COMPARISON OF BOND STRENGTH OF PORCELAIN LAMINATE VENEERS BONDED TO LASER TREATED DENTIN AND ACID TREATED DENTIN : AN IN VITRO STUDY

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CERTIFICATE

This is to certify that **Dr.J.RAGHUNATHAN,** Post Graduate student (2014-2017) in the Department of Prosthodontics and crown & bridge, Adhiparasakthi Dental College and Hospital, Melmaruvathur – 603319, has done this dissertation titled **"COMPARISON OF BOND STRENGTH OF PORCELAIN LAMINATE VENEERS BONDED TO LASER TREATED DENTIN AND ACID TREATED DENTIN : AN IN VITRO STUDY."** under our direct guidance and supervision in partial fulfilment of the regulations laid down by the Tamilnadu Dr.M.G.R Medical University, Chennai – 600032 for MDS., (Branch-I) (Prosthodontics and Crown & Bridge) degree examination.

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DECLARATION

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ABSTRACT

BACKGROUND:

Ideal laminate veneer preparations are supposed to be in enamel which provides excellent bond strength and ensures the longevity of the restorations. But certain clinical situations like dental caries extending to dentin, old restorations require the preparation to be extended into the dentin; wherein the bond strength gets compromised. Hard tissue lasers like Er,Cr:YSGG laser has the potential to prepare dentinal surface for adhesion.

AIM:

The purpose of this study is to compare the bond strength of the conventional acid etch technique and the laser treated dentinal surface bonded to porcelain laminate veneer restorations.

MATERIALS AND METHODS:

Hundred extracted human maxillary central incisors with approximately 10 mm anatomic crown length and 8 mm mesio-distal width are selected. The crown portion of tooth is cut and embedded in the clear acrylic resin. The labial surface is prepared flat to receive the porcelain laminates. 50 teeth treated with 37 % phosphoric acid (acid etching) and the other 50 teeth are treated with laser etching. Then the laminate veneers bonded to both these groups. This is kept in distilled water for 24 hours and shear bond strengths are tested with Universal testing machine. Then the results are statistically analysed.

RESULTS:

The mean and standard deviation value of Group A (Acid) is 8.5180 and .22829 with a maximum value of 8.9 and a minimum value of 8.1. The mean and standard deviation value of Group B (Laser) is 8.4980 and .11156 respectively with a maximum value of 8.7 and a minimum value of 8.3 .

CONCLUSION:

Within the limitations of this study, 37% ortho-phosphoric acid (8.5 Mpa) and laser (8.49 Mpa) treated dentin surfaces showed similar bond strength values. The differences are not statistically significant. But the results of the Laser etched bond strength were more consistent than Acid etched bond strength.

(Key words : Porcelain laminate veneers, Acid etching, Laser etching.)

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INTRODUCTION

The popularity of porcelain laminate veneers has increased due to its conservative tooth preparation and high end aesthetics.[1] The long-term clinical success of porcelain veneers depends on careful case selection, treatment planning and tooth preparation.[2]

Laminates made of porcelain do offer solutions that are both conservative in nature and esthetically pleasing for the following clinical situations.[3]

Discoloration: Teeth discolored by tetracycline staining, devitalization and fluorosis, and even teeth darkened with age can be given younger, brighter-looking smiles.[3]

Enamel Defects: Different types of enamel hypoplasia and malformations can be masked / corrected.[3]

Diastemata: Gaps and other multiple unsightly spaces in the anterior region can be closed.[3]

Malpositioned Teeth: Indicated in cases where orthodontics is not the treatment of choice or if the patient has unavailability of total treatment time. An illusion is created by changing the shape, position, size and surface appearance of a malpositioned / rotated tooth and making it appear straight. Ex: increasing the length or width of the anterior teeth.[3]

Malocclusion: The configuration of lingual surface of anterior teeth can be modified to develop increased guidance or centric holding cusp areas in malocclusions or periodontally compromised teeth.[3]

Poor Restoration: Teeth with multiple shallow, unaesthetic restorations on labial surfaces can be restored to naturality.[3]

Aging: The on going process of aging can result in color changes and wear in teeth. These teeth may be ideal candidates for improvement by bleaching or, in certain situations, bleaching with subsequent veneering.[3]

Wear Pattern: Porcelain laminates are also useful in those cases that exhibit slowly progressive wear patterns. If sufficient enamel remains and the described increase in length is not excessive, porcelain veneer can be bonded to the remaining tooth structure to change shape, color, or function.[3]

Porcelain laminate veneers are a powerful prosthetic tool to improve esthetics with minimal loss of tooth structure.[4] The technique requires a shallow reduction of the enamel on the labial surface. Some authors believe tooth preparation is unnecessary for porcelain veneer restoration. Tooth preparation is necessary for the following reasons, they provide for, the strength, restorative area and color of the restoration.[2] The prepared area for porcelain veneer should be in the enamel to maximize the resin bond strength and decrease the tensile stresses in the porcelain.[2]

The key to success is by understanding, that the final restoration obtained is a combined metamerism of the tooth, the resin cement used for bonding, and the ceramic laminate veneers used for the restorative procedure.[5] The main aim of the tooth preparation is that it should be simple and minimal reduction of sound tooth structure.[6] There are different approaches in tooth preparation for porcelain laminate veneers. Tooth preparation for porcelain laminate should be intra-enamel to maximize the resin bond strength.[7]

The resin bonding is a quite reliable and predictable method in the enamel. For bonding of ceramic laminate veneer, presence of enamel thickness is important. Pretreatment of the tooth surface is essential for establishing a strong bond between the ceramic and both the enamel and dentin.[8]

The acid-etching technique with phosphoric acid, introduced by Buonocore' in 1955, is still used to create an irregular surface of beveled enamel.[9] The retention to the dentinal surface is mainly due to the formation of hybrid layer and the micro-mechanical retention offered by the resin tags embedded in the dentin.[10]

The bonding of resin to enamel surface is gained via micro-mechanical retention on the irregular surface in cavity preparation. Therefore, the formation of a hybrid layer and resin tags is essential for the establishment of a strong bond at the dentin level.[10] This type of strong bond can be achieved by complete dissolution of the smear layer and demineralization of the intertubular dentin and peritubular dentin by acid etching method, resulting in an exposed collagen matrix that can be infiltrated by resin.[10] Bonding to dentin without dissolution of smear layer reduces the bond strength because the smear layer obliterates the tubules and reduces dentinal permeability by 86%.[11]

In recent years, there has been a growing debate about the use of lasers for various applications in dentistry, including carious dentin removal or cavity preparation.[10] Laser irradiation of dental hard tissues modifies calcium to phosphorus ratio, reduces carbonate to phosphate ratio, and leads to the formation of more stable and less acid-soluble compounds, thus reducing susceptibility to acid attack and caries.[12]

Advancements in laser technology have led to multiple dental applications such as soft tissue surgery, composite photo-polymerization, tooth whitening, endodontic procedures, and caries removal and cavity preparation with minimal pain and discomfort.[13] Kastler developed the “optical pumping effect” mechanism. LASER is Light Amplification by Stimulated Emission of Radiation described by Gordon Gould in 1957. The first laser used was Ruby laser by Maiman. Then various researches were done regarding this and Maiman found the therapeutic effect of the laser device as a “bloodless” surgical machine and used as a “dentist’s drill”. In the year 1990, introduction of first laser for general dentistry was done by Myers and Myers.[14]

A laser beam is created from a substance known as an active medium, placed between two optically parallel and extremely high reflecting mirrors with one of them partially transmitting, and an energy source to pump active medium. This may either be a solid, liquid, or gas. They have the property to amplify the amplitude of the light wave passing through it by stimulated emission.[14]

The pumping source may be electrical or optical. The gain medium used between pair of mirrors are placed in such a way that light oscillating between the mirrors passes every time through the gain medium placed in between mirrors, thereafter attaining considerable amplification which emits through the transmitting mirror.[14] (figure:1).

Laser etching is a painless procedure making the clinical procedure highly attractive for routine clinical use. The surface produced by laser etching is ideal for adhesion and is also acid resistant.[1] The erbium lasers with very short pulse durations easily ablade layers of calcified tissue with minimal thermal effects. For better adhesion to dentin, some authors have suggested the use of lasers for dentin conditioning, as laser irradiation can provide an apparently micro retentive surface, free of a smear layer and open dentinal tubules.[15]

Erbium, Chromium: Yttrium-Scandium-Gallium-Garnet (Er, Cr: YSGG) and Erbium: Yttrium-Aluminium-Garnet (Er:YAG)lasers can ablade enamel and dentin effectively because of the high absorption by water and hydroxyapatite.[10] Surfaces irradiated by these lasers showed a characteristic irregular surface area, with clean and without debris around it, leads to opened dentinal tubules, and micro-irregularities caused by the preferential removal of the inter-tubular dentin, suggesting that the resultant dentin surface is receptive to adhesive procedures.[10]

AIM AND OBJECTIVES

Ideal laminate veneer preparations are supposed to be in enamel which provides excellent bond strength and ensures the longevity of the restorations. But certain clinical situations like dental caries extending to dentin, old restorations require the preparation to be extended into the dentin; wherein the bond strength gets compromised. Hard tissue lasers like Er, Cr:YSGG laser has the potential to prepare dentinal surface for adhesion.

The purpose of this study is to compare the bond strength of the conventional acid etch technique and the laser treated dentinal surface bonded to porcelain laminate veneer restorations.

GENERAL REVIEW ON LASERS

HISTORY OF LASERS:

It all started with MAX PLANCK's work in 1900 that provided the understanding that light is a form of electromagnetic radiation. Without this understanding, LASER would not have evolved. The principle of the laser was first known in 1917, when physicist Albert Einstein described the theory of stimulated emission. The first laser was developed by Theodore H. Maiman. Using a theory originally postulated by Einstein, Maiman created a device where a crystal medium was stimulated by energy, and radiant, laser light was emitted from the crystal.[14] Approximately, the history of lasers begins similarly to much of modern physics, with Einstein. In 1917, his paper in Physikialische Zeil, "ZurQuantern Theorie der Strahlung", was the first discussion of stimulated emmission.[16]

At this stage, the engineers were working towards the creation of what was termed a MASER (Microwave Amplification by the Stimulated Emission of Radiation), a device that amplified microwaves as opposed to light and soon found use in microwave communication systems. Townes and the other engineers believed it to be possible to create an optical maser, a device for creating powerful beams of light using higher frequency energy to stimulate what was to become termed the lasing medium.[17]

Despite the pioneering work of Townes and Prokhorov, it was left to Theodore Maiman in 1960 to invent the first Laser using a lasing medium of ruby that was stimulated using high energy flashes of intense light. Townes and Prokhorov were later awarded the Nobel Science Prize in 1964 for their endeavours.[16]

TYPES OF LASERS[14]:

According to their sources:

- Gas Lasers
- Crystal Laser
- Semiconductors Lasers
- Liquid Lasers

According to the nature of emission:

- Continuous Wave
- Pulsed Laser

According to their wavelength:

- Visible Region
- Infrared Region
    - ❖ Far infrared
    - ❖ Near infrared
- Ultraviolet Region

According to their site of action:

- Soft tissue lasers
- Hard tissue lasers

GAS LASERS:

The HeNe gas laser was first gas laser introduced, many other gas discharges have been found to amplify light coherently. Gas lasers using many different gases have been built and used for many purposes. The helium-neon laser (HeNe) is able to operate at a number of different wavelengths, however majority are lased at 633 nm; these relatively low cost but are highly coherent lasers. Commercial carbon dioxide (CO_2) lasers can emit many hundreds of watts in a single spatial mode which can be concentrated into a tiny spot. This emission is in the thermal infrared at 10.6 µm Argon-ion lasers can operate at a number of lasing transitions between 351 and 528.7 nm. A nitrogen transverse electrical discharge in gas at atmospheric pressure (TEA) laser is an inexpensive gas laser, often home-built. Metal ion lasers are gas lasers that generate deep like the ultraviolet wavelengths. Helium-silver (HeAg) 224 nm and neon-copper (NeCu) 248 nm are two examples.[14]

CONTINUOUS WAVE:

Applications of lasers depend on a beam whose output power is constant over time and steady when averaged over any longer time periods, with the very high frequency. The power variations had little or no impact in the intended application. Such a laser is known as continuous wave (cw). Many types of lasers can be made to operate in continuous wave mode to satisfy such an application.[16]

