Review article | International Journal of Dental Materials 2022;4(3) | ISSN:2582-2209

Materials and methods used for adhesive remnant removal and polishing of enamel after orthodontic treatment: a review

Pradeep Kandikatla[1,*], Priyanka Polineti[2], Ushasree R[3], Pavan Kumar Chiluvuri[4]
[1]Reader, [2]Postgraduate Student, Department of Orthodontics and Dentofacial Orthopedics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
[3]Reader, Department of Orthodontics and Dentofacial Orthopedics, Lenora Dental College, Rajahmundry, Andhra Pradesh, India., India.
[4]Reader, Department of Orthodontics and Dentofacial Orthopedics, Konaseema Institute of Dental Sciences, Amalapuram, Andhra Pradesh, India.

Article History

Received 13th *June 2022*
Received revised 15th *August 2022*
Accepted *20th August 2022*
Available online *25th August 2022*

*Correspondence

Pradeep Kandikatla
Reader,
Department of Orthodontics,
Vishnu Dental College, Bhimavaram,
Andhra Pradesh, India
E-mail: *pkandikatla@gmail.com*
DOI: *http://dx.doi.org/10.37983/IJDM.2022.4303*

Abstract

Brackets are generally debonded and remaining adhesive is removed at the end of the orthodontic treatment. There are different methods for adhesive removal of which few methods have a chance of damaging enamel and roughen the tooth surface which can lead to plaque accumulation, discolouration, and aesthetic problems. Enamel polishing after debonding is one strategy to decrease such consequences. Several enamel cleaning and polishing methods include Sof-Lex discs, TC burs, ultrasonic tools, hand instruments, rubbers, composite burs, Arkansas stones, green stones, diamond burs, steel burs and lasers. Each method has some advantages and some lacunae. To be precise soflex discs and TC burs have less damage on enamel than other methods, i.e., Arkansas stone and greenstone. This article is a review of available different enamel cleaning and polishing methods after debonding, their advantages and disadvantages.

Keywords: Dental enamel, Debonding, Enamel polishing, Adhesive remnant removal.

1. Introduction

Active orthodontic treatment ends with debonding of brackets. Equipment utilized or type of plier used for debonding, residual resin removal techniques, the adhesive employed, and the operator's skills are critical aspects of bracket debonding [1]. After bracket debonding, the leftover resin must be removed efficiently and rapidly while preserving the topography of the enamel surface. The enamel surface must also be smoothed and polished to minimize plaque accumulation [2]. The rough surface prevents appropriate cleaning and encourages plaque deposition, bacterial retention, and stain formation, detracting from the teeth's aesthetic appeal. It's challenging to return enamel to its previous morphology [3].

Moreover, research on better adhesive removal methods which can effectively remove the residual resin and restore it best to its original form is continuing till date. With the evolution of composite resin and adhesive systems, more effective bonding between enamel and resin can be achieved, resulting in fewer bracket debonding rates. But, due to this increased resin adhesion to the enamel surface, resin removal after debonding becomes more troublesome. So, the technique used for residual resin removal plays a vital role in avoiding enamel surface damages, such as enamel cracks, rougher enamel surface, wear of enamel, overheating of the teeth, and pulpal damage [4].

Debonding and adhesive resin removal techniques are operator-dependent procedures. Thus, the results may probably differ among operators. Furthermore, one can achieve better resin removal and minor enamel damage by using a dental loupe that can affect the debonding procedure quality [5,6]. The present article gives a comprehensive review of evolution of different materials used to remove remanent orthodontic adhesive and polish the enamel surface post debonding the surfaces.

2. Classification [5]

- Materials used for remanent adhesive removal
- Materials used for adhesive removal and enamel polishing
- Materials used for enamel polishing

2.1 Materials used for remanent adhesive removal

2.1.1 Greenstone, Whitestone

The removal of residual resin with green and white stones (Figure 1) was effective. However, deep grooves were cut in enamel as the resin was removed. While a white stone reduced the size of the grooves, it did so at the expense of tissue removal. Nonetheless, many more minor scratches persisted following pumicing [8]. A study done by Sugsompian *et al.* [9] shows numerous fine scratches, some crack lines, and some on the teeth polished with a white stone bur; deep and coarse grooves parallel to the movement of the bur were apparent.

