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Comparison of Bacterial Colonization of Enamel associated with APC Flash Free Ceramic Brackets and Conventional Bracket- An SEM in vivo Pilot Study.

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Abstract

Context: In order to improve the efficiency of the bracket system the newer material APC Flash free ceramic brackets were introduced, where the bracket is loaded with the composite with sufficient quantity to reduce the amount of excess flash around the tooth during bonding, which favours for less flash, less irregularities on the enamel surface and less plaque accumulation around the brackets. APC Flash free brackets are more time consuming which makes the time for bonding lesser compared to that of normal conventional ceramic brackets which produces excess flash during the bonding procedure.

Aim: The aim of the present study is to compare the degree of bacterial colonization on the enamel surface of teeth bonded with APC Flash Free ceramic brackets and conventional ceramic brackets using Scanning Electron Microscope.

Materials and methods: The study consist of 10 subjects who were scheduled for fixed orthodontic treatment including extraction of four premolars. APC Flash free ceramic braclets and conventional ceramic brackets were bonded to the premolars to be extracted using composite (Transbond XT, 3M). Teeth were extracted after 3 weeks after bracket bonding. Plaque attached to the buccal surfaces was stained using plaque disclosing agent.The teeth were then immersed in fixative containing 4% formaldehyde and 1% glutaraldehydein phosphate buffer

for 24 hours, followed by 0.1 M phosphate buffer for 12 hours. The specimens were then mounted on aluminum stubs and sputter coated with gold prior to SEM examination.

Results: APC Flash Free ceramic brackets characterised by less bacterial colonization and surface changes than the Conventional ceramic brackets.

Conclusion: Orthodontic APC Flash Free brackets improves the efficay of working procedures and less time for bonding would be an alternative to conventional ceramic brackets.

Keywords: APC Flash Free ceramic brackets, Conventional ceramic brackets, Bacterial colonization, Scanning electron microscophy.

Introduction

With the growing awareness of aesthetics in general population, Fixed Orthodontic treatment is one of the main treatment procedure to achieve a well aligned dental arch and an aesthetic smile. As the mal-alignment of teeth have a pyschological impact among the society, aesthetic development plays prime role for fixed orthodontic treatment among the population. Fixed orthodontic appliances are made of multiple major and minor components like bands, brackets, archwires, ligature wires and modules.

In the initial period of fixed orthodontic therapy bands were adapted circumferentially around the teeth to hold the auxillary components of fixed orthodontic appliance.[1]

The fixed appliance however always induce continuous accumulation and retention of plaque.[2] The bonding of Orthodontic brackets on the teeth after acid etching by using composite resin have been the revolutionary development of acid etching technique came into existance, where the enamel surface of the tooth prepared for attachments of brackets.

Michael G Buonocore in the year (1955) developed the technique of acid etching. Buonocore MG developed the acid etching technique based on the principle of painting industry. Where they used phosphoric acid for treating the metal surface for better adhesion. In the similar manner the enamel more receptive to adhesion when treated with phosphoric acid.[3]

Acid etching procedure is major advancement in orthodontic practice. This procedure leads to creation of micro porosities in the surface enamel which in turn leads to roughening of enamel and concomitant plaque accumulation.[4]

The design and surface characteristic of the orthodontic attachments further influences plaque retention. This plaque accumulation can lead to development of white spot lesions during orthodontic treatment.[5]

Excess composite which produces roughness predisposes to rapid attachment and growth of oral microorganisms. Clinical observation has indicated that a common site of demineralization is at the junction between the bonding resin and the enamel, just peripheral & gingival to bracket base.[6]

During bonding, composites are not always able to be efficiently removed around the brackets, and these retentive areas cause the development of enamel demineralization by increasing plaque accumulation. To overcome the limitations of excess composite flash material around the bracket, which leads to roughness of the enamel surface thereby causing white spot lesion under the bracket and its periphery, APC flash free technology was introduced.[7] The main advantage of this adhesive system, is that there is preloaded composite material on the bracket base, which eliminates the necessity of excessive adhesive clean-up (reduced chances of plaque accumulation), reduced timing for bracket positioning and bonding.[8]

There is a great need to identify the relative role of different sites of bacterial accumulation associated with fixed appliances. SEM can be used to analyse accurate changes on the surface enamel and bacterial colonization.