PULSED WAVE:

Pulsed operation of lasers refers to any laser not classified as continuous wave, so that the optical power appears in pulses of some duration at some repetition rate. This encompasses a wide range of technologies addressing a number of different motivations. Some lasers are pulsed simply because they cannot be run in continuous mode. In other cases the application requires the production of pulses having as large an energy as possible. Since the pulse energy is equal to the average power divided by the repetition rate, this goal can sometimes be satisfied by lowering the rate of pulses so that more energy can be built up in between pulses.[16]

SEMICONDUCTOR DIODE LASERS:

Diode lasers are quite popular due to their compact size and relatively affordable pricing. A specialized semiconductor that produces monochromatic light when stimulated electrically is common to all diode lasers. A simple laser pointer is an example of a diode laser. Diode lasers can be used in both contact and non-contact mode and can function with continuous wave or gated pulse modes. They are not capable of free running pulsed mode. Diode lasers are invisible near infrared wavelengths and current machines range from 805 – 1064nm. One exception is the Diagnodent caries diagnostic laser which uses a visible red wavelength of 655 nm. Diode lasers are soft tissue lasers.[14]

The chromophores are pigments such as hemoglobin and melanin, similar to the Nd:YAG absorption spectrum. Photothermal interactions predominate whereby diode tissue cutting is via thermal energy. They are quite effective for a host of intraoral soft tissue procedures such as gingivectomy, biopsy, impression troughing, and frenectomy. Diode lasers also exhibit bactericidal capabilities and can be used for adjunctive periodontal procedures. They are also used for laser assisted tooth whitening. Diode lasers have photobiomodulation properties as well.[14]

EXCIMER LASERS:

The excimer laser is a special gas laser based on unstable molecules called excimers. They exist only in the excited state in for nanoseconds, just long enough for pulsed laser action. Excimer laser can ablate tissue very effectively via photochemical interaction without depositing heat therein.[14]

ARGON LASER:

The argon laser operates at a wavelength of 457 to 502 nanometers, using a pulsed or continuous waveform. The argon laser can be used for a variety of applications, including resin curing and tooth bleaching. In addition, this laser has a number of soft-tissue applications, including gingival troughing, esthetic contouring of gingiva, treatment of oral ulcers, frenectomy and gingivectomy.[14]

The primary advantage of the argon laser is that the laser operates at a wavelength that is absorbed by haemoglobin, which provides excellent haemostasis. Dentists should be aware that, when used for resin curing, argon lasers do not necessarily produce a resin with physical properties superior to those of resins cured with traditional halogen curing lights. In addition, some resins contain multiple initiators that activate at different wavelengths. This suggests that the relatively narrow spectrum of a laser might not be the best approach to activate the initiators.[14]

HELIUM-NEON LASER:

These types of lasers are one of the forerunners of all lasers which were at first theoretically proposed and then demonstrated in the year 1961. Generally only the red 632nm emission was widely applied as a pointing beam, however becoming replaced by diode lasers of similar wavelength.[14]

GALLIUM-ARSENIDE /DIODE LASER:

This type of diode laser operates at a wavelength of 904 nm, and uses a pulsed or continuous waveform and has proven to be successful with soft-tissue incision and ablation. This laser can be used for the following: gingival troughing, esthetic contouring of gingival, and treatment of oral ulcers, frenectomy and gingivectomy. This diode laser does not affect the inflammatory function of monocytes or endothelial cells, or the adhesion of endothelial cells. In addition, it can kill some microbes in the presence of a photosensitizer, as well as some fungi in the presence of some dye photosensitizers. Finally, within certain low-energy ranges, the diode laser can stimulate the proliferation of fibroblasts.[14]

NEODYMIUM:YTTRIUM-ALUMINIUM-GARNET(Nd:YAG) LASERS:

Nd:YAG lasers were the first types of true pulsed lasers to be used for dental procedures in 1990. They are a near infrared wavelength of 1064 nm. The Nd:YAG laser will penetrate into water to a depth of 60 mm before it is attenuated to 10% of its original strength. Therefore, the energy is scattered in soft tissue rather than being absorbed on the tissue surface as occurs with CO_2 laser energy. However, since this wavelength is attracted to colours, in heavily pigmented soft tissue such as skin, scattering is about twice as great as absorption. This heating effect with the Nd:YAG laser is ideal for ablation of potentially hemorrhagic abnormal tissue, and for hemostasis of small capillaries and very small venous vessels. Nd:YAG also have excellent biostimulative properties and unique capacity to stimulate fibrin formation. This effect is maximized when the pulse duration is set at 650 microseconds.[14]

However, the scattering effect increases the difficulty of judging the depth of penetration, particularly in pale coloured tissue, since the surface appearance of the tissue is not a reliable indicator of thermal damage. The depth of penetration has been estimated to be 2 ± 1 mm in soft tissue.[14]

A Nd:YAG laser device, designed and promoted for oral and dental applications, can deliver up to 3 watts of power in either a pulsed (20 pulses per second) or non-pulsed mode, utilizing a specially designed hand-piece with contact or non-contact probes. This laser also offers good haemostasis during soft-tissue procedures, which facilitates a clear operating field. In addition, the Nd:YAG laser offers a flexible fibre delivery system.[14]

The Nd:YAG laser has a number of disadvantages; however, it has the greatest depth of penetration of all the available dental surgical laser systems, which means that tissues under the surface are exposed to laser energy. This is cause for concern because of the risk of unwanted collateral damage, especially in the underlying bone as well as the associated postoperative morbidity.[14]

HOLMIUM: YTTRIUM-ALUMINIUM-GARNET(Ho:YAG) LASER:

The Ho:YAG laser operates at a wavelength of 2.1 μm, and uses a pulsed waveform. This laser is used for soft-tissue incision and ablation procedures, including the following: gingival troughing, esthetic contouring of gingival, treatment of oral ulcers, frenectomy and gingivectomy. The advantages of the Ho:YAG laser center on its surface effect on tissue. The Ho:YAG laser is less penetrating than the Nd:YAG laser and, therefore, is faster than the Nd:YAG at cutting soft tissue. Ho:YAG laser is also bactericidal.[14]

CARBON DIOXIDE LASERS:

CO_2 Lasers have been available in medicine since the early 1970's and have been used in dentistry for more than 25 years. They are a 10,600 nm infrared wavelength, which is highly absorbed by water. Articulated arms or hollow wave guides are used to transmit CO_2 laser beams and quartz optical fibres cannot be used.[14]

The CO_2 gas is in a chamber with nitrogen and helium and the active medium is pumped with an electrical current. CO_2 lasers are very efficient and exhibit excellent haemostasis. They are currently for soft tissue uses only. They are continuous wave lasers that can be operated in gated wave modes, including what are termed as "super-pulsed" modes. It is important to note even the super-pulsed mode is not a free running pulsed mode.[14]

These super-pulsed gated modes offer improved surgical control with less charring of tissue. CO_2 lasers are excellent tools for incising tissue for multiple purposes. Incisional and excisional biopsies, frenectomy, gingivectomy, pre-prosthetic procedures are all achieved with excellent haemostasis, de-epithelialisation of gingival tissue during periodontal regenerative procedures. Sutures are rarely needed and the controlled thermal effects and sealing of nerve endings often makes for a very comfortable post-operative experience for the patient.[14]

The CO_2 laser is safe around the implants because the energy is absorbed into water and not pigments. By affecting the intracellular water of bacteria, the CO_2 wavelength can safely and effectively treat peri-implantitis and mucositis, because the energy is not absorbed into the implant's surface.[14] With the CO_2 laser, the rapid rise in intracellular temperature and pressure leads to cellular rupture, as well as release of vapour and cellular debris, termed the laser plume. The debris arising from the site of impact, the char is carbonized tissue by the laser beam.[18]

ERBIUM AND ERBIUM-CHROMIUM LASERS:

The interest in the Er 3+ laser is based on the wavelength it can emit i.e. 1.54µm and 2.7-2.9µm. The former coincides nicely with the absorption minimum of optical silica fibres, allowing long-range optical communications. The later wavelength coincides nicely with the peak of water absorption. As water is contained in every biological tissue, efficient interaction and dense optical energy deposition is guaranteed. In medical applications and especially in dentistry, the Erbium lasers represent highly developed commercial lasers with high yield and efficiency in tissue removal. For dental hard tissue ablation, this is currently the type of laser most often used.[19]

ERBIUM:YTTRIUM –ALUMINIUM-GARNET (Er:YAG) LASER:

The laser operates at a wavelength of 2.94 µm and in a pulsed waveform. The FDA has cleared it for use on cementum and bone, and it has a variety of hard-tissue applications, including the following caries removal, cavity preparation in both enamel and dentin, preparation of root canals. The Er:YAG laser has a number of advantages as it produces clean, sharp margins in enamel and dentin, and in addition, pulpal safety is not a significant concern because the depth of energy penetration is negligible. Pulp may respond even better to preparations, done with the Er:YAG laser than those done with the bur. When the Er:YAG laser is used for caries removal, it usually does not require local anaesthesia. The laser is antimicrobial when used within root canals and on root surfaces, and it removes endotoxins from root surfaces. Finally, vibration from the Er:YAG laser is less severe than that from the conventional high-speed drill, and it is less likely to provoke discomfort or pain.[14]

ERBIUM,CHROMIUM:YTTRIUM-SCANDIUM-GALLIUM-GARNET (Er,Cr:YSGG) LASER:

The Er,Cr:YSGG operates at a wavelength of 2.78 µm, with an extinction length in water of 1.0 µm. The waveform for the Er,Cr:YSGG laser is pulsed. The Er,Cr:YSGG laser has several hard-tissue applications enamel etching, caries removal, cavity preparation, In-Vitro bone cutting with no burning, melting or alteration of the calcium: phosphorus ratio, root canal preparation.[14]

The Er,Cr:YSGG laser has a number of advantages. Multiple uses for the Er,Cr:YSGG laser make the economics of providing laser therapy more feasible. The laser produces a rough surface in enamel and dentin without significant cracking. In dentin, no smear layer remains, this suggests good results with bonding. The Er,Cr:YSGG laser is safe for the pulp. When using the Er,Cr:YSGG laser, no need to administer local anesthetic for caries removal and cavity preparation.[14]

REVIEW OF LITERATURE

Marco Franchi et al (1995)[9] stated that the best removal of dentinal smear layer resulted from the 37% phosphoric acid treatment; all the dentinal tubules orifices appeared to be completely opened. In this study three standard occlusal cavities with bevelled enamel margins were prepared on each tooth and etched with the etching solutions of three dentinal adhesive systems;(1) 37% phosphoric acid solution. (2) 4.3% oxalic acid and 2.6% aluminium salts solution, and (3) 10% maleic acid solution. Scanning electron microscopic analysis revealed that all the etching solutions affected the enamel surface morphology. The solution of oxalic acid and aluminium salts removed primarily the prism core material and partially the periphery of the prisms, but did not affect the non bevelled enamel surface. Phosphoric acid and maleic acid removed both prism core materials and prism periphery; these specimens also showed areas in which no prism morphology could be detected. These two acids also removed apatite crystals from the prism core of the intact enamel surface.

Arturo Martinez-Insua et al (2000)[12] stated that for both enamel and dentin, mean tensile strength of bonded brackets obtained after laser etching were significantly lower than those obtained after acid etching. In this study 80 healthy human premolars were used. Brackets were cemented to acid-etched enamel, laser-etched enamel, acid-etched dentin, or laser-etched dentin (20 teeth per group). Dentin was previously exposed using a high speed hand-piece. Acid etching was with 37% ortho-phosphoric acid (15 seconds for enamel, 5 seconds for dentin). Laser etching was with Er:YAG laser (four 200mJ pulses per second for enamel; four 160 mJ pulses per second for dentin). Brackets were bonded with auto-curing resin paste, having first applied a primer (dentin only) and then light cured bonding resin. Tensile strength was determined with a universal testing machine. Result shows that bond failure after laser etching was due to micro-cohesive fracture of tooth tissue.

