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Modern Etching and Bonding Materials in Orthodontics

Güvenç Başaran and İlknur Veli
Dicle University
Turkey

1. Introduction

Esthetics has been an indispensable element in human life for centuries. The elimination of esthetic problems substantially aids in confident self-expression. In addition to the different departments dealing with esthetics in medicine, orthodontists also make arrangements to eliminate various esthetic and functional concerns. These arrangements include the correction of skeletal and dental anomalies. Dental arrangements mostly involve the use of fixed orthodontic attachments. Previously, orthodontic treatments with fixed attachments had been performed by soldering brackets onto bands. In 1907, gold clamp bands were used by Angle as part of his edgewise philosophy. (Angle,1907) In later years, pitch-fit bands were used in full-mouth banding techniques, followed by the use of prefabricated stainless steel bands for orthodontic treatment. However, full-mouth banding techniques had some disadvantages, including increased chair-time, diastemata resulting from the removal of bands at the end of the treatment, unaesthetic appearances and soft tissue irritation.

In 1955, Buonocore applied 85% phosphoric acid to enamel and became a pioneer in science by providing a method for bonding acrylic structures by etching on enamel.(Buonocore, 1955) However, Newman (Newman,1965) and Retief (Retief,1970) started to use phosphoric acid with modification in percentage and application time in the 1960s. The preliminary results of the studies began to be shared in the 1970s(Silverman& Cohen, 1972), and the most extensive follow-up results were reported in 1977.(Zacrisson BU, 1977) In contemporary practice, 37% orthophosphoric acid gel or solution is applied to enamel for 30 seconds, and the minerals on the enamel surface are dissolved. The appearance of retention sites on enamel are as follows: the enamel prism walls remain stable while the cores are removed, the prism walls are removed while the cores remain stable or both structures are removed. (Type 1and 2 etching pattern) (Silverstone & Saxton, 1975; Galil & Wright, 1979) These demineralized areas, which are present after water rinsing and air drying, do not have uniform depths, and fixed attachments are bonded to the enamel surface by bonding adhesive materials to the gaps on the walls or in the center of the hexagonal enamel prisms.

Advances in etching and bonding materials took place over time with new developments in technology and clinician demands. In this chapter, information about the preliminary preparation for direct bonding and the development of etching, bonding and adhesive materials and their application guidelines will be given.

2. Surface and bonding preparation

2.1 Cleaning procedure

Organic pellicle layers on the enamel surface cannot be totally removed by brushing. This organic pellicle layer has been reported to reduce the bond strength between the adhesive resin on the base of the bracket and the tooth. (Ireland & Sherriff, 2002; Lew & Chew, 1991; Swartz, 1994) To prevent this, polishing is recommended before performing the bonding procedure. (Lew & Chew , 1991; Swartz ML, 1994) For the polishing procedure, using polishing brushes or rubber cups disposable or sterilization avaible (Fig. 1) with low-speed (lower than 20000 rpm) micromotors and non-fluoride pastes for 10 seconds is recommended. (Reisner &, Levitt, 1997; Burgess & Sherriff, 2006) Enamel loss of 5-14 µm in depth was reported as a result of the type and application time of the rubber cups or polishing brushes.(Pus& Way, 1980)

Another effective method for removing the pellicle layer is effective tooth brushing by the patient. Effective tooth brushing may be taught by enabling patients to see plaque layers over tooth surfaces by means of plaque disclosing tablets.(Fig. 2) No negative effects of fluoride- containing toothpastes on bracket failures have been reported. Furthermore, fluoride-containing toothpastes have been reported to be beneficial in preventing cariogenic factors.(Øgaard & Bishara, 2004)



Fig. 1. Low speed handpieces for polishing that can be sterilized which are disposable.



Fig. 2. Intraoral application of plaque staining solution.

The next step after intraoral preliminary preparation is controlling moisture contamination before etching because the available acid, primer and adhesive depend on a hydrophobic system. To enhance bond strength and reduce bonding failure, it is necessary to control saliva flow and provide a dry working field. For this, lip expanders, cheek retractors, vacuum systems and cotton pellets may be used. To eliminate difficulties in the supply and maintenance of dry surfaces before bracketing the posterior teeth, prefabricated cotton pellets can be used at the output of the parotid duct. (Fig. 3) Additionally, an appropriate working field for clinicians can be obtained by using antisialagogue tablets (Carter, 1981;

Zachrisson & Büyükyılmaz, 2005), such as atropine sulfate or injectable solutions (Brandt &, Servoss, 1981; White, 1975), in patients whose saliva flow control is difficult to achieve. However, in the literature, there is no consensus regarding the evaluation of success after clinical use of these premedical agents.(Ponduri & Turnbull, 2007)

3. Etching procedures

3.1 Phosphoric acid application

Phosphoric acid is used to eliminate oxidation of metal surfaces and enhance adhesion of dyes to metal surfaces in the metal and dye industry.(Rossouw, 2010) In light of this information, Buonocore used phosphoric acid to obtain as effective an adhesion on enamel surface as on metal surfaces. The concentration of the first phosphoric acid solution used by Buonocore was 85% (Buonocore, 1955), and it was applied for 30 seconds. Buonocore adhered acrylic materials onto the non-etched teeth surfaces and etched surfaces. Although acrylic materials adhered onto the etched surfaces were bonded with enough strength that they needed debonding procedures, failures were observed on non-etched surfaces. (Rossouw, 2010) This technique was an important advance in directly bonding orthodontic attachments to the tooth surface by means of micro-retention. However, honeycombed structures were not obtained in enamel prisms after etching with 85% phosphoric acid, and successful results in terms of retention were not achieved. Retief (Retief & Dreyer, 1970) investigated the use of 50% phosphoric acid and achieved successful bond strength results. Chow and Brown (Chow & Brown, 1973) reported easy removal of "monocalcium phosphate monohydrate," which can be soluble in use of concentrations higher than 27%, by washing. In concentrations phosphoric acid lower than 27%, there was production of "dicalcium phosphate dihydrate," which presented difficulties in removal by washing and thus negatively affected bond strength. Many researchers (Øgaard & Fjeld, 2010; Zacrisson & Büyükyılmaz, 2005, Üşümez & Erverdi, 2010) reported that a 35-38% concentration of phosphoric acid is effective in terms of optimum bond strength; however, 5-10% concentration changes did not have negative effects on bond strength.(Reynolds, 1979; Carstensen,1995; Bhad & Hazarey, 1995) Today, 35-38% orthophosphoric acid is effectively used to change enamel surface characteristics and to provide micromechanic bond strength by means of an opaque appearance where micromechanic retention areas occur. (Buonocore & Matsui, 1968; Gwinnett &, Buonocore, 1965; Gwinnett & Matsui, 1967)

An etching time of 15-30 seconds is accepted as the optimum working time by manufacturers and clinic. (Brännström & Malmgren, 1982; Brännström & Nordenvall, 1978, Newman, 1978; Nordenvall & Brännström, 1980; Wang & Lu, 1991;. Barkmeier &, Gwinnett, 1987; Sadowsky & Retief, 1990; Carstensen, 1995; Powers &, Kim, 1997; Sheen & Wang, 1993; Abdullah & Rock, 1996) It has been previously reported that etching times of less than 10 seconds and more than 60 seconds do not produce enough shear bond strength. (Üşümez & Erverdi, 2010; Olsen & Bishara, 1996) Ten seconds of etching time does not produce enough tagged areas on the enamel, and etching times of 60 seconds or more than 60 seconds impair the integrity of honeycombed prismatic structures on the enamel, which negatively affects bond strength. (Wang & Lu, 1991) For the protection of dental structures, a topical fluoride application is generally preferred. It is reported that no additional etching time is required for fluoride applied teeth before treatment. (Ng'anga & Øgaard, 1992; Büyükyilmaz & Øgaard, 1995; Garcia-Godoy & Hubbard, 1991; Meng & Wang, 1997)

Phosphoric acid is produced in a liquid or gel form, (Fig. 4) and neither form demonstrated any negative effects on bond strength. (Brännström & Malmgren, 1982) However, only the

intended area is etched when using a gel. (Fig. 5) by means of this, opaque enamel surface is gained only in the wanted region**.** (Fig 6) A more extended area beyond the bracket base is etched by the liquid form due to displacement of the acid by gravitational force. Therefore, redundant demineralized areas are produced in the enamel surface, which can cause plaque and bacterial retention areas. Additionally, gingival structures should be carefully protected during etching with liquid form because ulceration (Øgaard & Field, 2010) on gingival structures and unwanted bleeding (Øgaard & Field, 2010) can occur during application. However, when using bonding brackets or an eruption appliance on partially erupted or impacted teeth, procedures such as protective liquid polishing must be applied before contamination occurs to prevent negative effects on bond strength. (Sayınsu & Işık, 2007)



Fig. 3. Application of cotton to the cheek for restricting salive flow.



Fig. 4. Liquid and gel phosphoric acids.Likid ve jel fosforik asitler

The presence of prismatic and aprismatic enamel affects the efficacy of phosphoric acid. While a more uniform surface appearance is achieved by etching in the presence of prismatic enamel, bond strength is reduced in the presence of aprismatic enamel. Due to moisture contamination during respiration and the presence of aprismatic enamel, more bracket failures are observed in the lower second premolars of patients in permanent dentition. (Mattick & Hobson, 2000) Uniform prism structures on the outer enamel layer of deciduous teeth are not observed. Therefore, phosphoric acid application after sandblasting with 50-µm aluminum oxide is needed for deciduous teeth. (Zachrisson & Büyükyılmaz, 2005)

Etching procedures with phosphoric acid differ in terms of microtopographic etching patterns over enamel surfaces. (Mattick & Hobson, 2000; Hosein & Sherriff, 2004) The intended etching pattern was only observed in 1/20 of enamel etched with phosphoric acid. This was attributed to the presence of aprismatic enamel and partial contact between phosphoric acid and the enamel surface. (Mattick & Hobson, 2000) Microtopographic evaluation depending on the etching procedure revealed a non-uniform depth. It was reported that a depth of 3-15 µm or more is necessary to provide optimum shear bond

strength and penetration.(Hosein & Sherriff, 2004) However, in literature, surface depths between 10 µm and 175 µm were presented. (Diedrich, 1981; Gwinnett, 1973; Silverstone, 1977) The difference in the depth (Hobson & McCabe, 2002; Daronch & DeGoes, 2003) are thought to be caused by aprismatic enamel and remineralization of Ca-P to enamel surface. (Chow & Brown, 1973)



Fig. 5. 37 %Phosphoric acid gel application to the places that the brackets will be positioned.



Fig. 6. The micromechanical bonding places of the enamel after etching with phosphoric acid

Another alternative to phosphoric acid is maleic acid. Ten percent maleic acid is used by orthodontists. When the scanning electron microscopy (SEM) examination of enamel surfaces exposed to either phosphoric acid or maleic acid was evaluated, similar morphologic patterns were observed. (Baş-Kalkan & Orhan, 2007; Olsen & Bishara, 1997; Hermsen & Vrijhoef, 1993) However, in the topographic evaluation of surface depth, retention areas with less depth were observed. (Triolo & Swift, 1993) When compared with 37% orthophosphoric acid, some researchers found lower bond strength (Smith & Cartz, 1973; Årtun & Bergland, 1984; Maijer & Smith, 1986); however, other researchers found similar strengths. (Triolo & Swift, 1993) In any case, maleic acid has never been as popular as orthophosphoric acid worldwide. Gottlieb et al. (Gottlieb & Nelson, 1996) reported that 95.6% of orthodontists in the USA have never used maleic acid and only 0.5% have routinely used maleic acid.

