Sudan University of Science and Technology

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Effectiveness of Diode Laser (810nm and 980 nm) in Treatment of Dentine Hypersensitivity

فاعلية ليزر الدايود (810 و 980 نانو متر) في علاج حساسية الأسنان

A Dissertation Submitted in Partial Fulfillment of the Requirements of Degree of Higher Diploma in Laser Dentistry

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2022

Declaration

I would like to state, that the work only done is original and has not been submitted elsewhere.

Dedication

To

The soul of my father

To

My mother, for her constant support

To

My husband for his continuous encouragement

To

My sons for being so under standing

Sayda

March 2022

Acknowledgement

I would like express my deep thanks to my supervisor Dr. Alhadi Moheildin Awooda who had helped me and spended a lot of his precious time dealing with my thesis.

Also great thanks to my Co. supervisor Dr. Ali Abdel Rahman for his valuable comments.

Special appreciation to all patients who allowed to include them in this study.

I am grateful to the staff of the Laser Institute at Sudan University and my colleagues in the institute for their cooperation and efforts.

Great thanks to Dr. Eizzedin Mustafa for doing the statistical analysis for this study.

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Abstract

The successful treatment of dentine hypersensitivity was challenge due to difficult control of the causative factors. Treatment through conventional methods (using desensitizing agent} were not effective in all patients. Laser therapy was introduced as new treatment modality for dentine hypersensitivity.

This study aimed to evaluate the effectiveness of diode laser on treatment of dentine hypersensitivity.

A total of 35 teeth of 3voluntary male and female individuals (age from 30 - 60 years) The patients were all in a good health , and not under any medications for the last 72 hours preceding the treatment , and were not subjected to any periodontal surgery in the past 3 months. The severity of pain was recorded in analogous visual scale. Two different wavelengths (810nm and 980nm) diode laser was applied to a quadrant in a power 1 **watt** and 60 seconds exposure time. Comparison between different variables by **T** test with the level of significance set at **p=0.005**.

The results showed that there was significant decrease of sensitivity, a significance (**p<0.05**) on both wavelengths especially when **810 nm** was used immediately after exposure.

The diode laser (**810 nm** and **980 nm**) therapy was effective on treating dentine hypersensitivity. Decreasing wavelength led to decrease sensitivity.

مستخلص البحث

العلاج الناجح من فرط حساسية العاج يعتبر صعبا ، بسبب صعوبة السيطرة على العامل المسبب . العلاج من خلال الطريقة التقليدية (باستخدام عامل إزالة الحساسية) لم تكن فعالة في جميع المرضى . تم تقديم العلاج بالليزر كطريقة جديدة لعلاج حساسية العاج .

هدفت هذه الدراسة لتقييم فعالية الليزر اشباه الموصلات على علاج فرط حساسية العاج . عدد35 سن من3 أفراد (تتراوح أعمارهم بين30–60 سنة) جميعهم في حاله صحيه جيدة، وليسوا تحت تعاطي أي ادوية خلال الـ 72 ساعة الماضية التي سبقت العلاج ، ولم يخضع احد منهم لأي جراحة حول اللثة في الأشهر الثلاثة الماضية . تم تسجيل شدة الألم في مقياس بصري مماثل . واستخدم طوليين موجيين من ليزر اشباه الموصلات 810 نانومتر و 980 نانومتر بقدرة 1.0 واط ووقت التعرض 60 ثانية . تم تقسيم الأسنان إلى ربعين وتم تطبيق كل طول موجي على ربع الدائرة. المقارنة بين المتغيرات المختلفة تمت بواسطة T – test، مع مستوى الأهمية المحدد عند (0.00 = p). أظهرت النتائج وجود انخفاض معنوي في الحساسية، وكان هناك دلالة إحصائية عالية (p <0.05) على كل المجموعات خاصة عند استخدام 810 نانومتر مباشرة بعدالتعرض. كان العلاج بالليزر (810 و980 نانومتر) فعالاً في علاج فرط حساسية العاج، قلة الطول الموجي زادت من التأثير . ويفضل العلاج عن طريق ليزر ذو طول موجي 810 نانومتر.

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List of Abbreviations

CW	Continuous Wave
DH	Dentine Hypersensitivity
GA AL AS	Gallium Aluminum Arsenide
He-Ne	Helium-Neon
IR	Infra-red
Nd-YAG	Neodymium Yttrium Aluminum Garnet
UV	Ultraviolet
VAS	Visual Analogue Scale

CHAPTER ONE

INTRODUCTION & LITERATURE REVIEW

1.1 Introduction:-

The term dentine hypersensitivity (DH) has been used to describe a specific condition that is defined as pain arising from exposed dentine (Stephen Cohen et al 2002). Typically the pain in DH is brief, sharp, and well-localized in response to thermal, evaporative, tactile, osmotic, or chemical stimuli which cannot be reversed to any other form of dental defect or pathology (TrushKowsky et al 2011).

