TO ASSESS THE EFFECT OF LOW LEVEL LASER THERAPY ON SENSITIVITY OF TEETH PREPARED FOR FIXED PARTIAL DENTURE – A RANDOMIZED CONTROL TRIAL

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CERTIFICATE

This is to certify that **Dr. S. VINOTH KUMAR,** Post Graduate student (2015-2018) in the Department of Prosthodontics and crown & bridge, Adhiparasakthi Dental College and Hospital, Melmaruvathur – 603319, has done this dissertation titled **"TO ASSESS THE EFFECT OF LOW LEVEL LASER THERAPY ON SENSITIVITY OF TEETH PREPARED FOR FIXED PARTIAL DENTURE – A RANDOMIZED CONTROL TRIAL"** 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

TITLE OF THE DISSERTATION	To assess the Effect of low level laser therapy on sensitivity of teeth prepared for fixed partial denture – A Randomized Control Trial.
PLACE OF THE STUDY	Adhiparasakthi Dental College and Hospital, Melmaruvathur-603319.
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I hereby declare that no part of the dissertation will be utilized for gaining financial assistance or any promotion without obtaining prior permission of the Principal, Adhiparasakthi Dental college and Hospital, Melmaruvathur -603319. In addition, I declare that no part of this work will be published either in print or in electronic media without the guides knowledge who have been actively involved in dissertation. The author has the right to reserve for publish work solely with the permission of the principal, Adhiparasakthi Dental college and Hospital, Melmaruvathur-603319.

Co-guide **Guide & Head of Department**

Signature of candidate

ABSTRACT

Aim of the study: The study was conducted to evaluate the effect of low level laser therapy on sensitivity of teeth prepared for fixed partial denture.

Materials and methods: Thirty patients from the Department of Prosthodontics Adhiparasakthi dental college and hospital Melmaruvathur, Tamilnadu, who required conventional fixed partial denture were selected in random for the study purpose. Out of either of the abutments, one was selected using Block Randomization method and put in the test group. The other abutment was put in the Control group. So of the 60 abutments, 30 were control group, and 30 were in the test group. Tooth preparation was done by conventional method. After tooth preparation sensitivity of both the abutment teeth was recorded using Visual Analogue Scale (VAS). Then low level laser therapy was applied to test group abutment and placebo therapy was applied to control group. After laser therapy again sensitivity of both the abutment teeth was recorded using visual analogue scale (VAS).

Result: The test group showed a significant reduction in sensitivity. There was only a slight reduction in sensitivity over the 7 days of treatment. But in the intraday, before and after treatment with LLT, there was a significant reduction in sensitivity of the teeth.

Conclusion: According to results of this study Low level laser therapy is effective in treatment of sensitivity teeth prepared for fixed partial denture.

Key words:

Low level laser therapy, Dentin hypersensitivity, Fixed partial denture, tooth preparation.

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INTRODUCTION

Dentin hypersensitivity is defined as an exaggerated response to a stimulus that usually causes no response in a healthy tooth[1,2].Dentin hypersensitivity is a common problem for which there was no effective solution. Abel characterized the dentin hypersensitivity as a short, sharp pain arising from exposed dentine in response to stimuli typically evaporative, tactile, or chemical and that cannot be described as any other form of dental pathology[3].It is prevalent among the large portion of individuals aged 30-40 yrs. The most common factors responsible for dentin hypersensitivity are abrasion, caused by tooth brushing with inadequate intensity and abfraction, caused by tooth flexion associated with ill-directed occlusal forces, parafunctional habits or occlusal disequilibrium and erosion, as an effect of acids in the oral cavity and anatomic predisposition, due to structural deficiency in the cement enamel junction and cavity preparations in teeth with vital pulp that expose the dentin and Tooth preparation for fixed partial dentures would also causes sensitivity of prepared teeth.

Thermal, physical and chemical stimuli would also cause displacement of the dentinal fluid from dentin to pulp thus it stimulating the pulp nervous terminations. Origin of the hypersensitivity and the sensitivity caused by them are multi factorial, among them are chemical erosion, caused by indigestion, of acids in the diet, frequent vomit, bulimia, gastric disturbances [4], brushing, the use of abrasives and occlusal imbalance, when present alone or together with other causes it leads to loss of dental enamel in the cervical area and consequently leads to dentin hypersensitivity. The erosive agents are probably responsible for starting the sensitivity due to the opening of the dentinal tubules. The nociceptive stimulus commonly reported in majority of the cases is that of cold, followed by the mechanical stimulus of tooth brushing and the chemical stimulus of diet with a higher concentration of sugar.18% of the adult population suffer from this problem, and the higher incidence occurs in premolars, followed by the canines, incisors and molars and the vestibular area is most commonly affected(5).

According to hydrodynamic theory, when there is a stimuli which displaces the fluid in dentinal tubules inward and outward, thereby activating the nerve endings at the pulp dentin interface, resulting in hypersensitivity. The hydrodynamic theory is still currently accepted to explain the relationship between pain of dentinal origin and the displacement of odontoblasts in to the dentinal tubules(6).Under normal conditions, dentin is covered by enamel or cementum and does not suffer direct stimulation. Only with the exposure of the peripheral terminations of dentinal tubules, is a situation of strong dentinal sensitivity manifested and termed as hypersensitivity. In order to eliminate such discomfort for patients, several techniques and materials have been tested. Occlusion of the exposed dentinal tubules can reduce the intensity of dentinal sensitivity. This can be accomplished through passive mechanisms such as, precipitation of salivary calcium phosphate inside the dentinal tubules, adsorption of plasma proteins and saliva constituents, as well by active mechanisms such as deposit of intra canalicular crystalline material and secretion of protein material from the interior of the tubules, thereby diminishing dentinal permeability and sensitivity. However, hypersensitivity sometimes remains in spite of the effective blocking of the tubules, suggesting that other mechanisms contribute to nerve activation instead of or in addition to the hydrodynamic mechanism. This partially explains the large sensitivity variation of exposed dentin and furthermore, nerve activation may result in the release of neuropeptides from the activated nervous terminations and, consequently induce neurogenic inflammation. The symptoms of dentin hypersensitivity up to a certain point would be self-sustainable.

Any treatment that reduces the dentinal permeability must diminish dentin hypersensitivity. The occlusion of dentinal tubules leads to reduction of dentinal permeability which proportionally decreases the degree of dentinal sensitivity. According to the hydrodynamic theory, the effectiveness of dentin desensitization agents is directly related to their capacity to promote the sealing of the dentinal canaliculi. According to TRANSDUCTION THEORY, odontoblast has a special sensory function and they functional complex with nerve endings in or near the odontoblastic layer acts as an excitatory synapse. According to MODULATION THEORY, nerve impulses in the pulp are modulated through the liberation of polypeptides from the odontoblasts. When injured these substances may selectively alter the permeability of the odontoblastic cell.

These treatments are performed to block the hydrodynamic mechanism by transmitting stimuli to the dentin, and closing the dentinal tubules(7). Many treatments with topical products in form of dental cream, mouthwash, and varnishes have been offered to the population in an attempt solve the problem. Many literatures supports the application of dentin adhesive(8), propolis application(9) and the use of silver nitrate solution on cervical dentin, which were considered effective for reducing dentin hypersensitivity(10).

With the advent of laser technology and its growing utilization in the field of dentistry, an additional therapeutic option is available for the treatment of dentin hypersensitivity. The laser, by interacting with the tissue, causes different tissue reactions according to its active medium, wavelength, and power density and the optical properties of the target tissue. The lasers used for the treatment of dentin hypersensitivity are divided into two groups: Low output power (He-Ne or diode lasers) and middle output power [Diode, Nd:YAG, Er:YAG, ErCr:YSGG, CO2,Argon, and potassium titanyl phosphate (KTP)lasers].Helium neon therapy(He-Ne)therapy, new diode lasers were developed in an attempt to slightly higher the power output and wavelength that could penetrate soft tissues without damaging them. The Nd-YAG (high-level) and He-Ne (low-level) lasers can also be used in cases of dentin hypersensitivity, and is the another treatment of option for dentin hypersensitivity. However, its high cost restricts its use only to laser centers or universities(11,12,13). The Nd-YAG laser acts by Obliterating the dentinal tubules(14,15,16).

Low level laser therapy

Low level laser therapy (LLLT) was initially utilized in dentistry to accelerate wound healing, minimize pain, and to reduce inflammatory responses. Low level lasers have been widely investigated due to their lower costs compared with other lasers, and their simplicity of use. The first low-level laser introduced was helium - neon (He-Ne), which combined a gaseous mixture to produce a wavelength in the visible light spectrum (λ = 632.8 nm) and low power output (ranging from 5 to 30 mW). Since the wavelength produced by He-Ne laser was highly absorbed by soft tissues, its penetration was limited.

