Review Article

Iatrogenic Effects of Bonding in Orthodontics - A Narrative Review

Helen Rachel Xavier[1], U B Rajasekaran[2], Aniruddh V Yashwant[3], Vijay Kumar V[4], Lijin James[5], Basil Joseph[6]

ABSTRACT

Various procedures performed from the start till the end of orthodontic treatment such as bonding and debonding involve profound care and caution by the clinician. This can prevent iatrogenic effects of bonding procedures such as occurrence of white spot lesions, enamel cracks, tearouts and irreversible damage to the pulp. This review focuses on the various iatrogenic effects encountered and the possible precautions to be taken to prevent these effects from occurring.

Key words: Iatrogenic, Enamel cracks, White spot lesions (WSL).

Introduction

The success of orthodontic treatment depends upon the clinical efficiency of the orthodontist in procedures right from start of bonding procedure until debonding and retention reviews. Though the clinician aims to deliver the ideal and non iatrogenic treatment to the patient, inadequate attention to bonding and debonding procedures might cause more harm to the enamel and surrounding dentoalveolar structures at the end of treatment.

The common iatrogenic effects of orthodontic treatment as a whole involves local (discoloration of teeth, decalcification of teeth, periodontal problems and root resorption) [1, 2, 3] and systemic (allergic reactions) [4].Both the clinician and the patient should be aware of these risks so that they can fulfill their responsibilities during the treatment period. This helps to bring a successful result without any adverse effects. This narrative review will provide an overview on the precautions taken during procedures in orthodontic bonding and the iatrogenic effects that may occur in orthodontic bonding procedure.

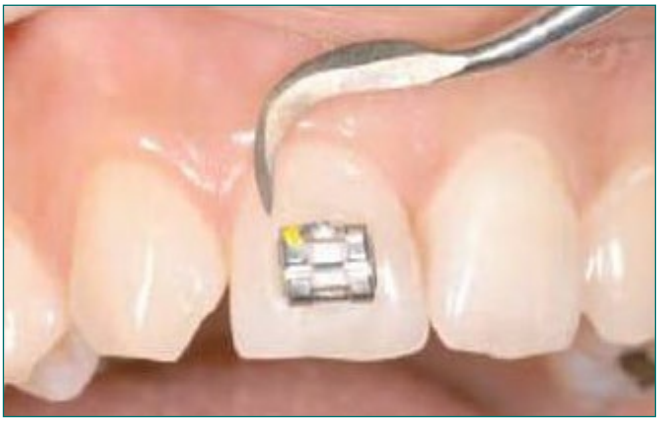
Orthodontic Bonding Procedure

Direct or indirect bracket bonding on both facial and lingual surfaces involves cleaning, conditioning of the enamel surface, microscopic sealing and bonding of the bracket/ buccal tube[1].

Cleaning

Cleaning of the teeth with pumice prior to bonding removes plaque and also the organic pellicle which might interfere with bonding by getting trapped at the enamel-resin interface. Proper supervision must be given to prevent trauma to the marginal gingiva which can cause bleeding.

Figure 1: Removal of excess adhesives during bonding



Acid etching of enamel removes about 10-20nm of enamel. Porosities are filled by saliva over time. An additional 6-50nm of enamel is estimated to be lost on debonding. The remaining resin tags in the enamel post debonding procedure may change in color with time[1].

Removal of Excess

Excess adhesives cannot be removed by tooth brushing or by other mechanical forces. It must be removed with a probe or an explorer before the setting of the adhesive [Figure 1]. After setting, the adhesives can be taken off with burs or scalers. Excess adhesives must be removed to minimize the occurrence of irritation to the gingiva and to prevent plaque buildup around the bracket base,

which is unesthetic. Moreover, the left over adhesives can discolour inside the oral cavity. The clinician should also instruct the patient to do proper brushing and can encourage fluoride mouth rinses (0.05% NaF) on a daily basis[1].