2.1.2 Green rubber wheel

The green rubber wheels (Figure 2.) range from mildly abrasive pumice wheels to medium-abrasive aluminium oxide (Al_2O_3) wheels to more abrasive silicon carbide wheels. The abrasives come in different sizes and shapes. In addition, the rubber binder itself may be soft, medium, or hard, synthetic or natural. A green rubber wheel may be used for bulk reduction or to abrade the remaining resin. A consistent application of air must accompany this because the rubber wheel generates heat. In a study done by Zachrisson *et al.*, [10] the surface will appear smooth and shiny after the green rubber wheel, but a few scratches similar to those caused by the medium-grit sandpaper disks remained on the tooth surface.

2.1.3 Sandpaper disks

The medium sandpaper disks (Figure 3) were relatively slow and ineffective in removing bulky remnants of resin. While they produced a clinically visible polish, the medium disk removed enamel in varying degrees. They were frequently causing some faceting and introducing scratches. While some facets persisted, scratches were reduced with fine disks [8].

2.1.4 Finishing and acrylic burs

These finishing burs (Figure 4) helps in effectively removal all types of resins. The removal rate was more significant at high speed (above 20,000 RPM) than at low speed (about 2,000 RPM). A more considerable enamel loss occurred with tungsten carbide burs at high speed and low speed with steel bars [8].

2.1.5 Air-abrasion

The standard abrasives used are Arizona sand of 0 – 80 μm and 0 - 200 μm particle size, Alumina particles of 1 - 3μm, and Sand with particle sizes of 11 – 13μm, 15 - 20μm, 20 - 24μm, 28 – 32μm and 42 – 52μm [7].

Dental air-abrasion with alumina is a minimally invasive procedure that utilizes the acceleration of abrasive particles in a stream of compressed gas directed to the tooth using a nozzle as shown in figure 5. Alumina air-abrasion (AAA) is effective in removing the composite at a higher rate than sound enamel, indicating that it may be possible for this technique to be used to remove residual orthodontic adhesive resin on sound teeth. However, several mild, rough, and short distributed microscopic scratches with a few shallow pits were seen over the abraded area on the teeth polished with the sandblaster under a SEM [9]. While AAA showed an enamel loss of 0.386 mm, Bioactive glass showed an enamel loss of 0.135mmunder a SEM [11]. Arizona sand showed highest abrasion activity.

2.1.6 Ultrasonic and hand scalers

Rotary instrument is the contemporary technique to remove adhesive. Mechanical elimination of adhesives, which are tooth-coloured materials, is associated with damage to the enamel surface. Ultrasonic hand scalers (Figure 6) and low-speed handpiece with abrasive create visible surface roughness, 10-20 μm deep gouges, and loss of 100 μm thickness of enamel. Also, enamel abrasion depended on the size and composition of the abrasive particles, the rotational speed, and the pressure against the enamel surface [12,13]. The Ultrasonic proved to be inefficient in adhesive removal, as it consumed significantly more time and tremendous operator pressure. These two factors, combined with the vibratory nature of the Ultra Sonic, may account for the large amount of damage caused, in particular to demineralized enamel. SEM image analysis of enamel following US adhesive removal showed significant surface damage and the presence of some residual adhesive. Large areas of enamel loss are seen in the centre of the crown [12,13].

Figures 1 – 8: 1. Green stone and white stone, 2. Green rubber wheel, 3. Sandpaper discs (courtesy: Ace dental supplies), 4. Finishing and acrylic burs (courtesy: Ortho technology), 5. Air abrasion (courtesy: Dental sky), 6. Ultrasonic and Hand scalers, 7. 12-fluted tapered TC bur (courtesy: ortho technology), 8. 30-fluted tapered TC bur (courtesy: Strauss diamond)

2.1.7 Lasers used for adhesive removal

2.1.7.1 CO_2 laser:

Pulsed CO_2 laser energy is very efficient at removing remnants of adhesive resin. Notably, the 2 W/100 msec setting appears to be the minimal laser setting required for complete resin penetration and thus gives the optimal balance between resin removal and coincident enamel damage. Smith *et al.* [14] identified discrete patches of enamel damage (diameter 750 pans) corresponding to the impact sites of distinct laser pulses. The depths of the craters corresponded to the pulse durations used. Large, elongated craters and surface cracks were also prominent. These features were less marked with lower laser powers and shorter pulse durations, and in some instances, no cratering was evident [14].