3.2 Self-etching application

Advances in adhesive technology lead orthodontists to use new adhesives, composite resins and bonding techniques in their clinical practices. Self-etching primers (SEP), which combine acid and primer, carry out bonding procedures by simultaneously etching and infiltrating the enamel surface. They ease the bonding procedure by reducing chair time and eliminating side-effects of etching. (Chigira & Koike, 1989; Nishida &, Yamauchi, 1993) Two-step SEPs and new single-step self-etching adhesive systems are new additives to a clinician's adhesive toolbox. (Pashley & Tay, 2001; Bishara & Adam, 2008; Amra &, Samsodien, 2007)

Advances in the next generation of bonding systems extends from etching enamel to dentine conditioning, treatment of smear layers and different application procedures of adhesive systems. (Schaneveldt & Foley, 2002) Fourth generation bonding systems consist of a 3-step application: etching, primers (which provide maximum adhesion by increasing monomer penetration to the etched enamel and hydrophilic dentine and increasing the wettability of tooth surfaces) and an adhesive resin agent. This system is also known as the total etch technique.

A new SEP (5th generation dentin bonding system) which combines the etching and priming steps to affect both enamel and dentine simultaneously has been developed to ease the dentin/enamel bonding systems. (Miyazaki & Hirohata, 1999) However, a reduction in bond strength by manufacturers as a way of easing clinical applications is a concern to clinicians. (Miyazaki & Hirohata, 1999) Studies regarding the development of SEPs have progressed with the presentation (Amra & Samsodien, 2007) of new single-step bonding systems. The current system is the 6th generation of bonding systems.

However, because it is difficult to form compounds with chemically evident concentrations (acid, primer and adhesive), 6th generation bonding systems are designed to be preserved separately in 2 compartments until mixing for clinical applications. This separation procedure prevents possible changes in initializers due to increases in sensitivity against acidity. (Van Meerbeek, 2003)

The main feature of single step acid/primer bonding systems is that no separate acid-etching of the enamel and rinsing with water and air drying are necessary. The liquid has a component that conditions the enamel surface. The active component of the SEPs is the methacrylated phosphoric acid ester that dissolves calcium from hydroxyapatite. The removed calcium forms a complex when the primer polymerizes. Etching and monomer penetration to the exposed enamel rods are simultaneous, and the depth of penetration is equal.

Three mechanisms stop the etching process. First, acid groups attached to monomers are neutralized by forming a complex with calcium from hydroxyapatite. Second, as the solvent evaporates from the primer during the air drying, the viscosity increases, and the transport of acid groups to the enamel interface slows down. Finally, as the primer monomers are polymerized with light curing, transport of acid groups to the interface is stopped. (Jost-Brinkmann & Schiffer, 1992; Cinader, 2001) The acid component of a self-etching primer is reported to cause as much demineralization on enamel surface as 30-50% phosphoric acid. However, dissolved calcium is not removed from the tooth surface, and it produces a complex with a phosphate group. The primer unites with this complex during polymerization to neutralize the acid. Most of the bonds in minimal etching obtained with SEPs occur by binding to the calcium in the enamel with chemical bond, which differs from the mechanical bond obtained with the conventional phosphoric acid application. (Swartz ML, 2004)

There are studies presenting the importance of enamel topography in terms of bond strength. The thickness of the resin-infiltrated layer after enamel treatment with SEP agents compared with a conventional method was evaluated by Hannig et al. (Hannig &, Bock, 2002) who observed 1.5–3.2 μm wide netlike, resinous structures with SEPs. A similar pattern, but a greater depth (6.9 μm) of enamel surface hybridization, was found with phosphoric acid. (Hannig &, Bock, 2002) The hybrid layer was measured at 4 μm for SEPs and 8 μm for phosphoric acid by Pashley and Tay (Pashley &, Tay, 2001) Despite being less

distinct, a similar etch pattern was observed when using SEPs with nanoretentive interlocking between enamel crystallites and resin when compared with a phosphoric acid etch. (Hannig & Bock, 2002) These similar etch patterns, in addition to nanoretentive interlocking, could explain the potential of the SEP systems. (Hannig & Bock, 2002)
In dentistry, there are many self-etching systems, such as Clearfil SE Bond (Kuraray ,Japan), Clearfil S3 Bond (Kuraray, Japan), One Step (Bisco, USA), Adper Prompt L-Pop (3M Espe, USA), Futurabond NR (Voco, Germany). However, Transbond Plus Self-Etching Primer (3M/Unitek,) is the most commonly used system in orthodontics. The single-use package consists of three compartments. (Fig. 7) The first one contains methacrylated phosphoric acid esters, photosensitizers and stabilizers. The second compartment contains water and soluble fluoride, and the third compartment contains an applicator microbrush. Squeezing and folding the first compartment over to the second compartment activates the system. (Fig. 8 a) The mixed component is passed to the third compartment to wet the applicator tip. (Fig. 8 b,c) To prevent gingival irritation, the application only occurs on the tooth surface. (Fig. 8 d) Transbond Plus Self-Etching Primer is applied by rubbing for at least 3 seconds. To ensure monomer penetration, the surface must be always wet with new solution. The presence of water in the chemical composition of Transbond Plus SEP may necessitate air drying during the procedure; however, the solvent evaporates and drying is no longer necessary. Today, etching patterns (Kawasaki & Hayakawa, 2003) and bond strengths similar to those from phosphoric acid etching are obtained by using the technologically advanced self-etching systems. (Erhardt & Cavalcante, 2004; Lührs & Guhr, 2008; Lalani & Foley, 2000)



Fig. 7. Self etching primer examples that are used in orthodontic bonding

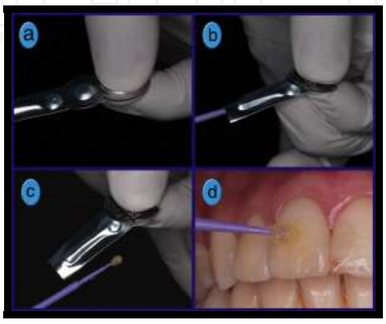


Fig. 8. a-c a) Mixing first and second compartments, b) Mixing second and third compartments, c) The image of primer, d) Application of self etching primer on tooth surface.

3.3 Laser etching application

Use of light for diagnosis and treatment has continued since ancient history. The ancient Greeks and Romans used sunbath and solarium. (Katzir, 1993) The ancient Egyptians, Chinese and Indians treated rickets, psoriasis, skin cancer and even psychological disorders by taking advantage of the treatment effects of light. (Daniell & Hill, 1991)

Gordon and Towness invented **M**icrowave **A**mplification by **S**timulated **E**mission of **R**adiation (MASER) by microwave simulation during their military research in Bell labs in 1958 and, and they also published theoretical calculations related to LASER. (Miserendino & Levy, 1995) In 1960, the Massachusetts Institute of Technology (MIT) made a laser device to strengthen radio waves for use as a sensitive detector in space research. The Ruby laser (694 nm) was first used in medicine by Theodore Maiman. (Maiman, 1966)The first dental laser applications were conducted by Dr. Leon Goldman in 1962.

Laser light has some differences when compared to visible light. These differences arise from the features of coherence, monochromacy and columniation in laser light. Coherence is a particular phase relationship of electromagnetic field and direction. Columniation is the observation of progress in a laser light source without disintegration in the same direction. During the observation of light, there is disintegration due to different wavelengths of visible light. Monochromacy is the generation of single color laser light in a specific frequency band.

Electrons moving in a particular orbit are the basis of laser light. Electrons release energy in the form of radiation called emissions when electrons from a particular spin move to a higher energy orbit. (Fig. 9 a) Electrons spontaneously return to low-energy orbit when they move out to a higher orbit and release a photon as energy. This ensures the atomic structure remains stable while spontaneous emissions also remain stable. An atom with the appropriate energy level forces an electron at the same level to enter a lower energy level while it enters the electromagnetic field of an excited atom. (Fig 9 b) The difference between the two levels manifests itself as another photon. (Fig. 9 c) If there are a collection of atoms in a stimulated environment, the excitation process will continue exponentially as a result of the energy release of each atom and the stimulation of others. (Fig. 10)

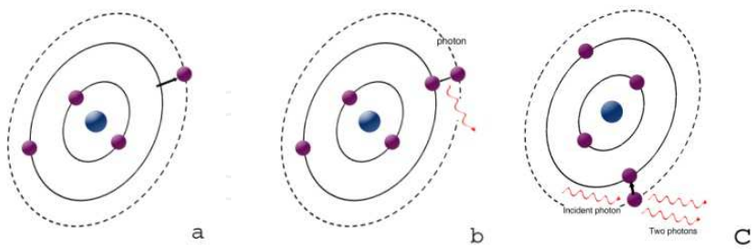


Fig. 9. a-c, a) Moving to a higher energy orbit of an atom after stimulation, b) Releasing of energy when returning to a lower energy orbit, c) Manifesting itself as another photon before returning to the old level.

Laser beam-producing devices are composed of an optical cavity, an energy source and cooling systems. The stimulation of the photon chain reaction takes place in an optical cavity. There are two parallel mirror systems in the optical cavity design. (Fig. 11) While a mirror in one direction provides 100% reflection, the mirror in the other surface has some permeability. Light reflection continues by photon emission from the surface of the mirror

with 100% reflection, and more photon energy is stimulated with the emitted energy. Thus, the motion of photons toward each other with constant energy transfer from an energy source achieves continuity. Because of the coherence, monochromacy and columniation properties of the semi-permeable surface structures, the photons move out and form laser light. An amount of energy is converted into heat during this formation. To neutralize this thermal effect, intra-device cooling units are used.

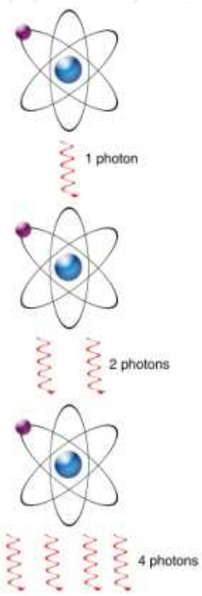


Fig. 10. Forming process of LASER light.

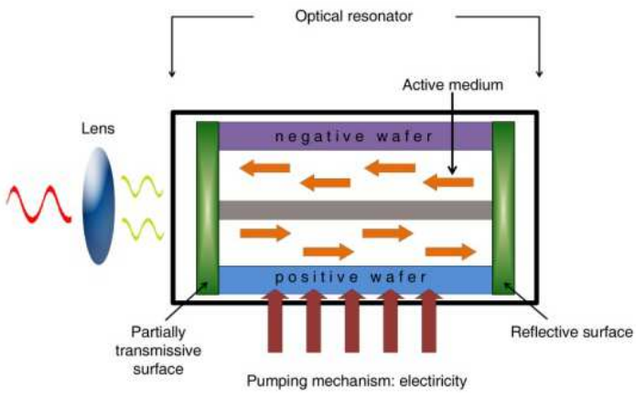


Fig. 11.The study mechanism of laser device

When the laser light hits the tissue surface, a layer of heated gas called "plasma" is generated. This layer allows the passage of decreased energy by absorbing the excess beams. However, this layer causes ablation and extreme warming by transferring the heat to the tissue surface. To minimize thermal effects on live tissue, air-water cooling systems are used in the current erbium laser systems.

The wavelength (λ) of light is the most important parameter in the effect of light on the tissue. The wavelength of light is the electromagnetic form of light produced by laser energy. This

structure is determined as the distance between any two points. Light is divided into two parts, including visible and invisible wavelengths in the electromagnetic spectrum. The invisible wavelengths are divided into two parts: thermal and ionized. (Fig12)

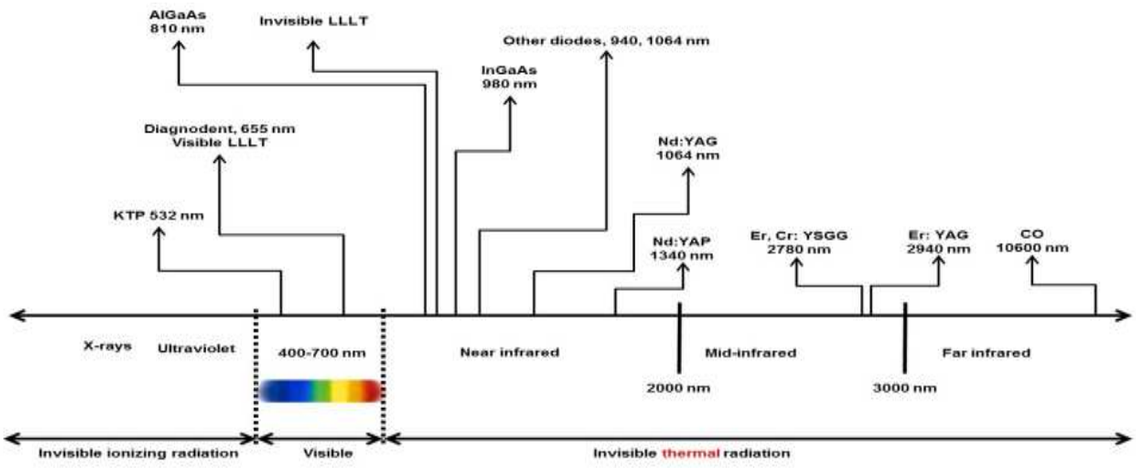


Fig. 12. Dental lasers in electromagnetic spectrum.

