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Microscopic evaluation of enamel surface after debonding of orthodontic brackets using atraumatic bracket remover and conventional debonding plier

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Abstract

Removal of orthodontic brackets from enamel surface is a potential risk for changes in enamel topography in form of microcracks. This enamel micro cracks is one of the forms of enamel damage after debonding. Hence, the present study evaluated the enamel surface topography under field emission scanning electron microscope after the debonding of orthodontic bracket using two types of debonding pliers – the conventional debonding plier and the atraumatic bracket remover. After debonding the orthodontic bracket, the bond failure was assessed using the adhesive remnant index. Bond failure under the enamel-adhesive interface was evaluated by means of Field Emission Scanning Electron Microscope. Topographic changes caused by debonding specifically the length and number of enamel microcrack were measured. All data were summarized by getting the frequency and percentage, while the Mann Whitney U Test was used to compare the differences between the two independent groups. The results showed that both conventional debonding pliers and atraumatic bracket remover had the same percentage that fell under enamel-adhesive type of bond failure after debonding. The atraumatic bracket remover produced more cracks as compared to the conventional debonding pliers. However, conventional debonding pliers produced longer length measurement as compared to atraumatic bracket remover. Moreover, the most affected surface area by microcracks are the occlusal surfaces for conventional debonding pliers. However, it was for mid-buccal surface for atraumatic bracket remover. The least affected areas were on the cervical surface for both conventional and atraumatic pliers. The results also revealed that there was no statistical difference for both pliers, except in terms of length measurements.

Keywords

Atraumatic Bracket, Debonding, Enamel Surface, Microcracks, Orthodontic Brackets

Introduction

One of the goals of an orthodontist is to preserve enamel surface especially during the debonding phase after orthodontic treatment. Removal of orthodontic brackets from enamel surface is a potential risk for changes in enamel topography in form of microcracks. This enamel micro cracks is one of the forms of enamel damage after debonding. It is quite often visible to the naked eye; it may weaken the integrity of the enamel; it may cause stain and plaque accumulation on the rough fractured surface and increase the susceptibility to caries formation and compromise the appearance of the teeth.

The unfavorable effect of bracket debonding from enamel using debonding pliers is an iatrogenic problem. Care should be taken when using debonding pliers because too much force with such instruments can visibly damaging the enamel.

There are various types of debonding pliers that can be used during the removal of the orthodontic brackets. Two of these are worth mentioning as they were used in the present study. One is the conventional metal debonding plier with stainless steel blades/beaks and placed on the mesial and distal edges of bracket-adhesive interface, using a squeezing motion to remove brackets, and the second is the atraumatic type of bracket remover, a lift type of instrument that has a metal hook for detaching the bracket to the tooth surface and a plastic rest that lessens the force pressure from debonding.

The site of bond failure is vital during debonding. Bond failure can occur at the Enamel-Adhesive Interface (all adhesive retained on bracket mesh), Bracket-Adhesive Interface (all adhesive retained on enamel surface), or combination of two the cohesive types. During bracket removal, using high bond strength on the location of bond failure will be moved at the enamel-adhesive interface (Soltani MK, et al., 2014). Though controversial, it is generally believed that the bond failure at enamel-adhesive interference is at risk of enamel damage (Khan H. et al., 2015).

The present study evaluated the enamel surface topography under field emission scanning electron microscope after the debonding of orthodontic bracket using two types of debonding pliers – the conventional debonding plier and the atraumatic bracket remover.

Methods

Sixty (60) human maxillary premolars with no visible cracks wee examined under transillumination. They were embedded to an acrylic block with the following measurements: 24 mm in height, 22 mm in length, and 14 mm in width, exposing the crown of the tooth until cementoenamel junction. All of the embedded premolars were marked with a number code. Numbers 1 to 60 were inscribed using nail polish on the front part of the acrylic block to facilitate easier identification.

