ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research

Vol. 17, Issue, 03, pp.32079-32083, March, 2025
DOI: https://doi.org/10.24941/ijcr.48679.03.2025

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

COMPARISON OF ULTRAVIOLET VERSUS WHITE LIGHT IN DETECTION OF ADHESIVE REMNANTS DURING ORTHODONTIC DEBONDING WITH CONVENTIONAL DEBONDING TECHNIQUES: AN IN VITRO STUDY

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ARTICLE INFO

Article History:
Received 20th December, 2024
Received in revised form
19th January, 2025
Accepted 26th February, 2025
Published online 30th March, 2025

Key words:
White light, Ultraviolet light, debonding plier, Ligature cutter.

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ABSTRACT

Objective: This study aims to compare the efficiency of ultraviolet versus white light in detecting adhesive remnants having fluorescence property during orthodontic debonding and comparing the efficiency of removing adhesives with the conventional debonding technique using debonding plier and ligature cutter. **Materials and Methods**: The study included 20 extracted premolars from patients undergoing fixed orthodontic treatment. Each premolar was mounted on an acrylic block and MBT brackets were bonded to these premolars with an adhesive having fluorescence property. Total premolars were divided into two groups, Group A and Group B with 10 samples each. Group A brackets were debonded with debonding plier and Group B with ligature cutter respectively. The adhesive remnants after debonding from Group A and B were removed under white light and ultraviolet light, with 5 samples each from Group A and Group B. Each tooth samples were observed under a Stereomicroscope for the estimation of adhesive remnants left behind after the adhesive removal. The photographic images were scaled and the surface area(mm^2) estimation of the remaining adhesive remnants was calculated with Image J software. **Result:** There was a significant difference in the surface area seen after adhesive remnants removal under Ultraviolet light and White light. Removal of adhesive remnants under Ultraviolet light showed lesser surface area of remnants on tooth surface compared with the white light, which showed the highest surface area($P<0.05$). There was no significant difference in surface area seen with adhesive remnants after debonding using debonding pliers and ligature cutter. **Conclusion**: Using Ultraviolet light, the adhesives remaining on the teeth surface after debonding can be easily detected and removed conservatively without abrading the teeth surface.

Citation: Dr. Arsha Darsh, Dr. Deepu Leander and Dr. Roopesh R. 2025. *"*Comparison of ultraviolet versus white light in detection of adhesive remnants during orthodontic debonding with conventional debonding techniques: an in vitro study*". International Journal of Current Research, 17, (03), 32079-32083.*

INTRODUCTION

After completing fixed orthodontic treatment, bonded brackets and adhesives are removed from the tooth surface. During bracket removal, bond failure frequently occurs at the adhesive-bracket interface, often leaving a significant amount of adhesive residue on the enamel. This residual adhesive can contribute to plaque buildup, white spot lesions, discoloration, and surface roughness, potentially compromising enamel integrity.[1]

To restore the enamel surface and maintain oral health, various adhesive removal techniques are used, including mechanical, chemical, and laser methods. Mechanical removal, typically performed with carbide burs, diamond burs, or scalers, is the most common approach but carries a risk of enamel damage if not executed carefully. Chemical removal involves using solvents to dissolve the adhesive, though concerns about enamel erosion and biocompatibility limit its widespread use.

After adhesive removal, polishing procedures are applied to smooth the enamel surface, reducing bacterial adhesion and enhancing aesthetics. Research indicates that combining appropriate adhesive removal methods with thorough polishing helps minimize enamel damage and supports long-term oral health.[1] Removing adhesive remnants under white light with the naked eye may result in micro-abrasions on the enamel surface, which can lead to staining over time. Since teeth naturally exhibit fluorescence under ultraviolet (UV) light, incorporating fluorescent properties into orthodontic adhesives can enhance their visibility under UV illumination, allowing them to mimic the natural fluorescence of teeth. This innovation enables easier detection of residual adhesive after debonding, facilitating its precise removal in a more conservative manner, minimizing the risk of enamel abrasion.[2]

The orthodontic debonding can be done using different techniques, and the time for each debonding technique also varies, along with the retaining resin over the teeth surface, causing enamel stain. This study was to comparatively evaluate the efficiency of Ultraviolet light and white light for removal of orthodontic adhesive remnants having fluorescence property during debonding, and also to compare the efficiency of removing adhesives with conventional debonding techniques using debonding plier and ligature cutter.