A Scanning Electron Microscope (SEM) is a powerful magnification tool that utilizes focused beams of electrons to obtain information. The high-resolution, three-dimensional images produced by SEMs provide topographical, morphological and compositional information makes them valuable in a variety of science and industry applications.

Aim of the study

To compare the degree of bacterial colonization on the enamel surface of teeth bonded with APC Flash Free ceramic brackets and conventional ceramic brackets using Scanning Electron Microscope.

Objectives

To evaluate and compare bacterial adhesion on enamel surface bonded with APC flash free ceramic brackets and conventional ceramic brackets and the surface characteristic of enamel around the brackets.

Materials and methods

1) 20 Extracted maxillary first premolar teeth from 10 patients undergoing Fixed Orthodontic Treatment from the Department of Orthodontics, MINDS.

2) 10 Adhesive Precoated Flash free ceramic brackets.(Clarity Advanced,3M , Monrovia, CA)

3) 10 Conventional ceramic brackets.(Clarity, 3M Unitek, Monrovia, CA)

4) 37% Phosphoric acid Etchant (Scotchbond, 3M Unitek, Monrovia, CA)

5) Light cure adhesive primer (Transbond XT, 3M Unitek, Monrovia, CA)

6) Light cure adhesive paste (Transbond XT, 3M Unitek, Monrovia, CA)

7) Disclosing Agent (Alpha Plac -Two Tone Disclosing Agent.

Patient Inclusion Criteria:

1. Patients undergoing fixed orthodontic treatment which requires extraction of upper right and left 1st premolars.

2. Patients in the age group of 14-19 years .

3. Patient selection will be based on uniform pre-treatment Silness and Loe Plaque index criteria.

4. Patient selection will be based on uniform pre-treatment Malocclusion Index of
Complexity, Outcome and Need.

Patient Exclusion Criteria:

1. Patients having severe crowding.

2. Patients having poor oral hygiene.

3. Malformed and cracked tooth.

4. Patients under antibiotic coverage for systemic conditions.

Fig 1: APC Flash Free bracket

Fig 2: Clarity advanced ceramic bracket

Fig 3: Etchant gel - Scotchbond

Fig 4: Bonding XT agent – Transbond

Fig5:Transbond XT- composite

Fig 6: Two Tone Plaque disclosing agent

Fig 7: Photograph illustrating disclosed plaque after 3 weeks of bonding around clarity bracket

Fig 8: Photograph illustrating disclosed plaque after 3 weeks of bonding around APC bracket

Fig 9: Preparation of fixative agent

Fig 10: Scanning Electron Microscope

Method

10 patients were selected based on the inclusion & exclusion criteria. Tooth number 14 of all 10 patients was bonded with APC Flash free brackets and tooth number 24 of all 10 patients were bonded with conventional ceramic brackets. Extraction of 14 and 24 of all 10 patients done after 3 weeks from the time of bonding.

At the time of bonding of brackets oral hygiene maintenance instructions were given and dental hygiene reinforced. The designated buccal tooth surface of premolars acid etched with 37% of phosphoric acid for 15 seconds, rinsed, dried and viewed the white frosted appearance on the enamel surface. Bonding agent applied, and cured for 20 seconds.

The APC brackets designated to, teeth 14 and cured. Light cure adhesive paste applied on the base of the conventional ceramic brackets, placed in position on the designated teeth 24 and excess composite removed before curing. One tooth pair were extracted at each session from one patient, one with APC Flash free ceramic bracket and the other with conventional ceramic bracket.

Surgical Procedure

Teeth were extracted after 3 weeks of bracket bonding. Teeth were luxated with a small straight elevator and removed with premolar forceps, which were engaged sub

gingivally so as to avoid dislodging the bracket and associated plaque accumulations.