DH is probably a symptom complex, rather than disease and a persisting problem that affects as many as one of seven dental patients (Stephen Cohen et al 2002). .

Dentine hypersensitivity is a prevalent oral problem, affecting more than 40% of adults worldwide and more than 40 million people in the United States (Irwin C Ret al 1997).

Some studies have been reported prevalence levels as high as 68% (Smith WA et al 2008). The cervical area of teeth is the most common site of hypersensitivity (Robersont et al 2006).

Studies have reported that the premolars are most commonly affected by dentin hypersensitivity (Addy M et al 2000).

However another study found that mandibular incisors were most commonly affected and determined that most hypersensitivity areas were found on the facial surface of teeth (Chu CH et al 2008).

The aim of this study is to evaluate the effectiveness of two types of diode lasers, one with wavelength of 810 nm and the other with the wavelength 980 nm as dentin desensitizers as well as the immediate and late effects in adult individuals of different ages.

1.2 Justification:-

The immediate analgesic effect in the treatment of dentine hypersensitivity with diode laser was reported by Brugnera Junior et al 2002 with an improvement index of 91.29% in 1102 treated teeth operating in different bands of wavelength, 780nm and 890nm and different power densities.

1.3 Objectives:-

1.3.1 Main Objective:-

To evaluate the effectiveness of two types diode lasers, one with wavelength of 810nm and the other with the wavelength of 980nm as dentine desensitizers as well as the immediate and late effects in adult individuals of different ages.

1.3.2 Specific Objectives:-

1. To assess pain intensity and quality on the affected teeth using a visual analogue scale of pain (VAS).

2. To compare pain intensity and quality after using diode laser of waves length 810nm and 980 nm.

1.4 Literature Review

1.4.1 Laser:

The acronym LASER, constructed from Light Amplification by Stimulated Emission of Radiation (SILFVAST 2004).

1.4.2 Common Components of all Lasers

1. Active Medium:

May be: Solid crystals such as ruby or Nd: YAG, liquid such as dyes, gases like CO2 or Helium/Neon, semiconductors such as GaAs. Active mediums Contain atoms whose electrons may be excited to a met stable energy level by an energy source (SILFVAST 2004).

2. Excitation Mechanism:

Excitation mechanisms pump energy into the active medium by one or more of three basic methods; Optical, electrical, chemical (SILFVAST 2004).

3. High Reflectance Mirror:

A mirror which reflects essentially 100% of the laser light. Partially Transmitive Mirror: A mirror which reflects less than 100% of the laser light and transmits the remainder (SILFVAST 2004).

1.4.3LasingAction;

Energy is applied to a medium in order to raising electrons to an unstable energy level. These atoms spontaneously decay to a relatively long-lived, lower energy, met stable state. A population inversion is achieved when the majority of atoms have reached this met stable state. Lasing action occurs when an electron spontaneously returns to its ground state and produces a photon. If the energy from this photon is of the precise wavelength, it will stimulate the production of another photon of the same wavelength and resulting in a cascading effect. The highly reflective mirror and partially reflective mirror continue the reaction by directing photons back through the medium along the long axis of the laser. The partially reflective mirror allows the transmission of a small amount of coherent radiation that we observe as the “beam”. Laser radiation will continue as long as energy is applied to the lasing medium (SILFVAST 2004).

Spontaneous emission and stimulated emission:

An excited electron may give off a photon and decay to the ground state by two processes: Stimulated emission: the excited atoms interact with a pre-existing photon that passes by. If the incoming photon has the right energy, it induces the electron to decay and gives off a new photon. Ex. Laser.

Spontaneous emission: Photons emitted in all directions and on a random time scale. The emitted photons are incoherent like neon light, light bulb (SILFVAST 2004).

1.4.4 Laser Properties:

The light emitted from laser is:

1. Monochromatic, that is, it is of one color/wavelength.

2. Directional, that is, laser light is emitted as a relatively narrow beam in a specific direction.

3. Coherent, which means that the wavelengths of the laser light are in phase in space and time.

4. High intensity: which can be defined as the number of photons emitted per unit surface area per unit solid angle. Even lasers with low intensity, compared with other lasers, are intense more than the sun light. This property is due to huge number of coherent photons emitted with very small angle (little divergence)(SILFVAST 2004).

1.4.5 Types of laser:

Lasers may be classified according to the type of active medium, excitation mechanism, and region of emitted wavelength or mode of operation. According to the active medium, lasers are classified to: solid, gas, liquid and semiconductor lasers. According to the spectral region of the emitted laser, the classification is: UV, visible and I.R. lasers.

Based on the mode of operation lasers are classified to : continuous wave (CW), chopped, pulsed and ultra-short pulsed lasers (SILFVAST 2004) According to the active medium lasers are classified as:

I. Solid State Lasers:

lasers contains solid crystalline or glass material as an active medium, this lasers sometimes called doped lasers because this lasers are available in combination of hosts and dopant material.