Figure 1. ***60 premolars with number coding are divided into 2 groups Numbers 1 to 30- GROUP A for Conventional Debonding Plier Numbers 31 to 60 GROUP B for Atraumatic Bracket Remover***

Orthodontic brackets were bonded on all samples. For bonding preparation, the human teeth were cleaned with the use of non-fluoride pumice, water, and rubber cup operated at low speed and then rinsed well with water for 10 seconds. After cleaning, the center of the enamel surface was etched with 35% phosphoric acid semi-gel form (Pulpdent USA) for 15 seconds and was rinsed with water for 15 seconds and dried until the enamel surface exhibited frosty white appearance. Light Cured Adhesive Primer (Transbond XT, 3M Unitek USA) was applied to prepare the enamel at a fine and uniform layer with disposable micro tip brushes and spread with a short burst of air blow from the 3-way syringe of the dental chair unit. Pre-adjusted stainless steel mini twin brackets (Ormco, CA) for the maxillary premolars which were pre-coated with Light Cure Adhesive paste (Transbond XT, 3M Unitek, USA) were positioned in the center of the crown and bonded. A Boone gauge (Ormco) was used as the guide for the bracket positioning which is 4mm from the cuspal tip to the center of the buccal surface of the premolar crown.

The Orthodontic bracket received a perpendicular force, allowing the excessive adhesive paste to flow off and produce a resin layer of similar thickness in all teeth. All excess adhesive paste was removed with a dental explorer.

Bracket-enamel interface was light cured using Ledex ^{TM} ^{WL} 070 Dental Curing Light (having 440-480 nm) for 5 seconds for the buccal, mesial, distal and incisal surfaces. After bonding the brackets, the 60 human teeth were grouped into two. Group A with premolars with brackets numbered from 1 to 30 was for conventional bond remover (J&T, China). Group B was composed of premolars numbered from 31 to 60, and were for atraumatic bracket remover (3M Unitek). After grouping, the samples were stored again in a normal saline solution until they were ready for debonding.

Bracket debonding was performed 24 hours after bonding to facilitate complete polymerization of the orthodontic adhesive between brackets and enamel surface. All debonding was performed by a single operator at Manila Central University, MS Orthodontic Clinic. In Group A, orthodontic brackets were removed using the conventional metal debonding pliers (J&T, China), where the stainless steel angled blades of the pliers were placed in the bracket-adhesive interface and a squeezing movement was performed. In Group B, brackets were debonded using atraumatic bracket remover (3m Unitek). This type of bracket remover has a wire hook and a plastic rest tip. For debonding, the wire hook was placed on the right incisal wing of the crown’s buccal surface, then lifted the front handle of the remover.

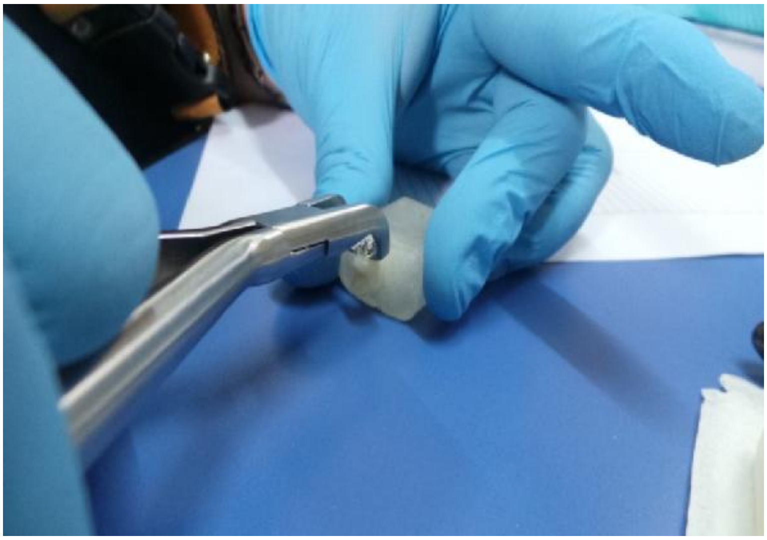

Figure 2. ***Orthodontic bracket debonded using Conventional Debonding Pliers***

Figure 3. Orthodontic *bracket debonded using Atraumatic Bracket Remover*

The type of bond failure was assessed and checked. Premolar samples with Enamel Adhesive Interface Bond Failure *(all adhesive left on the bracket mesh*) were the only samples subjected to Field Emission Scanning Electron microscope evaluation. Out of sixty (60) premolar samples, sixteen (16) fell under enamel adhesive interface bond failure, eight (8) comes from conventional debonding pliers, and eight (8) from atraumatic bracket remover. Ten (10) of the sixteen (16) were randomly picked for microscopic evaluation. There were five (5) premolar samples from Groups A and B, respectively.