Specimen Preparation

After extractions, the premolars were rinsed in water to remove the blood and debris. The plaque attached to the buccal surface disclosed and photographed for documentation.

Teeth were immersed in fixatives containing 4% formaldehyde and 1% of glutaraldehyde in phosphate buffer for 24hrs, followed by 0.1M phosphate buffer for 12 hrs. The lingual and root portion of the extracted premolar were dissected by using high speed bur. The specimens were dehydrated in graded alcohol and desiccated by critical point drying.

The specimen were mounted on aluminium stubs with gold coating prior to the examination under scanning electron microscope, to view the enamel surface changes and bacterial colonization, under an accelerating voltage of 15kv.

Method of plaque assessment

The samples were viewed under the scanning electron microscope for plaque accumulation around the bracket on the enamel surface. Based on morphological characteristics and in addition to the corn-cob formation, the extent of colonization around different orthodontic brackets and measured linearly around the brackets on the enamel surface.

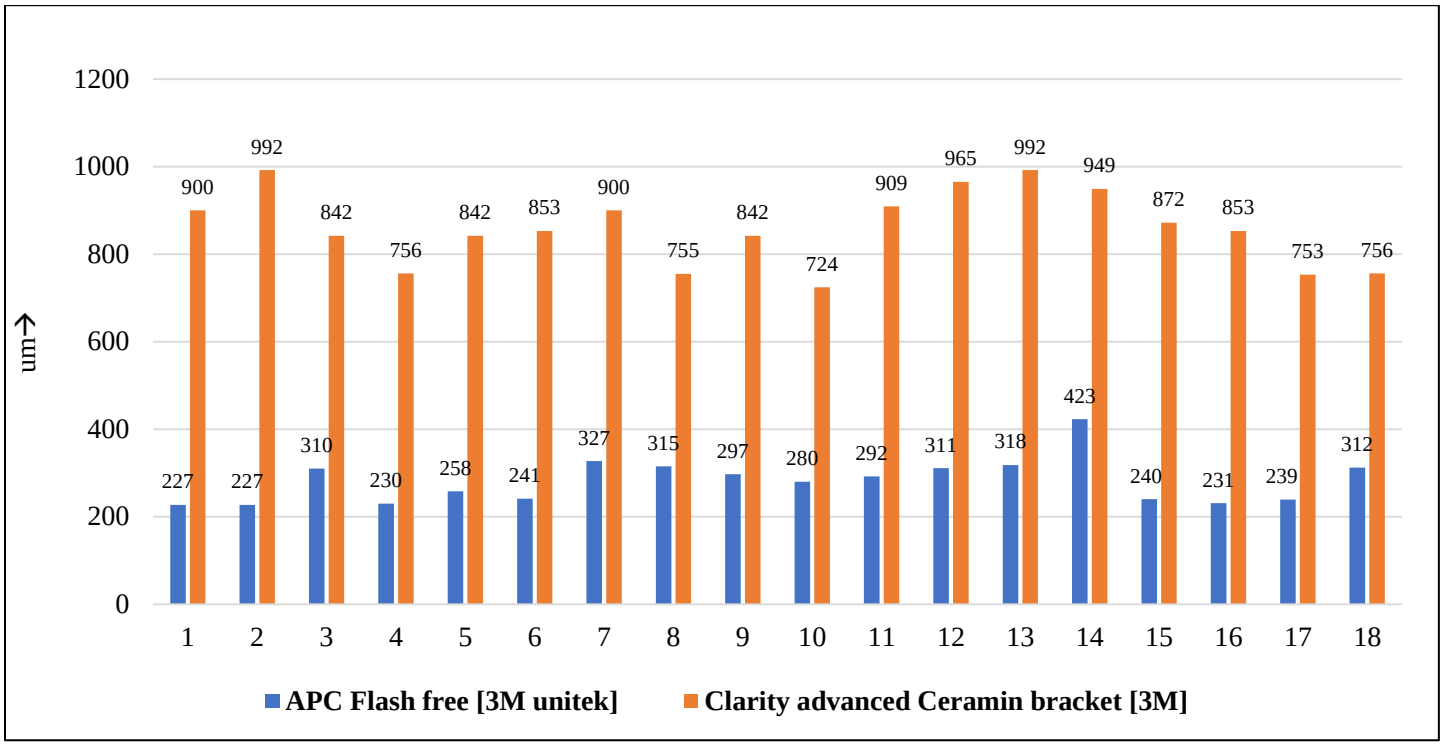
Results

The samples were prepared based on the specimen preparation protocal and all the samples were viewed under scanning electron microscope for the bacterial colonization, surface changes and gap between the composite- tooth surface around the two different types of brackets (APC Flash free bracket and clarity ceramic bracket). Based on the linear measurement, the APC Flash Free brackets showed around a mean value of 282.11 um extent of the bacterial colonization and surface changes, which was less compared to the Clarity ceramic bracket sample, measured about 858.6 1um. The study samples values were subjected to statistical analysis and evaluated for statistical significance. Paired t – test were analysed with the t value of 27. 529 and the p value of < 0.001,which proved the statistical significance among the two sample groups.

Table 1: Representing paired t test comparison between APC Flash free and clarity advanced brackets

Type	Mean±SD	t value	p value
APC Flash free [3M uni tek]	282.11±51.088 um	27.529	<0.001*
Clarity advanced Ceram in bracket [3M]	858.61±85.121 um		

*Statistically significant at p<0.05



Graph 1: Bar diagram representing the extent of colonization and the surface changes among the two types brackets.

The X axis of the bar diagram representing the number of samples, y axis representing the extent of bacterial colonization and enamel surface changes in the unit of um. The blue colour coding of the bar representing the extent of bacterial colonization and enamel surface changes of APC Flash Free bracket and the orange colour coding representing the Clarity ceramic bracket. (3M Unitek)

The diagrammatic representation of APC Flash Free brackets expressed lesser amount of bacterial colonization and enamel surface changes compared to Clarity ceramic bracket. (3M Unitek)