MATERIALS AND METHODS

Materials: This pilot in vitro study was approved by the Institutional Ethical Committee, PMS College of Dental Science and Research. The inclusion criteria were the premolars extracted for fixed orthodontic treatment with sound buccal tooth surface. The orthodontic adhesive used is Bracepaste® (American Orthodontics) which shows fluorescence property under ultraviolet light and the Ultraviolet LED light having wavelength of 395nm (Brand – LUMAND).

Sample preparation: Extracted human premolars with sound buccal surface extracted for fixed orthodontic treatments were collected, cleaned and stored in 0.5% chloramine-T solution. Each tooth sample was mounted on an acrylic block and the buccal surface was cleaned and polished with pumice using a rubber cup for 10 seconds then rinsed and dried with air-water syringe. The enamel on buccal surface of the teeth was etched with 35% phosphoric acid for 30 seconds, rinsed with water for 10 seconds and air dried for 5 seconds, applied bonding agent and cured. Orthodontic brackets were attached to the tooth with orthodontic adhesive with fluorescent property- Bracepaste® (American Orthodontics) and pressed firmly on the tooth surface and excessive adhesives were removed with explorer and curing for 3 seconds is carried out.

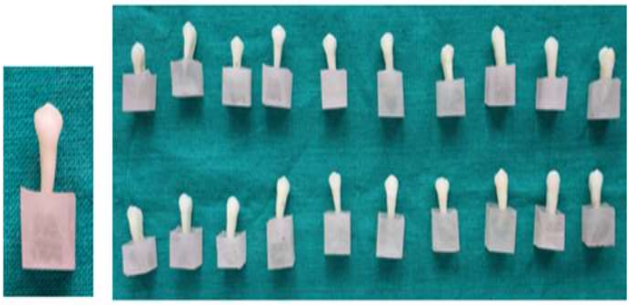


Figure 1. Premolar teeth samples mounted on acrylic blocks

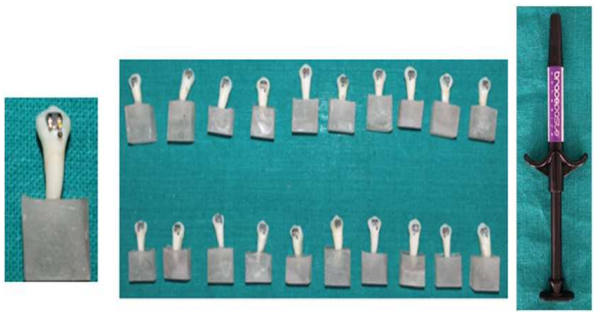
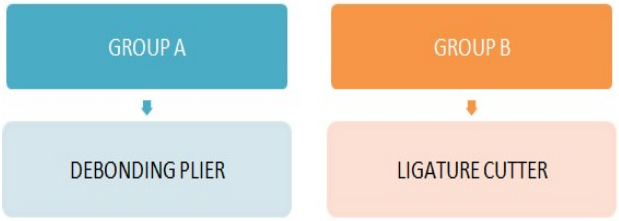


Figure 2. Orthodontic brackets were attached to the tooth with orthodontic adhesive with fluorescent property- Bracepaste® (American Orthodontics)

Procedure

Debonding: The brackets were debonded with two conventional debonding techniques- Debonding plier and Ligature cutter. The total sample is equally divided into 2 groups- Group A and Group B.



And the amount of adhesives remaining after debonding was assessed with ultraviolet light .UV protected eyewear and gloves were used for protection. And using a stereomicroscope, the tooth was illuminated with ultraviolet light and photographs were taken. The photographic images were scaled and the surface area (mm^2) of adhesive remnants was assessed with the Software - Image J and scored using Modified Adhesive Remnant Index.