M Peumans et al (2000)[7] stated that there is a general agreement among the practitioners that porcelain veneers will play a vital role in elective dental aesthetics. This places high demands on predictability, especially with colour matching and masking methods. In addition, patient acceptance of porcelain veneers in these clinical studies was high. Porcelain veneers are steadily increasing in popularity among today's dental practitioners for conservative restoration of unaesthetic anterior teeth. This current literature was therefore reviewed in search for the most important parameters determining the long term success of porcelain veneers. The adhesive porcelain veneer complex has been proven to be a strong complex in vitro and in vivo. An optimal bonded restoration was achieved especially if the preparation was located completely in enamel, if correct adhesive treatment procedures were carried out and if a suitable luting composite was selected. The maintenance of aesthetics of porcelain veneers in the medium to long term was excellent. Major shortcomings of the porcelain veneer were described as a relatively large marginal discrepancy, and an insufficient wear resistance of the luting composite. Although these shortcomings had no direct impact on the clinical success of porcelain veneers in the medium term, their influence on the overall clinical performance in the long term is still unknown and therefore needs further study.

Serdar Usumez et al (2002)[22] stated that etching of enamel surface with an Er,Cr:YSGG hydrokinetic laser system yielded statistically similar but lower and less predictable bond strengths than did etching with 37% phosphoric acid for 30 seconds. On the other hand, laser etching was found to be more practical and faster than conventional acid etching. Irradiation of enamel with laser energy changes the physical and chemical characteristics of the enamel surface, and these alterations hold promise for the conditioning of enamel for bonding procedures. This laboratory study examined the influence of laser irradiation of enamel at 2 different power settings with an erbium, chromium: yttrium, scandium, gallium garnet (Er,Cr:YSGG) hydrokinetic laser system on the shear bond strength of orthodontic appliances and compared these with that of acid etching. The prepared surfaces of 40 non-carious, intact, extracted premolars were exposed to laser energy: 20 teeth at 2W setting and 20 teeth at 1W setting of the commercial laser unit. 20 teeth were etched with 37% ortho-phosphoric acid. Brackets were bonded with an orthodontic no-mix adhesive, and shear bond strength was determined with a universal testing machine. Laser etching was found to be more practical and faster than conventional acid etching.

Mitsuharu Okamoto et al (2003)[4] stated that plasma curing for 3 second is sufficient to obtain similar bond strengths and stability to specimens cured with halogen light for 40 second for 1-mm-thick porcelain and that plasma curing for 5 second is sufficient even for porcelain of 2-mm thickness. Plasma and halogen lamp units were used to photo-cure a composite resin for porcelain bonding. Mean shear bond strengths to dentin after light curing through porcelain of 1 and 2mm thickness ranged from 20 to 27 MPa before and after thermo-cycling, indicating no significant effects due to porcelain thickness, curing method, or thermo-cycling, except for plasma curing for 3 second through porcelain of 2 mm thickness that overcame thermo-cycling.

GC Lopes et al (2003)[11] stated that for normal occlusal dentin, no difference exists in bond strength when 35% phosphoric acid etchant is applied following the manufacturer’s suggested time (15 seconds), or when the time is extended to 30 seconds. Bonding to sclerotic dentin resulted in lower bond strength to resin composite. Extending the phosphoric acid etching time can overcome this difficult factor with no detrimental effect to normal dentin considering the bond strength. In sclerotic dentin, the Hybrid Layer was very thin, with minimal resin tags in the dentinal tubules and, when present, they were shorter. Doubling the etching time resulted in more resin tags with the Hybrid Layer formation on peritubular dentin. The Hybrid Layer on normal dentin was thicker when it was acid etched for 30 seconds. Numerous resin tags were present with both etching times. The results suggest that the higher mineral amount in sclerotic dentin makes it difficult to bond to this substrate, resulting in a lower µ-TBS. However, doubling the etching time resulted in µ-TBS similar to normal dentin.

Aslihan Usumez et al (2003)[1] stated that 37% ortho-phosphoric acid and maleic acid treated enamel surfaces showed statistically similar bond strength values. Porcelain laminate veneers demonstrated the highest bond strength to 37% ortho-phosphoric acid etched and Er,Cr:YSGG hydrokinetic laser system- conditioned tooth surfaces. The differences were not statistically different. In this study 40 extracted caries and restoration free human maxillary central incisors were used. The teeth were sectioned 2 mm below the cement-enamel junction. The crowns were embedded in autopolymerising acrylic resin with the labial surfaces facing up. The labial surfaces were prepared with .05 mm reduction to receive porcelain veneers. The teeth were divided into 4 groups of 10 specimens. Thirty specimens received one of the following surface treatments before the bonding of IPS Empress 2 laminate veneers : (1) laser radiation from an Er,Cr:YSGG laser unit; (2) 37% ortho-phosphoric acid; and (3) 10% maleic acid. Ten specimens received no surface treatment and served as the control group. The veneers were bonded with dual polymerizing resin, Variolink II. One microtensile specimen from each of the cervical and incisal thirds measuring 1.2 × 1.2 mm was prepared with a slow speed diamond saw sectioning machine with a diamond rim blade. These specimens were attached to opposing arms of the microtensile testing device with cyanoacrylate adhesive and fractured under tension at a crosshead speed of 1 mm/min, and the maximum load at fracture (kg) was recorded. No statistically significant differences were found among the bond strengths of veneers bonded to tooth surfaces etched with Er,Cr:YSGG laser (12.1±4.4 MPa), 37% ortho-phosphoric acid (13±6.5 MPa), and 10% maleic acid (10.6±5.6 MPa). The control group demonstrated the lowest bond strength values in all test groups. Statistically significant differences were found between the bond strengths of cervical and incisal sections (p<.001). Invitro microtensile bond strengths of porcelain laminate veneers bonded to tooth surfaces that were laser etched showed results similar to ortho-phosphoric acid or maleic acid etched tooth surfaces.

John R Calamia et al (2007)[5] stated that etched porcelain veneer technology has demonstrated long-term clinical success. It has proved to be one of the most successful modalities of treatment that modern dentistry has to offer. The relatively few difficulties that have been encountered may be circumvented or eliminated if the practitioner pays close attention to detail. Development of new products and materials is expected to bring longer term success. Since its introduction more than two decades ago, etched porcelain veneer restoration has proved to be a durable and aesthetic modality of treatment. These past 25 years of success can be attributed to great attention to detail in the following areas: (1) planning the case, (2) conservative (enamel saving) preparation of teeth, (3) proper selection of ceramics to use, (4) proper selection of the materials and methods of cementation of these restorations, (5) proper finishing and polishing of the restorations, and (6) proper planning for the continuing maintenance of these restorations. This article discusses failures that could occur if meticulous attention is not given to such details. Failures that did occur structurally and aesthetically warned individuals who were learning the procedure what to watch for. Some concerns as to newer products and methods and their effect on the continued success of this modality of treatment are also addressed.

Galip Gurel (2007)[6] stated that porcelain laminate veneers have been one of the most used restorations for aesthetics. Although this approach is one of the most conservative treatment options, some rules must be followed. Best of all, however, is that it allows for minimal preparation on the recipient tooth. Tooth preparation is one of the most important considerations in this technique. Bonding to enamel rather than dentin provides the best/strongest bond values when we want to bond porcelain to tooth structure. When a porcelain veneer restoration is bordered on all margins by enamel, microleakage or debonding of these restorations is not likely to occur. A main objective of any restorative case involving these restorations is to keep the preparation simple and be conservative in reduction of sound tooth structure. Many other considerations come into play as the preparation becomes more aggressive and dentin is involved. A rigid veneer behaves differently when bonded to a rigid surface, such as porcelain, versus a less rigid surface, such as dentin, and the composite cement can only absorb so much of the stresses to which the restoration may be exposed. To minimize effects and possible problems, we should be precise and careful about case selection and tooth preparation.

Sevil Gurgan et al (2008)[32] stated that dentin surfaces prepared with the Er,Cr:YSGG laser and etched with the laser (at either 1.25 or 3 Watt) may provide comparable or increased composite resin bond strengths, depending on the adhesive used. The present study compared the in vitro shear bond strength of a nano-hybrid composite resin to human dentin that was prepared with either the diamond bur or the Er,Cr:YSGG laser, and treated with two different energy settings of laser (1.25 and 3 Watt), and two different adhesive systems (a conventional etch-and-rinse system that requires prior conditioning with phosphoric acid, and a two-step self etching system). In this study, they modified the surface morphology by cutting the tooth surface with a bur or an Er,Cr:YSGG laser, and then conditioned the surfaces with a bonding agent used with or without phosphoric acid or with self-etching primer, and they laser-treated them at different energy settings. In the present study, the highest bond strengths were achieved by laser preparation, laser etching, and application of Excite. Excite is a two-step etch and-rinse system, in which the primer and adhesive resin are combined into one solution. Generally, an etch-and-rinse procedure involves the use of phosphoric acid that demineralizes and exposes the collagen fibres on the dentin surface.

Mathew C A et al (2010)[3] stated that the ceramic laminate veneer remains the prosthetic restoration that best compiles the principles of present- day aesthetic dentistry. This “substitute enamel” now brings us closer to achieving the goals of Prosthodontics; to replace human enamel to its proper structure, shape and colour with this “bonded artificial enamel”. The history of aesthetic or cosmetic dentistry can be dated back to the Japanese customs of decorative tooth staining called “Ohoguro” which was documented 4000 years ago. Dr. Charles L. Pincus introduced the concept of veneering anterior teeth with laminates when approached by Hollywood directors in 1928. It was Buonocore's research about the acid etching technique in 1955, which provided a simple method of increasing adhesion to enamel surface for acrylic materials. But only after the introduction of light cured composites in 1970 did the dentist have the necessary working time to properly shape direct laminate veneers. In the mid 70's and 80's the composite resin laminate veneers, (with or without facing evolved). At first the composites were directly bonded to teeth and called “bonding”.

Cafer Turkmen et al (2010)[13] stated that the Er,Cr:YSGG laser-powered hydrokinetic system etched the enamel surface more effectively than 37% phosphoric acid for subsequent attachment of composite material. In this study sixty extracted caries- and restoration free human maxillary central incisors were used. The teeth were sectioned 2 mm below the cement-enamel junction. The crowns were embedded in auto-polymerizing acrylic resin with the labial surfaces facing up. The labial surfaces were prepared with 0.5-mm reduction to receive composite veneers. Thirty specimens were etched with Er,Cr:YSGG laser. This group was also divided into three subgroups, and the following three bonding systems were then applied on the laser groups and the other three unlased groups: *(1)* 37% phosphoric acid etch + Bond 1 primer/adhesive (Pentron); *(2)* Nano bond self-etch primer (Pentron) + Nano-bond adhesive (Pentron); and *(3)* all-in-one adhesive—single dose (Futurabond NR, Voco). All of the groups were restored with a nanohybrid composite resin (Smile, Pentron). Shear bond strength was measured. There were no significant differences in shear bond strength between self-etch primer + adhesive and all-in-one adhesive systems for non-etched and laser-etched enamel groups ($P > .05$).

Vinicius R. Geraldo-Martins et al (2010)[33] stated that the bonding effectiveness of adhesives to laser-irradiated dentin may be influenced not only by the structural substrate alterations induced by the laser, but also by the characteristics of the adhesive employed. Taking into consideration the experimental conditions of the present study, it can be concluded that the use of the Er,Cr:YSGG laser prior to the application of an etch and rinse adhesive did not negatively influence the action of the adhesive system in the dentin surface, since the results obtained for irradiated samples were not statistically different from those of control groups.

Guilherme Carpena Lopes et al (2011)[24] stated that bonding to old dentin with 30 seconds of etching time resulted in higher bond strength and more homogeneous hybrid layer formation than dentin acid etched for 15 seconds. According to this study the modification of dentin by physiological sclerosis due to aging should be considered during adhesive procedures. The clinical application of Adper Single Bond in old dentin after 15 seconds of acid etching may produce lower bond strengths. By simply doubling etching time from 15 to 30 seconds, bonding to old dentin resulted in higher bond strengths that were similar to those found in young dentin. Further investigation must be conducted with other etch-and-rinse simplified adhesives. Whether increasing etching time results in increased longevity of restorations in elderly patients remains to be determined. This issue requires further clinical investigation.