2.1.7.2 Er: YAG

Er: YAG laser removed more enamel than TC bur. Er: YAG laser caused significantly more severe enamel damage than TC burs [15]. Er: YAG laser was the slowest to remove adhesive residue [16]. In a study done by Ahrari *et al.* [16] Er: YAG laser created the roughest enamel surface and took the longest time to remove adhesive.

2.1.8 The 12-fluted tapered TC burs

The 12-fluted tapered TC burs (Figure 7) are used with a brushstroke by high-speed handpiece with water cooling. A study done by Khatria *et al.* showing horizontal scars with a consistent pattern found carbide bur at high speed to be efficient in residual resin removal but, when used alone, failed to produce a satisfactory enamel surface [18]. In a study by Ulusoy *et al.*, the 12-blade bur had deeper scratches at high speed [19].

2.1.9 The 30-fluted tapered TC burs

The 30-fluted tapered TC burs (Figure 8) are used with a brushstroke by high-speed handpiece with water cooling. The enamel surface was also less scarred with the 30-fluted TC burs. Cleaning the leftover resin with 30-fluted TCB took the least amount of time. Ulusoy *et al.* [19] found that employing 30-fluted TCB on the enamel surface resulted in decreased scarring on the enamel surface. On the other hand, both burs left remain on the enamel surfaces. TC bur was the quickest but most hazardous to the enamel [20].

Speed of handpiece is one of the critical issues while removing adhesive resin with the handpiece. A low-speed rotary instrument creates additional vibrations and makes uncomfortable for patients [21]. However, previous studies found that effective adhesive removal was achieved with low-speed burs more than with high-speed burs since both the depth and the area of the residual resin layer were significantly lower after using low-speed burs. Özer T *et al.* [22] and Bishara *et al.* [23] observed that enamel loss was less with low-speed burs than high-speed burs.

2.2 Materials used for adhesive removal and enamel polishing

2.2.1 Sof-Lex discs (3M ESPE, St Paul, Minn)

The Sof-Lex finishing, and polishing discs (Figure 9) are made from a urethane-coated paper that gives the discs their flexibility. This multi-step system is comprised of four individual aluminium oxide grits ranging from coarse, medium, fine and superfine [24] and whose colour and particle sizes are given in table 1.

For each polishing step, Soflex (3M ESPE) bulk and medium granulation discs were used with low pressure for leftover adhesive removal, and fine and ultra-fine granulations for 20 seconds. Final polishing was done with Enamelize – Cosmedent polishing paste applied with felt discs for 20 seconds. Discs were used with a low-speed handpiece at a speed of 10,000 rpm because higher speeds than 15,000 rpm may generate excess heat, dislocate the disk and cause injury [24,25].

Residual resin removal with Sof-Lex aluminium oxide abrasive discs showed a decrease in surface irregularities, but scratches were seen in every direction [26]. Sugsompian *et al.* [9] found that the teeth polished with Sof-Lex disc had uniform and smooth surfaces with some minor shallow scratches.

Table 1. The colour and particle size of various Sof-Lex discs.

Disc type	Colour	Particle size
Coarse	Dark orange	100 µm
Medium	orange	40 µm
Fine	Light orange	25 µm
Super fine	Yellow	8 µm

2.2.2 Sof-Lex spiral wheels

The Sof-Lex spiral wheels (Figure 10) are flexible enough to adapt to anterior and posterior tooth surfaces. The spiral "fingers" adhere to convex and concave surfaces as they go through the repair. There's no need to change shapes to accommodate different contours. You may use just one shape to replace specific points, cups, discs, and brushes and obtain a gorgeous, lifelike shine. Spirals should be utilized with a handpiece that spins at a modest speed of 15,000–20,000 rpm. The suggested rpm range has been evaluated to achieve paste-like gloss without intraoral diamond paste. This rpm range is usually the maximum speed when utilising a slow-speed handpiece. At speeds below 10,000 RPM, traditional rubber-based points, cups, or wheel finishing and polishing methods are typically employed [27]. Spirals should be utilized with a handpiece that spins at a modest speed of 15,000–20,000 rpm. The suggested rpm range has been evaluated to achieve paste-like gloss without the use of intraoral diamond paste. When utilizing a slow-speed handpiece, this rpm range is usually the maximum speed. At speeds below 10,000 rpm, traditional rubber-based points, cups, or wheel finishing and polishing methods are typically employed. Abrasive particles are embedded throughout the spiral to be used from any angle. It is recommended to use medium to moderate pressure when polishing a surface. The polishing surface should not come into contact with the central hub. When polishing, applying too much pressure or touching the corner may restrict the number of times a spiral may be used or remove it from the mandrel. Before using, inspect each spiral and eliminate notched or missing bristles. Dispose of used spirals according to the policies of your healthcare facility [27].