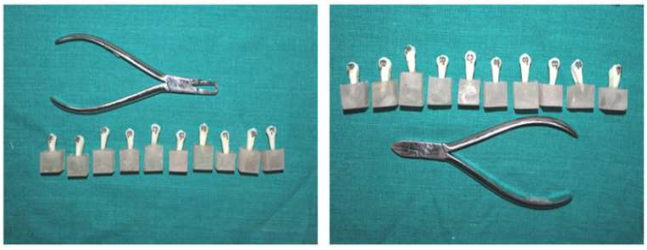


Figure 3. The samples are divided as Group A and Group B

SCORE	DEFINITION
0	No adhesive left on the tooth
1	1%-25% of adhesives left on the tooth
2	26%-50% of adhesives left on the tooth
3	51%-75% of adhesives left on the tooth
4	76%-99% of adhesives left on the tooth
5	All the adhesives left on the tooth with distinct impression of bracket mesh

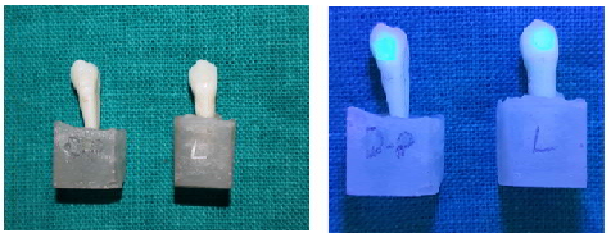


Figure 5. Illumination of samples under White light and Ultraviolet light

Adhesive removal: The adhesive removal was done with 30 fluted, flame shaped tungsten carbide bur in a high-speed handpiece without water spray. The premolars which scored 3,4,5 scores in Modified Adhesives Remnant index were considered for quantitative assessment of adhesive remaining. After debonding removal of adhesive remnants for half the sample premolars from Group A and Group B is done under

white light and the other half from Group A and Group B under ultraviolet light.

Adhesive removal: Quantitative assessment of adhesive remaining: Using a Stereomicroscope, the tooth was illuminated with ultraviolet light and photographs were taken after debonding and after adhesive removal. The photographic images were scaled and surface area (mm^2) of remaining adhesive remnants were assessed (Software - Image J).

Figure 6. Illumination of samples under Stereomicroscope with Ultraviolet light and photographic images were scaled

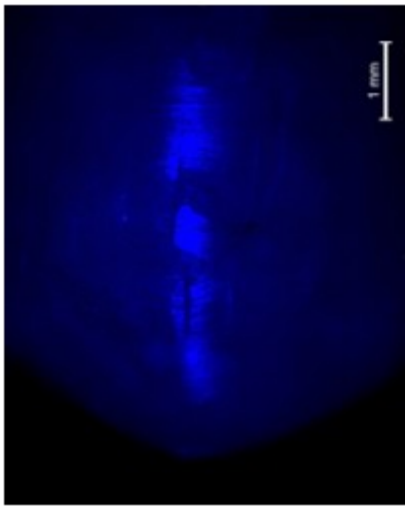


Figure 6: photographic images of adhesive remnants scaled with Image J Software

RESULTS

Data was entered into Microsoft excel data sheet and was analysed using SPSS for Windows (Statistical Presentation System Software, SPSS Inc.) version 17.0. Shapiro wilk test was done for normality testing and the Surface area (mm2) after de bonding was found to be non-normally distributed and non-parametric tests were used for this group. Continuous data was represented as mean and standard deviation. Student T test was used for comparing Surface area(mm2) after debonding. Kruskal Wallis test for comparing the four groups and pairwise comparison with Mann Whitney U test - Bonferroni correction was used. p value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests. After debonding with debonding plier and ligature cutter, the adhesive remnants showed no significant difference(p=0.993) in surface area(mm2) between the two groups. After adhesive removal under White light and Ultraviolet light, it was found that there was a significant difference($p<0.001$) in the surface area(mm^2) after debonding between the four groups. The surface area of the remaining adhesives was highest among White light (Ligature Cutter=3.16 & Debonding plier P=3.67) compared to Ultraviolet light (Ligature Cutter=0.80 & Debonding plier P=0.69).