Dental laser devices are comprised of visible and invisible thermal energy wavelengths (Manni, 2004; Coluzzi & Convissar, 2007). The wavelengths of dental lasers are quite small and, therefore, are indicated as nanometers (nm) or micrometers (μm). While wavelengths of light determine the relationship between the laser and the tissue as well as the type of reaction, the amount of energy and texture characteristics of the tissue determine the depth of effect and the amount of the reaction.

In hard tissues of the tooth, pulsated lasers are used due to their thermo-mechanical effects. Micro-explosions can occur depending on increased propulsion as a result of pulsations at the nanosecond level, which prevents the formation of plasma and the occurrence of microscopic mechanical ruptures. In millisecond-level explosions, while micromechanical effects decrease, thermal effects increase, and dehydration and cracks can occur as a result. If a pulsation period between 100-350 μs is used in conjunction with a cooling system, a sufficient mechanical effect can be obtained. (Akkurt, 2008) When light moves as a wavelength, it exhibits a motion around the zero axis known as the oscillation during each second. This structure is the frequency, which is measured in hertz (Hz).

Based on this basic information about lasers, the relationship between a laser device and tissue should be determined because a large number of laser devices with different wavelengths are available in dentistry. (Fig. 10) Certain laser devices should be preferred depending on the wavelength of laser beam, the energy density, and the optical properties of tissue because these determine the thermal and mechanical effects. Protective glasses in accordance with the wavelength should be worn. Laser light shows interactions in 4 different manners on tissue surfaces. The interactions are defined as reflection, absorption, scattering and transmission. (Miserendino & Levy, 1995)

During these movements, the physician, staff and patients need effective protection against reflected and scattered laser light. For example, while carbon dioxide (CO_2) and Erbium lasers affect the cornea and lens of the eye, retinal areas are affected by Neodymium: YAG (Nd: YAG) and Diode lasers. (Niemz, 2007) However, these effects are prevented by protective glasses, which are manufactured according to suitable wavelength.

Argon, Diode, Nd: YAG, CO_2 and Erbium lasers are commonly used in dentistry. While Argon, Diode and Nd: YAG laser systems are efficiently used in the soft tissues, Erbium: YAG (Er: YAG) with a wavelength of 2940 nm and Erbium, Yttrium-Scandium-Gallium-Garnet Chromium-doped (ErCr: YSGG) lasers with a wavelength of 2780 nm are used in dental hard tissues.

Laser use in etching has increased in recent years. However, there are conflicting results in terms of effects on the enamel surface before bonding. This situation depends on different power outputs and designs of the planned study. However, many researchers agree that there is heat increase in pulpal level as a result of laser energy applied to the enamel surface. (Wigdor & Walsh, 1995; Aoki & Sasaki, 2000; Berk & Başaran, 2008) This increase in temperature is especially noted in differences in depth when using Nd: YAG lasers. Reversible pulpal hyperemia occurs at temperatures between 43 and 49 °C. Temperatures above 49 °C cause pulpal necrosis. Reversible changes occur in the heat exchanges below 16 °C. (Miserendino & Levy, 1995; Miserendino & Neiburger, 1989; Powel &, Morton, 1989) Reversible injuries occur in dentin near the pulp as a result of Erbium lasers, and these injuries are self-tolerated by secondary dentin formation in 2 weeks. (Akkurt, 2008) In addition, a better recovery capacity is detected in the regeneration of perforated pulpal tissue when using cavitation studies rather than rotary instruments. Optimal micromechanic retention is provided in procedures at the enamel level with active cooling by means of air and water rates.

Researchers reported honeycomb-like fields similar to type 1 etching pattern on the surface of enamel. However, to obtain this pattern, appropriate power, frequency and time setting planning should be performed. Otherwise, although the amount of water and organic matrix in the enamel tissue are less than those in dentin, vaporization will occur in the hydroxyapatite matrix, and irregular heterogeneous micro-etching patterns will be observed due to the irreversible damage from microexplosions. (Rechmann & Goldin, 1998)(Fig 13) To minimize these effects, lasers should be used with appropriate power output and air-water rates.

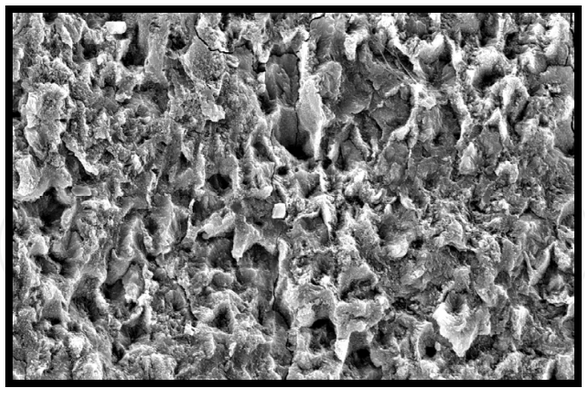


Fig. 13. The view of microcracks after laser application on the enamel surface.

Laser use is recommended at a non-contact mode or a distance of 1 mm by researchers. (Özer & Başaran, 2008) Bond strength is reported to be negatively affected by increasing distance between the tooth surface and laser output. (Başaran & Hamamcı, 2011) However, there is insufficient data about etching depth. Micro-cracks were sometimes observed in nearly ideal etched areas on the surface of enamel. (Akkurt, 2008) This constitutes a negative effect for the preservation of the integrity of the enamel after the treatment period.

3.4 Sandblasting (air-abrasive) application

The diameter of aluminum oxide powder used for pumicing dental surfaces is 50 μm. (Fig. 14) Reisner et al. (Reisner & Levitt, 1997) examined the effects of sandblasting techniques in comparison to conventional acid etching by using 50 μm aluminum oxide powder with 65-70 psi pressure for a period of 2-3 sec in their study. They observed decreased bond strength on the enamel surface. However, this situation is attributed to the exposure of enamel surface to less sandblasting time in comparison to the acid-etching procedure. Berk et al. (Berk & Başaran, 2008) observed a similar effect in their study on molar tubes in the posterior region. Sandblasting etching procedures alone are reported to be insufficient generators of bond strength in clinical studies. (Hogervorst & Feilzer, 2000; Olsen & Bishara, 1997; Reisner & Levitt, 1997) An inconsistent etching pattern was observed on enamel surfaces by SEM visualization. (Fig. 15) There are studies presenting additional retention areas when using the sandblasting method following orthophosphoric acid in terms of bond strength when compared with phosphoric acid (Black, 1950; Black, 1955; Goldstein & Parkins, 1994). Additionally, there are reports of reduced clinical bond strength when using resin modified glass ionomer cement instead of a splint mount design. (Özer & Arıcı, 2005)



Fig. 14. Microetcher system

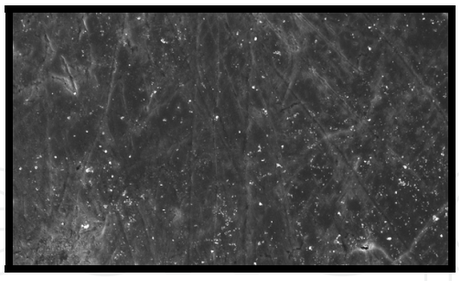


Fig. 15. The enamel surface view after 50μm Al_2O_3 application

3.5 Porcelain, amalgam and composite surface etching applications

Today, orthodontic treatment is frequently preferred by adults to overcome esthetic considerations. However, different types of restorations, such as porcelain prosthesis or laminate veneers, are encountered in an adult's mouth. A mechanical or chemical method different from etching procedures on the enamel surface must be followed in individuals thought to be treated with fixed orthodontic appliances to support these restorations. One point to be considered is the type of porcelain used in the restoration and the type of bracket.

A sufficient bond strength could not be obtained when using a mechanical etching procedure with diamond stone burs (Barbosa & Almedia, 1995 ; Cochran & O'Keefe, 1997), sandblasting (Andreasen & Stieg, 1998; Kocadereli & Canay, 2001; Cochran & O'Keefe, 1997; Zachrisson & Zachrisson, 1996), or sandpaper discs. (Barbosa & Almedia, 1995 ; Cochran & O'Keefe, 1997) To ensure an adequate bond strength, removal of the glaze layer on a porcelain surface and a suitable mechanical retention area are needed. Therefore, bonding to glazed ceramic with a coupling agent (silane) and a chemical preparation of the ceramic with acids, such as hydrofluoric acid (HFA) or acidulated phosphate fluoride, are used. (Major & Koehler, 1995; Hayakawa & Horie, 1992; Bourke & Rock, 1999) Silane coupling agents enhance bond strength by increasing the chemical bond between the resin composite and the ceramic material. (Tylka & Stewart, 1994; Nebbe & Stein, 1996; Aida & Hayakawa, 1995; Wood & Bubb, 1997; Gillis & Redlich, 1998) The silica of the ceramic is chemically joined with the acrylic group of the composite resin through silanization (Bowen & Rodriguez, 1962). Silane enhances the bonding of brackets to glazed ceramic surfaces, but the bond strengths achieved through this process may not be adequate for clinical use. Generally, a silane coupling agent is applied with chemical and mechanical roughening procedures. (Schmage & Nergiz, 2003; Özcan & Vallittu, 2004; Harari & Shapira-Davis, 2003; Huang & Kao, 2001) (Fig. 16)



Fig. 16. Hydroflouric acid, silane and ethyl alcohol that are used for porcelain surface treatments.

HFA is applied at concentrations of 5-9.6%. However, gingival barriers should be used to eliminate the negative effects of HFA in gingival tissues before application. In addition to studies indicating that a 5% concentration is sufficient (Trakyalı & Malkondu, 2009), the use of 9.6% HFA for a period of 120 sec is recommended to ensure optimal bond strength. (Al Edris & al Jabr, 1990; Simonsen & Calamia, 1983; Zacrisson & Büyükyılmaz, 2005)

Etching procedure on amalgam restorations varies depending on the size of amalgam restoration. If amalgam restorations are present in a limited area, enamel around the restoration can be conditioned with 37% orthophosphoric acid following by sandblasting with 50 µm aluminum oxide powder for 3 seconds. If there are large amalgam restorations covering the area to be bonded, a metal primer is applied onto the amalgam restoration following sandblasting with 50 µm aluminum oxide powder for 3 seconds and a 30 second waiting period. (Zacrisson & Büyükyılmaz, 2005; Zacrisson & Büyükyılmaz, 1993; Zacrisson & Büyükyılmaz, 1995)

Previous composite restoration is removed with the help of a rotary instrument, and sealant application onto a dry composite surface is completed with single bonding procedure. Clinical failures in these restorations are not frequently observed. (Jost-Brinkmann & Can, 1996; Klocke & Shi, 2003)

4. Sealant and primer applications

Depending on the type of primer used for orthodontics, the tooth surface can be either completely dry or slightly damp. If the primer is moisture sensitive, the enamel surface should be completely dried. Following the appearance of an opaque enamel surface, primer is applied in a thin layer onto the etched tooth surface with the help of a microbrush. Then, a quick application of the bracket and dental adhesive material onto the teeth is performed. To prevent bracket failures occurring from the difficulty of application, especially in the posterior region, primers with hydrophilic features were produced. Although the bond strength in hydrophobic primer applications onto dry surfaces is higher than the bond strength in wet surfaces, these hydrophilic primers provide significant convenience for clinicians in cases with partially impacted teeth and bonding to the second molar teeth.

