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Under the Blue Moon – An Innovation to Visualize and Remove the Residual Adhesive After Debonding

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Abstract: The resin adhesives used during the orthodontic treatment, needremoval a restoration of smooth tooth surface by the end of treatment to prevent accumulation plaque, white spot lesions, etc. If the removal is not carried out carefully, it can ca either enamel damage or adhesive residual on the tooth. The blue light of sh wavelength scatters through the enamel to reflect a bluish-white color, giving to enamel its opalescent quality.The visual aid innovated is the incorporation of a 3mm b LED light to contra-angled micro motor hand piece through an external circuit. The to is illuminated with blue light and due to the difference in the opalescent parameters (C of tooth enamel and adhesive, a clear demarcation of residual adhesive can be observ The removal of residual adhesive is carried out using tapered tungsten-carbide bur #1 in to a low-speed contra-angled micro motor hand piece. Pre-bonding and pc debonding scans when superimposed showed a difference of 0.019mm, indicat minimum enamel loss with the appliance.

Keywords: Debonding, Adhesive removal, Composite removal, Enamel loss, Opalescer of tooth, Blue fluorescent light visualization

Introduction

Orthodontic treatment not only involves aligning the teeth but also restoring the natural tooth structure as was before the beginning of the treatment. Direct bonding of brackets onto the enamel surface was a revolutionary technique in the field of orthodontics. The mechanical interlocking between resin to enamel surface is stronger than the resin-to-metal interface, which leads to more residual adhesive on the tooth surface. The type of adhesives, bracket material, method of debonding with pliers or burs, and finishing can impact the residual adhesive removal. [1]Residual resin identification is difficult due to similar optical properties with enamel. The procedure of debonding brackets post-orthodontic treatment is one of the many causes of enamel damage related to iatrogenicity.[2]

The main concern that arises before the commencement of orthodontic treatment is the esthetic and health of tooth structure post-orthodontic treatment, leading to serious questions regarding the enamel surface loss as mechanical removal has been proved detrimental. The enamel loss during removal of remnant adhesive is estimated to be 14.3-160μm, creating rough surfaces and making the tooth susceptible to accumulation of plaque, demineralization, and enamel discoloration.[3]In a study conducted by Ghaleb L et al, [1] tungsten-carbide burs were deemed superior to diamond burs and sof-lex disc system for adhesive removal as they produced the least enamel roughness when removed with the aid of magnifying loupes.

However, finishing and polishing with Zircate paste and rubber cups was still a supplementary step to restore the smooth tooth surface and required a magnifying loupe for identification of remnant adhesive from the tooth structure.The success of the debonding procedure depends on restoring the tooth surface without losing enamel, while retaining the enamel's original topography.
This article introduces a visual aid for effective removalofremnant adhesive post-debonding. The main goal is to distinguish the adhesive remnants from the tooth surface by utilizing the 'opalescence of human teeth'. The blue light of short wavelength scatters through the enamel to reflect a bluish-white color, giving tooth enamel its opalescent quality.[4]The opalescence of resin materials is caused by the light scatteringfrom the medium consisting of inorganic filler particles andresin matrix of different refractive indices referred to as the 'Rayleigh scattering of light'. [5]The size of the particles determines the amount of light scattering, with smaller filler particles scattering less light and an increase in size of filler particles scattering more light till it reaches the light wavelength, which then gradually decreases with further increase in particle size.

Materials & Method

This study was performed in the Department of Orthodontics and Dentofacial Orthopaedics of Modern Dental College and Research Centre, Indore.

MATERIALS

The materials required for undertaking the study are mentioned as follows:

1. Contra-angled micro-motor handpiece
2. Tapered tungsten carbide #1172
3. Extracted premolars mounted on a typodont
4. 37% phosphoric acid etchant (SS White PROEtch® Acid Etch Gel)
5. 3M UnitekTransbond XT primer and adhesive resin
6. Light curing unit
7. Platform 3D scanner

Appliance Design

The visual aid innovated is the incorporation ofa 3mm blue LED light with the peak of 440 ± 10nm and width of ~100nm [6] to the micromotor handpiece. The light source is powered by a 3W battery through an external circuit (Fig. 1a) and the appliance is set up on the contra-angle handpiece as illustrated in Fig. 1b. The tooth is illuminated with blue light and removal of residual adhesive is carried out using tapered tungsten-carbide bur #1172 on a low-speed contra-angled micromotor handpiece.

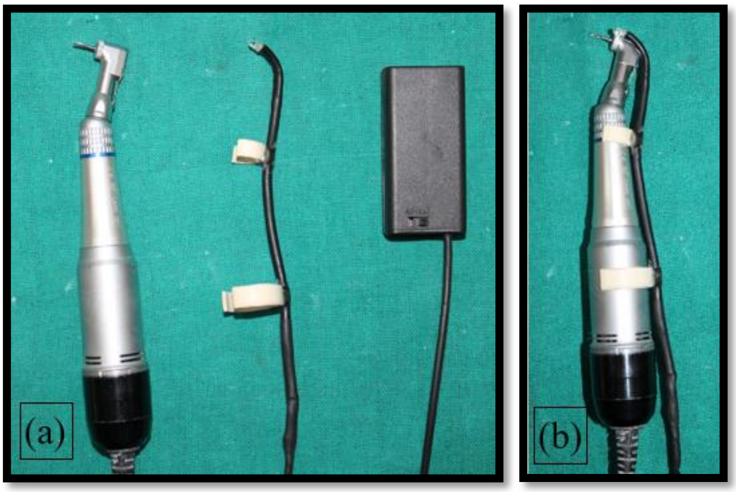

Fig. 1: (a) Components of appliance (b) Appliance Setup.