The commonly used host materials are:

Yttrium aluminum garnet (YAG) is the crystal host for Nd: YAG lasers. Glass is also used as a host for neodymium lasers. Crystal like Sapphire, tungsten oxide. The do pant material these materials dispersed in the host to act as active centers, examples for doped materials are: the ions of chromium, neodymium and erbium. The basic arrangement and principle of all solid state laser systems is same these systems use a laser rod placed closed to an optical pump source to focus light in to the rod. These lasers get excessively heated and to control the heat, the system is provided with a coolant. Advantage of Solid Laser can produce high power pulse lasers. The energy in these laser can be trapped for a longer time as the lifetime of the atoms at the met stable state is longer.

Also these lasers (four levels) can be used for CW power operation as the active density of ion is large. The types of lasers which fall in this category are: Ruby laser .Nd-YAG, Nd-Glass, Alexandrite and titanium sapphire laser (SILFVAST 2004).

II. Gas lasers:

In gas laser the active material used is a gas at low pressure, which can be excited either by electrical discharge or by optical pumping, may be operated in either CW or pulsed modes.

The gas lasers are classified into three groups:

1-Atomic or neutral atom lasers: He –Ne, He-Cd, copper vapor and gold vapor.
2-Ionic lasers: Argon ion, Krypton ion laser.

3-Molecular gas lasers: CO_2, N_2, Excimer lasers (SILFVAST 2004)

III. Liquid Lasers:

The active medium used is organic dye dissolved in a liquid solvent (alcohol), can be pumped optically by a laser or by a flash lamp and used elliptical reflectors The dye lasers are tunable up to large wavelengths. Desired wavelength at the output can be extracted by using wavelength selector switches like diffraction grating in the cavity. It is easy to change the active medium for desired application. The cooling is simple as the flowing liquid takes heat along with it. The dye lasers become popular because it is cheap and simple. Have very short pulses.

Disadvantage:

The excitation by other laser makes the system little complicated Dye used toxic material, They have short life time and needs early replacement The application Due to the fluorescence characteristic, dye laser is useful in diagnostic spectroscopy, kill tumor, destroy kidney stones and for photodynamic therapy (SILFVAST 2004).

IV. Semiconductor (Diode) Lasers:

These lasers are the most common lasers .The semiconductor laser have long life and high efficiency and require low power for operation. It is so tiny. A semiconductor is a material which has electrical Properties in between those of conductor and insulators The active medium of a semiconductor laser is the junction between two types of semiconductor materials; Gallium arsenide (GaAs) is an example of a material used in the manufacture of a semiconductor laser Current flow across the junction is the excitation mechanism. In semiconductors, there are two energy levels (bands), conduction band and valence band The population inversion or lasing is occur when the population of the electrons in the conduction band increases over the population of the electron in the valence band to create this situation a doped semiconductors are used A doped semiconductors is one in which trivalent (P- type) or pentavalent (ntype) impurity is added for extra energy levels to the semi-conductors (SILFVAST).

Delivery systems:

Free beam, articulated arm, and optical fibers (SILFVAST 2004)

1.4.6 Dentin hypersensitivity mechanism:

Theories about the transmission of pain stimuli in DH suggest that pain is amplified when the dentinal tubules are open to the oral cavity (Roberson et al 2006).

Many theories have been used to explain the mechanisms of DH. The most widely accepted theory is classic―hydrodynamic mechanism proposed by Brännström and Astron et al 1967 .

In this mechanism, sudden movements of fluid in the dentinal tubules are believed to deform mechanosensitive nerve fibers close to the odontoblastic layer (Stephen Cohen et al 2002).

A variety of stimuli can result in pressure change traverse the dentin, resulting in stimulation of interdental nerves (Trushkowsky et al 2011). Dentin Hypersensitivity is the result of activation of A-δ nerve fibers located in the dentinal tubules (Stephen Cohen et al 2002). A-δ fibers are probably activated by the hydrodynamic mechanism. Therefore, their activation is directly associated to the presence of opened or occluded tubules. 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 (Narhi M et al 1992).

An early hypothesis was the dentinal receptor mechanism theory, which suggests that DH is caused by the direct stimulation of sensory nerve endings in dentine (Irvin JH et al 1988). The odontoblastic processes mechanism proposed by Rapp et al. suggested that odontoblasts act as receptor cells, mediating changes in the membrane potential of the odontoblasts via synaptic junctions with nerves (Rapp Ret al, 1968).

The sensitivity of dentin has a direct correlation with the size and patency of the dentinal tubules. Absi and colleagues discovered that hypersensitive teeth have an increased number of patent tubules and wider tubules than those of non-sensitive teeth (Absi et al, 1987).

1.4.7 Etiology and Predisposing Factors of DH:

The relationship between DH and the patency of dentin tubules in vivo has been established, and the occlusion of the tubules seems to decrease that sensitivity (Roberson et al, 2005).

