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PROFORMA FOR REGISTRATION OF SUBJECTS FOR DISSERTATION

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1	Name of the Candidate and Address	Dr. Nandan Kumar N.M Post Graduate Student Department Of Orthodontics and Dentofacial Orthopedics, J.S.S. Dental College and Hospital, (A constituent of JSS University) JSS Medical Institution Campus S.S. Nagar, Mysore – 570 015.
2	Name of the Institution	J.S.S. Dental College and Hospital, (A constituent of JSS University) JSS Medical Institution Campus S.S. Nagar, Bannimantap, Mysore – 570 015.
3	Course of Study and Subject	Master of Dental Surgery (MDS) in Orthodontics and Dentofacial Orthopedics
4	Registration Number Date of Admission to Course	14D06104 29/05/2014

5 **TITLE OF THE THESIS:**

A Comparative Evaluation of shear bond strength of metal brackets bonded with two etching techniques and two different bonding agents –an in vitro study

6 **BRIEF RESUME OF THE STUDY**:

6.1 Need for the study

The purpose of acid etching is to remove the smear layer left by the high-speed dental drill and create an irregular surface by preferentially dissolving hydroxyapatite crystals on the outer surface. This topography will facilitate penetration of the fluid adhesive components into the irregularities. After polymerization, the adhesive is locked into the surface and contributes to micromechanical retention. If a laser can achieve the above-mentioned function of acid etching, and even produce a favorable surface for bonding to a restorative material, it may be a viable alternative to acid etching.

The ability of laser irradiation to remove the smear layer has been reported. After being exposed to laser, enamel underwent physical changes including melting and recrystallization, thus forming numerous pores and small bubble like inclusions. This was similar to the type III etching pattern produced by orthophosphoric acid. The recrystallization of dentin after laser exposure has also been demonstrated. With the formation of a fungiform appearance, the micro retention or possible chemical adhesion of a restorative material to tooth structure might be increased. Another study also showed that a laser could roughen the enamel surface. Therefore, laser etching may be a feasible method of etching enamel. Investigation of enamel surface roughness showed that laser irradiation yielded a comparable or smaller amount of surface roughness than acid etching. With regard to bond strengths of restorative materials, some studies indicated that acid-etched teeth had significantly more bond strength than laser-etched teeth,[8,11–13] whereas others demonstrated that laser etching could result in bond strength comparable with[5,14–17] or even stronger than acid etching. These variations could be attributed to the different types of lasers or different irradiation parameters used because the laser–hard tissue interaction is dependent on wavelength and irradiation energy.

The Er:YAG laser with a wavelength of 2940 nm is highly absorbed by water and hydroxyapatite. Being effective in cutting enamel and dentin, it is the first approved laser tool applied to dental hard tissues in the United States. It was shown that Er :YAG laser-prepared dentin had improved bond strengths when compared with acid-etched groups. However, the tensile strength of bracket-tooth bonds after preparation of the enamel surface by Er:YAG laser etching was inferior to that obtained after conventional acid etching. Nonetheless, if the irradiation parameters can be advertently controlled, the subsurface fissuring that is unfavorable to adhesion can be avoided.

Because of the hydrophobic properties of resin bonding systems and the fact that adhesion is not in any way chemical, tooth enamel must remain dry after acid etching. In this way, penetration of hydrophobic resin into the micro porous enamel is ensured for adequate mechanical retention. However, the reality of clinical conditions prevents the ideal of complete isolation from wet conditions during bracket bonding, especially when attachments are bonded to difficult to reach places. Under everyday clinical conditions, contamination may be produced through the presence of saliva, gingival exudation, or bleeding, or through the presence of water when teeth are washed. When brackets are bonded to enamel, two critical moments have been identified at which contamination may occur: (1) after the enamel surface has been etched, and (2) after primer has been applied, when the enamel surface is contaminated prior to primer application, plugging of the porosities of acid etching occurs, along with a reduction in surface energy. Penetration of the resin is impeded to the detriment of mechanical microretention, which, in turn, causes a reduction in bond strength between the resin and the etched enamel.