DISCUSSION

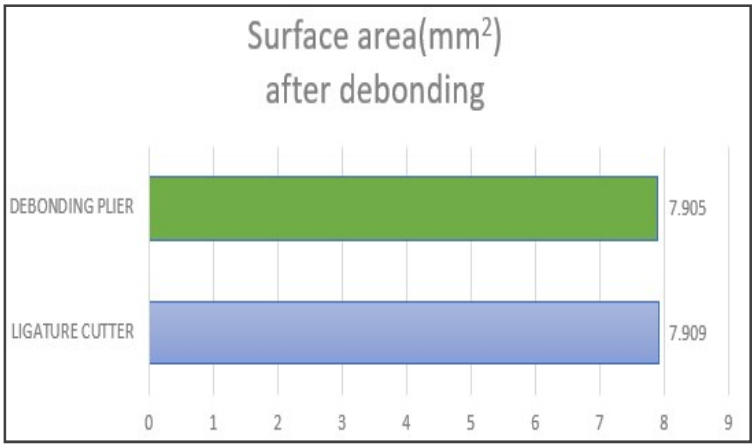
Numerous studies have explored various adhesive removal techniques aimed at minimizing damage to tooth structure, few have proposed methods to enhance the detection of residual adhesive.[3] Joanna *et al*[4] on a systematic review on the effect of orthodontic debonding and adhesive removal on the enamel, Tungsten carbide burs were the most popular tools, offering greater speed and effectiveness compared to Sof-Lex discs, ultrasonic tools, hand instruments, rubbers, or composite burs. Although they remove a significant layer of enamel and roughen the surface, they are less destructive than Arkansas stones, green stones, diamond burs, steel burs, and lasers. But tungsten carbide burs require multistep polishing, so further research is needed to develop methods that ensure complete adhesive removal while minimizing enamel loss and achieving a smooth surface. Connie Lai *et al*[1] assessed orthodontic adhesive remnants after debonding with a dissecting microscope revealed that groups using UV light during adhesive removal had significantly fewer adhesive remnants compared to those using white light. Additionally, the adhesive removal time was notably shorter when using UV light with Opal Bond MV adhesive compared to white light. Overall, UV light proves to be both more effective and more efficient than white light in detecting fluorescent adhesive during orthodontic debonding. In this study after adhesive removal under white light and ultraviolet light, a significant difference ($p < 0.001$) was observed in the remaining surface area (mm^2) after debonding among the four groups. The highest adhesive remnants were found under white light, with surface areas of 3.16 mm^2 for the ligature cutter and 3.67 mm^2 for the debonding plier. In contrast, significantly less adhesive remained under ultraviolet light, with surface areas of 0.80 mm^2 for the ligature cutter and 0.69 mm^2 for the debonding plier. Potential limitations of these study include the specific wavelength of UV light used (395 nm). While this wavelength has been identified as optimal for several composite resins, the ideal wavelength may vary for different orthodontic adhesives, potentially affecting the results.[5,6] Bora *et al*[7] conducted an in vitro study on the enamel surface damage during the debonding of ceramic brackets using different debonding techniques and concluded that using an ultrasonic scaler for debonding resulted in significantly higher enamel surface damage than the other techniques ie with ligature cutter, ultrasonic technique, and thermal method. The Adhesive Remnant Index (ARI) was notably greater when using a debonding plier than with the other methods. Additionally, the thermal method had a significantly longer mean debonding time compared to the debonding plier, ligature cutter, and ultrasonic techniques.

In this study after debonding with the debonding plier and the ligature cutter, the adhesive remnants were illuminated with Ultraviolet light under the stereomicroscope, and photographic images were scaled for surface area calculation of adhesive remnants and showed no significant difference(p=0.993) in surface area(mm2) between the two groups. Rocha *et al* [8] on

Table 1. Surface area of orthodontic adhesive remaining on tooth surface after debonding

Variable	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
Surface area(mm2) after debonding	LIGATURE CUTTER	10	7.9090	.70738	.22369	0.993
	DEBONDING PLIER	10	7.9050	1.18373	.37433	(Not significant)

*Significant at the 0.05 level using Student T test.