Subutay Han Altintas et al (2011)[26] stated that selection of the provisional cement is an important factor in the ultimate bond strength of the final restoration. Calcium hydroxide provisional cement and cleaning with a dental explorer are advisable. In the current study, three provisional cements and two cleaning techniques were evaluated for their effects on the final bond strengths of Porcelain laminate veneers. The results obtained did not support the research hypothesis as no differences were found between the cleaning procedures. Freshly cut dentin is the ideal substrate for dentin bonding. In practice, freshly cut dentin is present only at the time of tooth preparation, prior to taking impressions. Significant reductions in bond strength can occur when dentin is contaminated with various provisional cements, compared to freshly cut dentin. Since some period of time is necessary to make the final restoration, a provisional restoration is used for approximately 10 days after the fixation. This makes mechanical and/or chemical cleaning procedures necessary before the definitive restoration is cemented. In this current study, after a period of 1 week, provisional cements were found to affect the final bond strength to dentin, although the bond strength test achieved acceptable values for all cases.

Zahra Jaberi Ansari et al (2012)[8] stated that the micro-shear bond strength of groups prepared by bur cutting and acid-etching were higher than that of groups prepared and etched by an Er,Cr:YSGG laser within the conditions of this study. Therefore, re-etching with phosphoric acid would be recommended if an Er,Cr:YSGG laser is used for tooth preparation or surface treatment. Enamel preparation by the Er,Cr:YSGG laser results in a characteristically chalky surface. Scanning electron microscopic images showed that laser irradiation produces a surface that increases the restorative material retention, which in turn makes the surface suitable for the application of composite and composer filling materials.

Eugenia Koliniotou-Koumpia et al (2012)[28] stated that the cavities prepared by laser seem less receptive to adhesive procedures than conventional bur-cut cavities. Superficial and deep dentin specimens from human molars were treated either with carbide bur or an Er:YAG laser. Two etch and rinse adhesives (Single Bond and XP Bond) and two self-etch adhesives (Prompt L-Pop and Xeno III) were employed to bond the composite. Shear bond strength (SBS) was determined after storage in water for 24 hours using a universal testing machine with a crosshead speed of 0.5 mm/min. Failure patterns and modes were analyzed and evaluated using a stereomicroscope. In addition, samples were processed for Scanning Electron Microscopy (SEM) evaluation. A linear mixed model was used, and pair wise comparisons were made using the Bonferroni test. Results showed significant differences between the levels of dentin treatment (p=.01) in carbide bur-cut dentin and lased dentin, as well as significant interaction effects due to the depth of dentin and the bonding system used. The etch and rinse adhesives bonded less effectively with lased dentin than with carbide bur-cut dentin, while self-etch adhesives bonded equally well with lased and bur-cut superficial dentin but much less effectively with lased deep dentin than with bur-cut deep dentin. SEM revealed a predominantly adhesive failure mode in laser-ablated fractured specimens, while a mixed failure mode was apparent in the bur-cut fractured specimens.

Abdolrahim Davari et al (2013)[25] stated that when the cavity is prepared by bur, it is not necessary to etch the dentin surface by Er:YAG laser following acid etching and acid etching after laser etching. In this study the roots of 75 sound maxillary premolars were sectioned below the CEJ and the crowns were embedded in auto-polymerizing acrylic resin with the buccal surfaces facing up. The buccal surfaces were ground using a diamond bur and polished until the dentin was exposed; the samples were randomly divided into five groups (n=15) according to the surface treatment: (1) acid etching; (2) laser etching; (3) laser etching followed by acid etching; (4) acid etching followed by laser etching and (5) no acid etching and no laser etching (control group). Composite resin rods (Point 4, Kerr Co) were bonded to treated dentin surfaces with an etch-and-rise adhesive system (Optibond FL, Kerr Co) and light-cured. After storage for two weeks at 37°C and 100% humidity and then thermo-cycling, bond strength was measured. There were no significant differences between acid etching and acid+laser groups, and between laser+acid and laser groups.

Ayoub Pahlavan et al (2013)[30] stated that the air abrasion after laser treatment improved the shear bond strength compared to laser group alone. In this study, 40 human extracted molars divided into 4 groups (n=10) received the following treatments. Group 1: carbide bur, Group 2: air abrasion with aluminium oxide 50 µm, Group 3: irradiated with Erbium-Doped Yttrium Aluminium Garnet (Er: YAG) laser (150 mJ/20Hz), Group 4: irradiated with Er:YAG laser (150 mJ/20Hz)+ air. Specimens in all groups were chemically etched with phosphoric acid 37% and treated with bonding agent (single bond 3M). Then, composite build-up was performed by tygon tube. After storage in distilled water at 37°c for one week, all specimens were subjected to a shear bond strength test with universal testing machine. Air abrasion after laser treatment improved the shear bond strength.

Ayoub Pahlevan et al (2014)[2] stated that the enamel thickness in different parts of the labial surface is very important. The thickness of enamel in the gingival area does not permit a chamfer preparation. The knife edge preparation is preferable in the gingival area. But is believed to end with the over contouring. In this study, the thickness of enamel in different places of labial surface was measured. This measurement is an important guide for the preparation of the tooth in laminate veneer. The most critical area is the labial gingival third. This study showed the mean thickness of enamel at the gingival third is 410 μ on the maxillary central incisor and 367 μ on the maxillary lateral incisor. There are two approaches in the preparation of tooth for porcelain laminate in the cervical area, chamfer and knife-edge preparations. The interest in chamfer preparation is because of cosmetics and avoidance of over contouring. The knife-edge preparation is believed to end up with the over contouring. The result of this study showed that in the knife-edge preparation there is no risk of dentin exposure, whereas in chamfer preparation the risk of dentinal exposure is significantly higher in the preparation of porcelain laminate.

Jing Liu et al (2014)[29] stated that increased laser influence may lead to more collateral damage and lower dentin roughness, while scanning speed and scanning distance were also negatively correlated with surface roughness. Adequate parameters should be chosen to achieve therapeutic benefits, and different parameters can result in diverse ablation results. In this study twelve extracted human premolars were sectioned into crowns and roots along the cemento-enamel junction, and then the crowns were cut longitudinally into sheets about 1.5 mm thick with a cutting machine. The dentin samples were fixed on a stage at focus plane. The laser beam was irradiated onto the samples through a galvanometric scanning system, so rectangular movement could be achieved. After ablation, the samples were examined with a scanning electron microscope and laser three-dimensional profile measurement microscope for morphology and roughness study. With increasing laser fluence, dentin samples exhibited more melting and re-solidification of dentin as well as debris-like structure and occluded parts of dentinal tubules. When at the scanning speed of 2400mm/s and scanning distance of 24µm, the surface roughness of dentin ablated with femtosecond pulsed laser decreased significantly and varied between values of dentin surface roughness grinded with two kinds of diamond burs with different grits. When at the scanning speed of 1200mm/s and scanning distance of 12µm, the surface roughness decreased slightly, and the surface roughness of dentin ablated with femtosecond pulsed laser was almost equal to that grinded with a low grit diamond bur.

Upendra A Hoshing et al (2014)[23] stated that, for enamel surface, mean SBS of bonded composite obtained after laser etching were significantly lower than those obtained after acid etching. Data from this study demonstrated that bonding to Er; Cr:YSGG laser-etched surfaces provided markedly weaker values than bonding to acid-etched surfaces. In the laser etched enamel preparations, the high prevalence of cohesive tooth fractures suggests that disruption as a result of "micro-explosions" weakened the enamel and gave rise to a more heterogeneous surface than that obtained by acid etching. Acid etching typically produced a repeating surface pattern, with cracks and fissures no deeper than 12 mm that are readily filled with resin. In contrast to acid etch treatment, laser etching produced extensive surface fissuring and less regular and less homogeneous surface patterns arising from the union of different craters. Fissuring may be related to the orientation of enamel rods, because enamel is an anisotropic material. One of the potential disadvantages of enamel acid etching is that the acid causes demineralization of the most superficial layer. As a result, this surface becomes more susceptible to long-term acid attack and caries, especially when resin impregnation is defective because of air bubbles or saliva contamination. Such effects are particularly important given that plaque tends to accumulate at interfacial surfaces. The physicochemical changes caused by laser etching can be expected to decrease long-term susceptibility to acid attack and caries. This reduction may be related to changes in Ca:P ratio, reduced carbonates, and pyrophosphate formation, together with reduced water and organic component contents. It has also been suggested that laser etching may create remineralisation micro-spaces that trap free ions. Nevertheless, our results suggest that these putative advantages of laser etching may be outweighed by the extensive fissuring caused by the treatment and by consequently poor bonding strength. In addition, larger samples by means of SEM should be examined in future bond strength studies.

Figen Eren Giray et al (2014)[10] stated that dentin surfaces prepared with lasers may provide comparable ceramic bond strengths, depending upon the adhesive cement used. Two adhesive cements, one ‘‘etch-and-rinse’’[Variolink II (V)] and one ‘‘self-etch’’ [Clearfil Esthetic Cement (C)] luting cement, were used to lute ceramic blocks (Vita Celay Blanks, Vita) onto dentin surfaces. In total, 80 dentin specimens were distributed randomly into eight experimental groups according to the dentin surface-etching technique used Er,Cr:YSGG laser and Er:YAG laser: (1) 37% ortho-phosphoric acid + V (control group), (2) Er,Cr:YSGG laser + V, (3) Er,Cr:YSGG laser + acid + V, (4) Er:YAG laser + V, (5) Er:YAG laser + acid + V, (6) C, (7) Er,Cr:YSGG laser + C, and Er:YAG laser + C. Following these applications, the ceramic discs were bonded to prepared surfaces and were shear loaded in a universal testing machine until fracture. Shear Bond Strength (SBS) was recorded for each group in MPa. No statistically significant differences were evident between the control group and the other groups ($p>0.05$). The Er,Cr:YSGG laser + A + V group demonstrated significantly higher SBS than did the Er,Cr:YSGG laser + V group ($p = 0.034$). The Er,Cr:YSGG laser + C and Er:YAG laser + C groups demonstrated significantly lower SBS than did the C group($p < 0.05$). This in vitro study evaluated and compared two adhesive luting systems in terms of the SBS of ceramics to laser etched and acid-etched dentin surfaces. The null hypothesis that the SBS obtained after Er,Cr:YSGG or Er:YAG laser etching of dentin was similar to that obtained after acid etching, and can be an alternative to acid etching was accepted.

Rafael Massunari Maenosono et al (2015)[15] stated that the association of diode laser irradiation with simplified adhesive systems already applied to dentin, but prior to polymerization, is a promising alternative for achieving higher bond strength values. Laser irradiation after the immediate application of Dentin Bonding Systems (DBSs) and prior to their polymerization has been proposed to increase bond strength. The objective of this study was to evaluate the effect of diode laser irradiation (λ = 970 nm) on simplified DBSs through microtensile bond strength tests. Forty healthy human molars were randomly distributed among four groups (n = 10) according to DBSs used [Adper™ SingleBond 2 (SB) and Adper™ EasyOne (EO)], and the respective groups were irradiated with a diode laser (SB-L and EO-L). After bonding procedures and composite resin build-ups, teeth were stored in deionised water for 7 days and then sectioned to obtain stick-shaped specimens (1.0 mm). The microtensile test was performed at 0.5 mm/min, yielding bond strength values in MPa, which were evaluated by two-way ANOVA followed by Tukey's test ($p < 0.05$) for individual comparisons. For both adhesive systems, diode laser irradiation promoted significant increases in bond strength values (SB: 33.49 ± 6.77; SB-L: 43.69 ± 8.15; EO: 19.67 ± 5.86; EO-L: 29.87 ± 6.98). These results suggest that diode laser irradiation is a promising technique for achieving better performance of adhesive systems on dentin.

Muhammad Sohail Zafaret al (2015)[27] stated that the etching time influences on the surface properties of dental hard tissues particularly the surface enamel. Enamel surface properties such as roughness and hardness can be altered remarkably as a matter of few seconds, hence must not be etched for longer than 30 seconds. Similarly dentin should be etched for 15–30 seconds without any remarkable damage to the tissue surface. Prolonged etching time than recommended is likely to increase the surface roughness and decrease surface hardness hence compromising the bond strength of adhesive materials in clinical applications. The objective of this study was to evaluate the effect of etching time on the surface properties of dental hard tissues including enamel and dentin. For this purpose, samples were prepared using extracted human teeth and treated with 37% phosphoric acid for various length of time using the set protocol. The effects of etching time on surface roughness were assessed using non-contact surface roughness profilometer and surface hardness was measured using nano-indentation technique. All results were analyzed statistically using SPSS computer software. In the current study, the etching time has been found to affect the surface features of etched tooth tissues. For example, the recommended etching time for dentinal tissue is 15 seconds and observed to compromise the micro-tensile bonding strength while using a reduced etching time of 5 seconds. The variation in etching time affects the dental hard tissues at a structural level (such as surface properties) that is also reflected in clinical applications.