5. Adhesive applications

5.1 Composite resins

Dental composites are the materials produced by the homogeneous dissolution of inorganic fillers. Monomers, such as the organic matrix Bis-Glycidyl methacrylate (BisGMA) ; Urethane Dimethacrylate (UDMA), which provides good adhesion and is resistant to discoloration; and Triethylene glycol Dimethacrylate (TEGDMA), which is used to reduce viscosity, are used in commercially available dental composites. Good physical bonding between composite resins and metal brackets used in orthodontic treatments is especially provided by BisGMA. (Buzitta & Hallgren, 1982; Jost-Brinkman & Schiffer, 1992; Zachrisson & Brobakken, 1978)

Inorganic structures are composed of filler particles scattered into a matrix such as quartz, borosilicate glass, lithium aluminum silicate, strontium, barium, zinc, yttrium glass or barium aluminum silicate of various shapes and sizes. These materials give some properties to the composite resin materials. Strontium, barium, zinc and yttrium provide radiopacity for resins. Silica particles strengthen the mechanical properties. Pure silica is available in crystalline and non-crystalline forms. Because crystalline forms are hard, finishing and polishing of composite resins are difficult. For this reason, composite resins are produced using non-crystalline forms of silica. In addition, camphorquinone (CQ) is used as polymerization initiator for photopolymerization, and benzoyl peroxide is used for chemical polymerization. Close binding is necessary between the organic polymer matrix phase and the inorganic phase in composite resins. This binding is provided with an intermediate phase. This phase consists of silane, which is an organic silicon compound. In modern composite resins, surface silica particles are pre-coated with silane binding agents, and a thin layer is formed with single- molecule and dual-function molecules on the surface of the silica particles. One end of the molecules in this layer is bound with hydroxyl groups on the surface of silica particles, and the other end is bound with polymer in an organic matrix. Silane binding agents develop the physical and mechanical properties of resin, provide the hydrolytic balance by preventing the passage of water along the resin-particle interface and reduce the resolution and the water absorption of resin.

Hybrid and NanoFil composites are widely used in modern dentistry. In hybrid composite resins, inorganic filler particles of different sizes, including small particles (0.6 to 5 microns) and micro-fillers (0.04 m), are combined and added to the organic matrix (Duke, 2003; Davis, 2003). In this type of composite resins, a mixture of colloidal silica (0.04 m) and heavy metals containing glass particles (1 to 3.6 microns) are used as inorganic filler. (Oduncu, 2009) The

ratio of inorganic particles is 75-80%. The fact that hybrid composites do not negatively affect bond strength under brackets is a result of less polymerization shrinkage than microfilm composites and a decreased need for technical sensitivity (Powers & Kim, 1997).
Composites used in orthodontics are divided into either no-mix (Fig 17) or light-cured (Fig 18) composites based on the polymerization form. Following the application of a thin layer of liquid primer and no-mix composites to the bracket base, brackets are placed onto etched and dry tooth surfaces. Because polymerization begins immediately, even minimal revision of bracket positioning causes micro-fractures in the composite material, and thus, bond strength will be negatively affected. Optimal polymerization of the system occurs after 60 min. There are some disadvantages to this system. They include the fact that polymerized liquid activators and polymerization occur. Additionally, there is an increased waiting period for polymerization, and there are toxic and allergic effects in direct proportion to the amount of non-polymerized residual monomers and liquid activators present in the system. (Fredericks, 1981; Thompson & Miller, 1982)
Light-curing adhesive systems began to be used clinically in the early 1970s and are widely preferred today by orthodontists because of their advantages in working time and comfort. Light-curing adhesives enable bracket placement on impacted canine teeth after surgical uncovering, bracket repositioning of single tooth bracket loss, ease of applicability in areas with risk of bleeding and the possibility to check bracket position on premolar teeth. (Zacrisson & Büyükyılmaz, 2005) While ultraviolet light was used for polymerization in the first years of use, polymerization now takes place with visible light sources. Today, orthodontists perform direct bonding procedures by using halogen, plasma arc and light-emitting diode (LED) sources.



Fig. 17. No-mix composite system



Fig. 18. Light curing composites

6. Light-curing devices and orthodontic adhesive applications

6.1 Quartz-tungsten halogen

Quartz-tungsten halogen light (QTH) is produced by an electric current passing through a tungsten filament, and this process takes place at very high heat levels. Halogen lights should be filtered to infiltrate unwanted waves and keep the 400-500 nm light (blue light). Thus, only a small amount of energy from this source is used for polymerization and a large amount of energy is converted into heat. In QTH light sources, 70% of the energy is converted into heat. Only 10% is visible light. In fact, 90% of visible light is lost due to the use of filters. Because of this result, blue light output is only 1% of the total energy input. More heat may shorten the life of light filters, bulbs and halogen light devices over time. The operating life of halogen bulbs is around 100 hours, on average. (Mills & Jandt, 1999; Jandt & Mills, 2000) In the polymerization process, a 20 second irradiation time for composite resin and 40 second irradiation time for light-cured resin modified glass ionomer cement (RM-GIC) with a halogen light source are proposed for every bracket. (Zacrisson & Büyükyılmaz, 2005; Sfondrini & Cacciafesta, 2001) Light intensity of 500 mW/cm^2 from a halogen light source was increased up to 900mW/cm^2 to reduce working time by "turbo tips". Approximately 50% of the polymerization time is saved with these fast halogen devices. Plasma arc carbon (PAC) lamps have a tungsten anode and cathode in a quartz tube filled with xenon gas. The gas becomes ionized and forms a plasma that consists of negatively and positively charged particles and generates an intense white light when an electrical current is passed through the xenon. Plasma arc lights are contained in base units rather than in "guns" because of the high voltage used and heat generated. (Zacrisson & Büyükyılmaz, 2005; Büyükyılmaz & Üşümez, 2003)

6.2 Plasma arc light sources

Plasma arc light sources do not emit distinct frequencies but instead give continuous-frequency bands that are much narrower than those of conventional lights. Consequently, less radiation needs to be filtered to remove undesired frequencies. Plasma arc lights provide light intensity of 1500 mW/cm^2 and a wavelength range of 380-490 nm. Due to the intensity of the light source, manufacturers reported that a 1-3 seconds irradiation time would be sufficient for polymerization of composite restorations in restorative dentistry. In direct bonding, it is reported that a polymerization period of 3-5 sec for metal bracket and less time for ceramic brackets is sufficient. Similar results were obtained with 20 seconds polymerization using a halogen light source. (Hotz & McLean, 1977) However, prior to polymerization, the harmony between the adhesive material and light source should be evaluated. Hotz & McLean, 1977, Üşümez & Büyükyılmaz,2008) A common problem related to the use of plasma arcs is the high pulpal temperature increase generated during polymerization. When the temperature in the pulp reaches 42.5 ° C, irreversible hyperemic pulp tissue reactions begin. While the heat increase in a halogen light source is 1.8 ° C, the heat increase in the plasma arc light source can reach almost 3 times that level. (Özturk & Üşümez, 2004)

6.3 Light-emitting diode light source

Today, another widely used light source is a light-emitting diode (LED). Mills et al. (Mills & Jandt, 1999) proposed solid-state LED devices for dental adhesive polymerization to

eliminate some of the disadvantages of conventional halogen systems. There are two separate semi-conductors that transfer electrons from one another. When electricity is given by combination of these two separate semi-conductors, light with a specific wavelength (430-490 nm) is emitted from an LED lamp. The most important distinctive feature is the production of blue light. Approximately 95% of the produced light has the necessary qualification for polymerization. This situation gives the opportunity to work with less electricity and have up to 10,000 hours of bulb life. (Zacrisson &Büyükyılmaz, 2005) LEDs are resistant to shock and vibration during the production of blue light because of the absence of any filtration process. Very high rates of light-cured composite resins contain camphorquinone as photo-initiator in their composition. Camphorquinone is a material which is activated with visible blue light at a wavelength of 400-500 nm (peak level 468 nm). The main feature of the LED light sources is the production of visible blue light in this wavelength. Active spectra are reported to be 430-490 nm. However, LED light sources are effective on camphorquinone-containing dental materials. Therefore, the structures of materials used for polymerization should be well-known.

Light sources can be deleterious for orthodontists during long-term use because light sources can produce a wide range of light, ranging between ultraviolet and infrared ray beams. Light production in available wavelengths can cause irreversible changes in the retinal region depending on the wavelength of light used over time. As a result of this interaction in the retinal region, photochemical processes may cause a loss of vision, also known as a cataract, which is characterized by a loss of elasticity and quality of the lens in the long term. (Üşümez &Erverdi, 2010) In addition, loss of the receptor that provides nutrition for the cells in the retinal region may lead to retinal degeneration due to nutritional disorders. Clinicians should use protective eye glasses that have filtration effects of wavelengths of light to minimize these negative effects.

7. Bonding procedure

Bonding procedures in orthodontics are divided into direct and indirect bonding procedures. Direct bonding procedures involve bonding brackets onto the teeth in the dental arch during the same session; in the indirect technique, first implemented by Silverman and Cohen in 1972 (Silverman & Cohen, 1972), brackets are bonded following certain laboratory procedures.

7.1 Direct bonding procedure

There are some procedures to be followed for success of direct bonding technique. Bonding procedures begin following isolation and etching of the tooth surfaces (normal tooth surfaces or restored tooth surfaces). First, the mesiodistal and occlusogingival positions of teeth to be bonded should be determined separately for each tooth with the help of the guide. Thus, possible repositioning of brackets depending on the position differences will be eliminated. Second, the bracket is gripped with reverse action tweezers and the adhesive is applied to the bracket base. (Fig 19) It is important that the adhesive be evenly distributed on the bracket base without any gaps in the adhesive. (Fig20) The presence of a gap may act as a weak point and lead to premature failure. After the adhesive is added, the bracket is then placed on the tooth immediately.



Fig. 19. Application of composite to the bracket base



Fig. 20. Force application the the bracket in order not to leave any empty spaces.



Fig. 21. APC system that is marketed for orthodontists

A scaler or round probe is used to position brackets on tooth surfaces in occlusogingival and mesiodistal directions. Positioning errors should be eliminated by making use of intraoral mirrors and retractors due to the difficulty in imaging of posterior region. Proper positioning of the bracket on the enamel should be provided during bracketing, and excess adhesive resin overflowing around the bracket must be cleaned before polymerization by a probe or scaler. Polymerization is completed by an equal amount of irradiation from all surfaces, followed by the removal of excess adhesive resin. This excess adhesive resin can allow for bacterial colonization. Today, pre-colored adhesive material (Transbond XT, 3M Unitek)(Fig. 18) or bracket systems including colored adhesives placed on the bracket base (APC Plus, 3 M Unitek) are used for the comfort of clinicians. (Fig 21) Unwanted movements occur due to improper fitting, and rotation movement is generally observed as a result. Therefore, each bracket should be checked carefully, and brackets in non-appropriate positions should be removed and rebonded immediately. If this procedure is not performed immediately, position errors will occur in other sessions and treatment times will be longer.

6.2 Indirect bonding procedure

Silverman and Cohen (Silverman & Cohen1972; Silverman & Cohen, 1976) became pioneers of the indirect bonding technique. Today, this technique is preferred due to advantages that

include reduced chair time, higher comfort of patients during bonding procedures, elimination of equipment such as separators or bands, good vertical control of teeth, successful implementation of the bracket positions, good supply of proper oral hygiene, good adaptation of lingual brackets, and minimization of the need for staff. (Thomas, 1979; Klange, 2004; Klange, 2007) However, time lost during removal of excess adhesive on bracket bases due to lack of clinician experience, unwanted formation of lesions in interproximal areas (e.g., caries, decalcification, gingival irritation) and predisposition to poor oral hygiene are among the disadvantages. (Zacrisson & Büyükyılmaz, 2005)

Indirect bonding systems are used with carrier systems such as the full-arch, sectioned full arch, single tooth and double tray systems. The working procedure of this technique includes the transfer of brackets, which are exactly positioned in cast models with a temporary resin or sealant to a silicone carrier and removal of the resin located in silicone with the sandblast method. This is followed by a thorough cleaning of the base of the bracket with a solvent. Then, intra-oral adaptation via thermal, chemical or a light-curing adhesion occurs following the implementation of A and B resins to the tooth and bracket surfaces. Finally, the resins are removed following the 2 min suppression period.