New diode lasers were developed in an attempt to obtain slightly higher power output and wavelengths that could penetrate soft tissues without damaging them. Diode lasers are usually variants of gallium-aluminium-arsenide (Ga-Al-As), which emit in the near infrared spectrum (780, 830, and 900 nm; power output from 20 to 100 mW), or indium-gallium-arsenide-phosphorus (In-Ga-As-P) devices, which emit wavelengths in the red spectrum of visible light (600-680 nm, power output from 1 to 50 mW).It is believed that low-level lasers therapy stimulate nerve cells, interfering with the polarity of cell membranes by increasing the amplitude of the action potentials of cellular membranes, thus blocking the transmission of pain stimuli in hypersensitive dentin. It seems that the low output lasers mediate analgesic effects due to depressed nerve transmission. In addition to the analgesic effect, bio stimulation induced by low-level lasers increases the physiologic activity of tissues thus enhancing healing processes and minimizing the pain. Low-power Ga-Al diode laser irradiation, with energy densities of 3 J/cm2 and 4 J/cm2, power output of 120 mW, and wavelength of 904 nm, increased the number of cells in cultured fibroblasts about 3-6fold when compared with control cultures(14)and also discovered that small differences in energy density may produce different actions on cell growth and demonstrated that this particular laser irradiation could stimulate fibroblast proliferation without impairing pro collagen synthesis. The Ga-Al-As laser has been used for the treatment of dentin hypersensitivity.

REVIEW OF LITERATURE

1. Aldo Brugnera et al (2000) did a study on laser therapy in the treatment of dental hypersensitivity and concluded that, LLLT used with appropriate treatment parameters is effective in treating dentin hypersensitivity as it quickly reduces pain and maintains a prolonged pain free status in 91.27% of the 1102 cases studied. (WALT, special millinneum edition 2000,laser therapy vol 12,16-21.)
2. Karen Cristina et al(2003) did a study on, low level laser therapy for dentin hypersensitivity and concluded that the treatment with Ga-Al-As laser was effective for reducing dentin Hypersensitivity.(CiencOdontol Bras 2003 out./dez.; 6 (4): 17-24.)
3. Analucia Marsilio et al (2003) did a study on, effect of clinical application of the Ga-Al-As laser in the treatment of dentin hypersensitivity and concluded that, the initial DH was reduced after treatment with the low level Ga-Al-As laser. The difference between initial dentin hypersensitivity and dentin hypersensitivity at 60 days post-treatment was statistically significant.(Journal of Clinical Laser Medicine & Surgery Volume 21, Number 5, 2003).
4. LJ Walsh (2003) did a study on the current status on laser applications in dentistry and concluded that, Laser technology for caries detection, resin curing, cavity preparation and soft tissue surgery is at a high state of refinement, having had several

decades of development up to the present time.(Australian Dental Journal 2003;48:3)

5. Ana Raquel Benetti et al (2004) did a study on laser therapy for dentin hypersensitivity; a critical appraisal and concluded that, the available evidence is not consistent, and thus cannot prove the efficacy of laser therapy in the management of hypersensitive dentin.(J oral laser applications 2004; 4:271-278.)
6. Ahmet Eralp et al (2006) did a study on, a clinical investigation of low level laser irradiation on hypersensitive dentin and concluded that the action mechanism of low output lasers are unclear, the results of the study indicated that they were very effective in dentin hypersensitivity and resistant to mechanical forces and chemical irritation.(Cilt: 30, Sayı: 2, Sayfa: 94-99, 2006).
7. Alessandra Buhler et al (2012) did a literature review on dentin hypersensitivity – etiology , treatment possibilities and other related factors and concluded that, the adhesive systems are one of the most effective clinical treatments and the lasers are expected to play an important role in treating dentin hypersensitivity.(World Journal of Dentistry,Jan-Mar 2012;3(1)60-67).
8. Romeo Umberto et al (2012) did a clinical study on treatment of dentin hypersensitivity by diode laser and concluded that, the Ga-Al-As laser showed a very high capability to improve immediately the DH-related pain, both alone and even better in

combination with NaF gel.(International Journal of Dentistry Volume 2012, Article ID 858950, 8 pages).

9. Mohammad Asnaashari et al (2013) did a study on application of low level lasers in dentistry(endodontic) and concluded that, low level lasers are very effective in dental applications.(Journal of Lasers in Medical Sciences Volume 4 Number 2 Spring 2013).
10. Mohammad Ali Ansari (2013) did a study on mechanisms of laser-tissue interaction: 11.tissue thermal properties and concluded that ,cancer patients consume less oxygen and gain heat at a higher rate than the non-cancer patients.(Journal of Lasers in Medical Sciences Volume 4 Number 3 Summer 2013).
11. Rola et al (2014) did a study on the use of low level energy laser radiation in basic and clinical research and concluded that, LLLT holds promise as a novel supportive tool in the treatment of wounds and chronic pain syndromes.(AdvClinExp Med 2014,23, 5, 835–842)
12. Vartika Kathuria et al (2015) did a study on low level laser therapy; a panacea for oral maladies and concluded that, LLLT can prove to be an effective treatment modality for various oral maladies provided that the clinician takes proper training and adopts necessary safety measures.(Laser Therapy 24.3: 215-223)
13. Elossais Andre Afif et al (2015) did a study on, in vivo comparative evaluation of low level laser therapy and strontium chloride desensitizing agent on cervical dentin hypersensitivity and concluded that, both desensitizing methods reduced the

dentin hypersensitivity after three sessions and statistical significant differences were found between the groups. Group 1 (Desensibilize) presented 90% efficiency and Group 2 (Whitening Laser II) 95% efficiency.(Scientific Journal of Dentistry Vol. 2:4 Jul-Aug 2015.)

14. Snehal A, Naik et al (2016) did a critical review on , laser therapy in the management of dentin hypersensitivity and concluded that laser therapy is effective.(Universal Research Journal of Dentistry Sept-Oct 2012, Vol 2 ,Issue 3.)
15. ShariqNajeeb et al (2016) did a study on applications of light amplification by stimulated emission of radiation for restorative dentistry and concluded that, dental Lasers represents cutting edge technology for a wide range of restorative dental applications with promising outcomes.(Med PrincPract 2016;25:201–211)

MATERIALS AND METHODS

Clinical case selection:

Thirty patients from the Department of Prosthodontics, Adhiparasakthi Dental College and Hospital Melmaruvathur, Tamilnadu, who required conventional fixed partial denture were selected in random for the study purpose.

Inclusion criteria for abutment selection

- Subjects who requires fixed partial prosthesis
- Subjects with vital teeth
- Subjects with adequate crown root ratio
- Subjects with good periodontal health

Exclusion criteria for abutment selection

- Subjects with non-vital teeth
- Subjects with inadequate crown root ratio
- Subjects with poor periodontal health
- Note: Periodontal health to be assessed using Russel’s periodontal Index.

Evaluation of sensitivity of teeth:

In each appointment the sensitivity degree of each prepared abutment was tested using a probe. It was done by running the probe tip on prepared teeth surfaces from gingival to occlusal or incisal aspect with gentle finger pressure. Based on the subjective answer of the patient, scores from 0 to 10 were attributed, these values were registered on a filling sheet which had the Visual Analogue Scale [VAS](figure 1).

Low level laser therapy unit:

The laser unit used was: Class ШB laser [sun med] and the probe has Ga-Al-As diode that emits coherent light at the RED wavelength of 685 nm. It delivers maximum energy of 3 joule/cm² within one minute (figure 2).

Precautions and Safety features to be followed:

1. During laser application both the patient and the operator should wear the protective goggles.
2. Before laser application the operator should ensures that all the connection and power supply to the laser unit was kept ready
3. Place the laser probe perpendicular to the prepared teeth for effective irradiation.
4. Focus the laser probe on particular surface to be treated, so that unnecessary irradiation of the adjacent surfaces were protected.
5. During laser therapy laser beam should not passes through any metals.
6. During the laser application the probe tip should stay in the same position for specified time period.
7. Operator and the patient should not see the laser light with naked eye.

Procedure:

Tooth preparation was done by conventional method. It implies that the tooth preparation procedures for all type of fixed partial dentures are common, but only the amount of tooth reduction varies. So the amount of tooth reduction for all types of fixed partial dentures have minimum of 1 mm, therefore after tooth preparation patient may feel the sensitivity of prepared tooth. Of the two abutments, one abutment was selected by BLOCK RANDOMIZATION METHOD and included in the test group. The other abutment acts as the control. Totally out of 60 abutments, 30 abutments were grouped into test group, another 30 abutments in the control group.