2.2.3 Super-Snap discs

The Super-Snap discs (Shofu, Kyoto, Japan) are available with three grades: the medium grade (purple disk), which was used for removing gross remnants of adhesive, and the fine (green disk) and superfine (red disk) grades (Figure 11). The Shofu polishing system, Compomaster, widely used in Japan, has 6-µm Diamond abrasive particles that are dispersed and held in softer, elastomeric or rubberlike rotary devices. Super Snap Extreme is a recent next-generation enhancement to the original green and red Super-Snap disks of the Super Snap Rainbow kit. Super Snap Xtreme is an aluminium coated abrasive disc, and strips are made by bonding abrasive particles onto a thin polymer or plastic backing. Starting with a coarser grit disc and ending with a superfine grit disc, they are utilized in a sequence of grits. Manufacturers claim that the main feature of Super Snap Extreme is a 3D X-Tra coating on a superfine red disk, semi-spherical shaped grits covering the surface. The super-Snap polishing kit produces decreased surface roughness compared to the Sof-Lex polishing kit [28]. The New 3D coating maintains a smoother polishing surface and reduces clogging and secondary scratches. It allows space for ground debris discharge and reduces generated heat without any denaturing of the material. Super-Snap aluminium oxide discs provide good surface smoothness as these discs do not displace the composite fillers.

Figures 9 – 13: 9. Sof-Lex discs (courtesy:3M), 10. Sof-Lex spiral wheels (courtesy:3M), 11. Super-Snap discs (courtesy: Shofu), 12. Zirconia Debonding Bur (courtesy: DSI), 13. Stain buster (courtesy: Patterson dental).

Discs have long been used to polish enamel surfaces, and they have a reputation for producing the best polish when the residual resin has been removed [29]. Super Snap discs resulted in an enamel surface that was smooth and homogenous, with fewer scratches [18].

2.2.4 Zirconia Debonding Bur

Zirconia bur (Figure 12) is made of tough material that can withstand pressure. The sterilization procedure for this device is the same as for other surgical instruments: Remove deposits with water, a plastic brush, and detergent enzyme after using the bur, then sanitize by autoclaving at 134° C for 15 minutes. The suggested speed is between 10,000 and 20,000 rpm. DSI Adhesive Removal Bur features a rounded safety tip, unlike conventional adhesive removers on the market with a sharp or tapered end. The entire bur is built of a single piece of one-of-a-kind ceramic called yttrium-stabilized nano-structure zirconia. There is no literature on this polishing system; further studies have to be done on the effectiveness of the bur.

2.2.5 Stain buster

A new innovative composite bur enriched with zirconia-rich glass fibre has gained attention. This fibre-reinforced composite bur is a Stain buster (Abrasive Technology Inc., Lewis Centre, Ohio) (Figure 13). The unique characteristic of these burs is the fibre sections with abrasive powers covering the entire working surface and splitting up into tiny fragments as when they acted upon a hard surface. As the resin matrix is used up, new sections of fibres are exposed; STAINBUSTER burs are therefore self-sharpening and maintain continuous abrasive power. A study done by shah *et al.* showed that Stain buster bur seemed to be a very efficient way to clean the surface. This qualitative result of smoothest surface achieved with Stain buster bur agreed with their quantitative result [3,24].

2.3. Materials used for enamel polishing

2.3.1 One Gloss polisher

The latest addition to Shofu's abrasives and polishers' range is One gloss (Figure 14). One gloss is an aluminium oxide finisher and polisher, which provides an excellent finish for all types of composite and cemented restorations [29]. It may finish and polish all composite restorations with this one-step finisher and polisher by simply increasing the contact pressure on the repair without changing the instrument. One gloss can also be used to remove stains or excess resin cement from tooth surfaces without harming the enamel, which has proven to be very effective in orthodontic situations and post-scaling polishing, minimizing chairside time. One gloss comes with 60 polishers (20 of each shape: Cup, Midi Point, and Inverted Cone) and three mandrels, as well as instructions. OneGloss is polyvinylsiloxane impregnated with aluminium oxide. The excellent polishing ability of PoGo may be attributed to lower surface roughness and harder diamond (7000 KHN) particles compared to one gloss polisher aluminium oxide particles (2100 KHN).

