analysis for adhesive remnants



File Edit Font Results

	Area
1	0.006
2	0.019
3	0.026
4	0.009
5	0.005
6	0.007
7	0.019
8	0.010
9	0.006
10	0.010
11	0.006
12	0.019
13	0.026
14	0.009
15	0.005
16	0.007
17	0.019
18	0.010
19	0.006
20	0.010
21	9.884