In an attempt to overcome these difficulties, some manufacturers have introduced primers that are hydrophilic and that tolerate wet conditions; Transbond Plus Self-Etching Primer (TSEP; 3M Unitek Dental Products, Monrovia, Calif) and the moisture-insensitive primer Transbond MIP (TMIP; 3M Unitek) are examples of such products.The purpose of this study was to compare the bond strengths after acid etching with conventional primers, acid etching with moisture insensitive primers, laser etchants with conventional primers and laser etchants with moisture insensitive primers

6.2 Review of literature

1.A study by Ram kumar.G was done on Shear bond strength of stainless steel orthodontic brackets with a moisture-insensitive primer .The purposes of this study were to evaluate the shear bond strength of stainless steel orthodontic brackets bonded to dry and wet (with water and saliva) etched enamel with the use of the moisture-insensitive primer (MIP; Transbond; 3M Unitek, Monrovia, Calif) and to evaluate the effectiveness of MIP with chemically activated (Concise; 3M Dental Products, St Paul, Minn) and light-activated (Transbond XT; 3M Unitek) resin. One hundred forty-four freshly extracted bovine teeth were divided into 12 groups (n = 12 teeth), and brackets were bonded with either of the 2 resins in combination with the conventional primer or MIP in dry or wet enamel surface conditions. The test specimens were mounted in a screw-driven mechanical testing machine (model 4204; Instron Corp, Canton, Mass) and subjected to a crosshead speed of 0.5 mm/min. The data were analyzed by 2-way analysis of variance. MIP with Concise produced slightly higher bond strengths compared with the conventional primers under wet conditions (MIP vs conventional: saliva, *P* <.001; water, *P* =.004). However, MIP in combination with Transbond XT produced comparable bond strengths on both the dry and wet etched enamel (dry, 10.14 MPa; water, 9.69 MPa; saliva, 8.90 MPa). The results of this study suggest that MIP be used only with light-activated composite resins. (Am J Orthod Dentofacial Orthop 2001;119:251-5)

2. A study by Shane Schaneveldt, DDS, MCID[a] ,Timothy F Foley, DDS, MCID[b] London, Ontario, Canada from the Division of Graduate Orthodontics, University of Western Ontario, London, Ontario, Canada was done on Bond strength comparison of moisture-insensitive primers.The objective of this in vitro bonding study was to evaluate the effectiveness of 2 moisture-insensitive primers, Assure (Reliance Orthodontic Products, Itasca, Ill) and MIP (3M Unitek, Monrovia, Calif) compared with a control hydrophobic primer, Transbond XT (3M Unitek). Six groups of 40 premolars were acid etched and bonded using metal orthodontic brackets with the following in vitro protocols: (1) Transbond XT primer and adhesive applied to a noncontaminated surface; (2) Assure primer applied after saliva contamination; (3) MIP primer applied after saliva contamination; (4) Assure primer reapplied after saliva contamination; (5) MIP reapplied after saliva contamination; and (6) Assure adhesive applied after saliva contamination of the primer. All bonded specimens were stored in deionized water at 37°C for 30 days and thermocycled for 24 hours before debonding. Brackets were debonded using a shear-peel load on a testing machine, bond strength was measured in megapascals, and bond failure was analyzed by using the adhesive remnant index. In vitro shear-peel bond strengths were acceptable for all groups, and the bond strengths for Assure and MIP were not significantly affected by saliva contamination. The mean shear-peel bond strength of the control (14.82 MPa) was significantly higher (*P* <.001) than the contaminated groups with the exception of MIP group 5 (14.02 MPa). The values of the Assure primer and adhesive were less than the MIP primer and its respective adhesive; however, the hydrophilic Assure adhesive resin applied to a saliva-contaminated surface had acceptable bond strength. Bond failure analysis (adhesive remnant index) mainly showed adhesive bond failures. An increased frequency of enamel fractures at debond was noted, with the control group (1) and the MIP groups (3 and 5) having 22.5%, 12.5%, and 15%, respectively. The Assure groups had no enamel fractures. (Am J Orthod Dentofacial Orthop 2002;122:267-73)