METHODOLOGY

The experiment was carried out on extracted premolars, mounted on a typodont for replicating the natural dentition. The extracted tooth was scanned by a platform 3D scanner as illustrated in Fig.2to record the natural enamel surface. The tooth surface was etched for 10 seconds with 37% phosphoric acid etchant (SS White PROEtch® Acid Etch Gel), followed by the application of light cure adhesive primer (3M UnitekTransbond^{TM} XT) andlight cure adhesive paste (3M UnitekTransbond^{TM} XT) on the metal bracket base and positioned on the labial surface of the tooth. Excess flash around the bracket was carefully removed and light-cured using a light curing unit (iLed, Guilin Woodpecker Medical Instrument Co. Ltd.) with 1000mW/cm^2 of light intensity, for 5seconds each on the sides of the bracket(Fig. 3). With the help of debonding pliers as shown in Fig. 4, the metal bracket was debonded from the tooth surface The tooth was illuminated with blue light and removal of residual adhesive was carried out using tapered tungsten-carbide bur #1172 into low-speed contra-angledmicromotor handpiece as illustrated in Fig. 5 & Fig. 6.

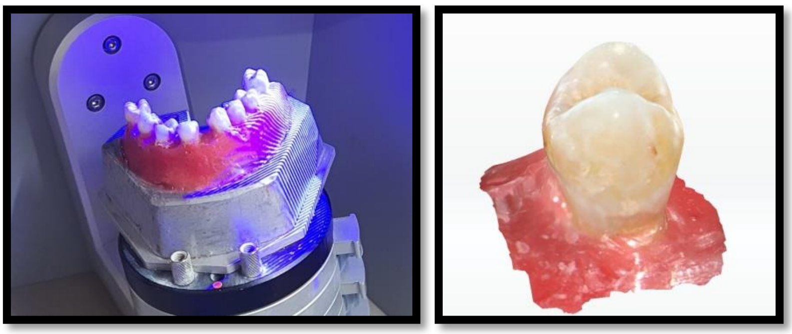

Fig. 2: Scanning of the extracted tooth mounted on a typodont with a platform 3D scanner.

Fig. 3: Bonding of metal bracket on the labial surface of the tooth.

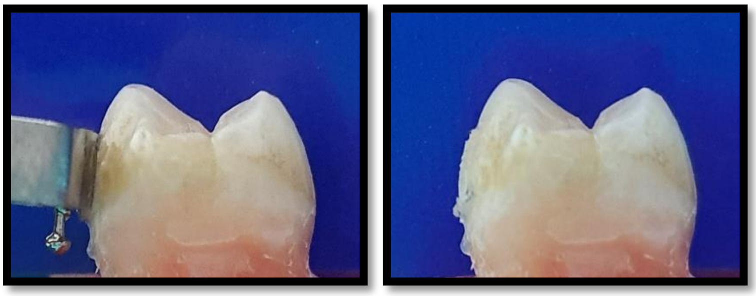

Fig. 4: Metal bracket debonded from the tooth surface using debonding pliers.

Fig. 5: Illumination of the tooth with blue light incorporated into the micromotor handpiece.

Fig. 6: Removal of residual adhesive with a tapered tungsten-carbide burin a contra-angledmicromotor handpiece atlow speed.

Results

After removing the residual adhesive with our innovative design, the tooth surface was again scanned with the platform 3D scanner. The pre-bonding natural enamel surface scan (Fig. 7a) was superimposed withthe post-debonding and removal of residual adhesive scan (Fig. 7b) to evaluate the difference in the enamel surface and enamel loss after debonding (Fig. 7c). Our innovated visual aid helped to easily visualize the residual adhesive and removal was carried out in a precise and effective way. The difference in the enamel layer on the labial surface was observed to be 0.019mm, indicating minimal enamel loss.

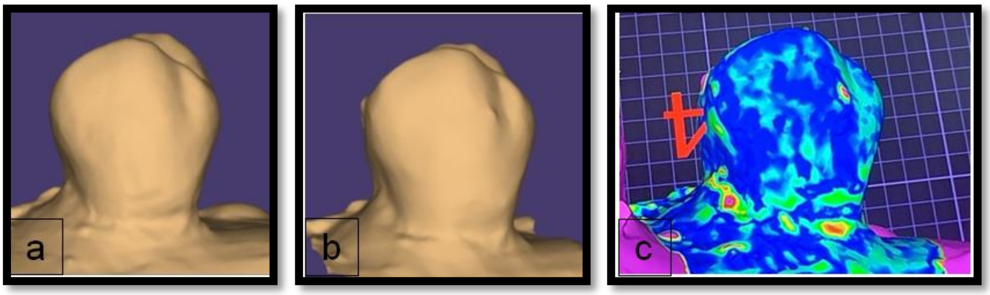

Fig. 7:(a) Pre-bonding scan (b) Post-bonding scan(c) Superimposition of pre-bonding and post-debonding scans.