2.3.2 PoGo Polishers

Recently, diamond or silicon carbide coated polishers were introduced to reduce chair time. The one-step PoGo Polishers (discs, cups and points) (Figure 15) are single-use diamond-impregnated polishing devices designed for use without water in the final polishing of composite resin restoration [30-33]. Yap *et al.* and St Georges *et al.* used PoGo micro polishers on composite surfaces without pre-treatment. Although few remnants were left on the enamel surface, which may be the remainders of fine diamond powder integrated into the polishing device, the one-step diamond coated PoGo micro-polishers produced the best surface finish scratches in the present study. Turku *et al.* showed that micro pogo polishers had surface roughness comparable to Mylar strips for resin composites [31]. PoGo micro polishers, when used without any pre-treatment, are effective in removing the residual remnants and returning the enamel as closely as possible to its original state. On the other hand, this method is the most time-consuming. PoGo micro-polishers combined with 30-fluted TCB cleaned the residual remnants from the enamel surfaces in a shorter time. Still, this method was not efficient in removing the scratches on the enamel surface produced by the bur. PoGo micro-polisher had the best surface without any scratches, although a few remnants were observed on the surface [19].

2.3.3 Opti Shine

Opti Shine (Figure 16) is a concave-shaped brush with silicon carbide polishing particles embedded in the bristles. The manufacturer recommends using the Opti Shine brush without a polishing paste. When used without pre-treatment on the enamel surface, a one-step Opti Shine brush should be the least preferred method for removing the residual resin after debonding brackets. Silicon carbide impregnated one-step Opti Shine brush caused severe roughness with islets of residual resin remnants on the enamel surface. Also, a lot of worn-out bristles were observed on the enamel surface. This method was not efficient for cleaning the enamel surfaces after debonding of brackets [19].

2.3.4 Porte polisher

A hand-held gadget with an orange-wood point is a porte polisher (Figure 17). This tool can be utilized on a variety of dental issues. It uses a wedge-shaped, tapered, or pointed wooden point to rub the abrasive substance against the tooth surface. Advantages of this method are transportable: it can be accessed through misaligned tooth surfaces, produces only a little amount of thermal heat, doesn't make as much noise as rotating instruments, and bacterial aerosol is kept to a minimum. However, instrumentation demands more hand strength, and cleaning teeth takes longer duration [34].

2.3.5 Engine-driven polishers

The Engine-driven polishers are popular among dentists and dental hygienists because of their efficiency and effectiveness. These polishers have straight, or contra-angled shanks attached to the appropriate handpiece or prophy-angle (Figure 18). After sterilization, they might be either disposable or reusable. The prophy-angle is equipped with a rubber cup or brush. Always utilize the handpiece at a slow, consistent 2500–3000 rpm speed [35]. In an in vivo clinical study, Christensen and Bangerter reported that the average speed used by dental hygienists was 2500 rpm [36]. Because estimating rpm in clinical practice is challenging, and the slow speed handpiece is always rotated at the slowest rpm possible. The rpm is too high if a "whining" or high-pitched sound occurs [36]. Most surfaces may be polished in 2–5 seconds using a light, consistent patting stroke. According to Christensen and Bangerter, the rubber cup contacted each tooth surface for 4.5 seconds. Miller and Hodges observed that treating the entire mouth took 10 minutes (3.4 seconds per tooth) when standardizing polishing time in a research study comparing rubber cups with air-polishing [34]. The applied pressure should be around 20 psi [37]. When a rubber cup fails to remove occlusal stains, a brush should be used to avoid traumatizing the soft tissue, which is challenging to regulate. Contraindications: Rubber cup latex-free products, prophy pastes, and pumice slurry without fluoride should be used in patients with latex or fluoride allergies [37]. Rubber cups, sometimes known as prophy cups, are employed in the handpiece. Prophy cups come in two sizes: 4 webs and 6 webs. The rubber cups are used in conjunction with prophylactic polishing, including fluoride. Rubber cups should not be used on top of the cementum because they risk losing the cementum covering from the cervical region. The risk of generating frictional heat and increased abrasion to the tooth surface may result from increased contact time, increased rotation speed, and increased cup pressure on the tooth. Short intermittent strokes should be used to avoid damage [27].