7. Debonding applications

The debonding process is of great importance in orthodontics. Debonding procedures may lead to serious fractures due to the differences in bond strength between the enamel and the metal and ceramic bracket structures. Spending sufficient time for the debonding procedures and independent implementation of debonding procedures on each tooth (without the arch wire) are among the simple measures taken to minimize failure.

7.1 The removal of steel brackets

To prevent damage to the enamel during removal of stainless steel brackets, failure at the bracket-adhesive interface is preferred. Zachrisson and Büyükyılmaz (Zachrisson & Büyükyılmaz, 2005) recommended using peeling type forces, which allow for a recycling process without deformation of bracket during the removal. In this technique, the debonding procedure is easily performed by eliminating the peripheral stresses with low force (Øilo, 1993) In this manner, failure will occur between the bracket and adhesive and the remaining adhesive on the enamel surface. Additionally, this method will prevent the formation of cracks and fractures. (Zacrisson & Büyükyılmaz, 2005)

7.2 Ceramic bracket removal

Debonding procedures is easily and reliably performed in metal brackets with peripheral forces. However, substnatial damage is observed to both enamel surfaces and brackets when debonding of ceramic brackets is performed by adding peripheral forces because ceramic brackets adhere strongly to enamel surfaces and do not show flexibility during implementation of the debonding pliers. (Redd & Shivapuja, 1991; Artun, 1997) Ceramic brackets behave differently during the debonding procedure depending on the differences in bracket structure and bonding mechanisms. For instance, fewer problems occur in ceramic brackets with mechanical retention than those with chemical retention. (Redd & Shivapuja, 1991, Viazis & Cavanaugh, 1990; Winchester, 1991) Squeezing brackets with twin-beaked pliers oriented mesiodistally is not recommended because it may cause

horizontal enamel cracks. However, possible fractures may be minimized by the development of bracket designs. For example, a vertical debonding slot was added to minimize fracture during debonding (Clarity bracket, 3M Unitek), and fracture risks were significantly eliminated in porcelain brackets designed with a ball-band reduction (Inspri Ice Bracket, Ormco Corp., Calif.) (Chen & Su, 2007; Bishara & Olsen, 1997) Grinding ceramic brackets with low speed and no water coolant may cause irreversible damage or dental pulp necrosis. Therefore, water cooling is necessary. Finally, thermal debonding (Stratmann & Schaarschmidt, 1996; Bishara & Fehr, 1997; Crooks & Hood, 1997; Rueggeberg & Lockwood, 1990) and the use of lasers(Ma & Marangoni, 1997; Rickabaugh & Marangoni, 1996; Tocchio & Williams, 1993) have the potential to be less traumatic, less risky for enamel damage and more easily applicable due to the its effect on water in composite. However, these techniques are still at an introductory stage.

7.3 Removal of residual adhesive

Bond strength of resin materials on enamel increased considerably due to technological advances. Therefore, complete removal of adhesive resin from enamel is sometimes not achieved during clinical use, and colored and plaque retention sites are observed over time. (Brobakken & Zachrisson, 1981; Hong & Lew, 1995)

In addition to low-speed applications with tungsten carbide burs, which are commonly used and diamond burs (Zachrisson & Årtun, 1979; Krell & Courey, 1993; Oliver & Griffiths, 1992) and laser devices (Thomas & Hook, 1996; Alexsander & Xie, 2002) can be utilized depending on the demands of clinicians and patients. About 30,000 rpm is reported to be the optimal speed for rapid adhesive removal without enamel damage. (Zachrisson & Årtun, 1979) The bur is moved in one direction as the resin layers are removed. (Cambell, 1995)Water cooling should not be used during the removal of last remnants because water lessens the contrast with enamel. Fine fluted tungsten carbide burs with speeds higher than 30,000 rpm may be useful for bulk removal but are not indicated closer to the enamel. (Zacrisson & Büyükyılmaz, 2005) Slower speeds (10,000 rpm and less) are ineffective, and the jiggling vibration of the bur may disturb the patient. (Hong & Lew, 1995) Following the removal of all adhesive, the enamel surface must be cleaned with soft discs and cups and polished with pumice (Campbell, 1995) (or a commercial prophylaxis paste).

Clinicians and staff are exposed to aerosol particles via inhalation during all of these applications. In addition to calcium, phosphor, silica, aluminum and iron particles (Price & Sandy, 2008), hepatitis B virus (HBV) has been observed to be transmitted depending on blood contamination. (Toroğlu & Bayramoğlu, 2003) In studies on the use of chlorhexidine gluconate during the debonding procedure, no positive impacts on infectious agents were detected. (Toroğlu & Bayramoğlu, 2003) In use of masks that do not have appropriate filtration mechanisms, terminal lung diseases were observed over time. (Toroğlu & Haytaç, 2001) However, aerosol contamination can be prevented when using masks with appropriate filtration mechanisms.

8. Problem encountered after orthodontic treatment

The formation of white spot lesions.(WSL) is a frustrating occurrence after orthodontic treatment. WSLs frequently occur due to lack of effective tooth brushing and cleaning during treatment. To eliminate this problem, the clinicians should provide hygiene control

during treatment sessions. A high incidence at the 5-year follow-up of patients receiving orthodontic treatment was determined.(Øgaard, 1989) Much evidence exists from in vivo and in vitro studies to support the claim that small carious lesions can heal, a process usually referred as remineralization.(Siverstone, 1982; Artun& Thylstrup, 1986; Øgaard & Rolla, 1988) To prevent WSL formation, topical fluoride containing mouth rinse and tooth pastes are recommended for patients and orthodontists may take precaution such as the use of fluoride-releasing adhesive materials and elastics. Daily routine use of casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) containing tooth pastes (Wiltshire, 1999; Fraizer & Southard, 1996; Lefeuvre & Amjaad, 2005; Uysal & Baysal, 2011) or fluoride containing mouth rinses (Gorelick & Geiger, 1982; Jordan, 1998) have been reported to significantly inhibit the formation of WSLs. However during all of these applications, the effective use has vital importance.

Microorganisms such as Streptococcus Mutans (SM) in microflora, which penetrate the flat surfaces better and effective in WSL formation leads to an acidic environment due to the digestion of nutrients and increase in the number of microorganisms. This situation increases the formation of decalcification by causing the dissolution of componenets on enamel. (Alves& Alviano, 2008; Başaran& Hamamcı, 2007, Başaran & Başaran, 2006) However the use of chlorhexidine gluconate containing mouth washes significantly impedes the formation of WSL. The use of fluoride releasing eleastic ligatures is one of the methods for the prevention of microorganism reproduction in retention areas around the brackets.(Cacascia & Gomes, 2007) However, the formation of effective sites for microorganism reproduction due to water absorbtion over time is a disadvantage of fluoride releasing eleastic ligatures.(Li & Hobson, 2007, Başaran & Hamamcı, 2007) If the use of glass-ionomer cement is planned for the bonding of brackets or bands in the posterior region, the use of high fluoride releasing adhesives such as Fuji Orto LC (GC International Corp., Itabashiku,Tokyo, Japan) will affect the incidence of WSL formation.(Marcusson & Norevall, 1997; Pascotto & Novarro, 2004) Another effective method for the prevention of SM is the use of Cervitec vanish. This application leads to a significant decrease in the number of SM between treatment sessions while the bond strength is not negatively effected. (Øgaard & Rolla, 1993; Eronat & Alpöz, 1994)

With technological advances such as the use of prebiotic bacteria, efficiency of harmful bacteria is reduced and and effective protection can be achieved (Çağlar & Sandallı, 2005; Meurman & Antila, 1995)

In patients with WSLs, effective fluoride applications in early period have been reported to inhibit the superficial appearence of demineralized areas. (Årtun & Thylstrup, 1986)

Another method for WSL treatment is a microabrasion method proposed by Gelgör and Büyükyılmaz. (Gelgör & Büyükyılmaz, 2003) In this method a custom-made abrasive gel is prepared with 18% hydrochloric acid, fine powdered pumice, and glycerin. The active mixture is applied using an electric toothbrush for 3 to 5 minutes following the isolation of gingiva by block-out resin or rubber dam. (Zacrisson & Büyükyılmaz, 2005) For best results, and depending on the severity of lesions, the repetition of the procedure monthly for 2 to 3 times is suggested and in 3-month follow-up period, WSL disappears gradually.

A new method recently came into use in the treatment of WSL is a technique called the micro-invasive infiltration technolgy (Icon-Etch-DMG, Chemische-Pharma. Fabrik GmbH, Hamburg) (www.drilling-no-thanks.com) The aim of this technique is to delay the drilling or filling in cases which does not require cavitation according to Gorelick's classification (Stage 2 or 3) but may need drilling due to improper oral hygiene and to preserve the available structure without no harm to the patient. The patients are controlled annually.

9. Conclusion

Todays orthodontists have a vast variety of adhesive and bonding materials. However, contemporary techniques that produce materials with nanotechnology lead to revolutionary developments in orthodontics as in other sciences and as a result of this, more effective materials could be produced. In the future, studies that would be in the area of biocompatible materials with genes would be interest of researchers.

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11. References

Abdullah, MSB.& Rock, WP. (1996) The effect of etch time and debond interval upon the shear bond strength of metallic orthodontic brackets *British Journal of Orthodontics Vol:*23 pp.121-124

Aida, M.;, Hayakawa, T. &, Mizukawa, K. (1995) Adhesion of composite to porcelain with various surface conditions *Journal of Prosthetic Dentistry Vol:*73 pp.464 – 470

Al Edris, A.; al Jabr, A.; Cooley, RL & et al. (1990) SEM evaluation of etch pattern by three etchants on three porcelains *Journal of Prosthetic Dentistry Vol:*64 pp.734

Alexsander, R.; Xie, J. & Fried, D. (2002) Selective removal of residual composite from dental enamel surface using the third harmonic of a Q-switched Nd:YAG laser *Laser Surgery Medicine Vol:*30 pp.240-245

Alves, PV.; Alviano, WS.; Bolognese, AM. & Nojima, LI. (2008) Treatment protocol to control Streptecocus Mutans level in an orthodontic patient with high caries risk *American Journal of Orthodontics and Dentofacial Orthopedics Vol:133 pp. 91-94*

Akkurt A. (2008) In vitro evaluation of shear bond strength of bonded premolar brackets with using erbium laser, self etching primer and ortofosforic acid etching systems vie SEM. Doctoral Thesis, Diyarbakır

Amra, I.; Samsodien, G.; Shaikh, A. & Lalloo, R. (2007) Xeno III self-etching adhesive in orthodontic bonding: the next generation. *American Journal of Orthodontics and Dentofacial Orthopedics Vol:*131 pp. 160–165

Aoki, A.; Sasaki, KM.; Watanabe, H. & et al. (2000) Lasers in nonsurgical periodontal therapy. Periodontology *Vol:*36 pp.59-97

Årtun, J. & Berglandi S. (1984) Clinical trials with crystal growth conditioning as an alternative to acid-etch pretreatment *American Journal of Orthodontics Vol:*85 pp.333

Artun, J. (1997) A post-treatment evaluation of multobonded ceramic brackets in orthodontics *European Journal of Orthoodntics Vol:*19 pp.219-228

Årtun, J. & Thylstrup, A. (1986) Clinical and scanning electron microscopic study of surface changes of incipient caries lesions after debonding *Scandinavia Journal of Dental Research* Vol: 94 pp.193

Andreasen, G F. & Stieg, M A. (1998) Bonding and debonding brackets to porcelain and gold *American Journal of Orthodontics and Dentofacia Orthopedics Vol:*93 pp.341 – 345

Angle AH. (1907) *The Malocclusion of the Teeth*, SS White Dental Manufacturing Philadelphia, 1907

Barbosa, V L.; Almedia, M A,; Chevitarese, O. &, Keith, O. (1995) Direct bonding to porcelain . *American Journal of Orthodontics and Dentofacial Orthopedics Vol:*107 pp.159–164

Barkmeier, WW.; Gwinnett, AJ. & Shaffer, SE. (1987) Effect of reduced acid concentration and etching time on bond strength and enamel morphology. *Journal of Clinical Orthodontics Vol:*21 pp.395- 398

Baş-Kalkan, A.; Orhan, M. & Üşümez, S. (2007) The effect of enamel etching with different acids on the bond strength of metallic brackets. *Turkish Journal of Orthodontics Vol:*20 pp.35-42

Başaran, G.; Hamamcı, N. & Akkurt, A.(2011) Shear bond strength of bonding to enamel with different laser irradiation distances. *Lasers in Medical Science Vol:*26 pp.149-156

Başaran, G. & Hamamcı O. (2007) Evaluation of the effect of different ligature system on microbial attack *Balkan Journal of Stamatology* Vol: 11 pp. 201-203

Başaran, G.; Başaran E. & Hamamcı, O. (2006) effects of orthodontic adhesive materials on S. Mutans and Lactobacilli levels in human saliva Biotechnolog & Biotechnological Equipment Vol: 20 pp. 156-159.