Masoumeh Moslemi et al (2016)[31] stated that the bond strength of self-adhesive flow-able composite depends upon the type of tooth surface preparation. The laser conditioning of the tooth surfaces increased the bond strength of Dyad flow-able composite to the tooth dentin. The highest bond strength belonged to flow-able composite when prepared by Er,Cr:YSGG laser irradiation. In this experimental study, 40 dentin sections were prepared from healthy third molars and divided into two groups according to their surface preparation by Er,Cr:YSGG laser or without laser, only with silicon carbide paper. In each group, two groups of 10 teeth were treated with self-adhesive flow-able composite (Dyad) and conventional flow-able composite (acid etch and bonding). Samples were stored in normal saline and after 48 hours their bond strength was measured. The failure mode of samples was observed on stereomicroscope. In order to analyse the results, the one way ANOVA and Tukey's test for multiple comparisons were used. The maximum bond strength was related to conventional flow-able composite with laser preparation group (24/21 Mpa). The lowest one was seen in Dyad composite without laser emitting (9/89 Mpa). The statistical difference between this two groups was significant (*P* value = 0/0038). The microshear bond strength differences between Dyad composite groups with laser preparation (mean = 16/427 ± 1/79) and without laser preparation (mean = 12/85 ± 1/90) were statistically significant too (*P* value = 0/01).

MATERIALS AND METHODS

This study is conducted with the approval of Institutional Ethics Committee (IEC) , Adhiparasakthi Dental College & Hospital, Melmaruvathur- 603319.

IRB/IEC Reference No **:** 2014-MD-BrI-RIJ-03.

INTRODUCTION:

Ideal laminate veneer preparations are supposed to be in enamel which provides excellent bond strength and ensures the longevity of the restorations. But certain clinical situations like dental caries extending to dentin, old restorations, require the preparation to be extended into the dentin; wherein the bond strength gets compromised. Hard tissue lasers like Er,Cr:YSGG laser might have the potential to prepare dentinal surface for adhesion.

OVERVIEW OF THE PROCEDURE:

Hundred extracted human maxillary central incisors with approximately 10 mm anatomic crown length and 8 mm mesio-distal width are selected. The crown portion of tooth is cut and embedded in the clear acrylic resin. The labial surface is prepared flat to receive the porcelain laminates. 50 teeth treated with 37 % ortho-phosphoric acid (acid etching) and the other 50 teeth are treated with laser etching. Then the laminate veneers bonded to both these groups. This is kept in distilled water for 24 hours and shear bond strengths are tested with Universal testing machine. Then the results are statistically analysed.

COLLECTION OF SAMPLES:

Hundred extracted human maxillary central incisors with approximately 10 mm anatomic crown length and 8 mm mesio-distal width are selected. Each tooth is free of dental caries, restorations and morphological abnormalities like attrition, hypoplasia etc. The teeth are cleaned and stored in saline solution at room temperature immediately after extraction. Periodically the saline solution is changed until the required samples are collected (figure : 2).

PREPARING CROWN PORTION:

The tooth are sectioned 2 mm below the cemento-enamel junction with a slow speed diamond saw section machine and the crowns are embedded in the blocks of clear auto-polymerising acrylic resin with the labial surface facing upward. The labial surface is prepared flat, deep enough to expose the dentin, in the middle of the tooth.[1] (figure : 3 , 4 & 5).

ETCHING THE TOOTH SURFACE BY ACID:

After preparing the labial surface flat, they are divided into two groups (Group A & Group B). In group A (control), dentin surfaces are treated with 37% ortho-phosphoric acid etching gel (3M ESPE) for 15 sec, then rinsed for 20 sec with distilled water and air dried.[1] (figure:6).

ETCHING THE TOOTH SURFACE BY LASER :

In group B, the dentin surfaces are exposed to an Er,Cr:YSGG laser (Waterlase MD, Biolase Technologies, Irvine, CA) (wavelength, 2780 nm; pulse duration, 140 µs; energy, 3.0 W; repetition rate, 20 Hz) with water spray (45% water, 60% air), in accordance with the manufacturer's instructions. The laser beam is used in a noncontact mode 7–9 mm from the target area, and the 600 µm diameter sapphire tip turbo hand-piece is held perpendicular to the dentin surface and moved in a sweeping fashion by hand during the exposure time (15 seconds) (figure : 7 & 8).

BONDING PORCELAIN LAMINATE VENEERS:

Porcelain veneers of size 5mm width, 5mm height, 2mm thickness are made. The inner surfaces of the porcelain veneer are etched with hydrofluoric acid and subsequently silaning the etched surface is done using silaning agents. Then, this is bonded to group A and group B with Rely X veneer cement (3M ESPE) light cure resin. Then, the embedded specimens are stored in distilled water for 24 hours before testing of bond strength (figure : 9 & 10).

MEASURING BOND STRENGTH:

The embedded specimens are secured in a jig attached to the base plate of a universal testing machine (Servo Controlled, Model – F 100).

Universal Testing Machine: This machine is used for measuring bond strength. It can also used for testing Tensile strength, Compressive strength, Fatigue testing of the materials etc. It is based on strain gauge load cells and servo-control systems (figure:11).

Components :

Load Frame – Usually consisting of two strong supports for the machine.

Load Cell – A force transducer or other means of measuring the load is required. Episodic calibration is usually needed by governing system.

Cross head – A movable cross head is controlled to move up and down. Usually this is at a constant speed.

Means of recording extension or deformation – Many tests needs a measurement of response of the test specimen to the movement of the cross head. Extensometers are sometimes used.

Output Device – A means of delivering the test result that is needed. Some of the older equipments have digital displays and chart recorders. Many newer machines have a computer interface for analysis and printing.

In this study, a chisel-edge plunger is mounted in the movable crosshead of the testing machine and positioned so that the leading edge is aimed at the dentin-veneer interface before being brought into contact at a crosshead speed of 0.5 mm/min. The force required to debond the veneer is measured in newtons, and the bond strength is calculated. The results are statistically analysed (figure : 12).