There are many varieties of potential causes for dentin sensitivity.

The loss of enamel and removal of cementum from the root with Exposure of dentin, however, is a major contributing factor (Trush kosky et al, 2011).

Enamel loss is usually due to a combination of two or more of these factors:

1-Attrition: is mechanical wear of the incisal or occlusal surface usually associated with occlusal functions 2,5.Attrition also includes proximal contact area because of physiologic tooth movement (Roberson et al, 2005).

Excessive or Para functional habits, such as bruxism, may result in extreme pathologic wear and increased sensitivity (Trush kosky et al, 2011).

2-Abrasion: is abnormal tooth surface loss resulting from direct friction forces between the teeth and the external objects; or from frictional forces between contacting teeth components in the presence of an abrasive medium. Toothbrush abrasion is the most common example which is usually seen as a sharp, V-shaped notch in the gingival portion of the facial aspect of the tooth (Roberson et al, 2005).

Tooth brushing by itself, however, has minimal effect on enamel and even with toothpaste the effect is minimal on both enamel and dentin. The combination of tooth brushing and erosive agents results in loss of tooth structure (Trush kosky et al, 2011).

3-Erosion: is the wear or loss of tooth surface by chemico-mechanical action (Roberson et al, 2005).

Exposure to non-bacterial acids in the diet, chemical products, medication, drugs or endogenous acids from reflux or regurgitation of stomach acid; that is, substances with low pH lead to the loss of dental structure by chemical dissolution. Moreover, this process can be associated with abrasion, particularly in the cases of an acidic diet or gastric reflux associated with brushing performed immediately after these processes (Portol et al, 2009).

4-Abfraction: May be a predisposing factor to DH (Portol et al, 2009). It has been proposed that the predominant causative factor of some cervical, wedge-shaped defects is a heavy eccentric occlusal force resulting in microfractures or abfractures. Such microfractures occur as the cervical area of the tooth flexes under such loads (Roberson et al, 2005).

Such fractures can cause the exposure of coronal dentin, and in more severe cases, coronal and root dentin (Portol et al, 2009).

5-Gingival recession: DH can be a major problem for periodontal patients, who frequently have gingival recession and exposed root surfaces (Roberson et al, 2005).

Abrasion also can cause gingival recession and as a result of the recession, the softer root surface is exposed. Exposed root surfaces could be also due to root prominence and thin overlying mucosa, dehiscences and fenestrations, frenum pulls, orthodontic movement, which causes a root to be moved outside its alveolar housing (Trush kosky et al, 2011).

5-Physiological Causes: As age advances the number of teeth with root exposure is increased; results in root exposure, which may lead to DH (Portol et al, 2009).

6-Bleaching: Post-dental bleaching sensitivity is a major adverse effect of vital tooth bleaching mainly attributed to the penetration of the bleaching agent into the pulp chamber and it reflects reversible pulpitis (Portol et al, 2009).

7-Periodontal Treatment: has been associated with DH due to the exposure of dentinal tubules after the removal of supra and/or subgingival calculi. Another factor is the removal of dental cementum which covers the root or the root dentin itself during periodontal scraping (Portol et al, 2009).

1.4.8 Diagnosis of DH:

There are many DH studies. Nevertheless, most dental professionals are confused about the diagnosis, etiology and mechanisms of DH (Portol et al, 2009). A good clinical history, clinical and radiographic examination and questions asked by the professional are essential to conclude a definitive diagnosis of DH.

Items which must be considered are: the pain (sharp, dull, or throbbing); how many teeth and their location; which part of the tooth elicits the pain; and the intensity of the pain (Trush kosky et al, 2011). When symptoms are associated with exposed dentin, the diagnosis is DH. However when there is a specific etiologic factor causing the sensitivity, such as caries, fractures, leaking restorations, or recent restorative treatment, teeth with vital pulps may exhibit symptoms that are identical to DH. The definitive diagnosis is more difficult when clinical causes of reversible pulpitis are present in combination with exposed dentin. Hypersensitive teeth and inflamed pulps in many ways present the same symptoms (such as sensitivity to cold, air and heat) (1). Pulpal pain is usually more prolonged, dull, aching, and poorly localized and usually lasts longer than the applied stimulus (Trush kosky et al, 2011).

1.4.9 Treatment—Self-Applied and Office Supplied Dentin hypersensitivity is a common clinical condition that is difficult to treat because the treatment outcome is not consistently successful (Roberson et al, 2005).

Current techniques for treatment may be only transient in nature and results are not always predictable (Trush kosky et al, 2011).

According to Grossman an ideal treatment for DH must act fast, be effective for long periods, be easy to apply, not irritate the pulp, not cause pain, not stain the teeth and be constantly effective (Gross man et al, 1935). Two chief methods of treatment of dentin hypersensitivity are tubular occlusion and blockage of nerve activity (Trush kosky et al, 2011).