Figures 14 – 20: 14. One Gloss polisher (courtesy: Shofu), 15. PoGo Polishers (courtesy: Dentsply Sirona), 16. Opti Shine (courtesy: Kerr), 17. Porte polisher (courtesy: Patterson dental), 18. Engine-driven polishers (courtesy: iClean), 19. Pumice (courtesy: Henry Schien.com), 20. Diamond polishing paste (courtesy: Ultradent.com).

2.3.6 Pumice

Pumice is a light grey, an extremely siliceous substance that forms due to volcanic activity [38]. Pumice flour (Figure 19) is a finely ground derivative used to polish tooth enamel, gold foil, dental amalgam, and acrylic resins [38]. Chalk, also known as calcium carbonate, is less abrasive than pumice. It results in a highly reflecting surface with minimum scratches. The efficiency of pumice flour in removing stains from enamel has been studied. With pumice powder, the average abrasive depth of enamel is significant (12.1 m on a scale of 15.6 m to 1 m), and the polishing score is average. Calcium carbonate leaves a smooth, polished surface with minimal scratches [39].

2.3.7 Diamond polishing paste

The diamond pastes (Figure 20.) mainly contain: diamond grains (1–6 mm), fine other oxides (less than 0.5 mm) such as anatase (TiO_2), corundum (Al_2O_3), zinc oxide (ZnO), Pumice (SiO_2) [40].

These diamond pastes are usually used to polish with plastic or rubber cone, and a soft brush ''Super snap buff disk'' consists of TiO_2 and polyester. ''PTC Cup'' consists of TiO_2, ZnO, and artificial rubber. ''Robinson brush'' consists of hard fibres such as horsehair or soft fibres such as sheep hair. Available as ''DirectDia paste'' and ''Diapolisher paste'' [41].

3. Conclusion

All the methods used for adhesive removal and polishing of the enamel surface have some change in the topography and roughness of the enamel. The orthodontist must have knowledge and awareness regarding different protocols and techniques which cause minimum damage to the patient and preserve the integrity of the enamel to the original condition. In the available materials and methods, TC burs and Soflex cause less surface irregularity than Arkansas and Greenstone. However, it also depends on the orthodontist and their choice of material of his own; careful selection and employing the technique prevent the adverse effects. Thus, the protocol causing the least surface roughness adhesive removal is preferable.

Conflicts of interest: Authors declared no conflicts of interest.