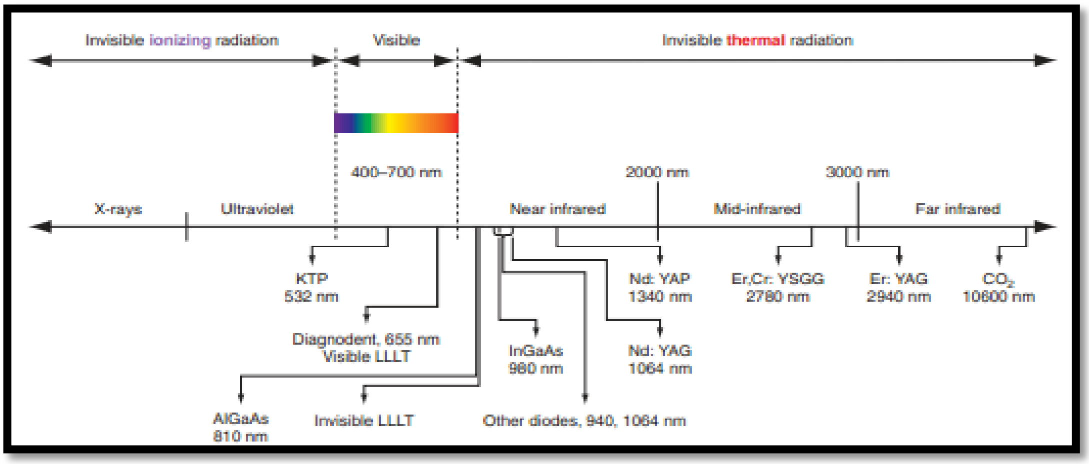


Figure : 1 Dental laser wavelengths on the electromagnetic spectrum

Figure : 2 Collection of samples

Figure : 3 Preparing crown portion

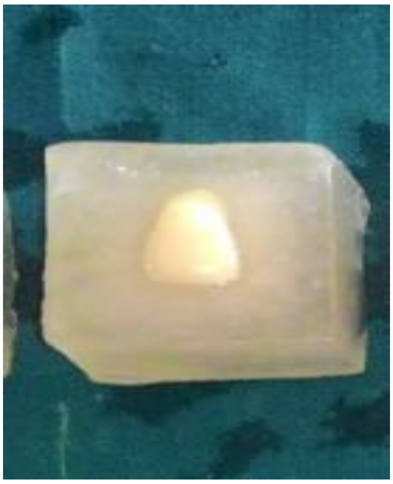


Figure : 4 Embedded crown in clear acrylic resin

Figure : 5 Prepared flat labial surface

Figure : 6 Acid etched surface

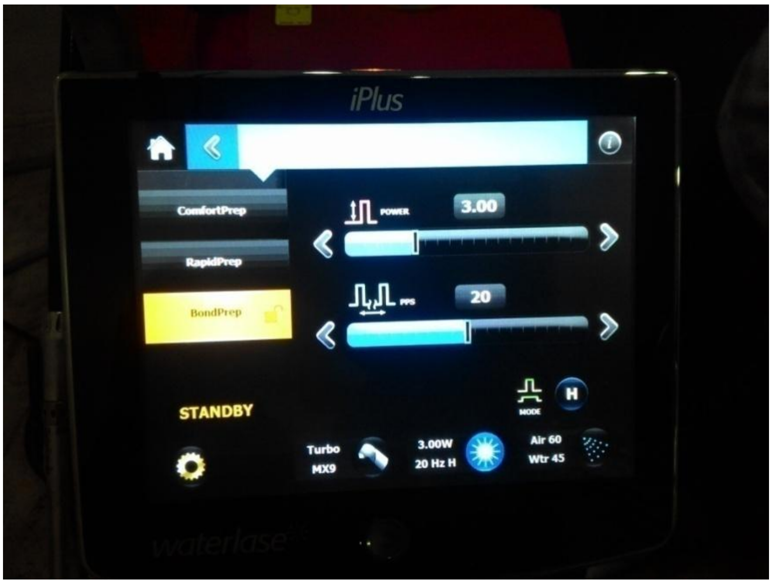


Figure : 7 Laser settings

Figure : 8 Laser etched surface

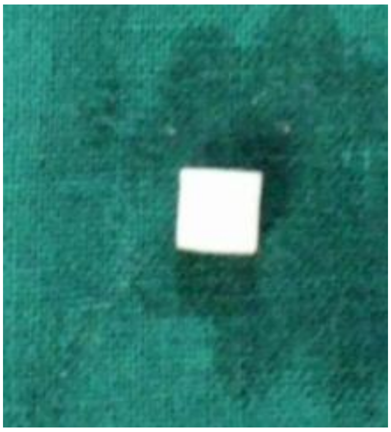


Figure : 9 Prepared veneer

Figure : 10 Bonded veneer to tooth surface

Figure :11 Universal testing machine

Figure : 12 Chisel placed at dentin – veneer interface

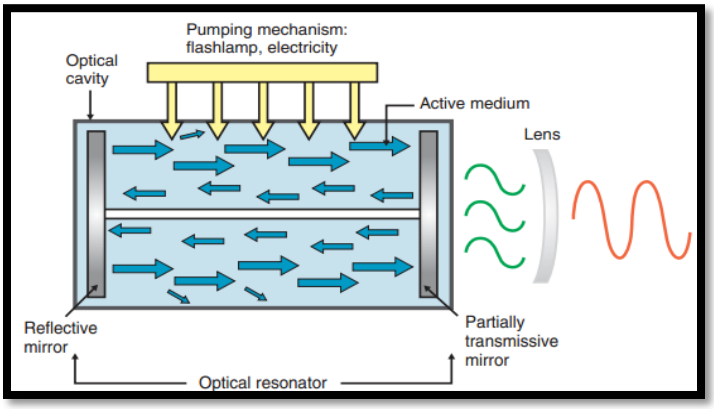


Figure : 13 Components of a laser unit

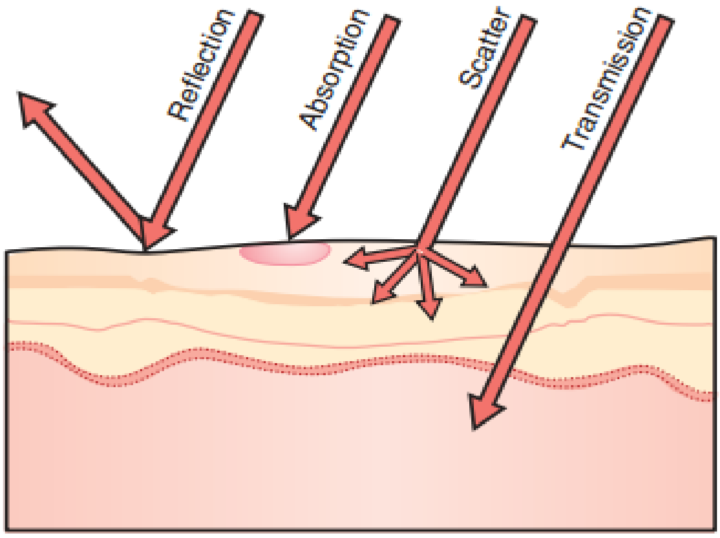


Figure : 14 Laser tissue interaction

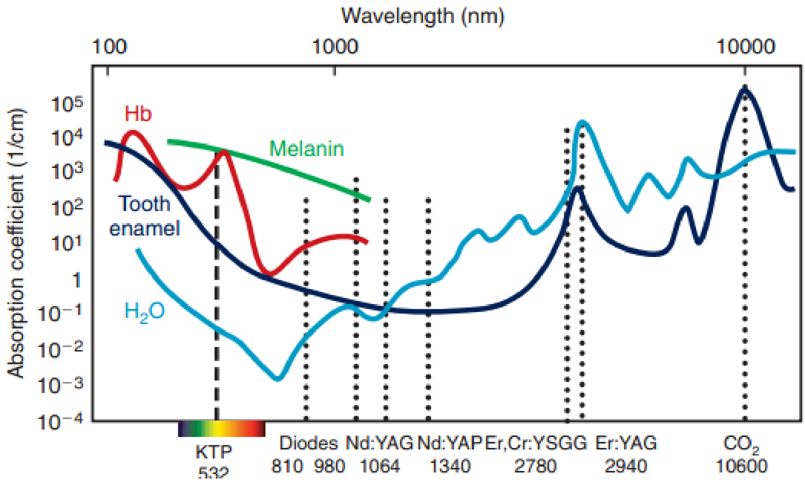


Figure : 15 Absorption curves of the prime oral chromophores

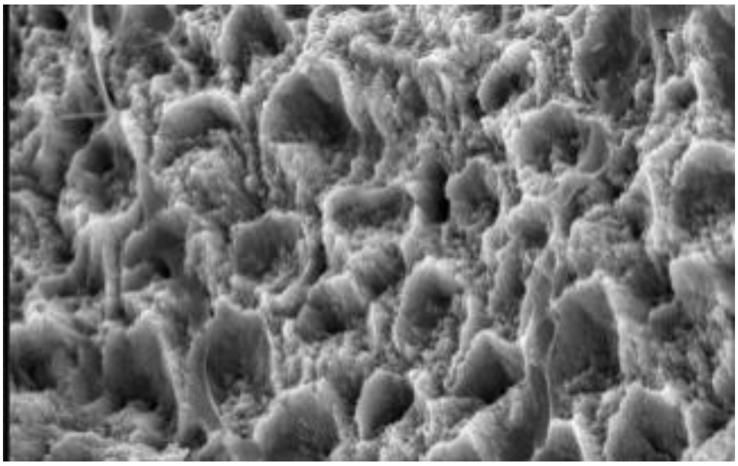


Figure : 16 Acid etched Enamel

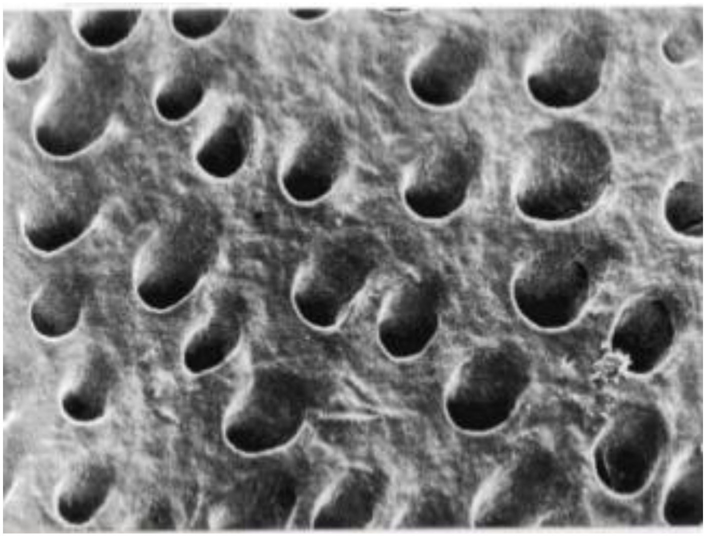


Figure : 17 Acid etched Dentin

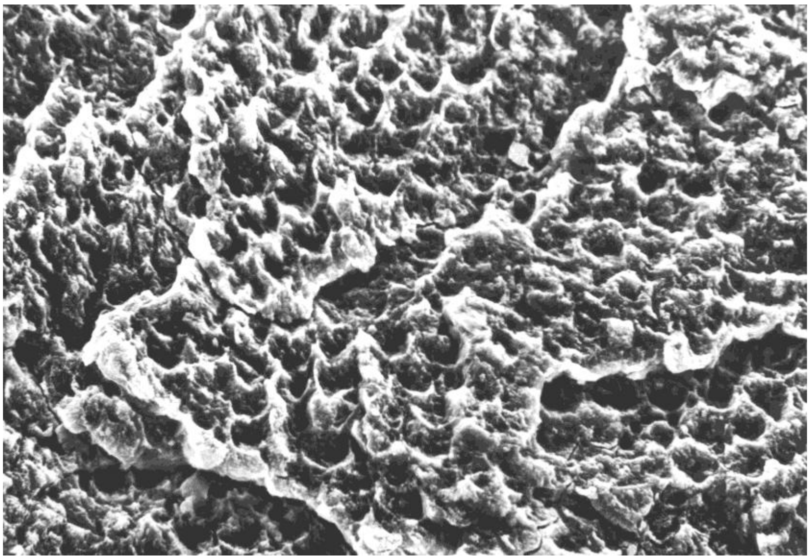


Figure : 18 Laser etched Enamel

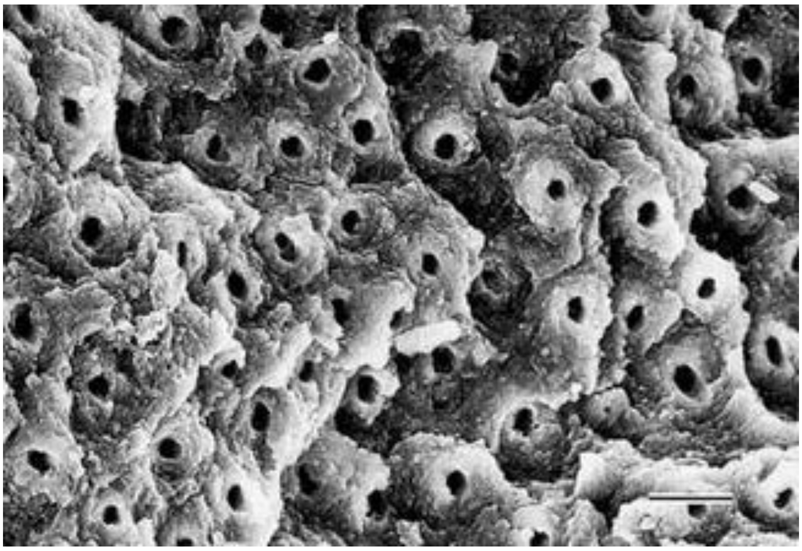


Figure : 19 Laser etched Dentin

RESULTS

The values obtained for the two groups under shear bond strength test are as shown in Table : 1. The test values of the samples are tabulated. The mean and standard deviation value of Group A (Acid) is 8.5180 and 0.22829 with a maximum value of 8.9 and a minimum value of 8.1. The mean and standard deviation value of Group B (Laser) is 8.4980 and 0.11156 respectively with a maximum value of 8.7 and a minimum value of 8.3. Since both the groups are different, unpaired ‘t’ test is performed (Table : 2 & Table : 3).

STATISTICAL ANALYSIS

The debonding values for the tests samples were measured and tabulated. Mean values and their standard deviations were calculated for each group. Since both the groups are different, unpaired ‘t’ test is performed. All datas are processed by SPSS software version 19.0 (SPSS Inc., Chicago, IL, USA). The power of the study was set at 90% with β at 5%. Differences are considered significant for a value of P < 0.01. The calculations show a P value of 0.579, which means that both group A and group B are statistically not significantly different.

