Original Article

Assessment Of Enamel Loss After Debonding Of Ceramic, Composite Plastic And Metal Brackets-An In Vitro Study.

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ABSTRACT

AIM: To assess the enamel loss after debonding of ceramic, composite plastic and stainless steel brackets and to compare them.
MATERIALS AND METHODS: The sample used was 90 maxillary first premolars that were extracted for orthodontic purpose. The teeth were segregated as three equal groups of 30 teeth each. Group I samples were bonded using ceramic brackets (Virage) and Group II with composite plastic brackets (Silkon Plus) and Group III with stainless steel (Mini master series) brackets. Debonding of all samples were done according to manufacturers' instructions. After debonding, the tooth surfaces were evaluated by ARI index and examined by scanning electron microscope for enamel cracks. All the bracket bases were examined under a stereomicroscope and scored according to the Modified Adhesive Remnant Index (m ARI) followed by energy dispersive spectroscopic (EDS) analysis to detect calcium (Ca++) on the adhesive composite material on bracket base after debonding.
RESULTS: On SEM examination, the enamel surfaces of Group I sample showed more enamel cracks. EDS analysis proved that the loss of elemental calcium
is more evident in tooth surface bonded with ceramic bracket.
CONCLUSION: The results indicate that after debonding procedure of ceramic bracket enamel loss is more, when compared to that of composite plastic and metal brackets.This implies that debonding of ceramic bracket needs meticulous attention.

INTRODUCTION

The earlier fixed appliances attached brackets and tubes to the patient's teeth with bands, and significant limitations existed in the degree of accuracy. Bonding of attachments, eliminating the need for bands, was a dream for many years before rather abruptly becoming a routine clinical procedure in the 1980s. The advantages of direct bonding are conservation of arch length, ease of placement and esthetic superiority. Direct bonding technique needs debracketing at the end of active treatment.

Great consideration should be given to de-bonding procedures and the effect that these procedures have on the enamel underlying the bonded attachments. 'The term debonding refers to removal of orthodontic attachments and all the residual adhesive from the enamel surfaces and restore as closely as possible to its pretreatment condition without inducing iatrogenic damage1'.

The color similarity between adhesives used and enamel does not allow for complete removal of remaining adhesive which discolors with time and creates an esthetic problem. The extent of enamel loss during the removal of adhesive composite may be of clinical significance because of the removal of a major part of the protective fluoride-rich layer of enamel.

As more adult patients demands orthodontic treatment, esthetic brackets were in need, orthodontist were started using ceramic brackets as an esthetic alternative to plastic brackets, which endure most orthodontic forces and resist staining. Debonding of these brackets has caused more enamel cracks and fractures than metal brackets.The lack of ductility of ceramic brackets generate stress in the adhesive composite–enamel interface that may lead to enamel cracks during debonding. So from the wide array of bracket materials available today, it becomes the duty of the orthodontist to select the best material that is esthetically pleasing, clinically effective, and at the same time causing trivial enamel loss.

Hence it is necessary to assess the extent of enamel loss after debonding of various bracket materials. This research study aims to take a further step forward in our understanding of enamel loss after debonding in orthodontic treatment.

MATERIALS AND METHODS

The sample used contained 90 maxillary first premolars (both right and left side) that were extracted for orthodontic purpose. A study by Hobson2 et al. (2001) showed significant bond

strength differences between upper and lower premolars. Pont3 (AJO 2010) reported that calcium loss was different between maxillary and mandibular teeth. To obtain reliable results in enamel bond strength studies, the same tooth type from the maxillary or mandibular arch should be used and only maxillary premolars were included for this study.

INCLUSION CRITERIA

1) All teeth had intact enamel on the buccal surface and were free of carious lesions and restorations.

2) No evidence of enamel decalcification.

3) No history of fracture during extraction by forceps.

4) No evidence of enamel cracks.

5) Not treated with any chemical agents.

6) All teeth were obtained from 14-23 age group.

All the samples were cleaned and kept in distilled water at room temperature. Before starting the experiment the teeth were rinsed and randomly assigned to three equal groups of 30 teeth.

BONDING OF BRACKETS

Prophylaxis was done with water and pumice without fluoride with a rubber cup for 5 seconds under low rotation; each rubber cup was replaced after 5 prophylactic procedures4. Rinsing was done for 15 seconds and drying was done with an oil-free air compressor. Group I were bonded using ceramic brackets (Virage), Group II were bonded using composite plastic brackets (Silkon Plus) and Group III were bonded using metal brackets.