Clinicians have used many materials and techniques to treat DH; including specific dentifrices (containing agents like calcium phosphate, potassium nitrate and oxalates), laser irradiation, dentin adhesives, antibacterial agents, resin suspensions (glass ionomercement,), fluoride rinses and fluoride varnishes, dentinal adhesives, periodontal membranes ((Roberson et al, 2005), (Portol et al, 2009)). Desensitizing agents have been classified according to their mode of action or by their mode of administration. But it is difficult to classify them by their mode of action, because in the case of some substances, their desensitizing action has not yet been well explained. It is perhaps easier to classify them by their mode of administration: at home or professional (Portol et al, 2009). Self applied treatments to reduce sensitivity consist of materials that occlude dentinal tubules, coagulate or precipitate tubular fluids, encourage secondary dentin formation, or obstruct pulpal neural response (Trush kosky et al, 2011).

After observing the severity and number of teeth involved, an active approach to DH can begin in the cases of generalized DH, by a home method followed by in-office treatment when the first option is not successful (Portol et al, 2009).

1.4.10 Laser Treatment in Dentin Hypersensitivity:

Laser therapy was first introduced as a potential method for treating dentinal hypersensitivity in 1985 (Mastumoto et al, 1985). Since then, many studies have been done on laser applications for dentine hypersensitivity treatment and much information has been gathered. Compared with conventional approaches, in-office DH laser treatment has some disadvantages (ie, high cost, complexity of use, decreasing effectiveness over time, etc) that limit its clinical utility (Orchandanson et al, 2006). In addition, the efficacy and mechanism of action of laser treatment for DH therapy are very controversial (Sogolarata et al, 2011). The possibility of a placebo effect must be taken into consideration, especially as patient reports were positive immediately after laser treatment (Kimura et al, 2000). According to a systematic review which was done by Sgolastra et al. laser therapy can reduce DH-related pain, but the evidence for its effectiveness is weak, and the possibility of a placebo effect must be considered (Sogolarata et al, 2011).

This effect consists of a complex mixture of physiologic and psychological

interactions, depending considerably on the doctorpatient relationship, with both parties needing to believe that the treatment is valuable and desiring to obtain relief of symptoms. On the other hand, since the mechanisms involved are multiple and unclear, questions arise regarding reproducibility and safety of this technique (Kimura et al, 2000). Studies have addressed the safety of using laser for treating DH, with some authors specifically analyzing the possibility of laserinduced pulp damage. One such study found that if the temperature increase within the pulp remains below 5°C, then no pulp damage is evident. This hermal threshold is generally not exceeded when the energy and power settings of the laser remain within reported ranges (Kimura et al, 2000).A systematic review of the literature which surveyed the effectiveness of laser therapy and topical desensitizing agents in treating dentine hypersensitivity (done by HE et al.), indicates the likelihood that laser therapy has a slight clinical advantage over
topical medicaments in the treatment of dentine hypersensitivity (HES et al, 2011). And finally, according to some studies, laser treatment seems to be transient, however, and the sensitivity returns in time (Orchandanson et al, 1994). The mechanism of recurrence is unknown. As laser effects are considered to be due to the effects of sealing of dentinal tubules, nerve analgesia or placebo effect. The sealing effect is considered to be durable, whereas nerve analgesia or a placebo effect is not (Grag et al, 2007).

1.4.11 Mechanism of Laser Treatment:

The mechanisms involved in laser treatment of dentine hypersensitivity are relatively unknown (Kimura et al, 2000). The laser, by interacting with the tissue, causes different tissue reactions, according to its active medium, wavelength and power density and to the optical properties of the target tissue (Garvis et al, 1990). In order for a laser to actually alter the dentin surface, it has to melt and resolidify the surface. This effectively closes the dentinal tubules. This does not occur. It is felt that laser treatment reduces sensitivity by coagulation of protein without altering the surface of the dentin (Trush kosky et al, 2011). Pashley (Orchandanson et al, 1994) suggests that it may occur through coagulation and protein precipitation of the plasma in the dentinal fluid or by alteration of the nerve fiber activity. The study by McCarthy et al. indicates that the reduction in DH could be the result of alteration of the root dentinal surface, physically occluding the dentinal tubules (Mc carthy et al, 1997).

According to Myers & McDaniel's study laser energy interferes with the sodium pump mechanism, changes the cell membrane permeability and/or temporarily alters the endings of the sensory axons (Kimura et al, 2000). The immediate analgesic effect in the treatment of dentine hypersensitivity with diode laser was reported by Brugnera Júnior et al. Based on this study the laser interaction with the dental pulp causes a photobiomodulating effect, increasing the cellular metabolic activity of the odontoblasts and obliterating the dentinal tubules with the intensification of tertiary dentine production (Brugnera et al, 2001).