Berk, N.; Basaran, G. & Özer, T. (2008) Comparison of sandblasting, laser irradiation, and conventional acid etching for orthodontic bonding of molar tubes *European Journal of Orthoodntics Vol:*30 pp.183-189

Bhad, WA. & Hazarey, PV. (1995) Scanning electron microscopic study and shear bond strength measurement with 5% and 37% phosphoric acid. *American Journal of Orthodontics Dentofacial Orthopedics Vol:*108 pp.410-414

Bishara, S E.; Adam, W.; Otsby, AW.; Ajlouni, R.; Laffoon, JF. & Warren, JJ. (2008) A new premixed self-etch adhesive for bonding orthodontic brackets *Angle Orthodontist Vol:*78 pp.1101–1104

Bishara, SE.; Olsen, ME. & VonWald, L. (1997) Evaluation of debonding characteristics of a new collapsible ceramic brackets *American Journal of Orthodontics Vol:*112 pp.552

Bishara, SE. & Fehr, DE. (1997) Ceramic brackets: something old, something new—a review *Seminers in Orthodontist Vol:*3 pp.17

Black, RB. (1950) Airbrasive some fundementals *Journal of american Dental Associatation Vol:*11 pp.701-710

Black RB. (1955) Application and evaluation of air abrasive technique. *Journal of American Dental Associatation Vol:*50 pp.408-414

Brandt, S.; Servoss, JM. & Persily, KB. (1981) Atropine sulphate: an effective antisialogogue *Journal of Clinical Orthodontics Vol:*15 pp.629

Brännström, M.; Malmgren, O. & Nordenvall, KJ. (1982) Etching of young permanent teeth with an acid gel, *American Journal of Orthodontics Vol:*82 pp.379

Brännström, M.; Nordenvall, KJ. & Malmgren, O. (1978) The effect of various pretreatment methods of the enamel in bonding procedures, *American Journal of Orthodontics Vol:*74 pp.134

Bourke, BM. & Rock, WP. (1999) Factors affecting the shear bond strength of metal orthodontic brackets to porcelain *British Journal of Orthodontics Vol:*26 pp.285–290

Bowen, RL. & Rodriguez, MS. (1962) Tensile strength and modulus of elasticity of tooth structure and several restorative materials *Journal of the American Dental Association Vol:*64 pp.378–387

Brobakken, BO. & Zachrisson, BU. (1981) Abrasive wear of bonding adhesives: studies during treatment and after bracket removal, *American Journal of Orthodontics Vol:*79 pp.134

Buonocore, MG.; Matsui, A. & Gwinnett, AJ. (1968) Penetration of resin dental materials into enamel surfaces with reference to bonding *Archive of Oral Biology Vol:*13 pp.61–70

Buonocore, MG. (1955) A simple method of increasing the adhesion of acrylic filling material to enamel surfaces *Journal of Dental Research Vol:*34 pp. 849–853

Burgess, AM.; Sherriff, M. & Ireland, AJ. (2006) Self etching primers: is prophylactic pumicing necessery? A randomized clinical trial *Angle Orthodontist Vol:*29 pp.114-118

Buzitta, VAJ.; Hallgren, SE. & Powers, JM. (1982) Bond strength of orthodontic direct-bonding cement-bracket systems as studied in vitro *American Journal of Orthodontics Vol:*81 pp.87

Büyükyilmaz, T.; Øgaard, B. & Dahm, S. (1995) The effect on the tensile bond strength of orthodontic brackets of titanium tetrafluoride (TiF4) application after acid etching, *American Journal of Orthodontics Vol:*108 pp.256

Cambell, PM. (1995) Enamel surfaces after orthodontic bracket debonding *Angle Orthodontist Vol:*65 pp.103-110

Carter, RN. (1981) Salivary control *Journal of Clinical Orthodontics Vol:*15 pp.562

Carstensen, W. (1995) Effect of reduction of phosphoric acid concentration on the shear bond strength of brackets. *American Journal of Orthodontics and Dentofacial Orthopedics Vol:*108 pp.274-277

Chen, HY.; Su, MZ.; Chang, HF.; Chen, YJ.; Lan, WH. & Lin, CP. (2007) Effects of different debonding techniques on the debonding forces and failure modes of ceramic brackets in simulated clinical set ups *American Journal of Orthodontics Dentafacial orthopedics Vol:*132 pp.680-686

Chigira, H.; Koike, T.; Hasegawa, T.; Itoh, K.; Wakumoto, S. & Hayakawa, T. (1989) Effect of the self etching dentin primers on the bonding efficacy of dentin adhesive *Dental materials Vol:*8 pp.86-92

Chow, LC. & Brown, WE. (1973) Phosphoric acid condition of teeth for pit and fissure sealeants *Journal of Dental Research Vol:*52 pp.1158

Cinader, D. (2001) Chemical processes and performance comparisons of Transbond Plus self etching primer, Orthodontic Perspective *Vol:*8 pp.5-6

Cochran, D.;, O'Keefe, KL.;, Turner, DT. &, Powers, JM. (1997) Bond strength of orthodontic composite cement to treated porcelain . *American Journal of Orthodontics and Dentofacial Orthopedics Vol:*111 pp.297 – 300

Coluzzi, DL. & Convissar, RA. (2007) *Atlas of laser applications in dentistry*, Quintessentence, Hanover Park III

Crooks, M.; Hood, J. & Harkness, M. (1997) Thermal debonding of ceramic brackets: an in vitro study, *American Journal of Orthodontics Vol:*111 pp.163

Çağlar, E. & Sandallı N. (2005) Probiotics and their effect on dental health *Turkish Journal of Orthodontics* Vol:18 pp. 287-292

D Price, R.; Sandy, JR. & Ireland, AJ. (2008) Inhalation aerosol produced during the removal of fixed orthodontic appliances: a comparasion of 4 enamel clean up methods *American Journal of Orthodontics Dentofacial Orthopedics Vol:*133 pp.11-17

Daniell, MD. & Hill, JS. (1991) A history of photodynamic therapy *The Australian and New Zelland Journal of Surgery Vol:*61 pp.340-348

Daronch, M.; DeGoes, MF.; Garrilho, MR.; Chan, DC.; Darochi, M.& Sinhoreti, MA. (2003) Antebacterial and conventional self etching primer sytem: morphological evaluation of intact primary enamel *Journal of Clinical Pediatric Dentistry Vol:*27 pp.251-256

Davis, NA, (2003, "Nanotechnology Composite", *Compendium Vol:* 24 pp.662-667

Diedrich, P. (1981) Enamel alterations from bracket bonding and debonding a study with the scanning electron microscope *American Journal of Orthodontics Vol:*79 pp.:500-522

Duke, ES. (2003) "Has Dentistry Moved into The Nanotechnology Era?" *Compendium Vol:*24 pp.380-382

Erhardt, MC.; Cavalcante, LM. & Pimenta, LA. (2004) Influence of phosphoric acid pretreatment on self-etching bond strengths *Journal of Esthetic and Restorative Dentistry Vol:*16 pp.33–40

Eronat, C. & Alpöz, AR. (1994) Effect of cervitec varnish on the salivary streptecocus mutans levels in patients with fixed orthodontic appliances *Journal of Dental Research* Vol:73 pp.425 (abstract)

Forsberg, CM.; Brattström, V.; Malmberg, E. & Nord, CE. (1991) Ligature wires and elastomeric rings: two methods of ligation and their association with microbial colonization of Streptococcus mutans and lactobacilli *European Journal of Orthodontics* Vol:13 pp.416

Fraizer, MC.; Southard, TC. & Doster, PM. (1996) Prevention of enamel demineralization during orthodontic treatment: an in vitro study using pit and fissure sealent. *American Journal of Orthodontics Dentafacial Orthopedics Vol:110 pp. 459-465*

Fredericks, HE. (1981) Mutagenic potential of orthodontic bonding materials *American Journal of Orthodontics Vol:* 80 pp.316

Galil, KA. & Wright, GZ. (1979) Acid etching patterns on buccal surfaces of permanenet teeth *Pediatric Dentistry Vol:*1 pp.230-234

Garcia-Godoy, F.; Hubbard, GW. & Storey, AT. Effect of a fluoridated etching gel on enamel morphology and shear bond strength of orthodontic brackets *American Journal of Orthodontics Vol:*100 pp.163

Gelgör, IE. & Buyukyilmaz, T. (2003) A practical approach to white spot lesion removal, World Journal of Orthodontics Vol: 4 pp.152-156

Gillis, I. & Redlich, M. (1998) The effect of different porcelain conditioning techniques on shear bond strength of stainless steel brackets . *American Journal of Orthodontics* and Dentofacial Orthopedics *Vol:*114 pp.387 – 392

Goldstein, RE. & Parkins, FM. (1994) Air-abrasive technology: its new role in restorative dentistry *Journal of american Dental Associatation Vol:*125 pp.551-557

Gottlieb, EL.; Nelson, AH. & Vogels, DS. (1996) Study of orthodontic diagnosis and treatment procedures. Part I. Results and Trend *Journal of Clinical Orthodontics Vol:*30 pp.615-630

Gorelick, L; Geiger, AM. &, Gwinnett, AJ. (1982) Incidence of white spot formation after bonding and banding, *American Journal of Orthodontics* Vol:81 pp.93

Gwinnett, AJ. & Buonocore, MG. (1965) Adhesion and caries prevention. A preliminary report. *British Dental Journal Vol:*119 pp.77–80

Gwinnett, AJ. & Matsui, AA. (1967) Study of enamel adhesives. The physical relationship between enamel and adhesive *Archive of Oral Biology Vol:*12 pp.1615–1620

Gwinnett, AJ. (1973) The bonding of sealants to enamel *The Journal of the American Society for Preventive Dentistry Vol:*3 pp.21

Hannig, M.; Bock, H.; Bott, B. & Hoth-Hannig, W. (2002) Inter-crystallite nanoretention of self-etching adhesives at enamel imaged by transmission electron microscopy *European Journal of Oral Science Vol:*110 pp.464–470

Harari, D.; Shapira-Davis, S.; Gillis, I.; Roman, I. & Redlich, M. (2003) Tensile bond strength of ceramic brackets bonded to porcelain facets. *American Journal of Orthodontics Dentofacial Orthopedics Vol:*123 pp.551– 554

Hayakawa, T.; Horie, K.; Aida, M.; Kanaya, H.; Kobayashi, T. & Murata, Y. (1992) The influence of surface conditions and silane agents on the bond of resin to dental porcelain *Dental Materials Vol:*8 pp.238 – 240

Hermsen, RJ. & Vrijhoef, MMA. (1993) Loos of enamel due to etching with phosphoric or maleic acid *Dental Materials Vol:*9 pp.332-336