Financial support: None

References

1. Sigilião LC, Marquezan M, Elias CN, Ruellas AC, Sant'Anna EF. The efficiency of different protocols for enamel clean-up after bracket debonding: an in vitro study. Dental Press J Orthod. 2015;20(5):78-85. https://doi.org/10.1590/2177-6709.20.5.078-085.oar
2. Zarrinnia K, Eid NM, Kehoe MJ. The effect of different debonding techniques on the enamel surface: an in vitro qualitative study. Am J Orthod Dentofacial Orthop. 1995;108(3):284–293. https://doi.org/10.1016/S0889-5406(95)70023-4
3. Shah P, Sharma P, Goje SK, Kanzariya N, Parikh M. Comparative evaluation of enamel surface roughness after debonding using four finishing and polishing systems for residual resin removal—an in vitro study. Progress in Orthodontics. 2019;20(1):1-10.https://doi.org/10.1186/s40510-019-0269-x
4. Almeida HC, Vedovello Filho M, Vedovello SA, Young AAA, Ramirez-Yanez GO. Er: YAG laser for composite removal after bracket debonding: a qualitative SEM analysis. Int J Orthod. 2009;20(1):9–13.
5. Goel A, Singh A, Gupta T, Gambhir RS. Evaluation of enamel surface roughness after various bonding and clean-up procedures on enamel bonded with three different bonding agents: an in-vitro study. J Clin Exp Dent. 2017; 9(5):608–16. https://doi.org/10.4317/jced.53237
6. Baumann DF, Brauchli L, van Waes H. The influence of dental loupes on the quality of adhesive removal in orthodontic debonding. J Orofac Orthop. 2011;72:125-32. https://doi.org/10.1007/s00056-011-0010-y
7. Mashloosh KM, Eyre TS. Abrasive wear and its application to digger teeth. Tribology Int. 1985;18(5):259-66. https://doi.org/10.1016/0301-679X(85)90104-5
8. Gwinnett AJ, Gorelick L. Microscopic evaluation of enamel after debonding: clinical application. Am J Orthod. 1977;71(6):651-65. https://doi.org/10.1016/0002-9416(77)90281-0
9. Sugsompian K, Tansalarak R, Piyapattamin T. Comparison of the Enamel Surface Roughness from Different Polishing Methods: Scanning Electron Microscopy and Atomic Force Microscopy Investigation. Euro J Dent. 2020;14(02):299-305. https://doi.org/10.1055/s-0040-1709945
10. Zachrisson BU, Årthun J. Enamel surface appearance after various debonding techniques. Am J Orthodont. 1979;75(2):121-37. https://doi.org/10.1016/0002-9416(79)90181-7
11. Banerjee A, Paolinelis G, Socker M, McDonald F, Watson TF. An in vitro investigation of the effectiveness of bioactive glass air-abrasion in the 'selective removal of orthodontic resin adhesive. Euro J Oral Sci. 2008;116(5):488-92. https://doi.org/10.1111/j.1600-0722.2008.00561.x
12. Cochrane NJ, Ratneser S, Reynolds EC. Effect of different orthodontic adhesive removal techniques on sound, demineralized and remineralized enamel. Aust Dent J. 2012;57(3):365-72. https://doi.org/10.1111/j.1834-7819.2012.01713.x
13. Oliver RG, Griffiths J. Different techniques of residual composite removal following debonding—time is taken and surface enamel appearance. Brit J Orthodont. 1992;19(2):131-7. https://doi.org/10.1179/bjo.19.2.131
14. Smith SC, Walsh LJ, Taverne AA. Removal of orthodontic bonding resin residues by CO_2 laser radiation: surface effects. J Clin Laser Med Surg. 1999;17(1):13-8. https://doi.org/10.1089/clm.1999.17.13
15. Almeida HC, Vedovello Filho M, Vedovello SA, et al. Enamel surface after debracketing of orthodontic brackets bonded with flowable orthodontic composite. A comparison with a traditional orthodontic composite resin. Int J Orthod Milwaukee. 2009;20:9–13.
16. Order EA, Akın M, Cime L, İleri Z. Evaluation of enamel surface roughness after various finishing techniques for debonding of orthodontic brackets. Turk J Orthod. 2016;29(1):1. https://doi.org/10.5152/TurkJOrthod.2016.15-00016R1
17. Ahrari F, Akbari M, Akbari J, Dabiri G. Enamel surface roughness after debonding orthodontic brackets and various clean-up techniques. J Dent (Tehran). 2013;10:82–93.
18. Khatri H, Mangla R, Garg H, Gambhir RS. Evaluation of enamel surface after orthodontic debonding and clean-up using different procedures: An in vitro study. J Dent Res Rev. 2016;3(3):88-93. https://doi.org/10.4103/2348-2915.194832
19. Ulusoy Ç. Comparison of finishing and polishing systems for residual resin removal after debonding. J Appl Oral Sci. 2009;17(3):209-15. https://doi.org/10.1590/S1678-77572009000300015
20. Campbell PM. Enamel surfaces after orthodontic bracket debonding. Angle Orthod. 1995;65(2):103-10.
21. Nazir S, Cheema JA, Ahmed F, Khan UQ, Alam MA, Rehman ST. Comparing enamel surface roughness parameters for resin removal following debonding using tungsten carbide bur and soflex discs with high speed and low-speed handpieces. Pak Oral Dent J. 2020;40(1):20-3.
22. Özer T, Başaran G, Kama JD. Surface roughness of the restored enamel after orthodontic treatment. Am J Orthod Dentofac Orthop. 2010;137(3):368-74.