Effectiveness of Various Laser Types in the Treatment of DH:

The lasers used for the treatment of dentine hypersensitivity are divided into two groups:

1- Low output power (low-level) lasers [(He- Ne) heliumneon and (GaAlAs) gallium-aluminumarsenide (diode) lasers]

2- Middle output power (Carbon Dioxide Laser (CO), neodymium- or erbium-doped yttriumaluminum garnet

(Nd:YAG, Er:YAG lasers) and erbium, chromium doped:

yttrium, scandium, gallium and garnet (Er,Cr:YSGG) lasers) (Kimura et al, 2000,Matsnmoto et al, 2007).

Desensitization seems to depend mostly on the type of laser therap adopted (Aranha et al, 2012). The mechanism causing a reduction in hypersensitivity is most unknown but is thought that the mechanism for each laser is different.

In case of low output power lasers, a small fraction of the lasers energy is transmitted through enamel or dentin to reach the pulp tissue (Grag et al, 2007).

Low-power laser therapy is an appropriate treatment strategy to promote biomodulatory effects, minimize pain and reduce inflammatory processes. Its use has been widely accepted and approved due to satisfactory results reported in the literature. In contrast, the effects of high-power lasers, such as the carbon dioxide, Nd:YAG, Er:YAG and Er,Cr:YSGG lasers, are related to an increase in surface temperature which can result in the complete closure of dentinal tubules after recrystallization of the dentinal surface (Aranha et al, 2012).

Low Output Power Lasers:

1-He-Ne laser: The first use of He-Ne laser for the treatment of dentine hypersensitivity was reported by (Senda et al, 1985), then, consecutively by several other investigators (Gomi A et al, 1986). Irradiation modes were two types: pulsed (5 Hz only) and continuous wave (CW) mode. The laser tip has to be placed as close as possible to the tooth surface in noncontact mode. The mechanism involved is mostly unknown. According to physiological experiments, He-Ne laser irradiation does not affect peripheral A-delta or C-fibernociceptors, but does affect electric activity. Treatment effectiveness rates of He-Ne laser ranges from 5.2%– 100% based on different studies (Kimura et al 2000, Mastumto et al 1994, Ladalardo et al, 2004).

2-GaAlAs laser: The first use of this laser in dentin hypersensitivity treatment was reported by Matsumoto et al. and later by others (Matsumoto et al, 1985). Three wavelengths (780, 830, and 900 nm) of GaAlAs have been used for the treatment of dentine hypersensitivity (Kimura et al, 2000). The laser tip has to be placed as close as possible to the tooth surface in noncontact mode. It is assumed that this type of low output power lasers mediates an analgesic effect related to depressed nerve transmission. According to physiological experiments using the GaAlAs laser at 830 nm, this effect is caused by blocking the depolarization of C-fiber afferents (Kimura et al 2000.Mastumoto etal,1994, Ladalardo et al, 2004). Treatment effectiveness rates range from 53.3%–94.2% for the GaAlAs laser at 1-month follow-up (Kimura et al 2000)

A clinical study was done in the treatment of dentine hypersensitivity by diode laser by Remeo Umberto and others(Remeo U et al, 2012).It assessed the efficacy of diode GaAlAs laser alone and in combination with a topical sodium fluoride gel (NaF) in the treatment of DH in order to evaluate the possibility of this device in the management of this pain full condition. Effect of the application of the diode laser (810nm) in the treatment of dentine hypersensitivity is study done by Nada Tawfig and others (Nada T et al, 2014) it assessed the effect of diode laser (810nm) with different exposure duration, in the treatment of dentine hypersensitivity. The results show significant reduction of pain after 15 minutes of laser application in the group with 30 seconds exposure duration (p=.001), and the pain completely fade away after one week in the same group ,while in the group with 1 minute exposure duration the pain completely disappeared(visual analogue scale =(0) after 15 minutes and one week of laser application(p=0.001) (Nada T et al, 2014) .

CHAPTER TWO

MATERIALS AND METHODS

2. Materials and Methods:-

2.1 Study Design:

Randomized clinical trial.

2.2 Study Area:-

Clinic of Laser Institute/ University Of Science and Technology.

2.3 study duration

The study was carried out in the period from 1st to 31st of march 2022.

2.4 Study Population:-

Patient with dentine hypersensitivity of both sexes age between 30- 60 years.

2.4.1 Inclusion Criteria:-

- Pt diagnose with dentine hypersensitivity evaluated by VAS.
- Age range 30-60 years.
- Both sexes male and female.
- Absence of active periodontal disease.
- Absence of per apical pathology.

2.4.2 Exclusion Criteria:-

- Teeth with carious lesion.
- Chronic debilitating disease with daily pain episodes.
- Use of analgesic, sedative, tranquilizing or anti-inflammatory mediators in the 72 hr. preceding treatment.

- Pt subjected to periodontal surgery in last 6 months.

2.5 Sample Size:-

A total of 35 teeth from 3 patients aged from 30-60 years with diagnosis of dentine hypersensitivity.

2.6 Sampling Technique:-

Purposeful (all subjects who was satisfied in the inclusion criteria that were present at the study area during the period of data collection were included in the study).

