Original Article

Comparison of Demineralization Around Orthodontic Brackets Cured by Conventional Method and Transillumination Technique – An *In Vitro* Evaluation

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Abstract

Background: Decalcification or demineralization is the loss of calcified tooth material. The dissolution takes place due to the acid produced by bacteria present in dental plaque. The present study was conducted to compare demineralization around orthodontic brackets cured by conventional method and transillumination method. **Materials and Methods:** The study was conducted to compare demineralization around orthodontic brackets cured by conventional method and transillumination method. Eighty freshly extracted human premolar teeth were taken for the study and divided into four groups. Group 1: Twenty teeth were cured by conventional method of bonding by curing labially for 40 s, Group 2: Twenty teeth were cured for 50 s by transillumination, Group 3: Twenty teeth were cured labially for 20 s followed by 30 s of transillumination, and Group 4: Twenty teeth were first cured by transillumination for 30 s followed by labial curing for 20 s. A score was assigned to the different degrees of microleakage at the demineralization zone around enamel-adhesive-bracket complex at the occlusal, middle, and gingival margins. **Results:** On comparing demineralization scores within each study group, in Group 1, demineralization on middle side (923.24) was significantly higher than cervical side (834.03) and occlusal side (645.12). Within Group 2, demineralization on occlusal side (1048.35) was significantly higher than cervical side (1003.67) and middle side (879.25). Within Group 3, demineralization on cervical side (605.41) was significantly higher than middle side (542.83) and occlusal side (534.89). Within Group 4, demineralization on cervical side (454.65) was significantly higher than middle side (442.87) and occlusal side (329.45). When comparing demineralization scores among different groups, on the occlusal side, Group 2 shows significantly higher demineralization score than other study groups. On middle side, Group 1 shows significantly higher demineralization score. On cervical side, Group 2 shows significantly higher demineralization. **Conclusion:** The present study concluded that transillumination for 30 s followed by labial curing for 20 s showed minimum demineralization.

Keywords: Conventional bonding, Curing, Transillumination.

Introduction

Esthetics has become increasingly crucial when it comes to determining the success of dental treatment, and in recent years, the demand for a better look has grown exponentially. The number of adults seeking orthodontic care increased from 14% to 27% between 2010 and 2014, based on a survey conducted by the American Association of Orthodontics back in 2015.[1] An ideal outcome of bracket bonding to any surface should result in an attachment that is strong enough to endure the forces of orthodontic treatment and mastication without dislodgement, while at the same time be safe enough to avoid damage to the surface during debonding following the end of the treatment.[2] Decalcification or demineralization is the loss of calcified tooth material. Areas of enamel demineralization are clinically visible as white spot lesions that occur due to alterations in the optical properties caused by subsurface mineral loss.[3,4] The dissolution takes place due to the acid

Access this article online

Website:
www.jrad.co.in

DOI:
https://doi.org/10.53064/jrad.2021.12.5.62

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Received: 12 Jun, 2021; **Accepted:** 15 Jul, 2021; **Published:** 21 Aug, 2021

How to cite this article: Rohria R, Verma N, Kundu J, Hirpara N, Chhaparwal A, Ahmed A. Comparison of Demineralization Around Orthodontic Brackets Cured by Conventional Method and Transillumination Technique – An *In Vitro* Evaluation. J Res Adv Dent 2021;12(5):1-257.

produced by bacteria present in dental plaque. These lesions mainly develop due to an imbalance between demineralization and remineralization of the enamel.[5,6] The white spot lesions are supposed to be the early signs of enamel caries.[3,7] The prevention of demineralization has become a critical concern during orthodontic therapy. Meticulous oral hygiene maintenance, fluoride rinses, and topical fluoride applications have been recommended.[8-10] The present study was conducted to compare demineralization around orthodontic brackets cured by conventional method and transillumination method.