The ten (10) premolar samples underwent gold sputter coating prior to analysis. The imaging and Energy Dispersive x-ray Spectroscopy (EDS) analysis was conducted using the following parameters: Instrument (Brand): Dual Beam Helios Nanolab 600i, accelerating voltage: 20kV and beam current: 86 pA. The observation zone of the samples was standardized at the buccal surface of the tooth where the orthodontic bracket was placed. Electron micrograph images were assessed for the enamel microcracks using 100 x, 150 x, 200 x, 500 x, 1000 x magnification. Microcracks were counted per tooth sample, measured of its length per crack, checked for the surface involved (occlusal/mid-buccal/ cervical) and compared for each debonding pliers.

To detect thesurfacesinvolved in the microcracks from digital micrographs, the vertical height of the tooth crown was measured. The buccal enamel surface was divided into three with equal measurements: Upper third (occlusal surface), Middle third (Mid-Buccal Surface) and Lower third (Cervical Surface). Location view of microcracks in field emission scanning electron microscope was marked with a box (where the microcrack are located) in an enlarged photo of tooth samples. With the guide of the buccal division the three thirds facilitated the surface location of microcracks (See Figures 4 and 5).

For one enamel microcrack with 2 surfaces involvement (e.g., one crack involving occlusal surface and mid buccal surface), montages of scanning electron microscope were made or the stitching together of multiple images. In this enlarge image, the researcher detected at which surface involvement was affected by the longest microcracks. Longest microcrack involvement was the surface location noted (See Figures 6 and 7).

Results and Discussion

The result of the study showed that the atraumatic bracket remover produced a number of cracks with a total of 32 microcracks while the conventional debonding pliers had a total of 23 microcracks. However, for the micro cracks length measurements for conventional debonding pliers, the results revealed more crack length having an average of 48,417.75 µm while the atraumatic bracket remover had an average of 37,358.45 µm. The surface most affected with microcracks was the occlusal surface for conventional debonding pliers while it was the mid-buccal surface for atraumatic bracket remover.

Mann Whitney U Test was used to compare the differences between the two independent groups. The results revealed that there was a statistically significant difference in the enamel surface topography when using conventional debonding pliers and atraumatic bracket remover in terms of micro crack length measurement with p-value of 0.003 which is less than the $\alpha = 0.05$. As shown by the Man Whitney result of 194, the conventional debonding pliers had 23 samples with a mean rank of 35.57, while the atraumatic bracket remover had 32 samples with mean rank of 22.56. There was no statistically significant difference in the enamel surface topography in terms of the number of enamel microcracks using both pliers.

Surface of the Tooth where Enamel Microcracks Occured Using Coventional Debonding Plier

PREMOLAR SAMPLE #	TOTAL NUMBER OF CRACKS	TOTAL MICRO CRACK LENGTH MEASUREMENT (µm)	NO. OF CRACKS PRESENT		
			OCCLUSAL	MID-BUCCAL	CERVICAL
#8	**5**	**9600.7**	1	4	0
#11	***NO CRACKS***				
#14	**4**	**8950.2**	4	0	0
#18	**5**	**10746.25**	2	3	0
#23	**9**	**19120.6**	6	3	0
	23	**48,417.75 µm**	**13**	**10**	**0**

Surface of the Tooth where Enamel Microcracks Occured Using Atraumatic Bracket Remover

PREMOLAR SAMPLE #	TOTAL NUMBER OF CRACKS	TOTAL MICRO CRACK LENGTH MEASUREMENT (µm)	NO. OF CRACKS PRESENT		
			OCCLUSAL	MID-BUCCAL	CERVICAL
#33	**5**	**10189.1**	1	1	3
#36	**11**	**15831.1**	8	3	0
#39	**4**	**1329.03**	2	2	0
#51	**3**	**2224.96**	1	2	0
#58	**9**	**7784.26**	0	6	3
	32	**37,358.45 µm**	**12**	**14**	**6**

Conclusion

The following conclusions are based on the results found in the present study:

1. Both conventional debonding pliers and atraumatic bracket remover showed the same percentage that fell under enamel-adhesive type of bond failure after debonding.

2. In terms of the number of cracks produced, it is the atraumatic bracket remover that produced more cracks as compared to the conventional debonding pliers. However, in terms of length of measurement of microcracks, conventional debonding pliers produce longer length measurement as compared to atraumatic bracket remover.

3. The most affected surface area by microcracks are the occlusal surfaces for conventional debonding pliers. However, it was for mid-buccal surface for atraumatic bracket remover. The least affected areas were on the cervical surface for both conventional and atraumatic pliers.