Hogervorst, WW.; Feilzer, AJ. & Prahl-Andersen, B. (2000) The air abrasion technique versus the conventional acid-etching technique: a quantification of surface enamel loss and a comparision of shear bond strength. *American Journal of Orthodontics Dentafacial Orthopedics Vol:*117 pp.20-26

Hosein, I.; Sherriff, M. & Ireland, AJ. (2004) Enamel loss during bonding, debonding and cleanup with use of self etching primer *American Journal of Orthodontics Dentofacial Orthopedics Vol:*126 pp.17-724

Hobson, RS. & McCabe, JF. (2002) Relationship between enamel etch characteristic and resin-enamel bond strength *British Dental Journal Vol:*192 pp.163-68

Hong, YH. & Lew, KK. (1995) Quantative and qualative assesment of enamel surface fallowing five composite removal methods after bracket debonding *European Journal of Orthodontics Vol:*17 pp.121-128

Hotz, P.; McLean, JW.; Seed, I. & Wilson, AD. (1977) The bonding of glass ionomer cements to metal and tooth substrates *British Dental Journal Vol:*142 pp.41-47

Huang, TH. & Kao, CT. (2001) The shear bond strength of composite brackets on porcelain teeth *Eurpean Journal of Orthodontics Vol:*23 pp.433–439

http://www.drilling-no-thanks.com/us/landing.html

Ireland, AJ. & Sherriff, M. (2002) The effect of pumicing on the in vivo use of rezin modified glass poly(alkenoate) cement and a conventional no-mix composite for bonding orthodontic brackets *Journal of orthodontics Vol:*29 pp.217-220

Jandt, KD.; Mills, RW.; Blackwell, GB. & Ashworth, SH. (2000) Depth of cure and compressive strength of dental composites cured with blue light emitting diodes(LEDs) *Dental Materials Vol:*16 pp.41-47

Jordan C. (1998) prevention of white spot enamel formation during orthodontic treatment *General Dentistry* Vol:46 pp. 498-502

Jost-Brinkmann, PG.; Schiffer, A. & Miethke, RR. (1992) The effect of adhesive layer thickness on bond strength *Journal of Clinical Orthodontics Vol:* 26 pp.718-720

Jost-Brinkmann, PG. & Can S, Drost C. (1996) In-vitro study of the adhesive strengths of brackets on metals, ceramic and composite. 2. Bonding to porcelain and composite resin *Journal of Orafacial Orthopedics Vol:* 57 pp.132

Katzir, A. (1993) Lasers and optical fibers in medicine, Acadenic press, San Diego, ,

Kawasaki, M.; Hayakawa, T.; Takizawa, T.; Sirirungrojying, S.; Saitoh, K. & Kasai, K. (2003) Assessing the performance of a methyl methacrylatebased resin cement with self-etching primer for bonding orthodontic brackets *Angle Orthodontist Vol:*73 pp.702–709

Klange, JT. (2004) Indirect bonding: a comprehensive review of the advantages *World Journal of Orthodontist Vol:*4 pp.301-307

Klange, JT. (2007) Indirect bonding: a comprehensive review of the literature *Seminers in Orthodontist Vol:*13 pp.3-10

Klocke, A.; Shi, J.; Kahl-Nieke, B. & Bismayer, U. (2003) Bond strength with custom base indirect bonding technique *Angle Orthodontist Vol:*73 pp.176-180

Kocadereli, İ.; Canay, Ş. & Akça, K. (2001) Tensile bond strength of ceramic orthodontic brackets bonded to porcelain surfaces . *American Journal of Orthodontics and Dentofacial Orthopedics Vol:*119 pp.616 – 620

Krell, KV.; Courey, JM. & Bishara, SE. (1993) Orthodontic bracket removal using conventional and ultrasonic debonding technique: enamel loss and time requirements *American Journal of Orthodontics Dentofacial Orthopedics Vol:*103 pp.258-266

Lalani, N.; Foley, TF.; Voth, R.; Banting, D. & Mamandras, A. (2000) Polymerization with the argon laser: curing time and shear bond strength *Angle Orthodontist Vol:*70 pp.28–33

Lefeuvre, M.; Amjaad, W.; Goldberg, M. & Stanislawski, L. (2005) TEGDMA induces miticindrial denage and oxidative stress in human gingival fibroblasts *Biomaterials* Vol: 26 pp. 5130-5137.

Lew, KK.; Chew, CL. & Lee, KW. (1991) A comparison of shear bond strengths between new and recycled ceramic brackets *European Journal of Orthoodntics* Vol:13 pp.306

Li, S.; Hobson, RS.; Bai, Y.;Yan, Z.; Carrick, TM. & McCabe JF. (2007) Method for producing controlled fluoride release from an orthodontic bracket *European Journal of orthodontics* Vol:29 pp. 550-554

Lührs, AK.; Guhr, S.; Schilke, R.; Borchers, L.; Guertsen, W. & Günay, H. (2008) Shear bond strength of self-etch adhesives to enamel with additional phosphoric acid etching *Operative Dentistry* Vol:33 pp.155–162

Ma, T.; Marangoni, RD. & Flint, W. In vitro comparison of debonding force and intrapulpal temperature changes during ceramic orthodontic bracket removal using a carbon dioxide laser *American Journal of Orthodontics and Dentafacial Orthopedics Vol:*111 pp.203

Maijer, R. & Smith, DC. (1986) Crystal growth on the outer enamel surface an alternative to acid etching. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:89 pp.183-193

Maiman, TH. (1966) A look at things to come: biomedical lasers evolve toward clinical application, hosp Manage Vol:101 pp.39-41

Major, PW.; Koehler, JR. & Maning. KE. (1995) 24-hour shear bond strength ofmetal orthodontic brackets bonded to porcelain using various adhesion promoters *American Journal of Orthodontics Dentofacial Orthopedics* Vol:108 pp.322–329

Manni, JG. (2004) Dental applications of advanced lasers. Burlington,

Marcusson, A.; Norevall, LI. & Person M. (1997) White spot reduction when using glass ionomer cement for bonding in orthodontics: a longitudinal and comperative study *Eurpean Journal of Orthodontics* Vol:19 pp. 133-242

Mattick, CR. & Hobson, RS. (2000) A comperative micro-topographic study of the buccal enamel of different tooth types *Journal of Orthodontist* Vol:27 pp.143-148

Meng, CL.; Wang, WN. & Yeh, IS. (1997) Fluoridated etching on orthodontic bonding, *American Journal of Orthodontics* Vol:112 pp.259

Meurman, JH.; Antila, H.; Korhanen, A. & Salminen, E. (1995) Effect of lactobacillus rhamnosus strain GG (ATCC 53103) on the growth of streptococcus sobrinus in vitro, *European Journal of Oral Science* Vol: 103 pp. 253-258

Mills, RW.; Jandt, KD. & Ashworth SH. (1999) Dental composite depth of cure with halogen and blue light emitting diode technology *British Dental Journal* Vol:186 pp.88-91

Miserendino, LJ.; Levy, G. & Miserendino, CA. (1995) In: *Laser interaction with biologic tissues*. Miserendino LJ, Pick RM, editors: Lasers in dentistry, Quintessence Chigaco

Miserendino, LJ.; Neiburger, EJ.; Waila, H.; Luebke, N. & Brantley, W. (1989) Thermal effects of continuous wave CO_2 laser exposure on human teeth: an in vitro study *Journal of Endodontics* Vol:15 pp.302-305

Miyazaki, M.; Hirohata, N.; Takagaki, K.; Onose, H. & Moore, BK. (1999) Influence of self-etching primer drying time on enamel bond strength of resin composites *Journal of Dentistry* Vol:27 pp.203–207

Nebbe, B. & Stein, E. (1996) Orthodontic brackets bonded to glazed and deglazed porcelain surfaces . *American Journal of Orthodontics and Dentofacial Orthopedics* Vol:109 pp.431–436

Newman, GV. (1978) A posttreatment survey of direct bonding of metal brackets *American Journal of Orthodontics* Vol:74 pp.197

Newman, GV. (1965) Epoxy adhesives for orthodontic attachments *American Journal of Orthodontics* Vol:51 pp. 901–912.

Ng'anga, P.; Øgaard, B.; Cruz, R.;, et al. (1992) Tensile bond strength of orthodontic brackets bonded directly to fluorotic and non-fluorotic teeth. *American Journal of Orthodontics and Dentofacial Orthopedics* Vol:102 pp.244-250

Niemz, MH. (2007) *Laser tissue interaction: fundementals and applications*, Springer ed 3, Berlin

Nishida, K.; Yamauchi, J.; Wada, T. & Hosoda, H. (1993) Development of a new bonding system *Journal of Dental Research Vol*::72 pp.137(abstract)

Nordenvall, KJ.; Brännström, M. & Malmgren, O. (1980) Etching of deciduous teeth and young and old permanent teeth: a comparison between 15 and 60 seconds of etching, *American Journal of Orthodontics* vol:78 pp.99

Olsen, ME.; Bishara, SE.; Boyer, DB. & Jakobsen, JR. Effect of varying etching times on the bond strength of ceramic brackets. *American Journal of Orthodontics Dentofacial Orthopedics* 1996;109:403-9.

Olsen, ME.; Bishara. SE.; Damon, P. & Jakobsen, JR. (1997) Evaluation of scotchbond multipurpose and maleic acid as alternative methods of bonding orthodontic brackets *American Journal of Orthodontics Dentofacial Orthopedics* Vol:111 pp.498-501

Özcan, M.; Vallittu, PK.; Peltomaki, T.; Huysmans, M. & Kalk, W. (2004) Bonding polycarbonate brackets to ceramic: effects of substrate treatment on bond strength. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:126 pp.220–227

Oduncu. BS. (2009) Investigation Of Polymerization Shrinkage Of Dental Composites Prepared With Different Fillers During Photopolymerization Biongineering, M.S. Thesis, Istanbul

Oliver, RG. & Griffiths, J. (1992) Different technique of residual composite removal following debonding: time taken and surface enamel appreance *British Journal of Orthodontist* Vol:19 pp.131-137

Özer, T.; Başaran, G. & Berk, N. (2008) Laser etching of enamel for orthodontic bonding *American Journal of Orthodontics and Dentofacial Orthopedics* Vol:134 pp.193-197

Özer, M. & Arıcı, S. (2005) Sandblasted metal brackets bonded with rezin modified glass ionomer cement in vivo *Angle Orthodontist* Vol:75 pp.406-409

Özturk, B.; Üşümez, A. & Üşümez, S. (2004) Temperature rise during adhesiveand rezin composite polymerization with various light curing sources *Operative Dentistry* Vol:29 pp.325-332

Pascotto, RC.; Navorro, MF.; Capelozza. FL. & Cury, JA. (2004) In vivo effect of rezin modified glass ionomer cement on enamel demineralization around orthodontic brackets *American Journal of Orthodontics Dentofacial Orthopedics* Vol:125 pp.36-41

Pashley, DH. & Tay, FR. (2001) Aggressiveness of contemporary self-etching adhesives. Part II: etching effects on unground enamel *Dental Materials* Vol:17 pp.430–444

Ponduri, S.; Turnbull, N.; Birnie, D.; et al. (2007) Does atropine sulphate improve orthodontic bond survival? A randomized clinical trial. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:132 pp.663-670

Powers, JM.; Kim, HB. & Turner, DS. (1997) Orthodontic adhesives and bond strength *Seminers in Orthodontist* Vol:3: pp.47-156

Powel, GL.; Morton, TH. & Larsen, AE. (1989) Pulpal response to irridation of enamel with continuous wave CO2 laser *Journal of Endodontics* Vol:15 pp.581-583

Pus, MD. & Way, DC. (1980) Enamel loss due to orthodontic bonding with filled and unfilled resins using various clean-up techniques. *American Journal of Orthodontics* Vol:79 pp.269-283

Rechmann, P.& Henning, T. (2001) Lasers in periodontology today and tomorrow *Medical Laser Application* Vol:15 pp. 223-230

Redd, TB. & Shivapuja, PK. (1991) Debonding ceramic brackets: effects on enamel *Journal of Clinical Orthodontics Vol*:25 pp.475-481