Materials and Methods

The study was conducted to compare demineralization around orthodontic brackets cured by conventional method and transillumination method. Before the commencement of the study, ethical approval was taken from the ethical committee of the institute and written consent was taken from the patient after explaining the study. Eighty freshly extracted human premolar teeth were taken for the study. These teeth were without caries, hypoplastic areas, cracks, or gross irregularities of the enamel structure and were stored in distilled water solution at room temperature. Immediately before bonding, teeth were cleaned with a scaler and pumiced to remove soft-tissue remnants, calculus, and plaque. Specimens were prepared for bracket bonding according to the following procedures: 37% phosphoric acid gel used to etch the teeth for 30 s. The teeth were then rinsed with water for 30 s and dried for 20 s. Subsequently, the liquid primer Transbond XT was applied to the etched surface. MBT premolar stainless steel brackets were bonded to teeth with Transbond XT light cure adhesive paste. Excess resin was removed with an explorer before it was polymerized and cured with the following varying procedures:

Group 1: Twenty teeth were cured by conventional method of bonding by curing labially for 40 s
Group 2: Twenty teeth were cured for 50 s by transillumination
Group 3: Twenty teeth were cured labially for 20 s followed by 30 s of transillumination
Group 4: Twenty teeth were first cured by transillumination for 30 s followed by labial curing for 20 s.

After curing, the specimens were immersed in an unstirred demineralizing solution for 24 h at pH 4. The teeth were further sealed with nail varnish wherein the buccal surfaces of all the teeth were coated with two consecutive layers of nail varnish. The samples were then immersed in distilled water to prevent dehydration. All the teeth were cut using a diamond disc mounted on low-speed handpiece motor under water irrigation. Longitudinal ground sections in mesiodistal plane were prepared using a laboratory lathe under the continuous cooling of water until the desired thickness was reached. Sections were then reduced using coarse side of an Arkansas stone, followed by the finer side and finally polished using 0.05 μm particle size aluminum oxide polishing paste to a thickness of approximately 100–200 μm. Later, the ground sections were cleaned carefully with xylene and mounted on glass slides using quinoline as the mounting media. Photomicrographs were taken focusing on the demineralization around enamel-adhesive-bracket complex at the occlusal, middle, and gingival margins at 10× and 40× and were then projected from the microscope to a monitor. When examined in quinoline, a 30–40 μm thick surface zone appeared distinctly positive birefringent, indicating that the outermost enamel reacted as a molecular sieve. Because of the lower content of minerals, the interpretation of this zone differed from that of similar "dark zones" observed in hypomineralized enamel. Microleakage in each sample was evaluated using a binocular microscope at 40× and an image was taken using a digital camera connected to the microscope. The images obtained were analyzed using Magnus Pro Image software which enabled measurements to be made using different tools. Finally, a score was assigned to the different degrees of microleakage at the demineralization zone around enamel-adhesive-bracket complex at the occlusal, middle, and gingival margins using linear measurement tool. Average of three counted values was taken to avoid intraobserver variability.

Results

In the present study, a total 80 freshly extracted human premolar teeth were taken for the study and divided into four groups. Group 1: Twenty teeth were cured by conventional method of bonding by curing labially for 40 s, Group 2: Twenty teeth were cured for 50 s by transillumination, Group 3: Twenty teeth were cured labially for 20 s followed by 30 s of transillumination, and Group 4: Twenty teeth were first cured by transillumination for 30 s followed by labial curing for 20 s.

On comparing demineralization scores within each study group, in Group 1, demineralization on middle side (923.24) was significantly higher than cervical side (834.03) and occlusal side (645.12). Within Group 2, demineralization on occlusal side (1048.35) was significantly higher than cervical side (1003.67) and middle side (879.25). Within Group 3, demineralization on cervical side (605.41) was significantly higher than middle side (542.83) and occlusal side (534.89). Within Group 4, demineralization on cervical side (454.65) was significantly higher than middle side (442.87) and occlusal side (329.45). When comparing demineralization scores among different groups, on the occlusal side, Group 2 shows significantly higher demineralization score than other study groups. Group 2 shows maximum demineralization score followed by Group 1 and Group 3. Group 4 shows least demineralization score on occlusal side. On middle side, Group 1 shows significantly higher demineralization score followed by Group 2 and Group 3. Group 4 shows least demineralization score on middle side. On cervical side, Group 2 shows significantly higher demineralization followed by Group 1 and Group 3. Group 4 shows least demineralization score on cervical side (Table 1).