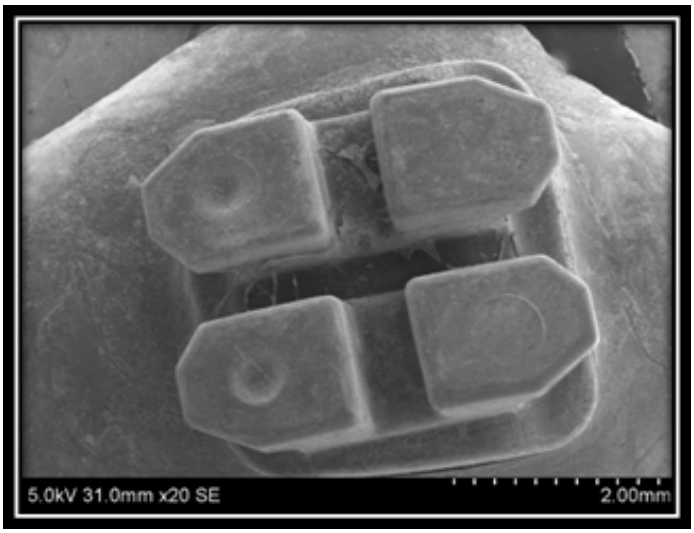


Fig 11: APC Flash Free bracket under SEM

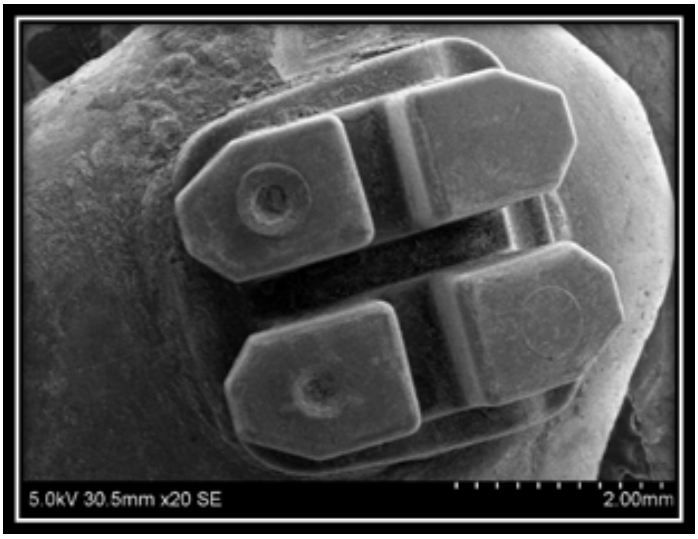


Fig 12: Clarity ceramic bracket under SEM

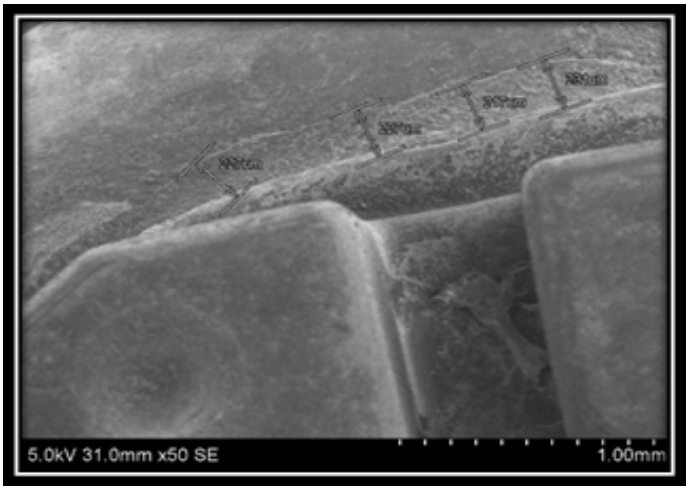


Fig 13: APC Flash Free bracket- measuring colonization and surface irregularity

Fig 14: Clarity ceramic bracket- measuring colonization and surface irregularity

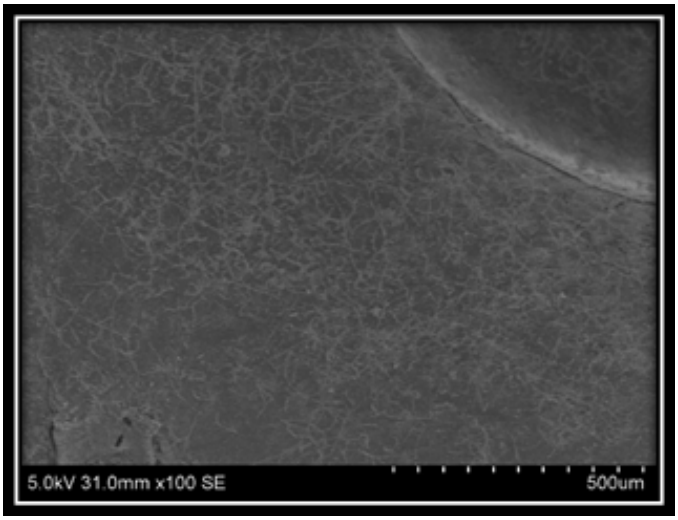