BLOCK RANDOMIZATION METHOD:

The purpose of randomization is to achieve balance with respect to known and unknown risk factors in the allocation of participants to treatment arms in a study(24,25). A premise of basic statistical tests of significance is that underlying observations are independently and identically distributed. The stochastic assignment of participants helps to satisfy this requirement. It also allows the investigator to determine whether observed differences between groups are due to the agent being studied or chance. By probability, a simple randomization scheme may allocate a different number of participants to each study group. This may reduce the power of a statistical procedure to reject the null hypothesis as statistical power is maximized for equal sample sizes(26). Additionally, an imbalance of treatment groups within confounding factors may occur. This is especially true for small sample sizes. Confounding distorts the statistical validity of statistical inferences about cause and effect. The failure to control for confounding may inflate type 1 error and erroneously lead to the conclusion that a putative risk factor is causally associated with the outcome under study (false positive finding). A chance run of participants to a particular study group also may occur under a simple randomization scenario. This can lead to bias, for example, if the initial participants in the trial are healthier than the later ones(24). Blocked randomization offers a simple means to achieve balance between study arms and to reduce the opportunity for bias and confounding.

Block randomization works by randomizing participants within blocks such that an equal number are assigned to each treatment. For example, given a block size of 4, there are 6 possible ways to equally assign participants to a block. Allocation proceeds by randomly selecting one of the orderings and assigning the next block of participants to study groups according to the specified sequence. Note that repeat blocks may occur when the total sample size is greater than the block size times the number of possible orderings. Furthermore, the block size must be divisible by the number of study groups. A disadvantage of block randomization is that the allocation of participants may be predictable and result in selection bias when the study groups are unmasked. That is, the treatment assignment that has so far occurred least often in the block likely will be the next chosen[27]. Selection bias may be reduced by using random block sizes and keeping the investigator blind to the size of each block.

Testing for Sensitivity:

Once the tooth preparation procedure was completed, then sensitivity of test group abutment teeth was recorded by using visual analogue scale (VAS) before application of laser on selected abutment teeth. Sensitivity degree of prepared abutment was tested through the probe by running the probe tip on prepared teeth surfaces from gingival to occlusal or incisal aspect with gentle finger pressure. Based on the subjective answer of the patient, scores from 0 to 10 were attributed, these values were registered on a filling sheet which had the Visual Analogue Scale [VAS] (figure 1). The perceived discomfort for each tooth was graded for each of stimuli by using a 10cm VAS, labelled at the two extremes with ‘no pain’ at the zero extreme and with ‘unbearable pain’ at the 100mm extreme.

Application of Laser:

Safety measures were followed for every patients and the dentist, which includes protective goggles (figure 3). Then the laser unit is switched on and the setting adjusted. The laser probe is pointed perpendicular to prepared tooth surface. First make sure that the probe was kept in desired position then activate the laser and hold the probe for four minutes with continuous mode. Once the laser therapy was completed, the patient is checked for the degree of sensitivity.

Low level laser therapy was performed on selected test group abutment teeth in non contact continuous mode with 12 joules /cm^2 energy for 4 minutes (figure 4). The procedure was repeated after day three and day seven for all thirty patients and the score were tabulated.

Placebo:

The procedure for placebo group is similar to that of test group. The only difference being that the placebo abutment was exposed to pointer light without laser energy. The subject thinks that both the teeth are treated. Then the subject is evaluated for dentin hypersensitivity and the results were recorded (figure 5).

The sensitivity of prepared abutment teeth was scored before and after low level laser therapy application on all the three visits and tabulated. The tabulated scores were compared and statistically analyzed.

RESULTS

Table 1 shows the VAS scores of the tooth hypersensitivity of the subjects. Table 2 shows the descriptive statistics of the data.

On day 1 before laser therapy the mean score for test group was 5.87 with a minimum score of 5.0 and a maximum score of 9.0 and the placebo showed a mean score of 4.97 with a minimum score of 3 and a maximum score of 8.0. After laser therapy the mean score for test group was 2.60 with minimum score of 0.0 and a maximum score of 4.0 and the placebo showed a mean score of 4.73 with minimum score of 3.0 and a maximum score of 7.0.(chart1&2)

On day 3 before laser therapy the mean score for test group was 5.57 with a minimum score of 4.0 and a maximum score of 8.0 and the placebo showed a mean score of 5.00 with a minimum score of 4.0 and a maximum score of 7.0. After laser therapy the mean score for test group was 2.20 with minimum score of 0.0 and a maximum score of 4.0 and the placebo showed a mean score of 4.60 with minimum score of 3.0 and a maximum score of 7.0.(chart 1&2)

On day 7 before laser therapy the mean score for test group was 4.27 with a minimum score of 3.0 and a maximum score of 6.0 and the placebo showed a mean score of 4.37 with a minimum score of 3.0 and a maximum score of 6.0. After laser therapy the mean score for test group was 1.37 with minimum score of 0.0 and a maximum score of 3.0

and the placebo showed a mean score of 4.07 with minimum score of 2.0 and a maximum score of 6.0.(chart 1&2).

STATISTICAL ANALYSIS

The Normality tests Kolmogorov-Smirnov and Shapiro-Wilks tests results reveal that variable does NOT follow Normal distribution. Therefore to analyze the data Non parametric methods are applied. To compare between test and control groups Mann Whitney test was applied(table 3). To compare values between before and after laser on same day Wilcoxon Signed Rank test was applied (table 4). To compare values between time points (days) Friedman test for repeated measures was used (table 5&7), Bonferroni adjusted P-values are calculated for pairwise comparisons (table 6&8). To analyze the data SPSS (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp. Released 2013) is used. Significance level is fixed as 5% ($\alpha = 0.05$).

DISCUSSION

Dentin hypersensitivity (DH) is a common problem followed by tooth preparation for fixed partial denture. Hypersensitivity is an abnormal response of the exposed vital dentin to thermal, chemical, or tactile stimuli. This condition may affect patients of all ages, and both genders are equally affected. Although different theories have been proposed for the mechanism involved in dentin hypersensitivity etiology, recent studies gave support to Brannstrom's hydrodynamic theory(28).According to this a stimulus applied to open tubules dentin increases the flow of dentinal tubular fluid, with mechanical deformation of the nerves located into the inner ends of the tubules or in the outer layers of the pulp(29). Type A delta fibers are supposed to be responsible for dentin sensitivity being probably activated by the hydrodynamic process(30).

There are so many treatment of choice are available for treating dentin hypersensitivity, which includes desensitizing agents, and use of lasers. Grossman listed the requirements for an ideal dentine desensitizing agent as: rapidly acting with long-term effects, non-irritant to pulp, painless and easy to apply, and should not stain the tooth.

At home desensitizing therapy

These “at home” desensitizing agents include toothpastes, mouthwashes and chewing gums(31). Majority of the toothpastes contain potassium salts (potassium nitrate, potassium chloride or potassium citrate), sodium fluoride, strontium chloride, dibasic sodium citrate, formaldehyde, sodium mono-fluorphosphate and stannous fluoride. Potassium salts act by diffusion along the dentinal tubules and decreasing the excitability of the intra dental nerve fibers by blocking the axonicaction[32,33]. Various clinical studies have shown the efficacy of potassium salts in controlling the dentin hypersensitivity[34,35]. It has been shown that toothpastes containing 5% potassium nitrate and 0.454%stannous significantly reduced the dentin hypersensitivity. Also, toothpastes containing potassium nitrate and fluorides have been shown to reduce post-bleaching sensitivity[36,37]. The desensitizing toothpastes should be used with the help of a toothbrush with soft bristles. Patients should be advised to use minimal amount of water to prevent the dilution of the active agent. Along with the desensitizing toothpastes, mouthwashes and chewing gums containing potassium nitrate, sodium fluoride or potassium citrate are also recommended[31]. The results of “at-home” desensitizing therapy should be reviewed after every 3–4 weeks. If there is no relief in dentin hypersensitivity, “in-office” therapy should be initiated.

In-office desensitizing agents :

Theoretically, the in-office desensitizing therapy should provide an immediate relief from the symptoms of dentin hypersensitivity. The in-office desensitizing agents can be classified as the materials which undergo a setting reaction (glass ionomer cement, composites) and which do not undergo a setting reaction (varnishes, oxalates).