Reisner, KR.; Levitt, HL. & Mante, F. (1997) Enamel preparation for orthodontic bonding: a comparison between the use of a sandblaster and current techniques *American Journal of Orthodontics* Vol:111 pp.366

Casaccia, RG.; Gomes, JC.; Alviano, D.; Ruellas OC. & Sant'Anna EF. (2007) Microbial evaluation of elastomeric chains. *The Angle Orthodontist* Vol: 77 pp. 890-893

Retief, DH.; Retief, CJ.; Dreyer. & Gavron G. (1970) The direct bonding of orthodontic attachments to teeth by means of an epoxy resin adhesive *American Journal of Orthodontics* Vol:58 pp. 21–40

Rickabaugh, JL. Marangoni, RD. & McCaffrey, KK. (1996) Ceramic bracket debonding with the carbon dioxide laser *American Journal of Orthodontics* Vol:110 pp.388

Rossouw, PE. (2010) A Historical Overview of the Development of the Acid-Etch Bonding System in Orthodontics *Seminers in Orthodontist* Vol:16 pp.2-23

Rueggeberg ,FA. & Lockwood, P. (1990) Thermal debracketing of orthodontic resins, *American Journal of Orthodontics* Vol:98 pp.56

Sadowsky, PL.; Retief, DH.; Cox, PR.; Hernandez, R.; Rape, WG. & Bradley EL. (1990) Effects of etchant concentration and duration on the retention of orthodontic brackets: an

in vivo study. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:98 pp.417-421

Sayınsu, K.; Işık, F.; Sezen, S. & Aydemir, B. (2007) The effect of blood and saliva contamination on bond strength of brackets bonded with a protective liquid polish and a light-cured adhesive. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:131 pp.391-394

Schaneveldt, S. & Foley, TF. (2002) Bond strength comparison of moisture-insensitive primers. *American Journal of Orthodontics and Dentofacial Orthopedics* Vol:122 pp.267–273

Schmage, P.; Nergiz, I.; Herrman, W. & Özcan, M. (2003) Influence of various surface-conditioning methods on the bond strength of metal brackets to ceramic surfaces. *American Journal of Orthodontics Dentofacial Orthopedics* Vol:123 pp.540–546

Sheen, DH.; Wang, WN. & Tarng, TH. (1993) Bond strength of younger and older permanent teeth with various etching times *Angle Orthodontist* Vol:63 pp.225-230

Silverman, E. Cohen, M.; Gianelly, AA. & Dietz, VS. (1972) A univesal direct bonding system for both metal and plastic brackets. *American Journal of Orthodontics* Vol:62 pp.236

Silverman, E. & Cohen, ML. The twenty minute full strap up *Journal of Clinical Orthodontics* vol:10 pp.764

Silverstone, LM.; Saxton, CA.; Dogon, IL. 81975) Variation in the pattern of acid etching of human dental enamel examinated by scanning electron microscopy *Caries Research* 1Vol:9 pp.373-87

Silverstone, LM. (1977) Remineralization phenomena *Caries Research* Vol:11 pp.59

Silverstone, LM. (1982) The effect of fluoride in the remineralization of enamel caries and caries-like lesions in vitro *Journal of Public Health Dentistry* Vol: 42 pp.42

Sfondrini, MF.; Cacciafesta, V.; Pistorio, A.;et al. (2001) Effects of conventional and high-intensity light curing on enamel shear bond strength of composite resin and resin modified glass ionomer *American Journal of Orthodontics Dentofacial Orthopedics Vol:*119 pp.30-35

Smith, DC. & Cartz, L. (1973) Crystalline interface formed by polyacrilic acid tooth enamel *Journal of Dental Research* Vol:52 pp.1155

Simonsen, RJ. & Calamia, JP. (1983) Tensile bond strength of etched porcelain *Journal of Dental Research* Vol:61 pp.279

Stratmann, U.; Schaarschmidt, K.; Wegener, H.; et al. (1996) The extent of enamel surface fractures: a quantitative comparison of thermally debonded ceramic and mechanically debonded metal brackets by energy dispersive micro- and image-analysis *European Journal of Orthoodntics Vol: 18* pp.655

Swartz, ML. (1994) Why prophy prior to bracket bonding? *Clinical Impressions* Vol:3 pp.11

Swartz, ML. (2004) Orthodontic bonding Orthodontist Select Vol:16 pp.1-4

Thompson, IR.; Miller, EG. & Bowles, WH. (1982) Leaching of unpolymerized materials from orthodontic bonding resin *Journal of Dental Research Vol:61 pp.9*89

Thomas, RG. (1979) Indirect bonding: simplicity in action *Journal of Clinical Orthodontics Vol:*13 pp.93-104

Thomas, BV.; Hook, CR. & Draughn, RA. (1996) Laser-aided degradation of composite resin *Angle Orthodontist* Vol:66 pp.281-286

Tocchio, RM.; Williams, PT.; Mayer, FJ.; et al. (1993) Laser debonding of ceramic orthodontic brackets, *American Journal of Orthodontics Dentofacial Orthopedics* Vol:103 pp.155

Toroğlu, MS.; Bayramoğlu, O.; Yarkın, F. & Tuli, A. (2003) Possibility of blood and hepatit B contamination throught aerosol generated during debonding procedures *Angle Orthodontist* Vol:73 pp.571-578

Toroğlu, MS.; Haytaç, MC. & Köksal, F. (2001) Evaluation of aerosol contamination during debonding procedures *Angle Orthodontist* Vol:71 pp.229-306

Trakyalı, G.; Malkondu, Ö.; Kazazoğlu, E. & Arun, T. (2009) Effects of different silanes and acid concentrations on bond strength of brackets to porcelain surfaces *European journal of orthodontics* Vol:31 pp.402-406

Triolo, PT. Jr; Swift, EJ. Jr; Mudgil, A. & Levine, A. (1993) Effects of etching time on enamel bond strengths *American Journal of Dentistry* Vol:6 pp.302-304

Tylka, DF. & Stewart, GP. (1994) Comparison of acidulated phosphate fluoride gel and hydrofluoric acid etchants for porcelain-composite repair *Journal of Prosthetic Dentistry* Vol:72 pp.121–127

Øgaard, B.; Bishara, S. & Duschner, H. (2004) Enamel effects during bonding–debonding and treatment with fixed appliances, in: *Risk Management in Orthodontics: Experts' Guide to Malpractice* Graber T, Eliades T editors, pp. 19-46:. Quintessence, Chicago

Øgaard, B. & Fjeld, M. (2010) The enamel surface and bonding in orthodontics *Seminers in Orthodontist Vol:*16 pp.37-48

Øgaard, B.; Rølla, G., Arends J, et al: (1988) Orthodontic appliances and enamel demineralization. 2. Prevention and treatment of lesions, *American Journal of Orthodontics Dentafacial Orthopedics Vol:* 94 pp.123

Ógaard B. (1989) Prevalance of white spot lesion in 19 year olds: a study on untreated and ortodontically treated person 5 years after treatment *American Journal of Orthodontics Dentafacial Orthopedics Vo:76 pp.423-427*

Øgaard, B.; Rølla G. (1993) Cariological aspects of treatment with fixed orthodontic appliances. Part II. New concept on cariostatic mechanism of topical fluoride *Kieferorthop Mitterlung* Vol:6 pp. 45-51

Øilo, G. (1993) Bond strength testing: What doesit mean? *International Dental Journal* Vol:43 pp.492-498

Uysal, T.; Baysal, A.; Uysal, B.; Aydınbelged, M. & Al-Qunaian T. (2011) Do fluoride and casein phosphopeptide–amorphous calcium phosphate affect shear bond strength of orthodontic brackets bonded to a demineralized enamel surface? *Angle Orthodontist* Vol:81 pp.490–495

Üşümez, S. & Erverdi, N. (2008) *Adhesive and bonding in orthodontics.* pp. 45-67, Elsevier.

Üşümez, S.; Büyükyılmaz, T. &, Karaman, AI. (2003) Effects of fast halogen and plasma arc curing lights on the surface hardness of orthodontic adhesivesfor lingual retainer *American Journal of Orthodontics Dentafacial Orthopedics Vol: 123 pp. 641-648*

Van Meerbeek, B.; De Munck, J.; Mattar, D.; Van Landuyt, K. & Lambrechts, P. (2003) Adhesion to enamel and dentin: current status and future challenges. Operative Dentistry Vol:28 pp.215–235

Viazis, AD.; Cavanaugh, G. & Bevis, RR. (1990) Bond strength of ceramic brackets under shear stress: an in vitro report *American Journal of Orthodontics* Vol:98 pp.214

Wang, WN. & Lu, TC. (1991) Bond strength with various etching times on young permanent teeth, *American Journal of Orthodontics* Vol:100 pp.72-79

White, LW. (1975) Effective saliva control for orthodontic patients *Journal of Clinical Orthodontics Vol:9* pp.648

Wigdor, HA.; Walsh, JT.; Featherstone, JD.; Visuri, SR.; Fried, D. & Waldvogel LJ. (1995) Lasers in dentistry *Lasers Sureryg Medicine* Vol:16 pp.103-108

Wiltshire, WA. (1999) In vitro and in vivo fluoride release from orthodontic elastomeric ligature ties. *American Journal of Orthodontics Dentafacial Orthopedics* Vol:115 pp. *288-292*

Winchester, LJ. (1991) Bond strength of five different ceramic brackets: an in vitro study *European Journal of Orthoodntics* Vol:13 pp. 293-305

Wood, DJ.; Bubb, NL.; Millar, BJ. & Dunne SM. (1997) Preliminary investigation of a novel retentive system for hydrofl uoric acid etch-resistant dental ceramics *Journal of Prosthetic Dentistry* Vol:78 pp.275–280

Zacrisson, BU. (1977) A posttreatment evaluation of direct bonding in orthodontics *American Journal of Orthodontics* Vol: 71pp.173

Zachrisson, BU. & Årtun, J. (1979) Enamel surface appearance after various debonding techniques *American Journal of Orthodontics* Vol:75 pp.121

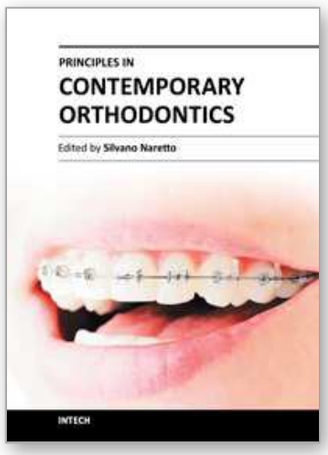
Zachrisson, BU. & Büyükyılmaz, T. (2005) Bonding in Orthodontics. In: *Orthodontics: current principles and techniques* , Graber TM, Vanarsdall RL, Vig KW of editors: pp.579-659, Elsevier Healt Sciences, St Louis

Zachrisson, YO.; Zachrisson, BU. & Büyükyilmaz, T. (1996) Surface preparation for orthodontic bonding to porcelain . *American Journal of Orthodontics and Dentofacial Orthopedics* Vol:109 pp.420 – 430

Zacrisson, BU. & Büyükyılmaz, T. (1993) Recent advences in bonding to gold, amalgam and porcelain *Journal of Clinical Orthodontics* Vol:27 pp.661

Zacrisson, BU.; Büyükyılmaz, T. & Zacrisson, YØ. (1995) Improving orthodontic bonding to silver amalgam *Angle Orthodontist* Vol:65 pp.35

Zachrisson, BU. & Brobakken, BO. (1978) Clinical comparison of direct versus indirect bonding with different bracket types and adhesives *American Journal of Orthodontics* Vol:74 pp.



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Orthodontics is a fast developing science as well as the field of medicine in general. The attempt of this book is to propose new possibilities and new ways of thinking about Orthodontics beside the ones presented in established and outstanding publications available elsewhere. Some of the presented chapters transmit basic information, other clinical experiences and further offer even a window to the future. In the hands of the reader this book could provide an useful tool for the exploration of the application of information, knowledge and belief to some orthodontic topics and questions.

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University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
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Phone: +86-21-62489820
Fax: +86-21-62489821

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