All the samples were bonded as stated by the manufacturer:-

Etching of enamel was done for 30 seconds with 37 per cent phosphoric acid gel , rinsed with water spray for 10 seconds, air-dried for 5 seconds (with oil-free compressed air), and sealed with 3M Unite Liquid (3M Unitek, Monrovia, California, USA). 3M Unite adhesive- a no mix adhesive for direct bonding (3M Unitek) was placed onto the bracket pad, and the bracket was firmly pressed on the prepared enamel; the excess adhesive was then removed with an explorer.

Due to the light transmitting nature of ceramic brackets,more chances of complete polymerization of the resin adhesive (Özcan5 et al., 2004) compared to other groups if light cure adhesive used. So, to avoid any bias due to this chemical cure adhesive was used in this study. The samples were kept in distilled water for 48 hours at 37°C before debonding6. Then debonding of all samples was done as stated by the manufacturer.

EVALUATION OF THE RESIDUAL ADHESIVE

After debonding all the tooth surfaces were examined by a magnifying hand lens after applying disclosing solution and evaluated by ARI index. The ARI scores also were used as a means of defining the sites of bond failure between the enamel, the adhesive, and the bracket base. Tooth surfaces corresponding to lower ARI scores are examined by scanning electron microscope(HITACHI-3400 N,Japan) and Gold ion sputtering machine, (HITACHI E 1010 Ion Sputter) in order to verify the presence and sites of the enamel cracks.

All the bracket bases were thoroughly examined under a stereomicroscope with 20×magnification using the Modified Adhesive Remnant Index (mARI) and scored with respect to the amount of resin material that adhered to the bracket surface. In addition, energy dispersive spectroscopy (EDAX TSL-AMETEK, Advanced Micro analysis solutions) attached to FEI Quanta FEG 200-High Resolution Scanning Electron Microscope was used to detect calcium (Ca++) on the adhesive composite material remaining on the base of the brackets.during debonding

Morphologically notable mineral-like particles attached to the adhesive fracture surface as well as the particle-free adhesive fracture surfaces were analyzed for their elemental composition by an energy dispersive X-ray microprobe.

RESULTS

Debonded tooth surfaces were examined using two tone disclosing solution and magnifying lens.

The amount of composite adhering to tooth surfaces was evaluated using 4-point ARI score. The recorded ARI scores, types of failure and modified ARI score on bracket surface are enumerated in tables 1, 2 and 3 respectively.

Tooth surface examination: No macroscopic evidence of enamel damage seen after debonding in all the specimens examined. While examining the tooth surfaces under SEM, an enamel crack was seen in nine of the specimens after debonding of the ceramic brackets. A minute enamel crack was seen in the enamel surface of one of the specimens after debonding of composite brackets. No evidence of cracks in the enamel of specimens after debonding of metal brackets.

QUANTITATIVE ASSESSMENT OF ENAMEL LOSS BY ENERGY DISPERSIVE SPECTROSCOPY:EDS analysis showed a minimal amount of Calcium(Ca++) on the composite attached to the base of metal bracket, while a high amount of Calcium(Ca++) was observed in ceramic brackets.

Ceramic brackets showed many points of elemental Calcium(Ca++),where as composite brackets showed few points of elemental Calcium(Ca++) and metal bracket showed one

point.

DISCUSSION

The iatrogenically produced enamel damage during debonding can lead to dental erosion which is the localized loss of dental hard tissues7. Preservation of maximum amount of enamel surface structure with least possible enamel loss while debracketing and polishing after orthodontic treatment is beneficial as the surface enamel has got greater micro-hardness and it contains more minerals and fluorides than the deeper layers8,9,10,11. But if the surface enamel is lost, subsequently it may lead to exposure of enamel prism endings to oral environment making it more vulnerable to demineralization due to its decreased resistance to organic acids in plaque.

Brudevold12, Koch13, Mellberg14, and Weatherell15 in their studies about the fluoride content of enamel surface stated that the gradient from the surface inward is very steep, with the highest fluoride concentration at the surface layer, and a rapid decline in concentration in the first 20 µm of enamel. It would therefore seem desirable to maintain that much enamel after any treatment procedure.

To maintain the enamel structure in its pretreatment state and to reduce the iatrogenic damage, correct bonding and debracketing techniques are of atmost important. The most prominent factors involved in debonding are the type of bracket and adhesive used, instruments used for bracket removal, and the armamentarium for resin removal.

Plastic brackets, ceramic brackets and ceramic filler reinforced plastic brackets16 were developed to meet the esthetic demand of adult patients who seek treatment at a larger number than ever before. The quest for esthetically superior appliances are increasing today and this has led to the introduction and improvisation of these bracket materials, but still the disadvantages of these materials remain unresolved. One such iatrogenic problem to be concerned is enamel loss and cracks after debonding of ceramic brackets.