https://doi.org/10.1016/j.ajodo.2008.02.025

23. Bishara SE, Ortho D, Truiove TS. Comparisons of different debonding techniques for ceramic brackets: an in vitro study: Part I. Background and methods. Am J Orthodont Dentofac Orthoped. 1990;98(2):145-53. https://doi.org/10.1016/0889-5406(90)70008-Z
24. Challa P, Chakravarthi S, Yudhistar PV, Rayapudi N. Evaluation of one-step micro polishers for residual resin removal after debonding on fluorosis teeth. APOS Trends Orthod. 2014;1(5):121-5. https://doi.org/10.4103/2321-1407.139497
25. Fan XC, Chen L, Huang XF. Effects of various debonding and adhesive clearance methods on enamel surface: an in vitro study. BMC Oral Health. 2017;17(1):1-10. https://doi.org/10.1186/s12903-017-0349-6
26. Uçtasli MB, Arisu HD, Omürlü H, Eligüzeloglu E, Ozcan S, Ergun G. The effect of different finishing and polishing systems on the surface roughness of other composite restorative materials. J Contemp Dent Pract 2007; 8(2):89-96. https://doi.org/10.5005/jcdp-8-2-89
27. Reddy VR, Jaiswal S, Chandrashekar B, Chandra A, Priyanka M. Finishing and polishing of composite's–A review. IP Indian Journal of Conservative and Endodontics. 2021;6(1):7-10. https://doi.org/10.18231/j.ijce.2021.003
28. Zarrinnia K, Eid NM, Kehoe MJ. The effect of different debonding techniques on the enamel surface: An in vitro qualitative study. Am J Orthod Dentofacial Orthop 1995; 108:284-93. https://doi.org/10.1016/S0889-5406(95)70023-4
29. Now Y. Made-to-measure restorations. Brit Dent J. 2010;209(6): 316. https://doi.org/10.1038/sj.bdj.2010.873
30. Karan S, Kircelli BH, Tasdelen B. Enamel surface roughness after debonding: comparison of two different burs. The Angle Orthodontist. 2010;80(6):1081-8. https://doi.org/10.2319/012610-55.1
31. Türkün LS, Türkün M. The effect of one-step polishing system on the surface roughness of three esthetic resin composite materials. Oper Dent. 2004; 29(2):203–211.
32. Uysal T, Eldeniz AU, Usumez S, Usumez A. Thermal changes in the pulp chamber during different adhesive clean-up procedures. Angle Orthod. 2005; 75(2):220–5.
33. Yap AU, Yap SH, Teo CK, Ng JJ. Finishing/polishing of composite and compomer restoratives: Effectiveness of one-step systems. Oper Dent. 2004; 29(3):275–279.
34. Sawai MA, Bhardwaj A, Jafri Z, Sultan N, Daing A. Tooth polishing: The current status. J Ind Soc Periodontol. 2015;19(4):375. https://doi.org/10.4103/0972-124X.154170
35. Rethman J. Polishing angles, cups and pastes. Pract Hyg 1997;1:32-3. Retraction in: Madan C, Bains R, Bains VK. Tooth polishing: Relevance in present-day periodontal practice. J Indian Soc Periodontol 2009;13:58-9. https://doi.org/10.4103/0972-124X.51899
36. Christensen RP, Bangerter VW. Determination of rpm, time, and load used in oral prophylaxis polishing in vivo. J Dent Res 1984;63(12):1376-82. https://doi.org/10.1177/00220345840630120701
37. Hodges K, editor. Concepts in Nonsurgical Periodontal Therapy. New York: Delmar; 1998. p. 345-66.
38. Alla RK. Abrasion and Polishing (in) Dental Materials Science. 1st Edition, Jaypee Medical Publishers Pvt. Ltd., 2013; 360-69. https://doi.org/10.5005/jp/books/12018_18
39. Retief DH, Denys FR. Finishing of enamel surfaces after debonding of orthodontic attachments. The Angle Orthodontist. 1979;49(1):1-0.
40. Ban S. Polishing of zirconia full contour restoratives and antagonist wear. QDT. 2012;32:1240-54.
41. Miyazaki T, Nakamura T, Matsumura H, Ban S, Kobayashi T. Current status of zirconia restoration. J Prosthodont Res. 2013;57(4):236-61. https://doi.org/10.1016/j.jpor.2013.09.001

How to cite this article: Kandikatla P, Polineti P, Ushasree R, Chiluvuri PK. Materials and methods used for adhesive remnant removal and polishing of enamel after orthodontic treatment: a review. Int J Dent Mater. 2022;4(3):62-68. DOI:*http://dx.doi.org/10.37983/IJDM.2022.4303*