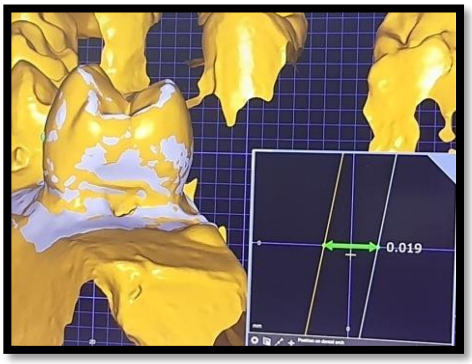

Fig. 8: Enamel surface comparison and evaluation of enamel loss.

Discussion

The optical phenomenon of opalescence arises from the different refractive indicesof spheres and in-between spacescausing shorter wavelengths of visible light to scatter, giving the medium it passes throughan orange-brown hue with transmitted light and a bluish tint with reflected light. In tooth enamel, the short blue wavelengths scatter to create a bluish-white reflection, contributing to its opalescent effect. [4] The enamel's translucent properties enhance the shorter wavelengths of light that interact with it, resulting in the light blue-grey reflections observed in the incisal halo.

In a study done by Lee et al, [7] results showed composite resins to have high opalescence parameters (OP). Commercial resin composite specimens of 1mm thickness had OP values ranging from 5.7 to 23.7, with variations depending on the brand and shade. Among the ten different shades or brands tested, two had OP values of 22.6 and 23.7, three had values between 16.6 and 18.9, and five had values ranging from 5.7 to 6.5. In another study done by Lee et al, [4]human enamel OP values were found to be in the range of 19.8–27.6. Based on these studies, only two of the resin composites had similar OP values to human enamel. The different OP values of resin adhesives and tooth enamel create visually differentiable bluish-grey hues, aiding in the effective removal of resin.

In search of an effective and safe method for adhesive removal from enamel surface various instruments and procedures have been introduced. Some of them include manual instruments such as hand scalers, ultrasonic and laser applications, composite polishing materials like zirconia paste or pumice slurry, Sof-Lex disks, and 8 to 32 fluted tungsten carbide burs for low or high-speed handpieces.[1]Campbell [8]suggested using tungsten-carbide bur of 30 flutes (#246LUF012) ona high-speed handpiece as the most competent mode of resin removal after debonding with lesser scarring clinically. In a study conducted by Albuquerque et al, [9]resin removal with Zatty 934 debonding pliers, 32fluted tungsten carbide bur, and aluminum oxide tipShofuon high-speed were efficient despiteproducing rough enamel surfaces due to the resin being indistinguishable from the enamel surface.Zachrisson and Arthun [10] studied the enamel surface under a scanning electron micrograph post-debonding and polishing with various instruments and concluded spiral-fluted and plain-cut tungsten-carbide fissure burs (Beavers No. 1171) operated at low speed to be efficient as it created finest scratch patterns, least enamel loss and greater accessibility to irregular tooth surfaces. As opposed to Fitzpatrick and Way's study where high-speed burs caused enamel loss of 55 microns, Zachrisson and Arthun's study proved low-speed burs used in painting movements caused the least enamel loss of 5-10 microns.

Tungsten carbide burs are recommended over diamond burs for adhesive resin removal, as they do not damage the enamel layer by creating deep scratches. Even tungsten carbide burs used at low speed did not provide effective removal as the main cause for enamel damage was the similar optical properties of adhesive resin and tooth enamel, which caused the clinician to often damage the tooth surface during the debonding procedure. This study proved the appliance to be a reliable source for efficient resin removal, utilizing the phenomenon of opalescence to visually differentiate the remnants of adhesive resin from the tooth surface post-debonding. The enamel layer scans pre-bonding and post-debonding when superimposed showed a minimal enamel layer difference of 0.019 mm, which was in the range of least enamel loss. The appliance consisting of blue light illuminated the tooth surface and adhesive removal was carried out, since the appliance can be attached to the micro-motor handpiece and no additional assistance was required for using the appliance, it rendered a greater advantage to the clinician.

Conclusion

Orthodontic treatment not only involves aligning the teeth but also restoring the natural tooth structure as was prior to the beginning of the treatment. Our innovative design utilizes blue light for precise removal of residual adhesive, preserving natural tooth structure without enamel damage at the end of treatment.

The various advantages of the innovative design are:

1. Easy chair-side visualization of remnant adhesive after debonding.

2. Residual adhesive removal with low to minimum enamel loss.
3. Does not require a dark room while illuminating and visualizing the adhesive material (as required in fluorescent-aided removal of residual adhesive).
4. Designed to be compatible with a micromotor handpiece.
5. Easy to sterilize.

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