3.A study by Bor-Shiunn Lee, DDS, MS, PhD, Tseng-Ting Hsieh, DDS, Yuan-Ling Lee, DDS, MSa, Wan-Hong Lan, DDS, PhD Yao-Jeng Hsu, DDS, Ping-Han Wen, DDS, and Chun-Pin Lin, DDS, MS, PhD was done on Bond Strengths of Orthodontic Bracket After Acid-Etched, Er:YAG Laser-Irradiated and Combined Treatment on Enamel Surface. The purpose of this study was to compare the bond strengths after acid etching, laser ablation, acid etching followed by laser ablation, and laser ablation followed by acid etching. Forty specimens were randomly assigned to one of the four groups. Two more specimens in each group did not undergo bond test and were prepared for observation with scanning electron microscope (SEM) after the four kinds of surface treatment. After the bond test, all specimens were inspected under the digital stereomicroscope and SEM to record the bond failure mode. Student's *t*-test results showed that the mean bond strength (13.0 ± 2.4 N) of the laser group was not significantly different from that of the acid-etched group (11.8 ± 1.8 N) ($P > .05$). However, this strength was significantly higher than that of the acid-etched then laser-ablated group (10.4 ± 1.4 N) or that of the laser-ablated then acid-etched group (9.1 ± 1.8 N). The failure modes occurred predominantly at the bracket-resin interface. Er:YAG laser ablation consumed less time compared with the acid- etching technique. Therefore, Er:YAG laser ablation can be an alternative tool to conventional acid etching.

4. A study by John A. Hess DDS, MPHIL was done on laser-induced morphologic changes of a coated enamel surface using a scanning electron microscope. A low-energy Nd:YAG laser was used to irradiate extracted human teeth coated with a black energy-absorbent laser initiator in a study to determine the extent of the morphologic changes produced in the enamel surface. The laser initiator was applied to a cleaned enamel surface and irradiated at an energy output of 30 mJ or 75 mJ. Both energy levels produced morphologic changes of the surface. There was a sharp line of demarcation between the coated, irradiated area and the surrounding noncoated enamel surface. The scanning electron microscope view at the lower energy level showed that the surface had melted and reformed with numerous small, bubble-like inclusions. The 75 mJ energy level showed individual impact craters with shallow centers and raised edges containing numerous pores and large, bubble-like inclusions. Etching is a dental procedure in which an acid is normally used to remove a thin outer layer of the tooth structure. This is necessary to create a roughened, irregular surface in order to provide mechanical retention for dental restorative materials. The changes produced by the laser in this study suggest a simple, effective, and controlled method of etching the enamel surface of a tooth by altering its surface characteristics.

5. A study by Sergio J. Weinberger, DDS, MCID, FRCD, Timothy F. Foley, DDS, Robert J. McConnell, BDS, FRCS, FFDRCS, MA, PhD, and Gerald Z. Wright, DDS, MSD, FRCD was done on bond strengths of two ceramic brackets using argon laser, light and chemically cured resin systems. Ninety extracted human premolars were prepared for bonding with pumice and gel etchant. Using single crystal alumina bracket with silanated bases, three groups of 15 teeth were bonded with one of the three polymerization methods. Similarly, three groups of 15 teeth were bonded with polycrystal alumina brackets with non silanated bases. Each bonded bracket was tested on an Instron tensile testing machine in shear mode to determine shear debonding strength. Fracture sites were recorded. Results demonstrated that (1) all combinations produced shear bond strength greater than those considered clinically acceptable, (2) the mean shear bond strength of the single crystal alumina brackets with silanated bases were significantly higher than those of the polycrystal alumina brackets with non silanated

bases, and (3) no enamel fractures were found on debonding the chemically cured brackets while the light and the laser groups exhibited a 10% rate of enamel fracture on debonding.