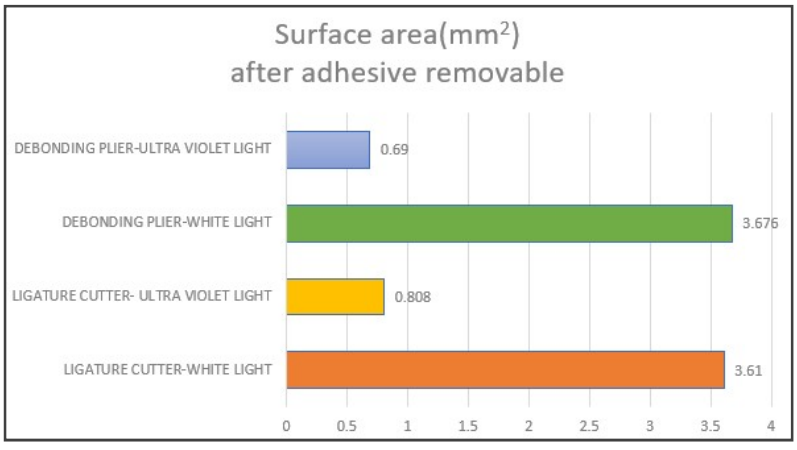


Graph 1. Graphical representation of surface area of orthodontic adhesive remaining on tooth surface after debonding

Table 2. Surface area of orthodontic adhesive remaining on tooth surface after adhesive removal under white light and ultraviolet light

Variable	Groups	N	Mean	Std. Deviation	Std. Error Mean	P-value
Surface area(mm^2) after adhesive removal	Ligature cutter- White light	5	3.610	.56249	.25156	0.001* (significant)
	Ligature cutter- ultra violet light	5	.8080	.41391	.18511	
	Debonding plier- White light	5	3.676	.55846	.24975	
	Debonding plier- Ultra violet light	5	.6900	.37570	.16802	

*Significant at the 0.05 level using Kruskal Wallis test.



Graph 2. Graphical representation of surface area of orthodontic adhesive remaining on tooth surface after adhesive removal under white light and ultraviolet light

the efficacy of auxiliary devices for removal of fluorescent residue after bracket debonding, and the benefits of complete adhesive removal, it is important to highlight that the accessory lens emits light over a broader area and at a higher intensity compared to the LED lighting system integrated into the high-speed handpiece. This lens filters light from higher-wavelength LEDs (two at 465 nm and one at 445 nm), reducing their intensity to 405 nm. The lower-wavelength LED plays a key role in detecting fluorescence, as it is activated by a light source between 395 and 405 nm.

CONCLUSION

The objective of this study was to evaluate and compare the efficiency of Ultraviolet versus White light in detecting adhesive remnants having fluorescence property during orthodontic debonding, and comparing the efficiency of removing adhesives with the conventional debonding technique using debonding plier and ligature cutter. This study observed a statistically significant difference in the removal of orthodontic adhesive remnants having fluorescence property

after debonding under White light and Ultraviolet light, with the efficiency of removing the adhesive under Ultraviolet light being more significant and conservatively removing the adhesives causing less damage to the enamel. Also, there was no significant difference in the surface area of the orthodontic adhesive remnant on the tooth surface after debonding with the debonding plier and the ligature cutter. Orthodontic brackets can be debonded by several methods, but the retaining adhesive over the tooth surface after debonding can eventually cause enamel staining, plaque retention, which may lead to white spot lesions. Using an adhesive having a fluorescent property and removal under Ultraviolet light than under White light can efficiently remove the remaining adhesives on tooth surfaces conservatively with ease and less time-consuming. The limitation to this study is with the practical use of Ultraviolet LED light, and also the safety precautions to be taken with the use of Ultraviolet LED light, even though the wavelength of light used falls in the visible light spectrum.

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