Fig 15: Bacterial colonization around the bracket

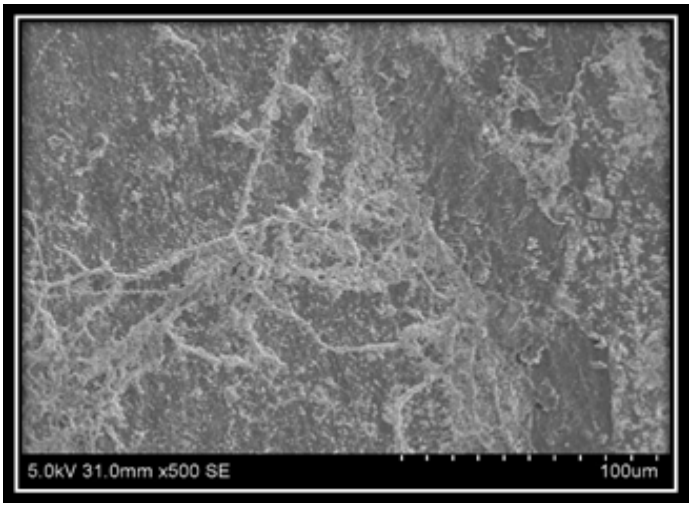


Fig 16: Co-aggregation of bacteria on the enamel tooth surface

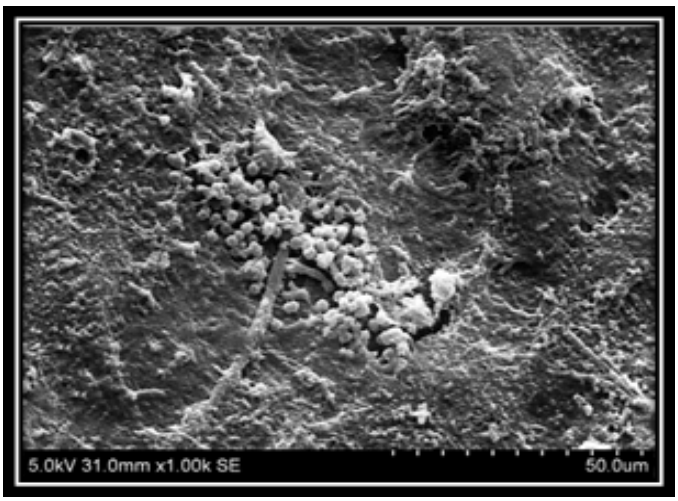


Fig 17: Co-aggregation of bacteria on the enamel tooth surface

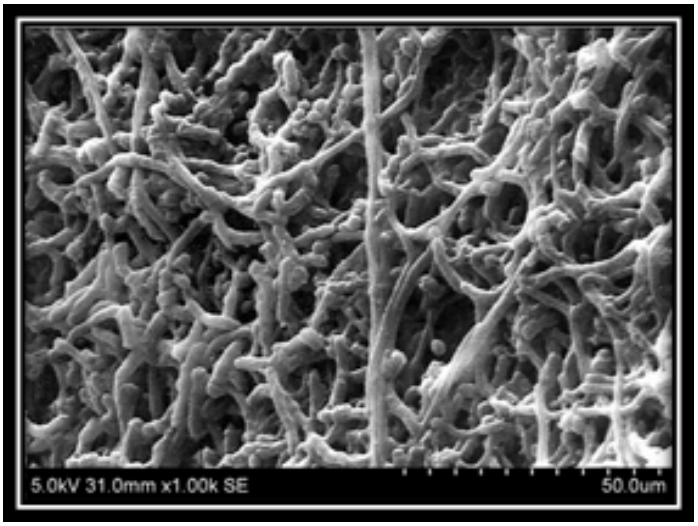


Fig 18: Strands of bacteria adhesion on the tooth surface

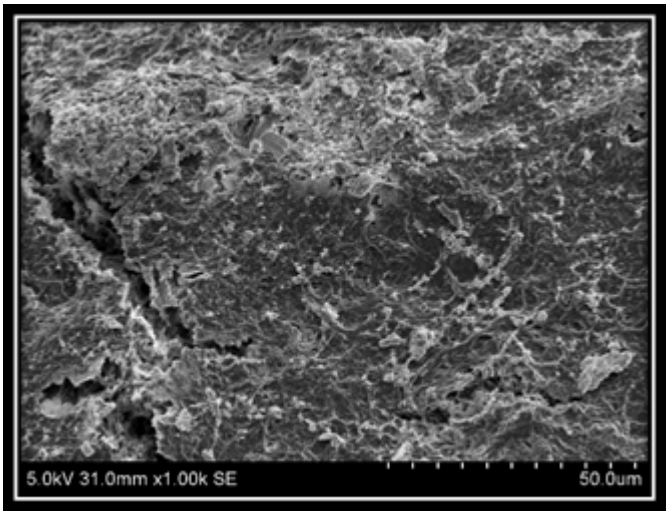


Fig 19: Surface irregularity on the enamel tooth surface

Discussion

Fixed orthodontic appliance treatment are considered to be a clinical risk factor in relation to enamel surface integrity after the etching procedures, which leads to surface roughness there by favouring for plaque accumulation around the bracket.[8]Early bonding systems consisted of brackets welded onto bands bonded to enamel with zinc phosphate cement.