6. An in vitro study by Ranga swamy Raja Gopal, Sri devi Padmanabhan and Janakirama gnanamani on shear bond strength comparison and debonding characteristics of conventional, moisture –insensitive and self etching primers conventional Transbond XT primer (3M Unitek), moisture-insensitive primer (MIP, 3M Unitek), and self-etch primer (Transbond plus, 3M Unitek) were used. Bond strength was tested under laboratory conditions with brackets bonded on both dry enamel and enamel contaminated with natural saliva. Self-etch primer showed maximum bond strength under both dry and wet conditions. Conventional primer was comparable with the former under dry conditions but did not offer clinically adequate bond strength in cases of moisture contamination. Both MIP and self-etch primer showed adequate bond strength superior to that of conventional primer in case of moisture contamination. All primers showed typical debonding characteristics of separation at the bracket-adhesive interface or within the adhesive itself, with the exception of the conventional primer used with moisture-contaminated enamel.

7. A study was conducted by Nuket Berk, Guvenc Basaran, Torun Ozer on comparison of sandblasting ,laser irradiaton and conventional acid etchng for orthodontic bonding of molar tubes, purpose of the study was to determine if sandblasted and laser-irradiated enamel may be viable alternatives to acid etching for molar tube bonding. Seventy-seven molar teeth extracted for periodontal reasons were used. Seventy teeth underwent shear bond strength (SBS) testing and the remaining seven were examined under scanning electron microscopy (SEM). Adhesive remnant index (ARI) scores were also considered. An erbium, chromium- doped:yttrium-scandium-gallium-garnet (Er, Cr: YSGG) laser was used for enamel etching. Sandblasted and laser-irradiated enamel surfaces with different power outputs (0.5, 0.75, 1, 1.5, and 2 W) were compared with conventional phosphoric acid etching. Descriptive statistics, including mean, standard deviation, and minimum and maximum values, were calculated for each group. Multiple comparisons of the SBS of different etching types were performed by analysis of variance testing. The chi-square test was used to evaluate differences in ARI scores between groups. Acid-etched, 1-, 1.5-, and 2-W laser irradiation groups demonstrated a clinically acceptable mean SBS (7.65 ± 1.38, 6.69 ± 1.27, 7.13 ± 1.67, 7.17 ± 1.69 MPa, respectively). Irradiation with an output of 0.5 and 0.75 W and sandblasting of the enamel showed a lower SBS than the other groups (2.94 ± 1.98, 4.16 ± 2.87, 2.01 ± 0.64 MPa, respectively). SEM evaluation of 1, 1.5, and 2 Watts laser irradiation revealed similar etching patterns to acid etching. Sandblasting and 0.5, and 0.75 W laser etching were not able to etch enamel in preferential patterns. Laser irradiation at 1.5 and 2 W was able to etch enamel. More adhesive was left on the enamel surface

with low-power laser irradiation.

Sandblasting and low-power laser irradiation (0.5, 0.75, and 1 W) are not capable of etching enamel suitable for orthodontic molar tube bonding, but 1.5- and 2-W laser irradiation may be an alternative to conventional acid etching.

6.3Aims and objectives

1. To evaluate and compare the shear bond strength using conventional acid etching with conventional primer and laser etching with conventional primers as two groups
2. To evaluate and compare the shear bond strength using conventional acid etching with moisture insensitive primer and laser etching with moisture insensitive primer as two groups
3. To compare shear bond strength between all the groups

7 **MATERIALS AND METHODS:**

7.1 Source of data

In this study, the shear bond strength test will be done on extracted human teeth using the above combinations of bonding system to evaluate the most effective bonding system for orthodontic treatments

7.2 Method of collection of data- Inclusion and exclusion criteria

Materials required

- Extracted human premolar teeth
- Hard tissue laser etchants
- Moisture insensitive primers
- Conventional acid etching(approximately 37% phosphoric acid)
- Conventional primers

Exclusion criteria : Grossly decayed teeth

Methodology:

Orthodontic metal brackets will be bonded to 60 extracted human premolar teeth using the different combinations of bonding systems which is as follows:

Group 1:Conventional acid etchants with conventional primers- 15 samples

	Group 2:Conventional etchants with moisture insensitive primers- 15 samples Group 3:Laser etchants with conventional primers- 15 samples Group 4:Laser etchants with moisture insensitive primers- 15 samples The shear bond strength testing will be done using a machine, a metallic loop embedded in acrylic will be mounted in the movable part of the testing machine, the maximum force required to debond the brackets will be recorded, hence the shear bond strength will be then calculated by dividing the force value with the respective bracket base area. The statistical analysis will be done using SPSS software version 16. The quantitative data will be presented as mean and standard deviation, the qualitative data will be presented as frequencies and percentages. The mean will be compared using one way ANOVA. The tukey's post hoc test will be used for multiple pairwise comparison, any other relevant tests might be used during data analysis if required, the statistical significance will be fixed at 0.05
	7.3 Does the study require any investigation or interventions to be conducted on humans or animals? If so, please describe briefly. Yes,extracted human premolar teeth required
	7.4 Has ethical clearance been obtained from your institution? (Attach the certificate) Not yet

8. **LIST OF REFERENCES**:

1. Study by Ram kumar.G titled as “Shear bond strength of stainless steel orthodontic brackets with a moisture-insensitive primer” (From american Journal of Orthodontics and Dentofacial Orthopaedics 2001;119:251-255)

2. Study by Shane Schaneveldt, DDS, MCID ,Timothy F Foley, DDS, MCID titled as “Bond strength comparison of moisture insensitive primers”(From American journal of orthodontics and dentofacial orthopaedics september 2002,122(3):267-273)

3. Study by Bor-Shiunn Lee, DDS, MS, PhD, Tseng-Ting Hsieh, DDS, Yuan-Ling Lee, DDS, MSa, Wan-Hong Lan, DDS, PhD Yao-Jeng Hsu, DDS, Ping-Han Wen, DDS, and Chun-Pin Lin, DDS, MS, PhD titled as “Bond Strengths of Orthodontic Bracket After Acid-Etched, Er:YAG Laser-Irradiated and Combined Treatment on Enamel Surface (Angle orthodontics,October 2003,73(5)565-570)

4. Study by John A. Hess DDS, MPHIL titled as “ Laser-induced morphologic changes of a coated enamel surface using a scanning electron microscope”(From laser surgical medicine,1990;10(5);458-462)

5. Study by Ranga swamy Raja Gopal, Sri devi Padmanabhan and Janakirama gnanamani titled as “Shear bond strength comparison and debondong characteristics of conventional, moisture –insensitive and self etching primers”(Angle orthodontist ,volume 74,number 2, 2004)

6. Study by Nuket Berk, Guvenc Basaran,Torun Ozer titled as “Comparison of sandblasting ,laser irradiaton and conventional acid etchng for orthodontic bonding of molar tube”(European journal of orthodontics 30(2008)183-189)

7. Study by Sergio J. Weinberger, DDS, MCID, FRCD, Timothy F. Foley, DDS, Robert J. McConnell, BDS, FRCS, FFDRCS, MA, PhD, and Gerald Z. Wright, DDS, MSD, FRCD titled as “Bond strengths of two ceramic brackets using argon laser, light and chemically cured resin systems”(Angle orthodontics,1997;volume-67,number-3;page number 173-178)

9	**Signature of the Candidate**	
10	**Remarks of the Guide**	
11	**Name and Designation of** **11.1 Guide** **11.2 Signature**	**Dr.N.Raghunath** Professor Dept. of Orthodontics &DentofacialOrthopaedics JSSDC & Hospital Mysore
	11.3 Co-Guide (if any) **11.4 Signature**	
	11.5 Head of Department **11.6 Signature**	**Dr. Shivalinga B.M.** Head & PG incharge Dept. of Orthodontics &Dentofacial Orthopedics JSSDC & Hospital Mysore
12	**12.1 Remarks of the Chairman and Principal** **12.2 Signature**	