Enamel fracture or the appearance of fracture lines during debonding can be attributed to the high bond strength of ceramic brackets. The fracture toughness of the enamel is lower than that of ceramic, so the ceramic brackets bonded to rigid, brittle enamel have little ability to absorb stress; hence debonding of these brackets resulted in bond failure at the enamel-adhesive interface, rather than at the bracket adhesive interface.

Hard and brittle nature of ceramic brackets have necessitated the use of special debonding instruments to prevent both the enamel and bracket fracture. Virage brackets used in this study were debonded by using the recommended #001-343E debonding pliers.

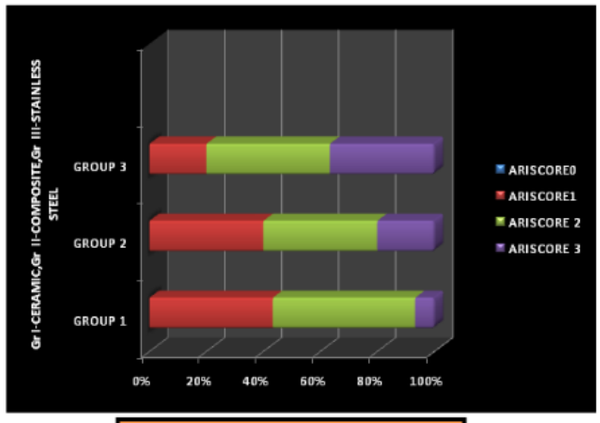


CHART No.1 -ARI score on tooth surface

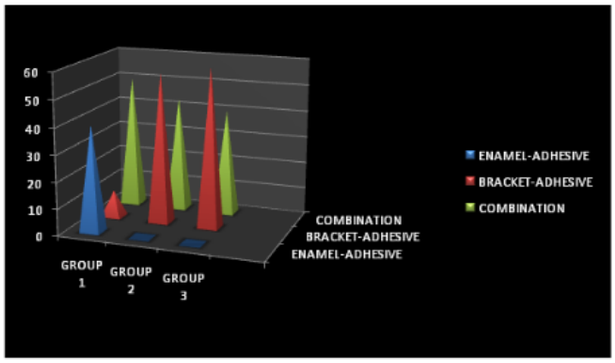


CHART No.2-Bond failure pattern

New types of reinforced plastic brackets with and without steel slots inserts have been introduced as the damage caused by ceramic brackets became evident. Steel-slotted plastic brackets (Silkon plus composite plastic brackets) are useful as an aesthetic alternative, and hence were used in this study. They were debonded by ligature cutters by giving pressure from the mesial and distal aspects.

Stainless steel brackets are most commonly used in practice today as they are cost effective. Several different procedures for debracketing of these metal brackets with pliers are available. The recommended technique, in which brackets are not deformed, is the technique that uses a peeling-type force, which creates peripheral stress concentrations that cause bonded metal brackets to fail at low force values. The break is likely to occur in the adhesive–bracket interface, thus leaving adhesive remnants on the enamel.

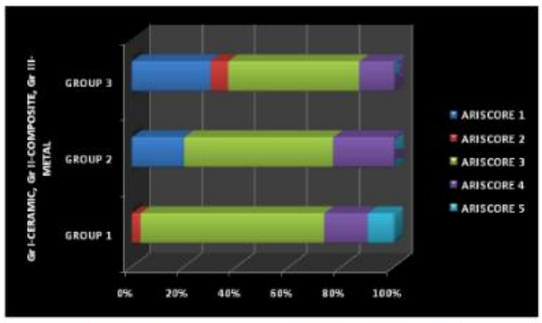


CHART No.3-Modified ARI score on bracket surface

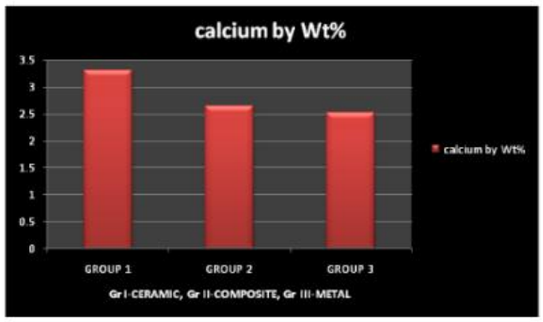


CHART No.4 -Elemental Calcium present on bracket base

Mini master series stainless steel brackets used in this study were debonded using debonding pliers by applying peeling-type force from the gingival to occlusal aspect at 45° angulations1. After debonding the tooth surfaces were evaluated for remaining adhesive by using Adhesive Remnant Index(ARI) score (Fig 1) that was introduced by Artun and Bergland17 (1984). ARI scores provide a qualitative surface area assessment of the tooth surface after debonding. It provides a rank score, not a true numerical value.