Debonding

The goals of debonding involve the removal of brackets and the residual adhesives from the tooth and bring back the enamel surface nearly to its previous state without asserting any iatrogenic effects[5]. There are 4 debonding techniques: mechanical debonding, electrothermal debonding[7], laser debonding [8]and ultrasonic debonding.

Mechanical debonding is the disengagement at the enamel–adhesive interface with debonding pliers by appling force at a controlled level[6]. The other means of debonding such as electrothermal and laser debonding work by dissolving the adhesive used for bonding by generating heat. Mucosal burns and pulpal damage are the possible risks of electrothermal debonding. Ultrasonic vibrations are used for facilitating bond failure in ultrasonic debonding[7, 9].

The various features under debonding procedures include:

- Clinical procedures
- Impact of various debonding instruments on the enamel
- Enamel loss during debonding
- Enamel tearouts
- Enamel cracks (fracture lines)
- Wear of the residual adhesives
- Removal of decalcifications

Clinical Procedures

Debonding can be considered as a two step procedure which involves:

1. Removal of brackets
2. Elimination of residual adhesives

Removal of bracket

The usage of debonding pliers are considered to be the most convenient and simple method of debonding[11]. When debonding metal brackets, forces are applied to peel the bracket base away from the enamel surface. This leads to a bond failure at bracket-adhesive interface[12]. Another debonding technique which involves the application of squeezing force at the bracket base is considered to be a better method. This dislodges the bracket and leave some amount of residual adhesives, which can be cleared off later.[11] Debonding of ceramic brackets can pose a risk to the patient in the form of enamel fractures due to the greater bond strength.[13] Chemically retained ceramic brackets bring about a greater degree of iatrogenic effects than mechanically retained ceramic brackets. Dislodging the brackets with the application of peripheral force is the preferred method of debonding for ceramic brackets[14]. Cutting the brackets off with gradual pressure using the tips of twin-beaked pliers, directed close to the bracket-adhesive interface is not advised due to the chance of horizontal enamel cracks. Grinding of ceramic brackets (when tie wing fractures) without water spray may result in irreversible damage or necrosis of the pulp.

Removal of remnant adhesive

Nowadays the color resemblance between the adhesives and enamel makes the complete removal of residual adhesive difficult and this can result in discoloration of the adhesives in the long run, which is undoubtedly unaesthetic.

Residual adhesives can be dislodged by bracket removing pliers or with a scaler or by the use of tapered shaped tungsten carbide bur (#1171 or #1172) in a contraangled handpiece[15]. Previous studies suggested 30,000 rpm as the ideal for the fast adhesive removal without iatrogenic damage. Water cooling should not be used during removal as water lessens the contradiction with enamel. High speed more than 30,000 rpm can pose the risk of marring the enamel surface. Ultrafine high-speed diamond burs are also not advisable as it can result in enamel surface scratches[16].

Effect of various debonding instruments on the enamel

On comparing various debonding instruments and grading their degrees of surface marring on the enamel, it was found that diamond instruments were unsatisfactory as they produced coarse scratches. The plain cut and spiral fluted tungsten carbide burs regulated at about 25,000 rpm were found to be showing acceptable enamel surface

representation. Previous studies advocated the use of oval shaped tungsten carbide bur for removing residual adhesives after removing attachments on the lingual surfaces of teeth[16].

Adhesive Remnant Wear

Usually leftovers of adhesive can be observed on the enamel surface even after mechanical instrumentations.

Gwinnett and Ceen proclaimed that leftover adhesives will not cause any plaque deposition and they will get removed with time[24]. In contrast to this, Brobakken and Zachrisson's found that residual adhesive will not get cleared by itself following debonding[26].