4. The enamel surface changes were measured based on the number and length of microcracks produced for both the conventional debonding pliers and atraumatic bracket remover. Using the Mann Whitney statistical analysis, enamel surface topography in terms of enamel microcracks number, the results revealed that there was no statistical difference for both pliers, but in terms of length measurements, it was shown that there is a significant difference between both pliers.

Recommendations:

1. Utmost care should be given to patients especially during the termination of the orthodontic treatment such as debonding of brackets as it may cause irreversible enamel microcracks.
2. Atraumatic Bracket Remover may be used as it causes fewer changes in enamel surface topography in terms of microcrack length during debonding.
3. Future researchers may do more studies about a similar topic in a bigger number of samples and make the result more definitive.
4. Future researchers may conduct more studies about other types of debonding pliers that we can be used during debonding. That is one of the best ways to minimize enamel damage.
5. Future researchers may look into and study for other types of technical measure/ machine that can assess enamel microcracks. That can be done in both vitro and in vivo study.
6. Future researchers may conduct an extensive research study about the depth of enamel microcrack that may be produced by different debonding pliers.

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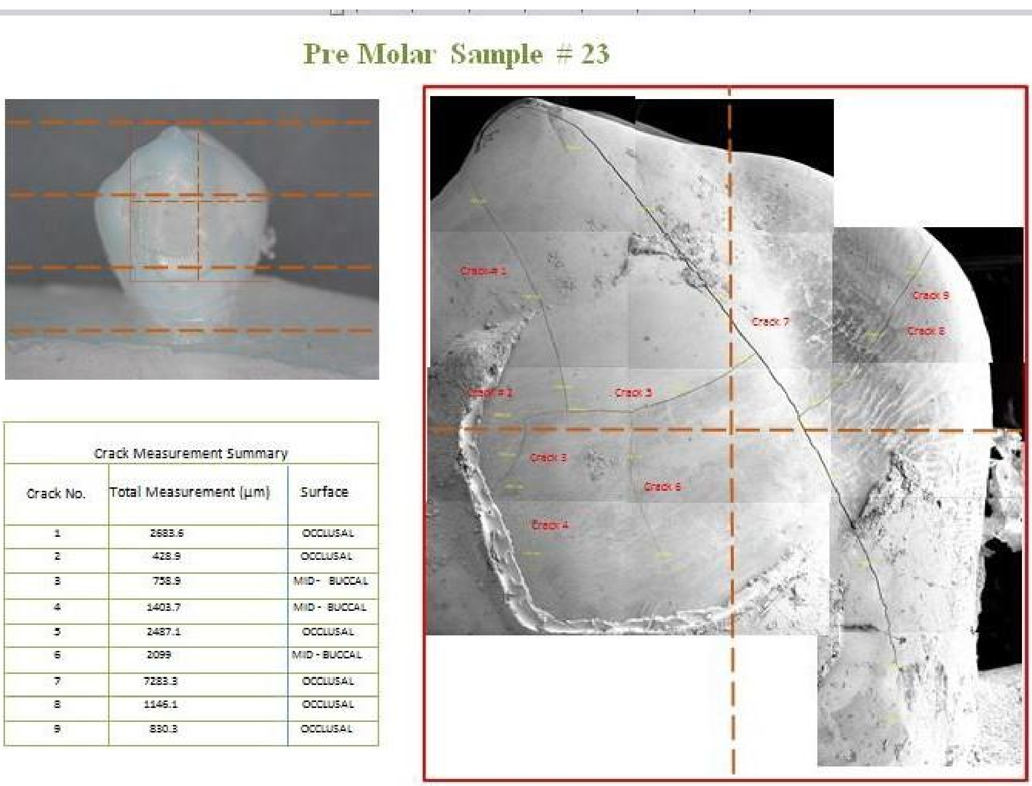
Appendices:

PREMOLARSAMPLE#23: NUMBER OF MICROCRACKS WITH LENGTHMEASUREMENT

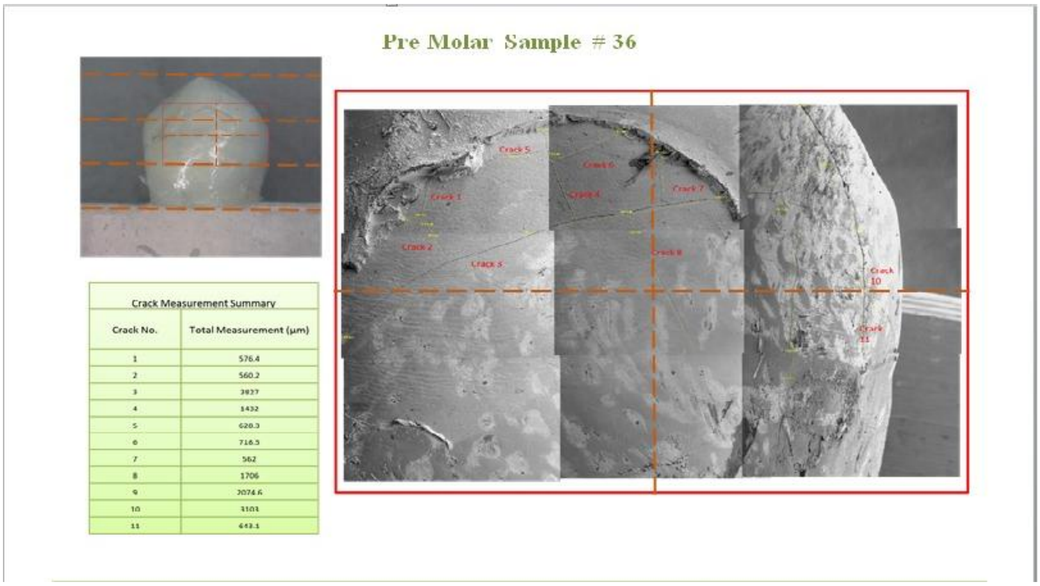


Crack Measurement Summary

Crack No.	Total Measurement (µm)	Surface
1	2683.6	OCCLUSAL
2	428.9	OCCLUSAL
3	738.9	MID - BUCCAL
4	1403.7	MID - BUCCAL
5	2487.1	OCCLUSAL
6	2099	MID - BUCCAL
7	7283.3	OCCLUSAL
8	1146.1	OCCLUSAL
9	830.3	OCCLUSAL

FIGURE 4. PREMOLAR SAMPLE NO. 23 SHOWING NUMBER, LENGTH AND SURFACE LOCATION OF MICROCRAKS

PRE MOLARSAMPLE #36: NUMBER OF MICROCRACKS WITH LENGTHMEASUREMENT



Crack Measurement Summary

Crack No.	Total Measurement (µm)
1	576.4
2	560.2
3	3827
4	1432
5	620.3
6	716.5
7	562
8	1706
9	2074.6
10	3103
11	643.1