Alternative methods include quantitative analysis using a miniaturized Boley gauge18, scanning ruby laser digitizer19, non-contacting laser probe20 or a 3D laser profilometer21. The amount of residual adhesive can be assessed with both qualitative and quantitative methods.

Due to its simplicity & being qualitative in nature, both the original 4-point scale was used for tooth surface examination (here after referred to as ARITOOTH) and modified 5-point scale version introduced by Bishara and Trulove was used for bracket base surface examination (here after referred to as ARIBRACKET) in this study.

Table I lists the recorded ARI scores on tooth surface after debonding of 3 types of brackets. It shows the difference between the 3 groups is statistically significant (significant at 5% level).Group I (ceramic brackets) showed a high frequency of ARITOOTH score 1 compared to other groups, signifying less adhesive remaining on tooth surface.

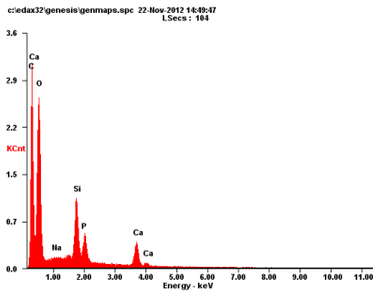


FIGURE 6-EDS Analysis for evaluation of the presence of Ca^{++} on the composite bracket base after debonding showing the elements by peaks derived from the *k* shell of atoms.

Element	Wt%	At%
CK	22.82	29.58
OK	66.86	65.07
NaK	00.52	00.35
SiK	05.44	03.02
PK	02.45	01.23
CaK	01.91	00.74
Matrix	Correction	ZAF

TABLE 6-Amount of elements on the composite bracket base (Group II sample no.1)

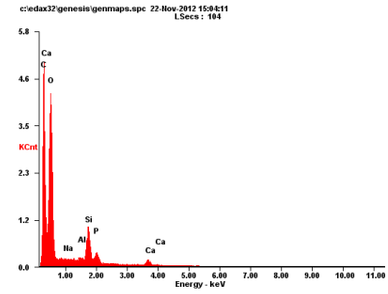


FIGURE 7-EDS Analysis for evaluation of the presence of Ca^{++} on the composite bracket base after debonding showing the elements by peaks derived from the *k* shell of atoms.

Element	Wt%	At%
CK	15.85	20.72
OK	76.69	75.26
NaK	00.23	00.16
AlK	00.44	00.26
SiK	04.81	02.69
PK	01.23	00.63
CaK	00.73	00.29
Matrix	Correction	ZAF

TABLE 7-Amount of elements on the composite bracket base. (Group II sample no. 1)

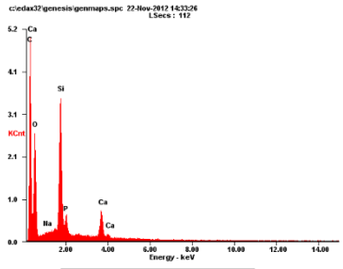


FIGURE 4-EDS Analysis for evaluation of the presence of Ca^{++} on the ceramic bracket base after debonding showing the elements by peaks derived from the *k* shell of atoms.

Element	Wt%	At%
CK	22.86	30.93
OK	57.19	58.08
NaK	00.42	00.30
SiK	14.57	08.43
PK	02.15	01.13
CaK	02.80	01.14
Matrix	Correction	ZAF

TABLE 4-Amount of elements on the ceramic bracket base (Group I sample no.1)

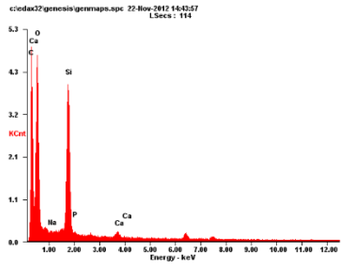
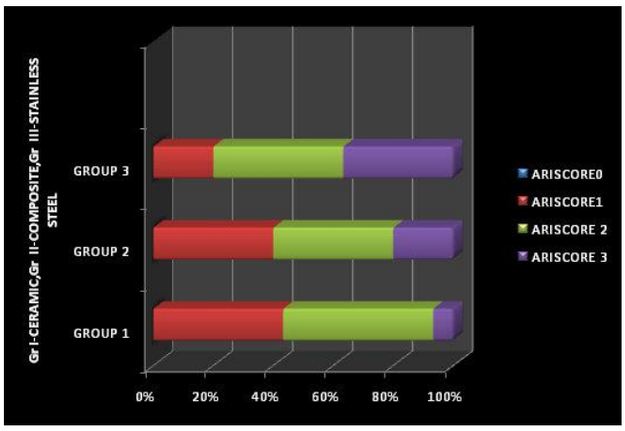