Amount of Enamel Lost in Debonding

Previous studies shows informations regarding the enamel loss following bonding procedures. Various factors like prophylactic and debonding instruments or even adhesive resins used can be responsible for this. The enamel surface generally have a thickness of 1500 to 2000 µm. The primary prophylaxis with bristle brush for about 10 to 15 seconds for each teeth may scrape off approximately 10 µm of enamel. The usage of rubber cups can remove about 5 µm of enamel. Removal of adhesive remnants using hand instruments can result in an enamel loss of 5 to 8 µm. Depending upon the prophylactic instruments, the approximate enamel loss for unfilled resins can be upto 2 to 40 µm. Proper removal of filled resin usually needs rotary instruments. The enamel loss then may be 10 to 25 µm. A high-speed bur or a green rubber wheel can remove about 20 µm and a low speed tungsten carbide bur reduces about 10 µm of enamel. Generally the enamel loss for filled resins was calculated to be around 30 to 60 µm, depending on the instruments used for prophylaxis and debonding. Additional deep-reaching enamel tearouts down to a depth of 100 µm and localized enamel loss of 150 to 160 µm also have been reported. However, Van Waes et al. reported lesser enamel loss with the usage of tungsten carbide burs. It was found that an average enamel loss is of only 7.4 µm and concluded that lesser damage to enamel is observed with cautious usage of tungsten carbide bur[17].

Iatrogenic Factors Affecting Enamel

Abrasion

Ceramic brackets generate more enamel abrasions than metal brackets. Polycrystalline ceramic brackets causes less enamel abrasions than monocrystalline ones. Cross bite correction should be done before bonding ceramic brackets and the ceramic brackets bonded on mandibular teeth must be relieved from occlusion for preventing enamel abrasion[10].

Tearouts

Tearouts on the surface of enamel were described in literature following bonding and debonding of metal and ceramic brackets. Tearouts can be related to many factors such as bond failure location and the type of filler particles in the adhesives. The enamel surface appearance followed by debonding metal brackets which are bonded with macrofilled (10 to 30 µm) adhesives when compared with microfilled (0.2 to 0.3 µm) adhesives, a difference was found when pliers were used for scraping off the resin. Macrofilled particles can penetrate less into the etched enamel than microfilled particles. The voids correspondent to the dissolved enamel prism cores in the central etch type are 3 to 5 µm in diameter. During debonding adhesive tags were reinforced by the small fillers. The macrofillers, however, create a more natural break point in the interface between enamel and adhesive. The precautions to be followed are:

1. Use brackets that have mechanical retention
2. Use debonding instruments and procedures that leaves most of the adhesives on the tooth and
3. Avoid scraping the left over adhesive with hand instruments.

Cracks

Cracksoccurs as split lines in the enamel [Figure 2]. They are common but usually unnoticed at clinical examination. Most of the cracks seems to be very difficult to differentiate properly without special techniques. Usually pinpointing them on routine intraoral photographs is challenging. Fiberoptic transillumination is essential for a proper visualization of cracks. Cracks can occur due to many causes. Mechanical and thermal insults can cause fracture to the enamel following eruption.Sometimes the sharp sound heard on removal of orthodontic brackets with debonding pliers can be associated with the generation of enamel cracks. A study by Zachrisson et al discussed the occurance of cracks in debonded, debanded and orthodontically untreated teeth.[16] The most important findings were that vertical cracks are common and the most notable cracks (i.e., those invisible under normal office illumination) are on the maxillary central incisors and canines.

Figure 2: Enamel cracks

Figure 3: Decalcification

The clinical relevance of these observations is that if an orthodontist observes several distinct enamel cracks on the patient's teeth after debonding or detects cracks in a horizontal direction, it suggests that the bonding or debonding technique has to be improvised.

Another clinical implication may be the need for pretreatment examination of cracks, notifying the patient and the parents if pronounced cracks are present. The reason for this examination is that if the patient notices this only after debonding of the appliance, they might question the orthodontist regarding the cause of the cracks.

Allergic reactions to bonding agents

The unpolymerized methyl methacrylate in composite or acrylic has the tendency to cause allergic reactions such as tissue inflammation and necrosis in some patients. The cytotoxic effects may still be evident 2 years after polymerization[4]. Excess adhesive should be removed by scaling particularly in areas close to the gingival margin.