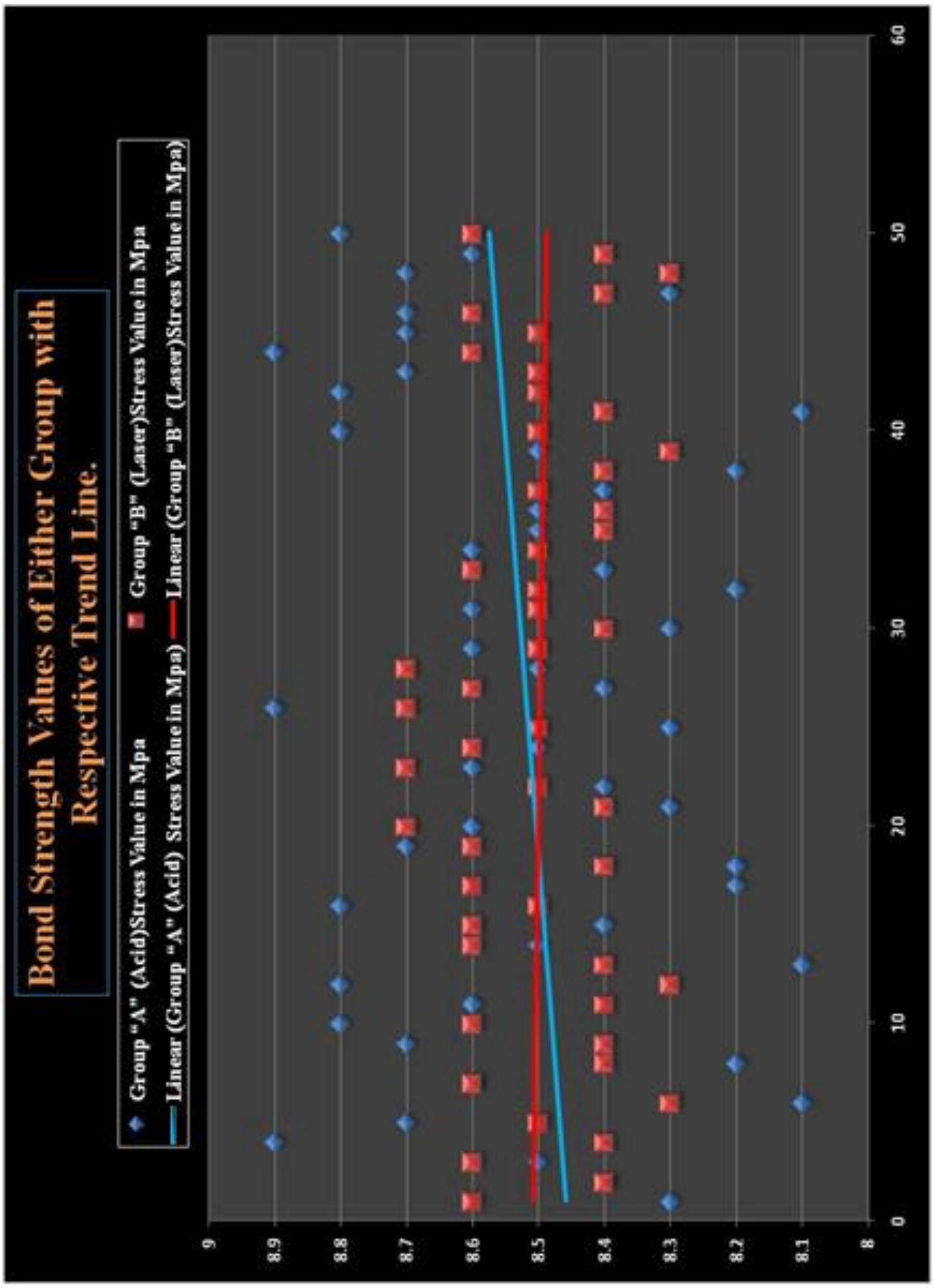
Table : 1 Shear Bond Strength Values

S.No	Group "A" (Acid)Stress Value in Mpa	S.No	Group "B" (Laser)Stress Value in Mpa
1	8.3	1	8.6
2	8.4	2	8.4
3	8.5	3	8.6
4	8.9	4	8.4
5	8.7	5	8.5
6	8.1	6	8.3
7	8.6	7	8.6
8	8.2	8	8.4
9	8.7	9	8.4
10	8.8	10	8.6
11	8.6	11	8.4
12	8.8	12	8.3
13	8.1	13	8.4
14	8.5	14	8.6
15	8.4	15	8.6
16	8.8	16	8.5
17	8.2	17	8.6
18	8.2	18	8.4
19	8.7	19	8.6
20	8.6	20	8.7
21	8.3	21	8.4
22	8.4	22	8.5
23	8.6	23	8.7
24	8.5	24	8.6
25	8.3	25	8.5
26	8.9	26	8.7
27	8.4	27	8.6
28	8.5	28	8.7
29	8.6	29	8.5
30	8.3	30	8.4
31	8.6	31	8.5
32	8.2	32	8.5
33	8.4	33	8.6
34	8.6	34	8.5
35	8.5	35	8.4
36	8.5	36	8.4
37	8.4	37	8.5
38	8.2	38	8.4
39	8.5	39	8.3
40	8.8	40	8.5
41	8.1	41	8.4
42	8.8	42	8.5
43	8.7	43	8.5
44	8.9	44	8.6
45	8.7	45	8.5
46	8.7	46	8.6
47	8.3	47	8.4
48	8.7	48	8.3
49	8.6	49	8.4
50	8.8	50	8.6

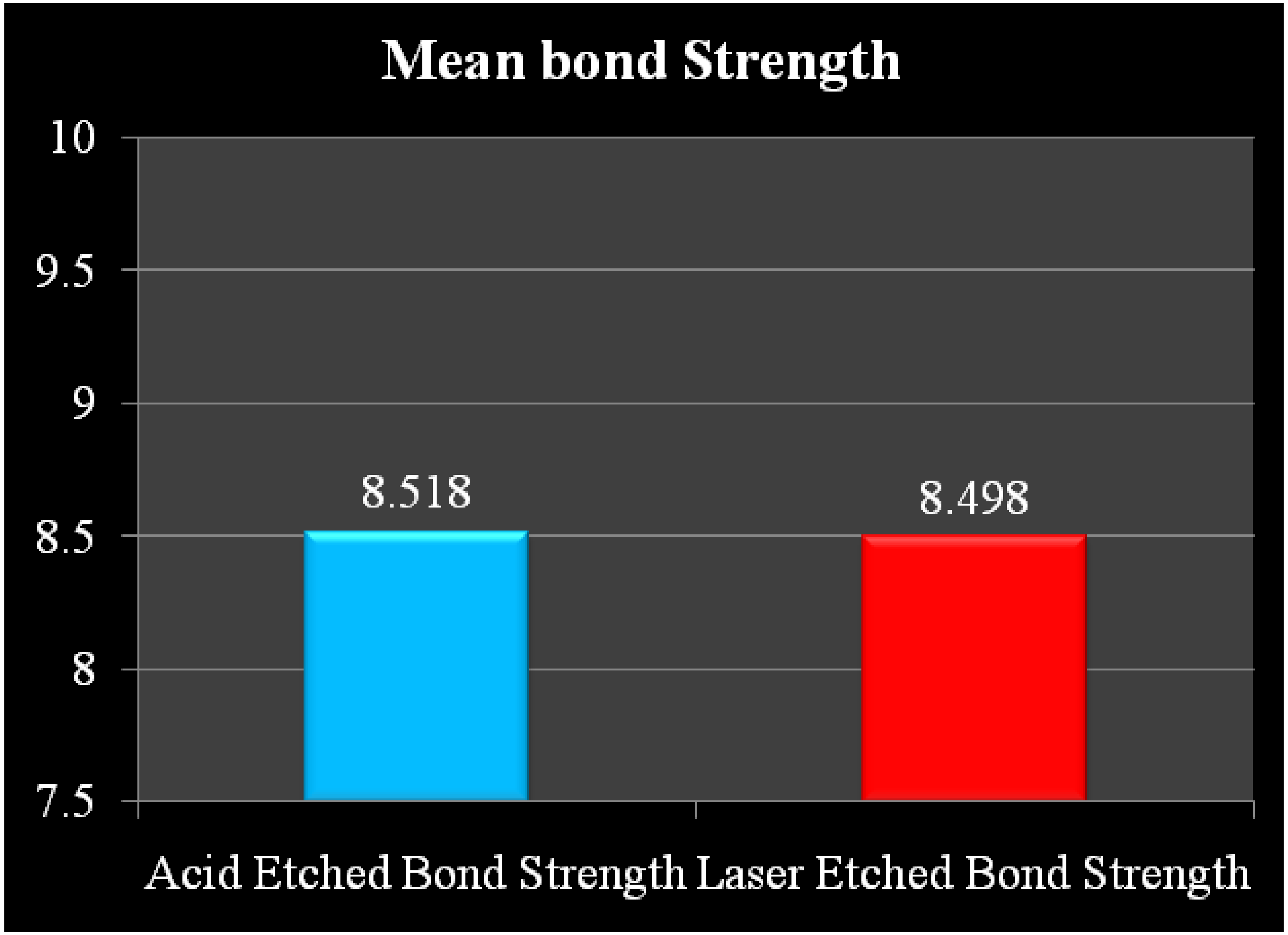
Table 2 : Descriptive statistics			
Groups (Stress Value in Mpa)	Sample N	Mean	Std. Deviation
Acid (A)	50	8.518	0.22829
Laser (B)	50	8.498	0.11156

Table 3 : Comparison between two groups						
Groups (Stress Value in Mpa)	Sample N	Mean	Std. Deviation	Mean difference	t value	p value
Acid (A)	50	8.518	0.22829	0.02	0.557	0.579
Laser (B)	50	8.498	0.11156			

GRAPH : 1


Bond Strength Values of Either Group with Respective Trend Line.
Group "A" (Acid)Stress Value in Mpa
Group "B" (Laser)Stress Value in Mpa
Linear (Group "A" (Acid) Stress Value in Mpa)
Linear (Group "B" (Laser)Stress Value in Mpa)
0
10
20
30
40
50
60
8
8.1
8.2
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9

GRAPH : 2


Mean bond Strength
10
9.5
9
8.5
8
7.5
8.518
8.498
Acid Etched Bond Strength
Laser Etched Bond Strength

DISCUSSION

The aim of this study is to compare the bond strength of porcelain laminate veneer bonded to acid treated dentin and laser treated dentin. Most dentin bonding systems rely on some type of dentin etching and priming to maximize micromechanical adhesion. Etching enamel affects the prism core and prism periphery. Etching dentin affects the inter-tubular and peri-tubular dentin, resulting in enlarging the tubular openings, removing a large amount of the surface hydroxyapatite crystals, and leaving an organized network of collagen fibrils.[20] Etching of tooth surface can be done either by acid or laser.

BRIEFLY ABOUT COMPONENTS OF LASER UNIT:

Laser unit has active medium, laser resonator and a power source. The active medium may be gas, solid, liquid, or semi-conductor. Active medium is contained within an optical enclosure. Active medium needs to be charged to release photons. The external source of energy may be electrical, chemical, or flash lamp. The gain medium is pumped by an external energy source. The gain medium then emits photons, which bounce back and forth between the reflectors. Part of the radiation is allowed to exit through an aperture in one of the reflectors, resulting in the laser beam[14] (figure : 13).

SPONTANEOUS EMISSION:

When this pumping mechanism pumps energy into the active medium, the energy is absorbed by the electrons in the peripheral most layer of the active medium’s atoms. These electrons have gained a specific amount of energy to reach the next shell farther from the nucleus, which is at a higher state of energy level. A “population inversion” can occur when there is more electrons in the higher energy level than the ground state. The electrons which are in that excited state spontaneously release that energy in the form of a photon. This is called spontaneous emission.[16]

EMISSION MODE OF LASERS:

Dental laser devices can emit light energy in two modalities as a function of time:

(1) Constant / Continuous

(2) Pulsed

- Gated-pulse mode
- Free-running pulsed mode

1.Continuous-wave mode:

Lasers depend on a beam whose output power is constant over time and steady when averaged over any longer time periods, with the very high frequency. The power variation has little or no impact in the intended application. Such a laser is known as continuous wave. Many types of lasers can be made to operate in continuous wave mode to satisfy such an application. The beam is emitted at only one power level for as long as the operator depresses the foot switch.[17]

2**. Gated-pulse mode:**

There are periodic alternations of the laser energy, similar to a blinking light. This gated-pulse mode is reached by the opening and closing of a shutter which is placed in front of the light beam pathway of a continuous-wave emission. All surgical devices that operate in continuous wave have this gated-pulse feature. The more advanced units have computer-controlled shutters that allow for these very short pulses.[17]

3. **Free-running pulsed mode:**

It is a true-pulsed mode. This emission is unique in that large peak energies of laser light are emitted for usually microseconds, followed by a relatively long time in which the laser is off. These devices have a rapidly striking flash lamp that pumps the active medium. With every pulse, high powers are generated. However, because the pulse duration of this mode is short, the average power that the tissue experiences is small. Free-running pulsed devices cannot have a continuous-wave or gated-pulse output.[17]

Contact mode-

Terminal end of fibro optic is placed in direct contact of target tissue and the operator will have a tactile feedback.[14]

Non contact mode:

The hand piece is held away from the tissue and the operator has to adjust the focus of the beam by varying distance between the hand piece and target to have the desired effect.[14]

LASER ENERGY AND TISSUE TEMPERATURE:

The principle effect of laser energy is photo thermal (i.e., the conversion of light energy into heat). This heat effect on tissue depends upon the temperature rise and the corresponding reaction of the interstitial and intracellular water.[18]

TARGET TISSUE EFFECTS IN RELATION TO TEMPERATURE[18]

TISSUE TEMPERATURE	OBSERVED EFFECT
37–50^{0}C	- Hyperthermia
60–70^{0}C	- Coagulation, protein denaturation
70–80^{0}C	- Tissue Welding
100–150^{0}C	- Vaporization, ablation
>200^{0}C	- Carbonization.

EFFECTS OF LASER ON TISSUES :

Laser light has either four different interactions with the target tissue, depending on the optical properties of that tissue (figure : 14). They are as follows

- ABSORPTION
- TRANSMISSION
- REFLECTION
- SCATTERING

ABSORPTION:

Laser light is converted into effective thermal energy. The amount of energy that is absorbed by the tissue depends on the tissue characteristics, such as pigmentation and water content, on the laser wavelength and emission mode. In general, the shorter wavelengths are readily absorbed in pigmented tissue and blood elements. Longer wavelengths are more interactive with water and hydroxyapatite[21] (figure : 15).