Fluorides

Traditionally, fluorides have been used as a caries preventive material which can help in remineralization of enamel/dentin[38].Also, various clinical trials have shown that application of fluoride solution can decrease the dentin hypersensitivity[39,40]. Fluorides decrease the dentinal permeability by precipitation of calcium fluoride crystals inside the dentinal tubules[31]. These crystals are partially insoluble in saliva. SEM revealed granular precipitates in the peritubular dentin after application of fluorides[41].Various fluoride formulations are used to treat dentin hypersensitivity. These include sodium fluoride, stannous fluoride, sodium monofluoro phosphate, fluorosilicates and fluoride combined with iontophoresis[31]. Sodium fluoride has been used in dentifrices or may be professional applied in a concentration of 2%. The precipitates formed by sodium fluoride can be mechanically removed by the action of saliva or mechanical action. Therefore, an addition of acid formulation is recommended. The acidulated sodium fluoride can form precipitates deep inside the tubules. Also, some authors have recommended the use of ionotophoresis along with sodium fluoride[41,42].The electric current is supposed to increase the ion diffusion. A clinical study has shown that 0.4% stannous fluoride along with 0.717% of fluoride can provide an immediate effect after a 5 minute professional application[43].Stannous fluoride acts in a similar fashion as that of sodium fluoride, i.e., formation of calcium fluoride precipitates inside tubules. Also, SEM studies have shown that stannous fluoride itself can form insoluble precipitates over the exposed dentine[44]. Fluorosilicates act by formation of precipitates of calcium phosphates from saliva. Ammonium hexa fluorosilicate has been used as a desensitizing agent. It can present a continuous effect of dentinal tubule occlusion via precipitation of a mixture of calcium fluoride and fluoridated apatite[45,46]. If the precipitate is predominantly composed of fluoridated apatite, it can form stable crystals deposited deep inside the dentinal tubules[45,46]. These crystals are resistant to removal from the action of saliva, brushing or action of dietary substances.

Oxalates

Oxalates can reduce dentinal permeability and occlude dentinal tubules. Thirty percent potassium oxalate had shown a 98% reduction in dentinal permeability[47]. Also, topical application of 3% potassium oxalate reduced dentin hypersensitivity after periodontal therapy[47]. The oxalate reacts with the calcium ions of dentine and forms calcium oxalate crystals inside the dentinal tubules as well as on the dentinal surface. This results in a better sealing as compared with an intact smear layer[31]. It has been shown that the effect of oxalates on dentin hypersensitivity diminishes over a period of time. This can be attributed to the removal of the calcium oxalate crystals by brushing or dietary acids. The condition can be improved by acid etching of the dentinal surface, thus increasing the penetration of calcium oxalate crystals deep into the dentinal tubules[48]. Many vegetables like rhubarb, spinach and mint contain oxalates. It has been shown that phytocomplexes obtained from these natural products can reduce the dentinal permeability. This can also be followed by covering the exposed surface with a dental adhesive(49).Potassium oxalate can lead to gastric irritation. Therefore, it should not be used with a tray with prolonged placement. Varnishes are commonly used useful in-office measures to treat dentin hypersensitivity. Copal varnish can be applied to cover the exposed dentinal surface. But its effect is for short term and is not recommended for long term management of dentin hypersensitivity(50). To improve its efficacy, removal of smear layer is advocated. Also, the varnishes can act as a vehicle for fluoride. The fluoride varnishes can be acidulated to increase the penetration of ions(50).

Adhesive materials

Resin-based dental adhesive systems can provide a more durable and long lasting dentine desensitizing effect. The adhesive resins can seal the dentinal tubules effectively by forming a hybrid layer(31). Various clinical studies have demonstrated the effectiveness of adhesives in management of dentin hypersensitivity(51,52,53). Traditionally, resin composites or dentin bonding agents are used as desensitizing agents. The conventional dentin bonding agents (DBA) removes the smear layer, etches the dentinal surface and forms deep dentinal resin tags inside the dentinal tubules. The combined dentin–resin layer (consisting of penetrating resinous tags) has been termed as hybrid layer. It effectively seals the dentinal tubules and prevents dentin hypersensitivity(51,52,53). Newer bonding agents modify the smear layer and incorporate it in into the hybrid layer(54). Recently, some dentin bonding agents have been introduced in the market with the sole purpose of treating dentin hypersensitivity. Gluma Desensitizer (HeraeusKulzer, Hanau, Germany) contains hydroxyl ethyl methacrylate (HEMA), benzalkonium chloride, gluteraldehyde and fluoride. Gluteraldehyde causes coagulation of the proteins inside the dentinal tubules[54]. It reacts with the serum albumin in the dentinal fluid, causing its precipitation. HEMA forms deep resinous tags and occludes the dentinal tubules[54]. Gluma has shown promising results in the clinical trials[54,55].

Bioglass

Bioglass was developed to stimulate the formation of new bone[56]. It is used in orthopedics to cover the implants to promote union between implant and bone[56,57]. It has been used in dentistry to fill up the osseous defects during periodontal surgery[58]. It has been reported that a formulation of bioglass can promote infiltration and remineralization of dentinal tubules[59]. The basic component is silica, which acts as a nucleation site for precipitation of calcium and phosphate. SEM analysis has shown that bioglass application forms an apatite layer, which occludes the dentinal tubules[59]. The use of bioglass in management of dentin hypersensitivity has been shown by some products such as NovaMin (NovaMin Technology Inc., FL, USA).

Portland cement

Some authors have shown that calcium silicate cement derived from Portland cement can help in the management of dentin hypersensitivity[31]. It helps to occlude the dentinal tubules by remineralization.

Casein phosphor peptide–amorphous calcium phosphate

Recently, milk protein casein has been used to develop a remineralizing agent (GC Tooth Mousse). The casein phosphor peptide (CPP) contains phosphoseryl sequences which get attached and stabilized with amorphous calcium phosphate (ACP)[60]. The stabilized CPP–ACP prevents the dissolution of calcium and phosphate ions and maintains a supersaturated solution of bio available calcium and phosphates[60]. Various studies have shown that CPP–ACP can effectively remineralize the enamel subsurface lesions[61,62]. By virtue of its remineralizing capacity, it has also been proposed by the manufacturers that it can also help in prevention and treatment of dentin hypersensitivity.

Laser

It has been shown in various studies that lasers can be used in the effective management of dentin hypersensitivity[63,64,65,66]. The mechanism of action of lasers in treating dentin hypersensitivity is not very clear. Some authors have shown that Nd–YAG laser application occluded the dentinal tubules[64,65].Ga-Al-As laser is thought to act by affecting the neural transmission in the dentinal tubules[66]. It has also been proposed that lasers coagulate the proteins inside the dentinal tubules and block the movement of fluid[63].

Most of the treatments tested have aimed to block exposed dentinal tubules, but none of these treatments has produced consistently effective or long lasting results. So to overcome this problem, low level laser therapy was tried in the management of dentin hypersensitivity followed by tooth preparation for fixed partial denture. It is necessary to consider the severity of the dentin hypersensitivity before using the laser and the efficiency of the use of laser for dentin hypersensitivity treatment is higher than other methods.

The laser therapy is a painless, safe, fast, conservative treatment, and it is well accepted by the patients [(31)]. High-level lasers are very expensive and only a trained professional can use it. The low-level lasers are on the other hand, are more accessible. But even with such equipment due diligence and intimate knowledge is a prerequisite. Supporters of LLLT will argue that no adverse effects have been reported with the use of such therapy to treat hypersensitive teeth. In addition to the biological effect of increasing the action potential of pulp tissue and also LLLT are safer to the pulp because they stimulate circulation and cellular activity[(21,32,33)].The majority of the papers that positively relate laser therapy and reduction in sensitivity of hypersensitive dentin are uncontrolled trials. Randomized controlled trials are rare in studies of laser and dentin hypersensitivity[(21)].

Present study:

In this study Ga-Al-As laser was used to treat sensitivity of teeth prepared for fixed partial denture. In day one after laser irradiation most of the test group samples showed slight reduction in sensitivity of prepared teeth, but in control group there was no significant reduction in sensitivity of prepared teeth (table 2). On day three, after laser application there was no change in the control group samples but in test samples there was much better reduction in sensitivity of prepared teeth when compared to day one (table 3). In day seven after laser application again control group samples showed no change in amount of sensitivity and in test group samples showed great reduction in sensitivity when compared to day three(table 3). So in test group after laser application sensitivity of prepared teeth gradually decreased in day by day appointments.

On comparing day 1,3 and 7control group showed no change(table 5). In this time period, the test group showed a significant reduction in sensitivity both before and after the treatment with LLLT(chart 3). This proves the positive effect of LLLT on sensitivity of teeth. This could be attributed to the negative reinforcement of the A delta fibers and reduction in neural conduction.

SUMMARY

The analysis and values obtained from the clinical study can result in the following findings;

- On day one, application of low level laser therapy on sensitivity tooth prepared for the fixed partial denture resulting in immediate relief.
- On day three, after laser application there was much better reduction in sensitivity of prepared teeth when compared to day one.
- On day seven, after laser application it showed great reduction in sensitivity when compared to day three. So in test group after laser application sensitivity of prepared teeth gradually decreased in day by day appointments.
- On comparing day one, three and seven control group showed no change(table 5). In this time period, the test group showed a significant reduction in sensitivity both before and after the treatment with LLLT(chart 3).