Decalcification

Orthodontic patients are found to be the sufferers of decalcification but the orthodontic appliance cannot be the cause of caries [Figure 3]. However, fixed appliances interfere with the normal oral hygiene practice of the patient [18]. An increase in counts of *Streptococcus mutans*, reduction in the salivary pH and high food debris retention predispose patients undergoing orthodontic treatment to decalcification [19]. Fluoride being an anticariogenic agent has been quite effective in remineralization of white spot lesions[20]. Administration of topical fluoride or the use of fluoride containing toothpastes and mouth rinses offer powerful protection in opposition to white spot formation by blocking the bacterial enzymes. Agents such as Xylitol, argon laser irradiation and topical fluoride have helped in decreasing enamel demineralization [21, 22].

Reversal in enamel decalcification

White spot lesions are subsurface porosities in enamel resulting from carious demineralization. There have been several studies in literature which have evaluated the frequency of white spot lesions post orthodontic treatment. The incidence of white spot lesions were found to be increased in teeth which had undergone fixed appliance therapy as compared to the teeth that are untreated.

Remineralization is a phenomenon of healing of small carious lesions. Fluoride ions can improve the extend of remineralization in a short period of time by absorbing calcium and phosphate from the saliva. Årtun and Thylstrup suggested that removal of the cariogenic factors following debonding can eliminate the progression of demineralization with the initiation of some amount

of remineralization. However, Øgaard et al observed that the surface-softened lesions can remineralize rapidly and totally than subsurface lesions[23]. White spots that have evolved in the duration of orthodontic therapy therefore should not be dealt with fluoride agents immediately after debonding because this method will arrest the white spot lesions and prevent complete repair. It is better to recommend 2 to 3 months of good oral hygiene maintenance without fluoride supplementation after debonding.

Microabrasion

Once the white spots are established, microabrasion is the recommended way of removal of superficial enamel opacities. This technique removes enamel stains with minimal enamel loss. This involves the use of abrasive gel with 18% hydrochloric acid, finely powdered pumice, and glycerin applied using electric toothbrush.

Microabrasion procedure can be repeated 2 to 3 times per month based on the nature and severity of the lesions for a better outcome. The microabrasion method is effective in getting rid of white spots and streaks and brown or yellow discolorations of the enamel. In cases of huge mineral loss, however, grinding with diamond burs under water cooling or composite restorations are inevitable.

Conclusion

Various iatrogenic effects might occur during orthodontic treatment. Hence, proper care and caution should be implemented by the orthodontist during each step in bonding and removal of orthodontic appliance. The orthodontist should also motivate the patient regarding the importance of maintaining good oral hygiene and dietary regime. The ideal oral hygiene regime during fixed orthodontic treatment involves the use of topical fluoride agents such as fluoridated toothpaste and mouth rinse, gels and varnishes. The proper implementation of this protocol followed by the clinician and the patient might prove successful in prevention of occurrence of the mentioned iatrogenic effects.

Abbreviations

NaF	Sodium Fluoride
WSL	White Spot Lesions

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Address of Correspondence

Helen Rachel Xavier,
Post Graduate Student,
Department of Orthodontics and Dentofacial Orthopaedics,
Indira Gandhi Institute of Dental Sciences,
Sri Balaji Vidyapeeth Deemed University
Email id: helenrachelxavier@gmail.com
Phone no: +91 9961750082

Authors

[1,5,6]Post Graduate Student, Department of Orthodontics and Dentofacial Orthopaedics. Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth Deemed University.

[2]Professor and Head, Department Of Orthodontics and Dentofacial Orthopaedics. Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth Deemed University.

[3,4]Senior Lecturer, Department Of Orthodontics and Dentofacial Orthopaedics. Indira Gandhi Institute of Dental Sciences, Sri Balaji Vidyapeeth Deemed University.

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