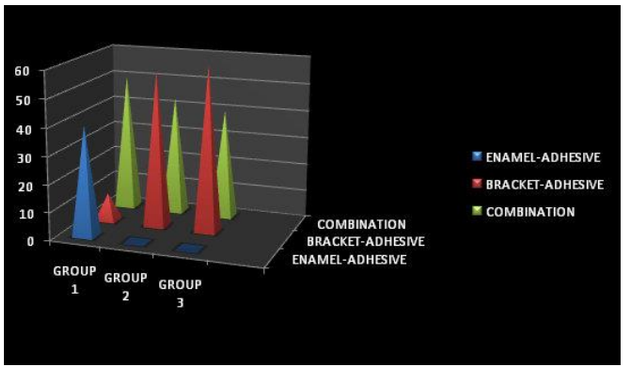
FIGURE 5-EDS Analysis for evaluation of the presence of Ca^{++} on the ceramic bracket base after debonding showing the elements by peaks derived from the *k* shell of atoms.

Element	Wt%	At%
CK	16.79	22.66
OK	67.86	68.24
NaK	00.34	00.24
SiK	14.87	08.58
PK	00.12	00.06
CaK	00.51	00.21
Matrix	Correction	ZAF

TABLE 5-Amount of elements on the ceramic bracket base (Group I sample no.1)



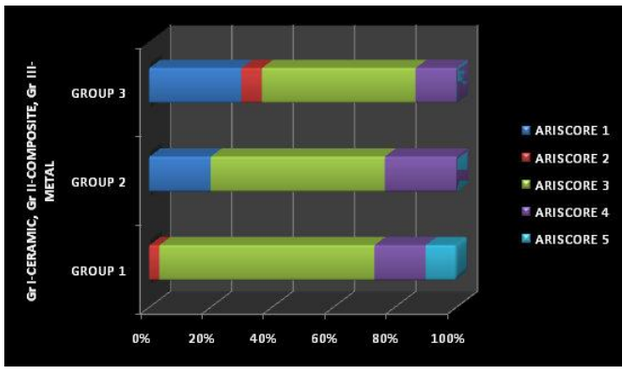
Group II (composite plastic brackets) showed equal distribution of ARITOOTH scores 1&2, indicating that some adhesive always remains on tooth surface. In group III (metal) ARITOOTH score 3 is seen at a higher frequency when compared to other groups indicating there is more residual adhesive remaining on tooth surface. Low ARITOOTH score usually corresponds to more damage to the enamel surface.

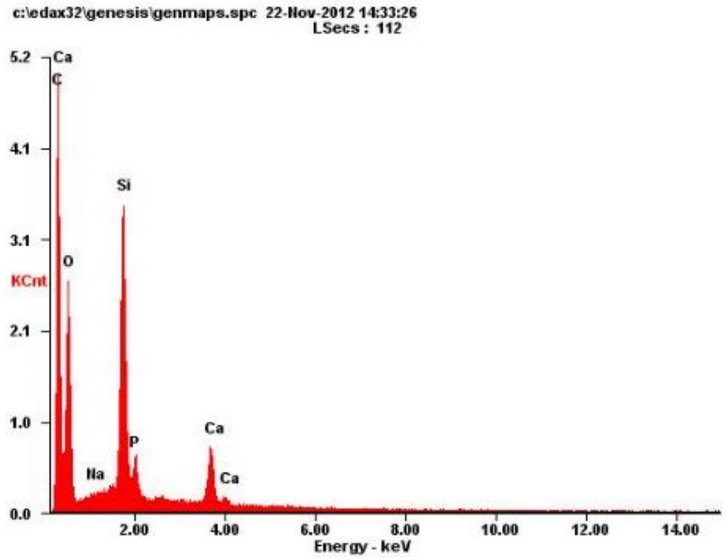


The results of this study shows an ARITOOTH score of 3 for 40% of metal brackets & ARITOOTH score of 3 for 6.7% of the ceramic brackets. This is in contrary to the reports of Bulent haydar, Simtent sankaya22 which showed a ARITOOTH score of 3 for all the metal brackets, ARITOOTH score of 3 for 40% of ceramic brackets. This may be attributed to the difference in composite adhesive material used in their study.