CONCLUSION

The results of this study demonstrated that low level laser therapy was effective in treating sensitivity of teeth prepared for fixed partial denture when used along with the appropriate treatment parameters as it quickly reduces sensitivity.

LIMITATIONS OF THE STUDY

- We standardized the values of mW, joules/minute, mode of application, and the duration period for all the subjects. Effect of change of these parameters on sensitivity of the tooth can be further explored.
- Objective type of data requires rather than subjective data. This study was based on subjective evaluation of the patient. More robust results can be seen if more subjective evaluation was done.
- Long term follow up studies are required further to conclude the results.

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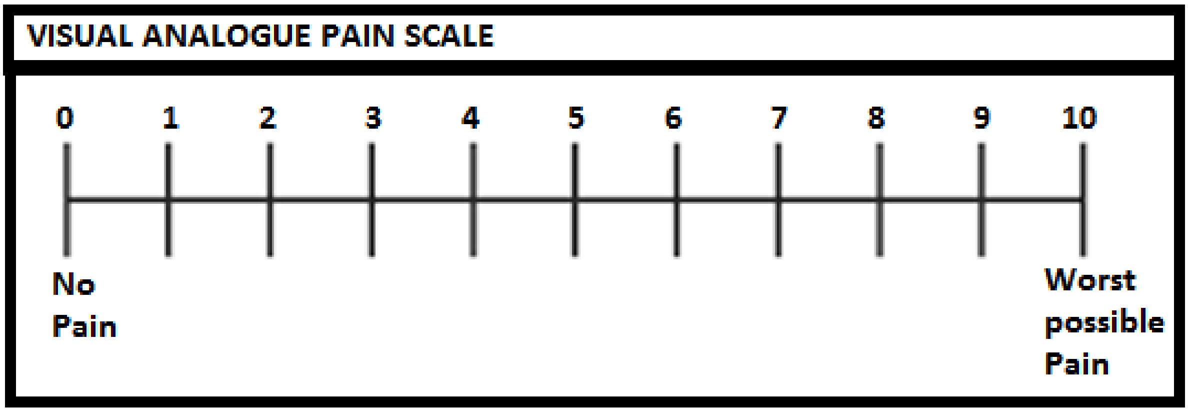
DATA AND PHOTOS

Figure 1:



VISUAL ANALOGUE SCALE

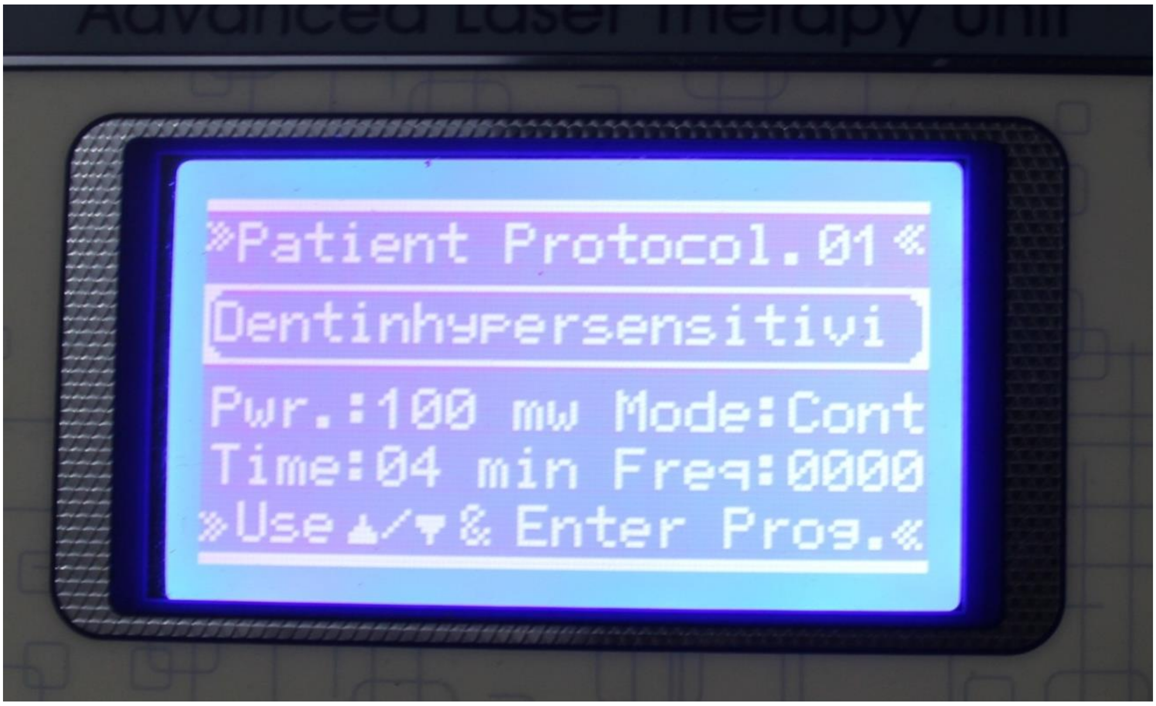
Figure 2:

LOW LEVEL LASER THERAPY UNIT

Figure 3:

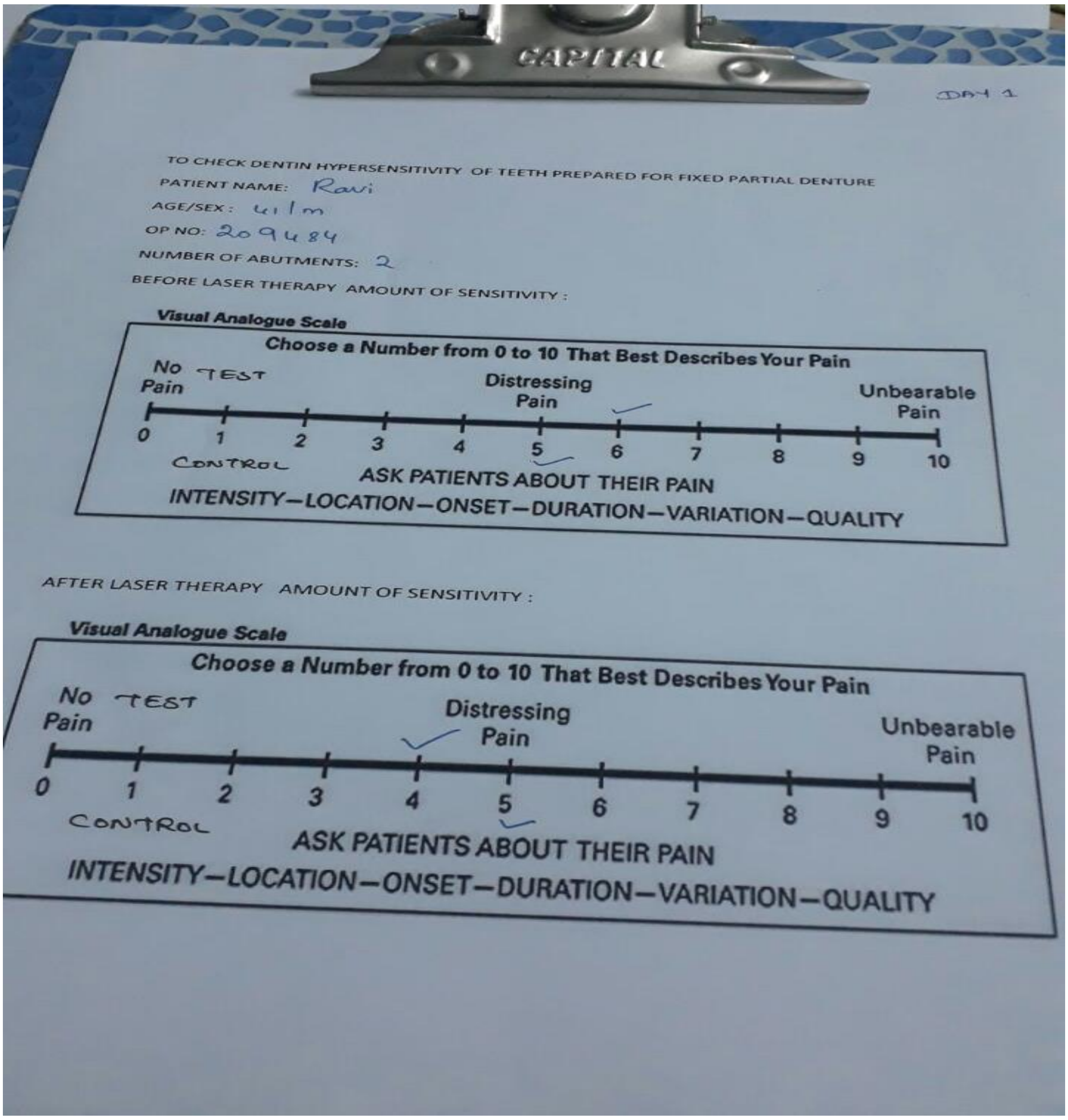
APPLICATION OF LOW LEVEL LASER THERAPY

Figure 4:



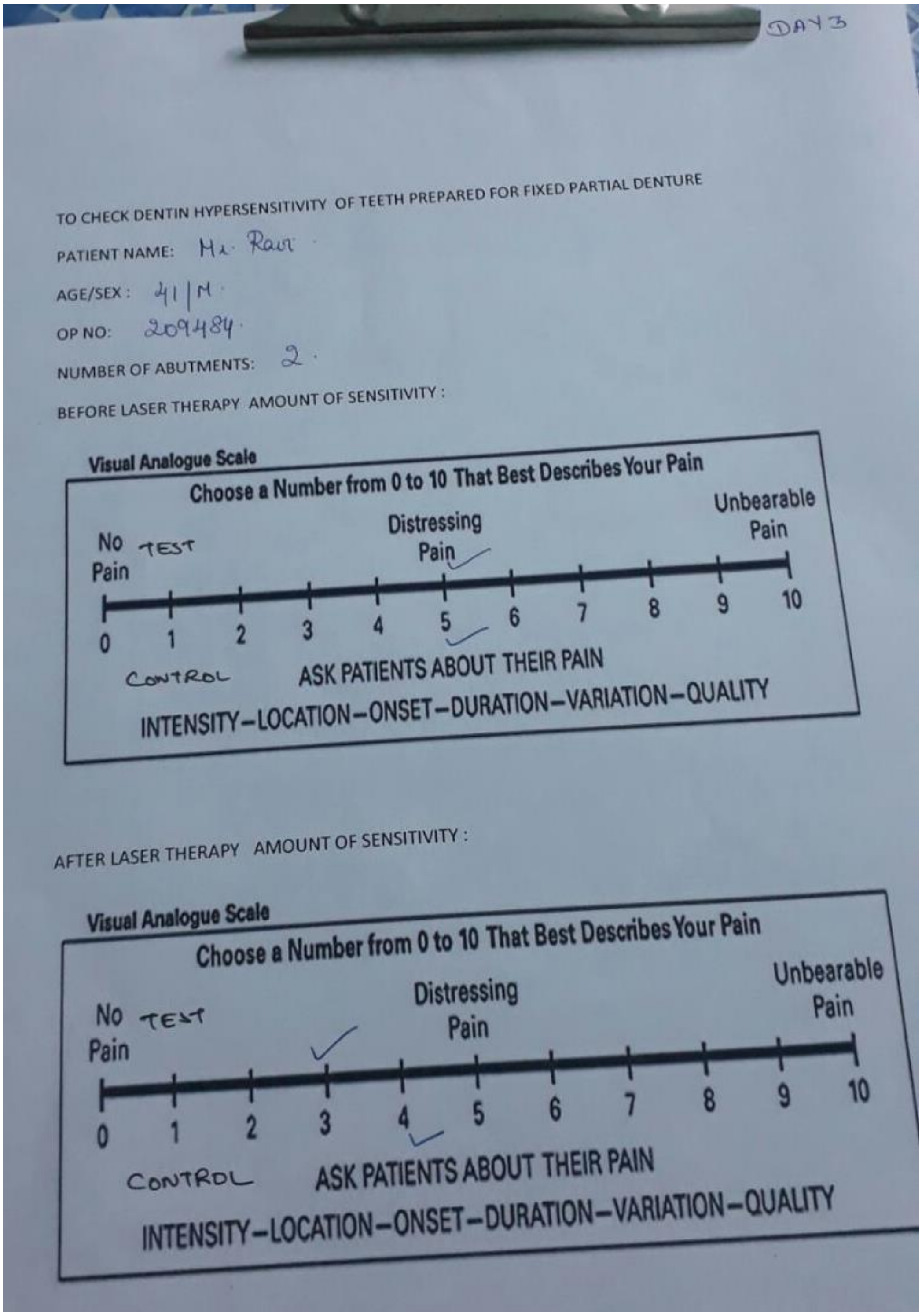
STANDARDIZATION OF LOW LEVEL LASER THERAPY

Figure 5:



EVALUATION OF TEETH SENSITIVITY BY USING VISUAL ANALOGUE SCALE ON DAY ONE

Figure 6:



DAY 3

TO CHECK DENTIN HYPERSENSITIVITY OF TEETH PREPARED FOR FIXED PARTIAL DENTURE

PATIENT NAME: Mr. Ravi

AGE/SEX : 41 | M

OP NO: 209484

NUMBER OF ABUTMENTS: 2

BEFORE LASER THERAPY AMOUNT OF SENSITIVITY :

Visual Analogue Scale

Choose a Number from 0 to 10 That Best Describes Your Pain

No Pain — TEST — Distressing Pain — Unbearable Pain

0 1 2 3 4 5 6 7 8 9 10

CONTROL

ASK PATIENTS ABOUT THEIR PAIN

INTENSITY–LOCATION–ONSET–DURATION–VARIATION–QUALITY

AFTER LASER THERAPY AMOUNT OF SENSITIVITY :

Visual Analogue Scale

Choose a Number from 0 to 10 That Best Describes Your Pain

No Pain — TEST — Distressing Pain — Unbearable Pain

0 1 2 3 4 5 6 7 8 9 10

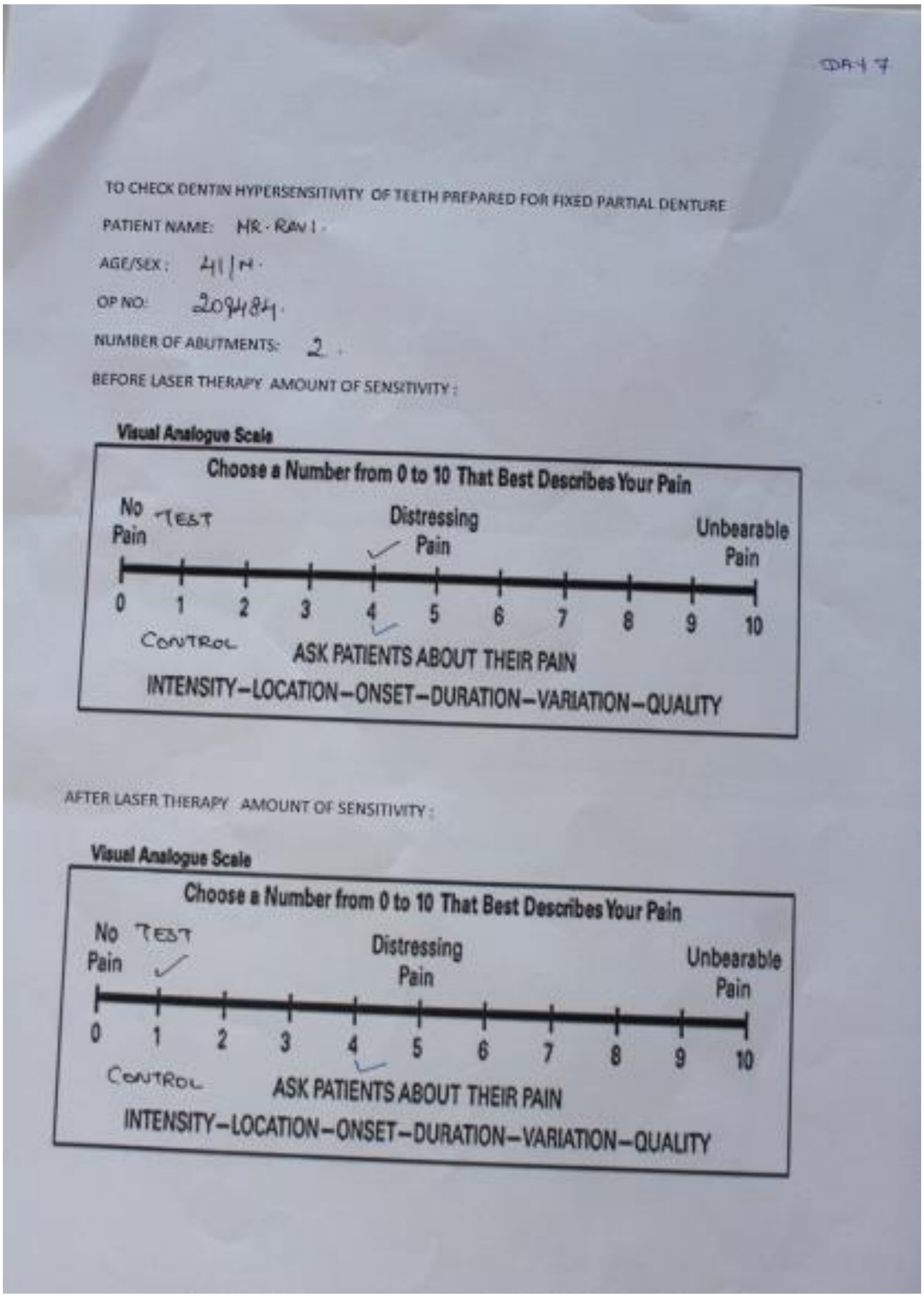
CONTROL

ASK PATIENTS ABOUT THEIR PAIN

INTENSITY–LOCATION–ONSET–DURATION–VARIATION–QUALITY

EVALUATION OF TEETH SENSITIVITY BY USING VISUAL ANALOGUE SCALE ON DAY THREE

Figure 7:



DAY 7

TO CHECK DENTIN HYPERSENSITIVITY OF TEETH PREPARED FOR FIXED PARTIAL DENTURE

PATIENT NAME: MR. RAVI.