Discussion

Enamel demineralization adjacent to orthodontic bands and brackets remains a concern to the practitioner. Reports of these

Table 1: Comparison of the demineralization scores in all groups among occlusal, middle, and cervical

Groups	Mean±SD	*P*-value
Group 1		<0.05
Occlusal	645.12±154.34	
Middle	923.24±247.14	
Cervical	834.03±234.04	
Group 2		<0.05
Occlusal	1048.35±221.09	
Middle	879.25±142.14	
Cervical	1003.67±187.23	
Group 3		<0.05
Occlusal	534.89±143.23	
Middle	542.83±203.12	
Cervical	605.41±167.85	
Group 4		<0.05
Occlusal	329.45±123.67	
Middle	442.87±105.78	
Cervical	454.65±56.44	

"white spot lesions" have been made by several investigators and have been documented as early as 1 month after the start of treatment.[11-13] Increased difficulty of plaque removal around orthodontic brackets, increased bacterial adhesion to resin bonding materials, and increased oral bacteria during orthodontic treatment all contribute to demineralization adjacent to orthodontic brackets.[13-16]

On comparing demineralization scores within each study group, in Group 1, demineralization on middle side (923.24) was significantly higher than cervical side (834.03) and occlusal side (645.12). Within Group 2, demineralization on occlusal side (1048.35) was significantly higher than cervical side (1003.67) and middle side (879.25). Within Group 3, demineralization on cervical side (605.41) was significantly higher than middle side (542.83) and occlusal side (534.89). Within Group 4, demineralization on cervical side (454.65) was significantly higher than middle side (442.87) and occlusal side (329.45). When comparing demineralization scores among different groups, on the occlusal side, Group 2 shows significantly higher demineralization score than other study groups. Group 2 shows maximum demineralization score followed by Group 1 and Group 3. Group 4 shows least demineralization score on occlusal side. On middle side, Group 1 shows significantly higher demineralization score followed by Group 2 and Group 3. Group 4 shows least demineralization score on middle side. On cervical side, Group 2 shows significantly higher demineralization followed by Group 1 and Group 3. Group 4 shows least demineralization score on cervical side.

In studies by Ramuglu *et al*. and Uysal *et al*., light was irradiated from the occlusal surface and a significant amount of microleakage was reported at the gingival margin. They reasoned that this result might be due to the degradation of light intensity and insufficient polymerization of composite.[17] Arhun *et al*.[18] found that microleakage is more likely to occur around the ceramic brackets compared to metal brackets. Lindel *et al*. have supported the present study, as he found that the result in enamel demineralization occurring in the ceramic brackets is higher than that in the metal ones. The study indicates that metal brackets have lower potential for bacterial accumulation (*Streptococcus mutans*) compared to plastic and ceramic brackets.[19]

Oesterle and Shellhart[20] who reported comparable bond strength in the group using transillumination for 50 s with the group cured for 40 s at the margins as well as with Heravi *et al*.[21] who stated that to achieve an acceptable bracket bond strength to the posterior teeth, doubling the curing time from 40 to 80 s and increasing the light intensity to 800 mW/cm^2 during the transillumination technique would give better results. Since, demineralization scores were more in individual transillumination curing technique and individual labial curing technique as compared to a combination of both, a combination technique-like transillumination followed by labial curing can be employed to lessen the amount of demineralization.

Conclusion

The present study concluded that transillumination for 30 s followed by labial curing for 20 s showed minimum demineralization.

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