After debonding, tooth surfaces corresponding to lower ARITOOTH score were examined for presence of enamel cracks. Cracks, occurring as split lines in the enamel, are prone to debris and stains leading to discoloration of teeth and esthetic problems for the patients 23, 24 .With ceramic brackets, the risk for creating enamel cracks is larger than for metal brackets.

Debonding of ceramic bracket may generate stress in the adhesive–enamel interface that may produce enamel cracks at debracketing. Mode of debonding has been a factor potentially capable of creating enamel cracks25 .In this study the original method of debonding with a twin-beaked pliers advocated by Bishara et al26 was used to simulate clinical situation.





Element	Wt%	At%
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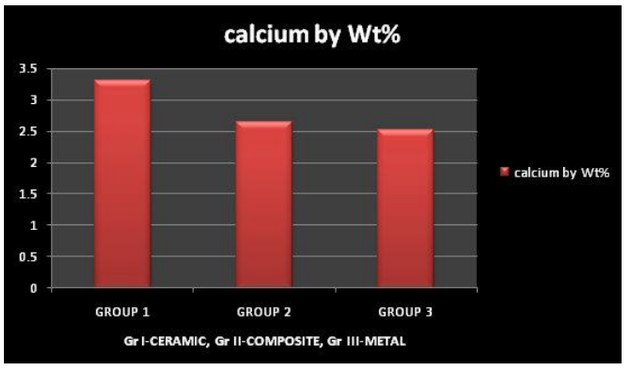
PK	02.15	01.13
CaK	02.80	01.14
Matrix	Correction	ZAF

Sinha PK, Nanda RS28, Habibi M, Nik TH6 which showed enamel damages subsequent to debonding. However other studies29, 30, 31 did not demonstrated any permanent damage

TABLE 1

			ARI Score on Tooth surface				Total	P value
			0	1	2	3		
Surface	Ceramic	Count	0	13	15	2	30	
		% within Surface	0%	43.3%	50.0%	6.7%	100.0%	
	Composite	Count	0	12	12	6	30	
		% within Surface	.0%	40.0%	40.0%	20.0%	100.0%	
	Metal	Count	0	6	13	11	30	
		% within Surface	.0%	20.0%	43.3%	36.7%	100.0%	
Total		Count	3	30	40	17	90	0.049
		% within Surface	3.3%	33.3%	44.4%	18.9%	100.0%	

0-No adhesive left on the tooth.
1-Less than half of the adhesive left on the tooth.
2-More than half of the adhesive left on the tooth.
3-All adhesive left on the tooth, with distinct impression of the bracket mesh



Cracks can be distinguished by finger shadowing in good light or, preferably, fiber-optic trans-illumination. Recently developed magnetic resonance imaging (MRI) technique, called SWeep Imaging with Fourier Transform (SWIFT), is capable to visualize dental tissues including enamel cracks .In this study scanning electron microscopy (SEM) that produces images of a sample by scanning it with a focused beam of electrons was used to detect the enamel cracks.

While examining the tooth surfaces under SEM, enamel cracks were seen in nine of the specimens after debonding of the ceramic brackets. Minute enamel crack was seen in the enamel surface of one of the specimens after debonding of composite brackets. No evidence of enamel cracks in specimens after debonding of metal brackets.

These findings are similar to the reports of Olsen M, Bishara S, Boyer D27(1996),Bishara SE, Fehr DE23(1997) and, to tooth enamel after debonding of ceramic brackets with mechanical retentive locks.

Differences in the results of studies might be attributed to different retention

mechanisms of brackets, the method of bonding and the type of adhesive. Adhesion of composite has 2 aspects—one to the tooth surface and the other to the bracket base—evaluation of the ARITOOTH scores also provides information on the site of bond failure (Fig.2).

Possible failure types after bracket debonding are in the interface between the enamel and the adhesive resin, partially adhesive and cohesive in the adhesive resin (mixed), and interface between the bracket base and the adhesive resin, where the latter 2 require removal of the remnants. Macroscopic evaluation could also show cohesive failures in the enamel or in the adhesive resin.

Score 0 implies weak adhesion between the adhesive and the enamel, and Score 3 means weak adhesion between the bracket and the adhesive resin. Though the ARITOOTH score of 0 is often considered to represent a weak bond or a lower hazard to the enamel, calcium loss is still possible7, 17, and 32. This further indicates cohesive failures in the enamel prisms that could be detrimental for possible demineralization or erosion.