AGE/SEX: 41/M.

OP NO: 209484.

NUMBER OF ABUTMENTS: 2.

BEFORE LASER THERAPY AMOUNT OF SENSITIVITY:

Visual Analogue Scale

Choose a Number from 0 to 10 That Best Describes Your Pain

No Pain — TEST — Distressing Pain — Unbearable Pain

0 1 2 3 4 5 6 7 8 9 10

CONTROL

ASK PATIENTS ABOUT THEIR PAIN

INTENSITY–LOCATION–ONSET–DURATION–VARIATION–QUALITY

AFTER LASER THERAPY AMOUNT OF SENSITIVITY:

Visual Analogue Scale

Choose a Number from 0 to 10 That Best Describes Your Pain

No Pain — TEST — Distressing Pain — Unbearable Pain

0 1 2 3 4 5 6 7 8 9 10

CONTROL

ASK PATIENTS ABOUT THEIR PAIN

INTENSITY–LOCATION–ONSET–DURATION–VARIATION–QUALITY

EVALUATION OF TEETH SENSITIVITY BY USING VISUAL ANALOGUE SCALE ON DAY SEVEN

Figure 8:

APPLICATION OF LOW LEVEL LASER THERAPY FOR VARIOUS PATIENTS

Table 1:
VISUAL ANALOGUE SCALE SCORES.

	Day 1				Day 3				Day 7			
	Before laser		after laser		before laser		After laser		Before laser		After laser	
S.No.	TEST	CONTROL	TEST	CONTROL	TEST	CONTROL	TEST	CONTROL	TEST	CONTROL	TEST	CONTROL
1	6	5	3	4	5	5	2	5	4	4	2	4
2	6	5	4	5	5	5	3	4	4	4	1	4
3	7	6	4	5	5	5	3	5	6	6	2	5
4	5	5	4	5	6	5	3	4	4	5	3	5
5	5	4	3	4	6	5	3	4	4	4	2	4
6	7	6	4	5	5	5	3	5	6	5	2	4
7	6	4	3	4	4	5	3	4	5	4	1	4
8	7	3	4	3	6	4	2	4	4	3	1	3
9	5	4	3	4	6	4	4	4	4	3	1	2
10	5	3	3	3	6	4	1	3	4	4	1	4
11	6	5	1	4	5	5	2	5	3	4	0	4
12	5	5	2	5	6	4	2	4	4	5	1	4
13	5	6	3	6	4	5	3	5	4	5	2	4
14	6	5	3	5	7	6	4	5	4	4	0	4

15	5	6	3	6	5	5	3	5	4	4	2	4
16	5	4	2	4	6	5	3	4	4	5	1	4
17	6	6	1	5	5	5	2	4	4	4	1	4
18	6	5	3	6	5	5	2	5	4	4	1	3
19	7	6	3	6	5	6	1	5	4	5	2	5
20	7	6	3	5	6	5	0	4	5	3	1	3
21	9	8	4	7	6	7	1	7	5	5	2	6
22	5	4	1	4	7	5	1	6	6	5	1	5
23	5	4	2	4	6	5	1	5	4	4	1	4
24	6	5	1	5	8	6	4	5	4	5	1	4
25	5	4	0	4	6	5	2	5	4	4	1	4
26	6	5	1	5	5	4	2	4	4	4	2	4
27	6	5	0	4	5	5	1	4	4	5	1	5
28	6	5	4	5	5	5	2	5	4	4	1	4
29	5	5	3	5	6	4	1	4	4	5	2	4
30	6	5	3	5	5	6	2	5	4	5	2	4

Table 2:
Descriptive Statistics

		Before Laser		After Laser	
		Test	Control	Test	Control
Day 1 Values	N	30	30	30	30
	Mean	5.87	4.97	2.60	4.73
	Std. Dev.	.937	1.033	1.221	.907
	Minimum	5.0	3.0	.0	3.0
	1st Quartile	5.0	4.0	2.0	4.0
	Median	6.0	5.0	3.0	5.0
	3rd Quartile	6.0	6.0	3.0	5.0
	Maximum	9.0	8.0	4.0	7.0
Day 3 Values	N	30	30	30	30
	Mean	5.57	5.00	2.20	4.60
	Std. Dev.	.858	.695	1.031	.770
	Minimum	4.0	4.0	.0	3.0
	1st Quartile	5.0	5.0	1.0	4.0
	Median	5.5	5.0	2.0	5.0
	3rd Quartile	6.0	5.0	3.0	5.0
	Maximum	8.0	7.0	4.0	7.0
Day 7 Values	N	30	30	30	30
	Mean	4.27	4.37	1.37	4.07
	Std. Dev.	.691	.718	.669	.740
	Minimum	3.0	3.0	.0	2.0
	1st Quartile	4.0	4.0	1.0	4.0
	Median	4.0	4.0	1.0	4.0
	3rd Quartile	4.0	5.0	2.0	4.0
	Maximum	6.0	6.0	3.0	6.0

Table 3:
Mann-Whitney Test to compare values between Groups

	Comparison Group	P-Value
Day 1: Before laser	Test vs Control	0.001
Day 1: After laser	Test vs Control	0.001
Day 3: Before laser	Test vs Control	0.006
Day 3: After laser	Test vs Control	0.001
Day 7: Before laser	Test vs Control	0.298
Day 7: After laser	Test vs Control	0.001

Table 4:
Wilcoxon Signed Ranks Test to compare values between Before and After laser

Group	Day	Comparison group	P-Value
Test	Day 1	Before vs After	<0.001
	Day 3	Before vs After	<0.001
	Day 7	Before vs After	<0.001
Control	Day 1	Before vs After	0.020
	Day 3	Before vs After	0.001
	Day 7	Before vs After	0.007

Table 5:
Friedman test for repeated measures to compare before laser values between 1, 3 and 7 Days

Group	Comparison group (Before laser)	P-Value
Test	Day 1 vs Day3 vs Day 7	<0.001
Control	Day 1 vs Day3 vs Day 7	0.001

Table 6:
Bonferroni adjusted Wilcoxon Signed Ranks test to compare values between pairwise time points

Group	Comparison group (Before laser)	P-Value
Test	Day 1 vs Day3	0.999
	Day 1 vs Day 7	<0.001
	Day3 vs Day 7	<0.001
Control	Day 1 vs Day3	0.999
	Day 1 vs Day 7	0.035
	Day3 vs Day 7	0.011

Table 7:
Friedman test for repeated measures to compare after laser values between 1, 3 and 7 Days

Group	Comparison group (After laser)	P-Value
Test	Day 1 vs Day3 vs Day 7	<0.001
Control	Day 1 vs Day3 vs Day 7	0.001

Table 8:
Bonferroni adjusted Wilcoxon Signed Ranks test to compare values between pairwise time points

Group	Comparison group (After laser)	P-Value
Test	Day 1 vs Day3	0.660
	Day 1 vs Day 7	<0.001
	Day3 vs Day 7	0.017
Control	Day 1 vs Day3	0.999
	Day 1 vs Day 7	0.007
	Day3 vs Day 7	0.051