Methods:

2.7 Subject Selection:-

Patient of both sexes, aged between 30-60 years, were selected. The patients were selected according to the inclusion criteria. The study was explained to patients and was requested to participate in the study voluntary, those who accepted to participate vountory were signed informed written consent.

2.8 Pain Assessment:-

The degree 0f dentine hypersensitivity was evaluated by visual analogue scale (VAS) Consisting of a marked horizontal line from 0 cm (no pain) to 10 cm (worst pain) .Dentine hypersensitivity was stimulated by both air and touching the dental cervix with the tip of the probe, with mesial-distal directionality .All patients were asked to assess their level of dentine hypersensitivity using the VAS scale of 0 to 10, where 0 represents "no pain" and 10 represents "greatest pain" .After initial sensitivity was assessed and recorded ,laser therapy was initiated (Breivik.H, 2008).

Except the waves length the irradiation parameters were identical, one 810 nm and other 980 nm .The power was one watt continuous emission form. The exposure time was 60 seconds .The application with non-contact mode on the region of exposed dentine. The evaluation was performed at the following times: before laser application, immediately after laser application, and one week after laser application.

The applied laser device was QUICK LASE DIODE LASER (810+980nm) with power 0.1 to 12.0 watt. class IV).

2.9 Data analysis:-

Data were analyzed by SPSS version 25

From Chicago USA

Comparison between different parametric data was done by T. test (paired -samples T test) with the level of significance set at P value of less than 0.05.

2.10 Ethical Consideration:-

Approval letter from the Ethical committee of university of Sudan was obtained prior to the condition of the study.

The aim and the methods of the study were explained verbally to the Participants approval and written consent was obtained.

CHAPTER THREE

RESULTS

Table (1): comparison between treatments in both groups treated with (810 nm) and (980 nm) lasers.

Paired Samples Test

	Mean	Std. Deviation	T	df	Sig. (2-tailed)
810 nm and 980 nm treatments results	-.647	1.222	-2.184	16	0.04

Table (2): Comparing the means of the responses in the treatments of the 2 waves length diode laser groups.

Paired Samples Statistics

	N	Mean	Std. Deviation	Std. Error Mean
810 nm treatment results	17	1.18	0.393	0.095
980 nm treatment results	17	1.82	1.286	0.312

Table (3): Comparison of (810 nm) laser results before treatment and (810 nm) laser results after treatment after one week

	N	Mean	Standard Deviation	Minimum	Maximum
nm 810 laser results before treatment after one week	4	1.75	0.500	1	2
nm 810 laser results after treatment after one week	4	1	.000	1	1

Table (4): Comparison of (980 nm) laser results before treatment and (980 nm) laser results after treatment after one week

	N	Mean	Standard Deviation	Minimum	Maximum
980 nm laser results before treatment after one week	6	2.33	0.516	2	3
980 nm laser results after treatment after one week	6	1	.000	1	1

CHAPTER FOUR

DISCUSSION, CONCLUSION AND RECOMMENDATION

4.1 Discussion:

Although several types of treatments for dentine hypersensitivity have been demonstrated in the literature , there is no treatment that reduces pain to satisfactory levels. Pain resulting from dentine hypersensitivity can be eliminated by interruption of stimuli transmission to the nerve endings of odontoblast processes which can be accomplished by reducing the fluid movement inside the dentinal canalicules, by narrowing or occlusion of tubules openings (Bra'nnstro' et al 1984). However, other treatment modalities have been proposed, such as laser therapy.

The aim of the present study was to assess the efficacy of diode laser in treatment of dentine hypersensitivity. To achieve this aim two different laser waves length (810 nm and 980 nm) were used. The results supported the efficacy of both laser waves length (810 nm and 980 nm) uses in the reduction of dentine hypersensitivity. Furthermore, the diode laser of wavelength 810 nm showed better results immediately after treatment. However, this progress did not in the same pace in the after one week follow up and the results were approximately similar. The result of the present study corroborates the finding of a number of studies reporting effectiveness of diode laser in treatment of dentine hypersensitivity .The rapid desensitizing effect of laser therapy observed in the conducted research may be attributed to a mechanism through which diode laser can induce changes in neural transmission network within the pulp (depressed never transmission), rather than the alteration in the exposed dentine surface, as observed with other treatment modalities. In addition, laser therapy may stimulate the normal physiological cellular functions. Therefore, the laser would stimulate the production of sclerotic dentine, thus promoting the internal obliteration of dentinal tubules (Corona SAM et al 2003) and this suggestion is reinforced by the histological analysis of dental pulps in teeth carried out by Matsumoto (Matsumoto Ket al 1985). The laser irradiation contributed to the repair of dentine –pulp complex, preserving the pulpal vitality**.**

Reviewed literature show that the ideal treatment for DH does not exist, even in case of combination of different protocols.