Therefore, after bracket debonding, with ARITOOTH scores of 0, 1, or 2, these teeth need to be monitored for higher calcium loss from their enamel. The failure site at the bracket-adhesive interface macroscopically indicates safe debonding and less

TABLE 2-BOND FAILURE PATTERN

			Type of failure			Total	
			ENAMEL-ADHESIVE	BRACKET-ADHESIVE	COMBINATION		
Bracket	Ceramic	Count	12	3	15	30	
		% within Bracket	40.0%	10.0%	50.0%	100.0%	
	Composite	Count	0	17	13	30	P Value
		% within Bracket	.0%	56.7%	43.3%	100.0%	0.000
	Metal	Count	0	18	12	30	
		% within Bracket	.0%	60.0%	40.0%	100.0%	df=4
Total		Count	3	55	32	90	
		% within Bracket	3.3%	61.1%	35.6%	100.0%	

chance of enamel loss. In this study, no macroscopically cohesive failures in the enamel were observed for all the three groups.

Table II lists the bond failure pattern of three groups .The difference between composite plastic and metal brackets is not statistically significant. This is in contradictory to the findings of Diedrich33 which showed that plastic brackets displayed more torn-off fragments of enamel than the metal brackets and in which fracture mainly occurred at the adhesive-bracket interface. Bracket fracture occurred during debonding of composite brackets.

The difference between ceramic and plastic brackets is statistically significant. This differs from the results of M. Özcan, K. Finnema34 in which no difference in failure sites observed between the ceramic and polycarbonate brackets. The difference could be due to the different adhesive material (Enlight Light Cure Adhesive,Ormco) used in their study.

The difference between ceramic and stainless steel is statistically more significant. The mode of failure for the metal brackets was predominantly at the bracket-adhesive interfaces. This coincides with the results of other investigations in which primarily bracket-adhesive failure with metal brackets was found.

Twelve specimens in ceramic brackets group showed failure at the enamel-adhesive interface. These findings could be related to the fact that mechanically retained ceramic brackets had higher mean debonding strengths, and the site of bond failure shifted toward the enamel adhesive interface.

Ceramic brackets showed a higher frequency (40%) of bond failure at enamel-adhesive interface when compared to other groups, indicating debracketing of ceramic brackets should be done cautiously. This is similar to the findings of Thomas.B.Reddy; Shiv puja25 in which 20% of the ceramic brackets (Transcend 2000) showed failure at the enamel-adhesive interface. However this is contradictory to the findings of Lina P.Theodorakopoulou, Alex Jacobson35, in which 10% failed at the combination of bracket-adhesive and adhesive-enamel interface, and Samir E. Bishara et al36 in which 40% of ceramic brackets failed showed combination failure.

Bracket surfaces (Fig.3) were examined and evaluated using Modified Adhesive Remnant Index (mARI). Montasser and Drummond37 compared ARI scores under different magnifications (×10 and ×20) and proved that the accurate results were obtained when using higher magnifications. So, the magnification factor of ×20 was used for visual assessments in the present study.

S. Burcak Cehreli, Omur Polat-Ozsoy38 results show that qualitative visual assessment using the 5 point ARIBRACKET scale was capable of providing high precision and conclusive results. In this study optical stereo microscope was used to assess the Modified ARI index.

It produces a three-dimensional visualization of the sample being examined. Table III shows the Modified ARIBRACKET score values for three groups of bracket surfaces.

Statistical analysis showed a significant difference between three types of brackets tested. Ceramic brackets showed a higher frequency score of 5 compared to other groups indicating 100% adhesive remains on bracket surface.They also showed a higher frequency of score 3 within their group indicating remaining adhesive level of more than 10% but less than 90%.Stainless steel brackets had a higher frequency of ARIBRACKET score 1 compared to other 2 groups, indicating no adhesive remains on bracket surface. All the three groups showed a higher frequency of score 3.

On evaluation stainless steel brackets showed lower

ARIBRACKET scores mostly, followed by composite and ceramic brackets. Most of the stainless steel brackets showed ARIBRACKET score 3 and followed by composite brackets (but less than metal brackets).Twelve ceramic brackets showed ARIBRACKET score 5,five ceramic brackets showed ARIBRACKET score 4,while two composite brackets showed score 4.

Table 3

			MODIFIED ARI Score on Bracket surface					Total
			1	2	3	4	5	
Surface								
	Ceramic	Count	0	1	21	5	3	30
		% within Surface	.0%	3.3%	70.0%	16.7%	10.0%	100.0%
	Composite	Count	6	0	17	7	0	30
		% within Surface	20.0%	.0%	56.7%	23.3%	.0%	100.0%
	Metal	Count	9	2	15	4	0	30
%within Surface		30.0%	6.7%	50.0%	13.3%	.0%	100.0%	
Total		Count	15	3	53	16	3	90
		% within Surface	16.7%	3.3%	58.9%	17.8%	3.3%	100.0%

1. All adhesive remained on the tooth.
2. More than 90% of the adhesive remained on the tooth.
3. More than 10% but less than 90% of the adhesive remained on the tooth.
4. Less than 10% of the adhesive remained on the tooth.
5. No adhesive remained on the tooth.