Apart from aesthetic considerations, this approach presented other serious disadvantages. In order to overcome the disadvantages of fixing bands to each tooth surface which is a time-consuming procedure, Alternative procedure that would provide retention of the brackets to tooth enamal is the direct resin bonding of orthodontic attachments offers many advantages when compared to conventional banding.

Various orthodontic adhesive materials and different bonding techniques have been developed and have been subjected to multiple in vivo and in vitro studies. The three main components that have to be considered for sufficient orthodontic bonding are the surface of the tooth , the base of the individual orthodontic attachment and the bonding material itself.

Recent advancement in the material science lead to the development of new material system the APC Flash free ceramic brackets, where the adhesive is pre- coated to eliminate the removal of excessive adhesive during the bonding procedure.

This new era in bonding material is in a nonwoven mat that is soaked with a relatively low viscosity adhesive resin and consists of randomly oriented and entangled polypropylene fibers in the bracket base. This structure is compressed and the leaked resin fills the gap between the base and enamel surface.

Considering the main advantage of this newer material, in addition to shorter chair time, adequate bond strength and shorter clean-up time, the possibility of better oral hygiene owing to the protective effects of the adhesive and the decrease in retentive sites for plaque accumulation, are favorable aspects of flash-free brackets.[9-12]

The SEM has the ability to analyse the changes around the bracket and the toth surface to a larger depth of focus and also wider area arounrd the tooth specimen. It has the ability to classify the micro-organisns based upon the morphology. A SEM technique was chosen for assessing bacterial colonization, as it is a rapid and convenient means of screening microbial samples for major morphotypes.[13] SEM provides a large depth of focus that

allows a wide area of the specimen surface to be examined, and it offers a 3D view of a superficial layer of bacterial colonization. It was evident as Carrasi et al classified the micro-organism based on the morphology.[14]

The primary study was carried out in two different bracket system.The samples(APC Flash Free brackets and Clarity advanced ceramic brackets were prepared and viewed under SEM. The specimen that were bonded after the brackets which favoured excess plaque accumulation around the bracket.

The variable amount of composite were present on the enamel surface around the bracket base in all specimen, allthough effect has been made to remove excess composite during the bonding. As the bonding composite has a similar to the enamel surface, it is difficult to detect residual composite clinically around the bracket.

The bacterial colonization present around the brackets were differentiated by the presence of co-aggregation of the bacteria. The bacterial colonization and surface irregularities around where measured by the linear measurements which revealed that APC Flass Free bracket sample group showed mean and standared deviation of 271.20 +/- 394.01um and the Clarity advanced bracket sample group showed the mean and standared deviation of 840.60+/- 804.28um. Based on the comparison between the groups the APC Flash Free bracket revealed lesss amount of colonolization and surface irregularities than the clarity advance brackets. They are statistically significant with p value less than 0.001.

However, the patient were instructed to maintain their oral hygiene protocols, the results indicated the significant amount of plaque accumulation arount the brackets. These findings revealed te excess flash and the surface irregularity caused by the removal of composite around the bracket to be the pre-disposing factor for more amount of plaque accumulation.

Conclusion

Considering the main advantage of this newer APC Flash Free material system ,like shorter chair time, adequate bond strength and shorter clean-up time, the possibility of better oral hygiene owing to the protective effects of the adhesive and the decrease in retentive sites for plaque accumulation.

The present study compared the degree of colonization, enamel surface changes and the gap at the tooth –ceramic interface between the APC Flash Free bracket system and conventional ceramic brackets under the scanning electron microscope and found APC Flash Free bracket system offered the advantage of reduced bacterial colonization and surface changes due to reduced flash material around the brackets and lesser clean up.

List of abbreviations

APC-Adhesive Pre-Coated

SEM- Scanning Electron Microscope

um -Micrometre

SD - Standard Deviation

% - Percentage

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