FIGURE 5. PREMOLAR SAMPLE NO. 36 SHOWING NUMBER, LENGTH AND SURFACE LOCATION OF MICROCRAKS

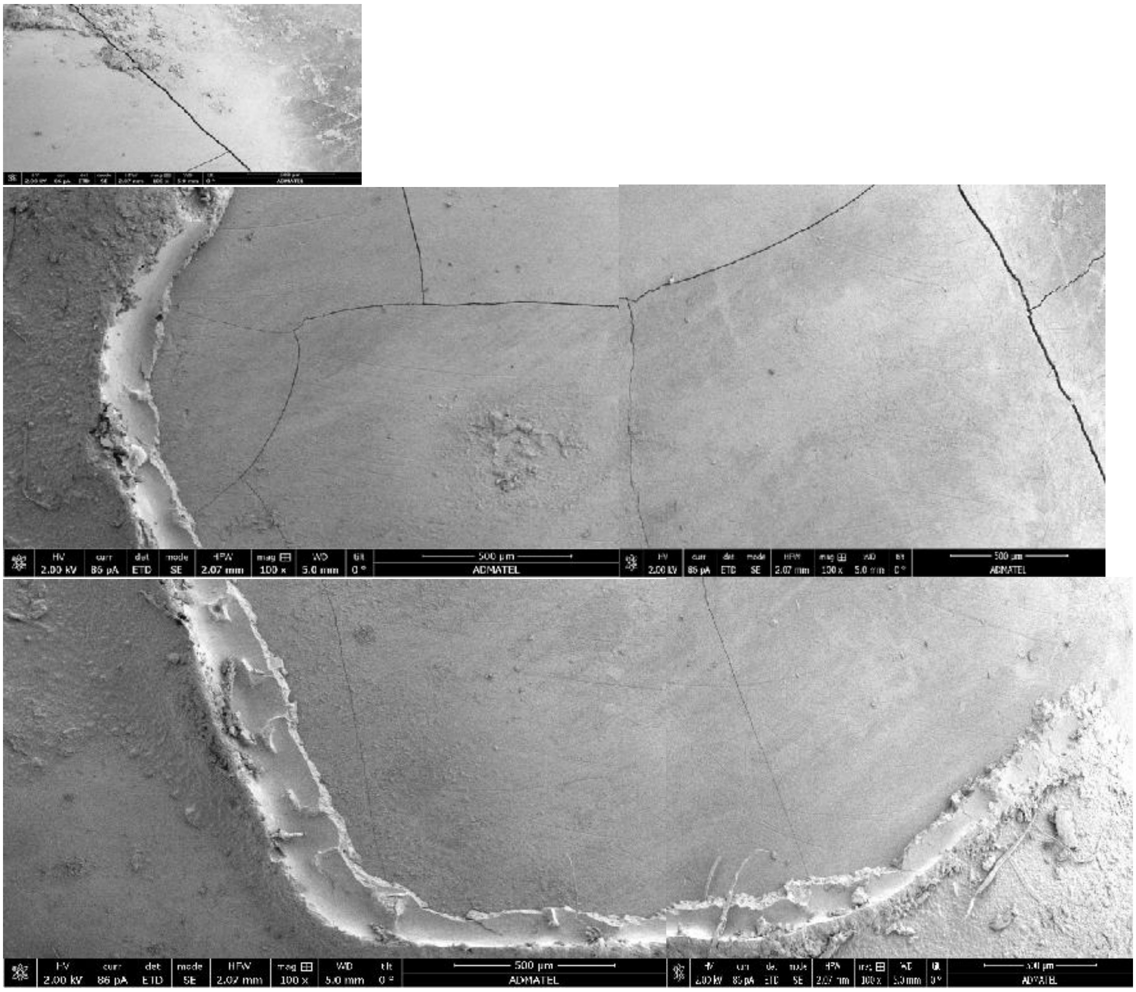


FIGURE 6. Montages or stitching of PRE-MOLAR SAMPLE no. 23 in 100 x magnification – CONVENTIONAL DEBONDING PLIERS

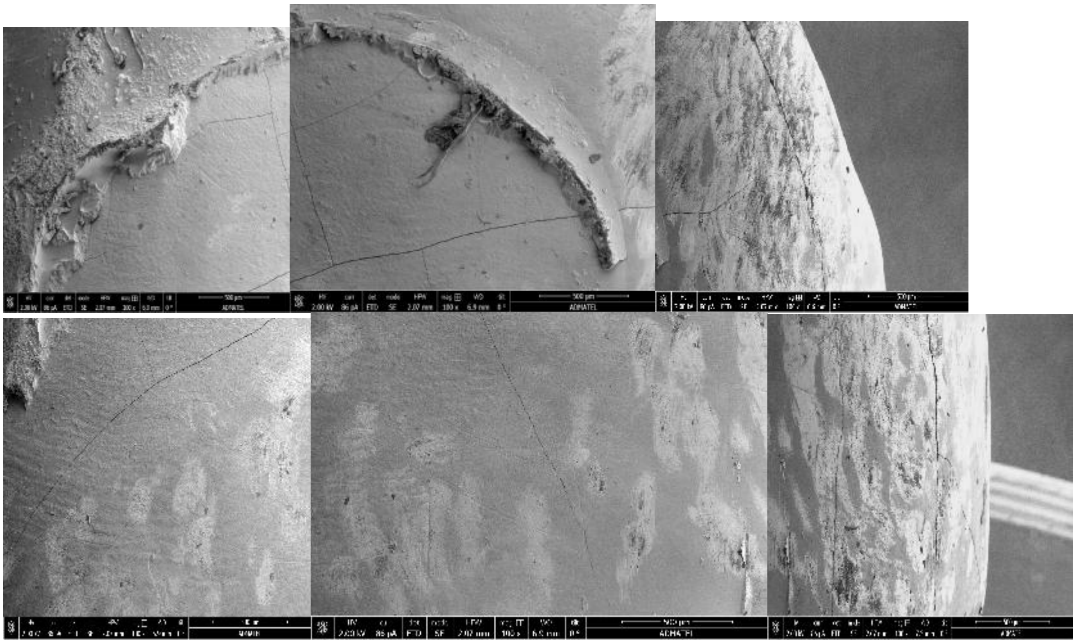


FIGURE 7. montages or images stitching of PRE-MOLAR SAMPLE no. 36 in 100 x magnification - ATRAUMATIC BRACKET REMOVER

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