These variations were statistically significant at 5% level. These results were consistent with the findings of Maryam Habibi6. Following visual scoring, the brackets with higher ARIBRACKET scores of each group were subjected to Quantitative assessment in a High Resolution Scanning Electron Microscope with Energy-dispersive X-ray spectroscopy (EDS or EDX).

EDS was used to find the elemental analysis or chemical characterization of a sample. EDS analysis (Fig.4) showed a very high amount of elemental calcium (Ca) on the composite attached to the base of group 1(ceramic brackets), while a high amount of elemental calcium (Ca) was observed in group 2(composite plastic brackets).

EDS showed that by Wt% the metal brackets (Group III) demonstrated very less amount of elemental calcium which cannot be compared statistically with other groups. These

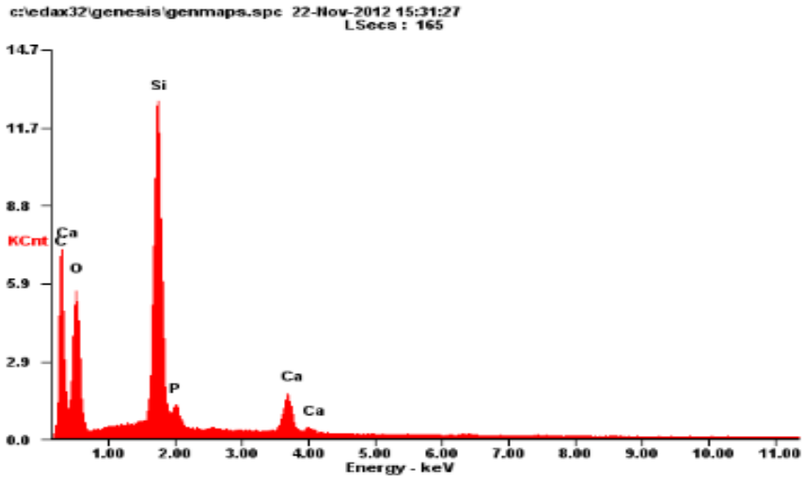


FIGURE 8-EDS Analysis for evaluation of the presence of Ca^{++} on the stainless steel bracket base after debonding showing the elements by peaks derived from the k shell of atoms.

Element	Wt%	At%
CK	21.98	30.56
OK	52.59	54.88
SiK	20.85	12.40
PK	02.06	01.11
CaK	02.51	01.05
Matrix	Correction	ZAF

TABLE 8-Amount of elements on the stainless steel bracket base. (Group III sample no.1)

findings were similar to that of Diedrich33 who demonstrated that localized detachments of terraced or ribbed enamel particles occurred more frequently with plastic than with metal brackets and similar to the findings of Ponts 3 who reported that the more ARI remnants on the bracket base, the higher the Ca% revealed by EDS.

These findings were in contrast with the report of Wei Nan Wang, DDS, a Ching Liang Meng39 in which no enamel detachment was found by EDS in the base of either metal or ceramic bracket after debonding and to the reports of U. Stratmann, K. Schaarschmidt40 which showed least amount of calcium loss with ceramic brackets than SS brackets.

This difference may be attributed to the technique of thermal debracketing of ceramic brackets used in their study.

SUMMARY AND CONCLUSION

The extent of damage to the enamel surface after debonding of ceramic, composite plastic and metal brackets was assessed in-vitro both qualitatively and quantitatively.

Adhesive Remnant Index on tooth surface, SEM examination of tooth surface for enamel cracks, modified Adhesive Remnant Index on bracket surface were the qualitative methods and quantitative assessment was done using Energy Dispersive Spectroscopy analysis(EDS).

Conclusions arrived at the end of study were as following.

1. Adhesive Remnant Index on tooth surface with ceramic brackets showed least amount of lower ARITOOTH score which implies more damage to enamel surface and composite plastic and metal brackets showed mostly higher ARITOOTH Score indicating less damage to tooth surface.

2. On scanning electron microscopic examination, the enamel surfaces bonded using ceramic bracket resulted in more enamel cracks; composite plastic bracket showed very few enamel crack and metal brackets showed no enamel cracks.

3. Ceramic brackets showed higher ARIBRACKET score indicating more damage to enamel surface, composite plastic bracket and stainless brackets showed lesser values indicating minimal enamel damage.

4. Energy Dispersive Spectroscopy analysis proved that the loss of elemental calcium is more evident in tooth surface bonded using ceramic bracket.

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