TRANSMISSION:

Light energy passes freely through the tissue, without interaction of any kind and has little or no effect. It is an inverse of absorption.[21]

REFLECTION:

Light energy reflects off tissue surface with little or no absorption and consequently has no effect on tissue. The laser beam generally becomes more divergent as the distance from the head piece increases, which become dangerous because the energy is directed to an unintentional target such as eye. This is major safety concern for laser operation.[21]

SCATTERING:

Light energy is re-emitted in a random direction and ultimately absorbed over a greater surface area which produces less intense and less precisely distributed thermal effect. When laser light emerges from a laser, it usually enters in the form of pencil thin beam of energy travelling at speed of light.[21]

This beam travels in straight line until it hits something that reflects or refracts it or until it hits something that stops it and absorbs it energy. The laser beam diverges gradually as it travels away from laser which means that the beams diameter increases with the distance between hand piece and target tissue.[14]

TISSUE CHANGES BY LASER:

There are five important types of biological effects that can occur once the laser photons enter the tissue: fluorescence, photothermal, photodisruptive, photochemical, and photobiomodulation.[14]

Fluorescence happens when actively carious tooth structure is exposed to the 655 nm visible wavelength and the amount of fluorescence is related to the size of the lesion, and is useful in diagnosing incipient carious lesions. e.g., Diagnodent.[14]

Photothermal effects occur when the chromophores absorb the laser energy and heat is generated. This heat is used to perform work such as incising tissues or to coagulate the blood. Photothermal interactions predominate when most soft tissue procedures are performed with dental lasers. Heat is generated during these procedures and great care must be taken to avoid thermal damage to the tissues.[14]

Photodisruptive effects: Hard tissues are removed through a process known as photodisruptive ablation. Short-pulsed laser light with tremendously high power interact with water in the tissue and from the hand-piece causing rapid thermal expansion of the water molecules.[14]

The pulsed Erbium laser ablation efficiency seems to result from these micro-explosions of overheated tissue water in which their laser energy is predominantly absorbed. Thus tooth and bone are not vaporized but pulverized instead through the photomechanical ablation process. This shock wave creates the distinct popping sound heard during erbium laser use. Thermal damage can be prevented when used properly, especially when the concept of thermal relaxation is considered.[14]

Photochemical reactions occur when photon energy creates a chemical reaction. These reactions are utilized in some of the beneficial effects found in biostimulation. e.g, Photodynamic therapy.[14]

Photobiomodulation or Biostimulation refers to lasers ability to speed healing, increase circulation, reduce edema, and minimize pain. The exact mechanism of these effects is not clear, but it is theorized they occur mostly through photochemical and photobiological interactions within the cellular matrix and mitochondria. Biostimulation is used dentally to reduce postoperative discomfort and to treat maladies such as recurrent herpes and aphthous stomatitis. e.g., Low Level Laser therapy.[14]

Thus the primary and beneficial goal of laser energy is therefore primarily due to Absorption of the laser light which produces Incision/Excision, Ablation/Vaporization and Hemostasis/Coagulation. Now, there has been growing interest in laser application for treating medical and dental problems.[22] Thus different laser systems have been invented (soft & hard tissue lasers).

It was in 1975 when Rochette described the concept of etching porcelain with acid and bonding to the tooth, and described a technique for making ceramic restorations for fractured incisors without operative influence, which made the pioneers in veneers to turn towards porcelain, one of the most popular and attractive materials in the dental armamentarium and thus was born, the ceramic laminate veneer. After which, Graham J. Roberts in 1983, clinically evaluated the technique of mastique acrylic veneers which were bonded to teeth with composite resins after the acid etch technique.[3]

EFFECT OF ACID ETCHING ON ENAMEL AND DENTIN :

Acid etching of the enamel appears to improve the retention by selectively eroding certain hydroxyapatite crystals. The smear layer is gently removed by the application of acid on the enamel surface. Microscopic irregularities and acid treated enamel surface energy are enhanced by removing prismatic and inter-prismatic mineral crystals and facilitating the penetration with the development of resin tags.[23] (figure : 16)

Phosphoric acid etching is one of the best methods to bond resins to enamel and dentin. The smear layer is removed by applying acid on the enamel and dentin surface. In general, 10-37% ortho-phosphoric acid is applied to both enamel and dentin.[23] By simply doubling etching time from 15 to 30 s, bonding to old dentin resulted in higher bond strengths that were similar to those found in young dentin.[24]

Despites advances in the chemistry of adhesive systems, dentin remains a challenging substrate for bonding due to its heterogeneity. The bonding mechanism of composite resin to acid-etched dentin is well known. The formation of a hybrid layer and resin tags is essential to the establishment of a strong bond at the dentin level and may be achieved by complete dissolution of the smear layer and demineralization of inter-tubular and peri-tubular dentin by means of acid etching, resulting in an exposed collagen matrix which is infiltrated by resin that polymerizes in situ.[25] (figure : 17).

The clinical success of porcelain laminate veneers is attributed to the intimate bond achieved between the restoration and tooth structure through the luting cement.[26] Adhesive dental restorative materials have some major advantages over non adhesive materials. For example, better adhesion with the tooth surfaces and prevention of secondary caries thereby preserving the natural tooth structures as limited cavity preparation is needed.[27]

EFFECT OF LASER ETCHING ON ENAMEL AND DENTIN :

Recently, the use of laser technology has been introduced as an alternative to traditional mechanical rotating instruments in cavity preparation.[28] But little is known about the adhesion of resin to laser irradiated dentin, but it appears that the formation of an inter-diffusion zone, which is the basis for dentin hybridization in acid-etched dentin, is unlikely. Instead, laser-treated dentin mostly acquires its bond strength through the penetration of resin tags into dentinal tubules.

These resin tag formation shows advantage for only a fraction of the bond strength in normal hybridized dentin. Some researchers have explored the use of lasers to modify the surfaces of teeth intentionally and improve bonding of restorations.[25]

Grinding with rotary instruments is the most commonly used clinical method for tooth preparation and caries removal. It brings effectivity and efficiency as well as some inevitable drawbacks, such as the noise and vibration produced which always make the patients feel scary about the therapy.[29] Recently, new techniques were introduced for caries removal. One of the main advantage in these techniques is providing minimal damage to tooth structure during caries removal. Among new techniques, Erbium laser showed promising results.[30] Erbium laser has a wide range of advantages, such as, absence of vibration effect, sound, and stress and reducing the need of local anesthesia.[31]

Currently, laser etching of enamel and dentin surfaces is popular because of the potential drawbacks of acid etching. Acid etching leads to chemical changes that can alter the organic matter and decalcify the organic component. As a result of this demineralization, enamel and dentin becomes more susceptible to caries attack, which is induced by plaque accumulation around the bonded composite resin. Recently, Er:YAG and Er;Cr:YSGG lasers were introduced in dentistry.[23] (figure:18).

Due to its beneficial effects, they are used in the hard tissue treatments. The advantage of an Erbium laser wave is that it is highly absorbed by water and dental hard tissue. The strong absorption of water decreases the level of heat throughout tooth preparation. Laser radiation are better absorbed by water than dental hard tissue, it reduces the increasing temperature of the tissue during the preparation. Water reaches the boiling point and causes micro-explosion of the tooth.[23]

This mechanism breaks up the surrounding tissue into small fragments and dissipates them at the same time. This micro-explosion of tooth is so-called a preparation triggered by water. Although most radiation is highly utilized by water, a certain amount of heat transmission is unavoidable. Therefore, a water spray is used for cooling. Lack of adequate water spray causes pulpal damage.[23]

This laser can also be used for etching of enamel and dentin surfaces for the purpose of bonding the composite resin to enamel and dentin surface. Er,Cr:YSGG, which has a high absorption coefficient in water, enamel and dentin led researchers to explore its use in dentin conditioning.[23]

Sevil Gurgan et al stated that Enamel etching with the laser at both energy settings appeared to yield better results than acid etching. The effect of the Er,Cr:YSGG laser as a dentin-conditioning agent depends upon multiple parameters. They are energy output, frequency, type of pulse mode, focal distance, irradiation duration, and water cooling.[32] Dentin characteristics created by erbium lasers are irregular surface, absence of smear layer, with opened dentinal tubules.[33]

Generally, there is variability among the dentin bond strength values reported by various researchers. This may be attributed to various testing methods and conditions, the different nature of dentin substrate, and the composite adhesive used. Although several reports have compared bond strengths attained with Er:YAG lasers with varying results. Few studies have investigated the bond strength attained with the Er,Cr:YSGG laser.[32]

Visuri et al reported high shear bond strengths of composite to dentin prepared with an Er:YAG laser using the parameters of 350 mJ and 6 Hz. In contrast, Sakakibara et al and Dunn et al used the parameters of 140 mJ and 30 Hz, and Ceballos et al who used 180 mJ and 2 Hz, reported decreased bond strength, and Armengol et al and Kataumi et al found no differences between laser-irradiated and non-irradiated specimens.[32]

It was postulated that the lased dentin surface yielded an improved bonding surface due to its scaly and flaky appearance following laser irradiation. This is caused by the micro-explosions induced by the laser treatment due to its thermo-mechanical ablation.[32] The erbium laser initially vaporizes water and other hydrated organic components of the tissue. On vaporization, internal pressure increases in the tissue until explosive destruction of the inorganic components of the surface occurs. Since intertubular dentin contains more water and has a lower mineral content than peritubular dentin, it is selectively ablated more than the peri-tubular dentin, leaving protruding dentinal tubules with a cuff-like appearance.[32] (figure : 19).

This may contribute to an increase in the adhesive surface area. Opened dentinal tubules and lack of a smear layer are some additional factors that may enhance bonding to laser-treated dentin. Improved adhesion to laser-treated dentin may be explained by the mechanical retention provided by resin tag formation and the infiltration of adhesive resin into the micro- irregularities in lased demineralized dentin. The highest bond strengths were achieved by laser preparation and laser etching.[32]

The increase in surface roughness may be one explanation for the higher dentin bond strengths we found for the laser-treated dentin. This increased surface roughness allows increased micromechanical retention at the resin-dentin interface.[32]

Recent improvements in laser technology, and the increased interest in their potential use for hard tissue applications, warrant further investigation of the Er,Cr:YSGG laser to prepare teeth for adhesion with resin-based composites.[32]

According to this present study the bond strength values for both the groups shows no significant difference. Both have more or less same bond strength values. Laser etching does not make any statistically significant difference in comparison with acid etching. The values obtained shows that acid etching has a wide range of values varied from 8.1 to 8.9 Mpa. But in laser etching the values are more consistent, varied from 8.3 to 8.7 Mpa.

Observation of the XY scatter graph of the Acid etched and Laser etched bond strength shows that acid etching has a wide range of values varied from 8.1 to 8.9 Mpa, but in laser etching the values are more consistent, varied from 8.3 to 8.7 Mpa. Also the trend line of Laser etched bond strength graph is more horizontal than the trend line of the Acid etched bond strength graph (Graph : 1 & Graph : 2).

The results have indicated that there are no significant differences in shear bond strengths between the two groups, but as the values of Laser etched bond strength are more consistent, they can be more reliable than the Acid etched bond strength values. Furthermore, it is easy to perform laser etching in patient since it is highly convenient. Because in acid etching there may be chance of spilling acid into the adjacent soft tissue, which can cause adverse reactions. Laser etching is also easy to perform, because there is no usage of acid. Furthermore, laser etching is more patient friendly.

Acid etching results in chemical changes that can modify the organic matter and decalcify the organic component. As a result of this demineralization, enamel and dentin becomes more susceptible to caries attack, which is induced by plaque accumulation around the bonded composite resin. So laser etching can be used as an alternative tool for acid etching.

CONCLUSION

Within the limitations of this study, 37% ortho-phosphoric acid (8.5 Mpa) and laser (8.49 Mpa) treated dentin surfaces showed similar bond strength values. The differences are not statistically significant. But the results of the Laser etched bond strength were more consistent than Acid etched bond strength. Moreover with recent popularity and availability of LASER equipment, etching and restoration can be accomplished without any need of additional armamentarium and with better comfort to the patient. Further research needs to be done on the nature of biological response to laser irradiation in vital teeth undergoing laser etching.

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This ethical committee has undergone the research protocol submitted by **Dr.J.Raghunathan,** Post Graduate Student, Department of Prosthodontics and crown & bridge under the title **"Comparison Of Bond Strength Of Porcelain Laminate Veneers Bonded To Laser Treated Dentin And Acid Treated Dentin – An In Vitro Study"** Reference No: **2014-MD-BrI-RIJ-03,** under the guidance of Prof. **Dr.A.S.Ramesh MDS.,** for consideration of approval to proceed with the study.

This committee has discussed about the material being involved with the study, the qualification of the investigator, the present norms and recommendation from the Clinical Research scientific body and comes to a conclusion that this research protocol fulfils the specific requirements and the committee authorizes the proposal.

Date: **Member secretary**