Chart:1

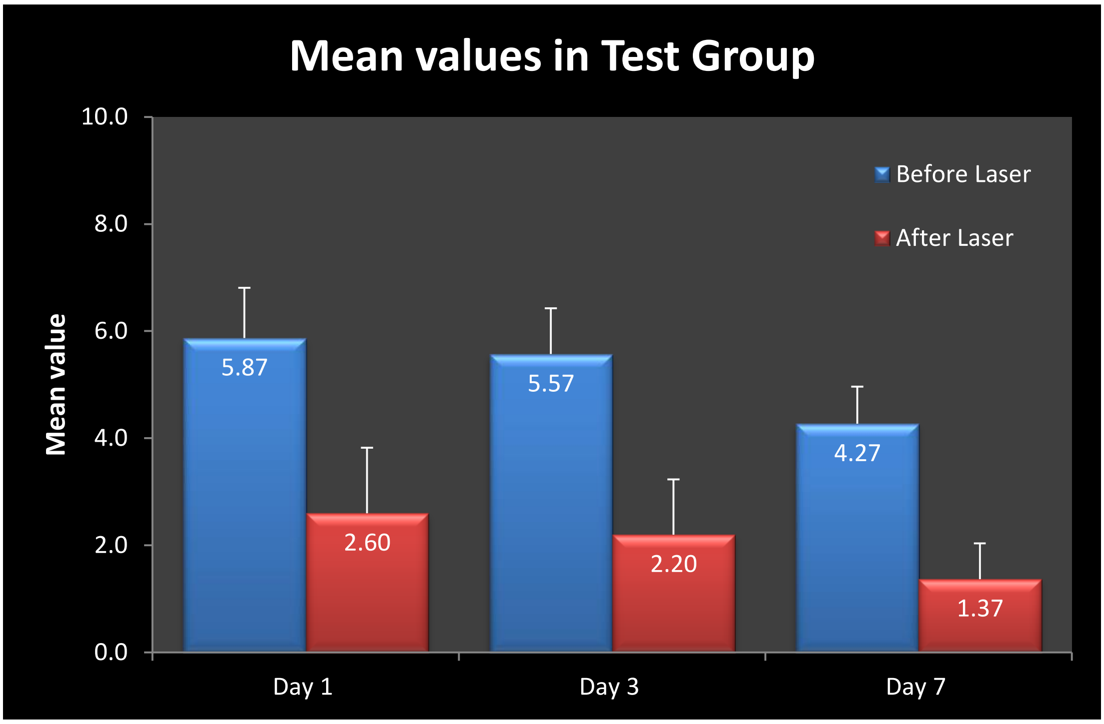


Chart: 2

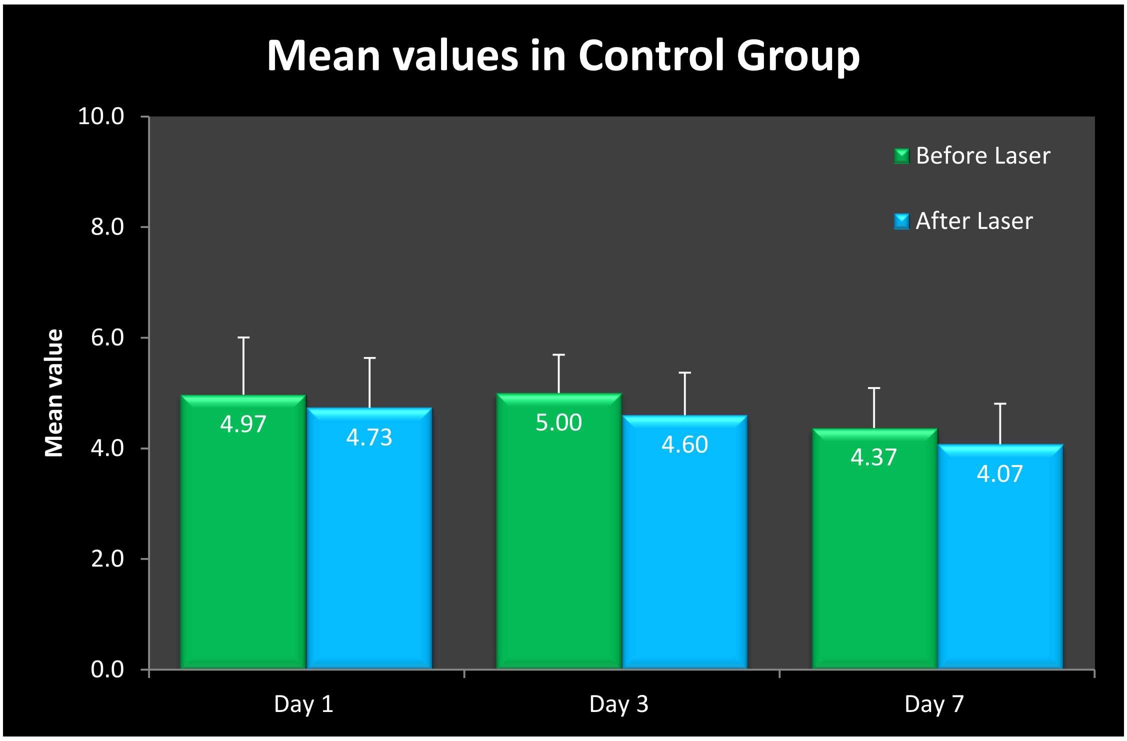
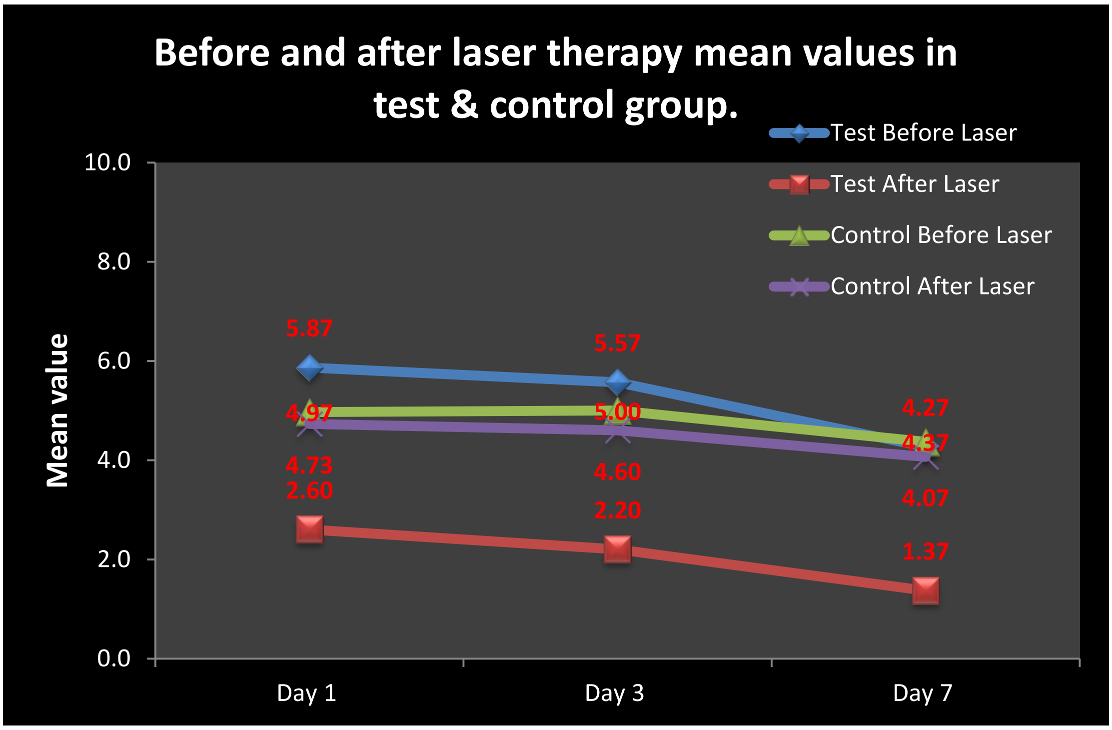


Chart: 3


Before and after laser therapy mean values in test & control group.
Test Before Laser
Test After Laser
Control Before Laser
Control After Laser
Mean value
10.0
8.0
6.0
4.0
2.0
0.0
5.87
5.57
4.27
4.97
5.00
4.37
4.73
4.60
4.07
2.60
2.20
1.37
Day 1
Day 3
Day 7

ANNEXURE

INSTITUTIONAL ETHICS COMMITTEE AND REVIEW BOARD

ADHIPARASAKTHI DENTAL COLLEGE AND HOSPITAL

Melmaruvathur, Tamilnadu-603019

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This ethical committee has undergone the research protocol submitted by **Dr. S.VINOTH KUMAR** Post Graduate Student, Department of prosthodontics under the title "**To assess the Effect of low level laser therapy on sensitivity of teeth prepared for fixed partial denture – A Randomized Control Trial",** Reference No: **2015-MD-BrI-VEN-03/APDCH** under the guidance of **DR. T. RAMAKRISHNAN**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:

CHAIR PERSON

- Inform IEC/IRB immediately in case of any issue(s) / adverse events.
- Inform IEC/IRB in case of any change of study procedure, site and investigator.
- Annual report to be submitted to IEC/IRB.
- Members of IEC/IRB have right to monitor the trial with prior intimation.