Conventional therapies for the treatment of DH comprehend the topical use of desensitizing agents .Either professionally or at home such as protein precipitants Gangrosa et al1994(),tubule –occluding agents((Kems et al 1991,Ikemora et al 1991).tubule sealants Wichgers et al 1996(),and .recently .lasers (Moritz et al 1996,Zhang et al 1998,Watanable H et al 2003) .().

Several studies (Kumar et al 2005. Pesvesca et al 2010) describe synergistic action of lasers in association with desensitizing agents. In fact, the laser system can favor the permanence of the desensitizer for longer time than when they are used alone. For this reason, if laser device is used in addition to a conventional desensitizing agent, the latter remains above the tooth surface for 60 seconds before the irradiation.

Focusing on the effectiveness of the sole diode laser ,this was investigated by several authors . (Matsuto et al, 1985). Showed an 85% improvement in teeth treated with laser ; (Aun et al, 1989). reported success in laser –irradiated teeth in 98% of their cases ; (Yamaguchi et al, 1990), noticed an effective improvement index of 60% in the group treated with laser compared to the 22.2 % of the control non lased group ; (Kumazaki et al, 1990), showed an improvement of 69.2 % in the croup treated with laser compared to 20% in the placebo group.

This study agree with study done by Thereza et al which evaluated the effectiveness of two types of lasers (660 nm wavelength red, and 830 nm wavelength infrared) as dentine desensitizers, as well as both the immediate and late therapeutic effects in individuals 25 to 45 years of age. A total of 40 teeth with cervical exposure were treated in 4 sessions. They were divided into 2 groups according to treatment. A 660 nm wavelength red diode laser and an 830 nm wavelength infrared diode laser were used. Dentine sensitivity to cold nociceptive stimulus was evaluated by means of a pain numeric scale from zero to 10 before each treatment session, at 15 and 30 min after irradiation, and in a follow-up period of 15, 30 and 60 days after the end of treatment. Significant levels of dentinal desensitization were only found in patients ranging in age from 25 to 35 years. The 660 nm red diode laser was more effective than the 830 nm infrared laser and a higher level of desensitization was observed at the 15 and 30minute post-irradiation examinations. The immediate and late therapeutic effects of the 660 nm red diode laser were more evident in 25-35-year-old patients compared with those of the 830 nm infrared diode laser, in terms of the different age groups.

In this conducted research, it was observed that teeth, which presented exacerbated sharp pain during air blasting and tactile touch with dental instrument and continuous discomfort after the removal of these stimulation before desensitizing treatments were accomplished, showed an accentuated decrease of painful sensation immediately after 1 first application of diode laser (810nm and 980 nm) and even one week after initial irradiation. The rapid desensitizing effect of laser therapy observed in the conducted esearch may be attributed to a mechanism through which diode laser can induce changes in neural transmission networks within the pulp (depressed nerve transmission), rather than alterations in the exposed dentine surface, as observed with other treatment modalities (Walsh et al 1997). In addition laser therapy may stimulate the normal physiological cellular functions. Therefore, the laser would stimulate the production of sclerotic dentine, thus promoting the internal obliteration of dentinal tubules (Corona SAM et al 2003) and this suggestion is reinforced by the histological analyses of dental pulps in teeth carried out by (Matsumoto et al 1985) the study showed a better degree of repair at 14 and 30 days after laser irradiation when compared with the non-irradiated dental pulp group.

4.2 Conclusion:

Based on the results obtained in the treatment of 35 teeth with cervical dentine hypersensitivity we concluded that:

- Diode laser (810 nm and 980 nm) provided a decrease in dentine hypersensitivity.
- The therapeutic immediate effects of the diode laser810 nm were greater than those of 980 nm.

4.3 Recommendation:

1-There is a need for a more systematic approach to the clinical management of dentine hypersensitivity, particularly in determining the long-term effect of the currently available desensitizing agents.

2-Further studies with adequate sample sizes are required.

3-For more effective treatment, further investigation is required to increase the understanding of the mechanisms and etiology of dentinal pain.

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Appndix

Appndix 1: Pt consent

جامعة السودان للعلوم والتكنولوجيا

كلية الدراسات العليا

السلام عليكم ورحمة الله وبركاته

إقرار مريض

تقوم الدكتورة/ **سيدة عبد المعروف الماحي بشير** بإجراء بحثاً علمياً لدراسة فعالية ليزر أشباه الموصلات (diode laser) في علاج فرط حساسية العاج (dentine hypersensitivity) .

وإسهاماً منكم في دعم البحوث العلمية نرجو من سيادتكم التكرم بالموافقة على المشاركة في هذا البحث علماً بأن بيانات البحث تشمل كشف سريري للأسنان مع إستخدام ليزر أشباه الموصلات للمعالجة.

وليس هناك أي آثار جانبية مترتبة على ذلك كما تضمن لك سرية المعلومات وعدم إستخدامها لأي غرض آخر.

ولكم فائق الشكر والتقدير

التوقيع

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