TITLE: UNDERSTANDING AND EFFICACY OF CONVENTIONAL LASER SYSTEMS AND WATERLASE LASER SYSTEM IN DENTAL PRACTICE

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Abstract-
Introduction: The Waterlase ™ is a revolutionary tool for dentists which is a unique combination of laser energy and water, a process called Hydro Photonics™, to perform many traditional dental procedures with less need of anesthesia. Since the Waterlase laser cuts hard and soft tissue without heat, vibration or pressure, the dentist may be able to perform the procedure without anaesthesia.

Materials and methods: The questionnaire based cross sectional study was carried out in different dental practitioners in Pune city. The sampling technique used was convinience sampling. Multiple choice based questionnaire with 3-5 options was developed and used for assessment of understanding and efficacy and; awareness and practice regarding conventional lasers and waterlase lasers among dentists.

Result: A statistical significant difference in mean scores was observed in all three domains when compared against the demographic variables (p<0.05). [Table 3] Correlation analysis revealed that there was statistically significant association between the three variables among study subjects.


INTRODUCTION:
The diseases of the periodontium comprise of a group of inflammatory diseases. It is commenced by microbes that colonize the teeth and spread infection. Earlier, the local factors causing periodontal diseases were eliminated by the hand instruments and ultrasonic scaler1.

However, calculus and debris exertion using hand scaling method has been considered to be inadequate and resulting for enhancement the use-fullness and efficacy of debridement of the root surface calculus, different devices have been tried such scalers both ultrasonic and only sonic. Recently lasers also have been used for the same.2

History in 1917, Albert Einstein laid the foundation for the invention of the laser and its prior versions, ‘The Maser,’ by theorizing that photoelectric amplification effects could emit a single frequency, or stimulated emission. The term laser was first introduced to the public in 1959, in an article by a Columbia university graduate student, Gordon Gould.3 Theodore Maimane, at the Hughes research laboratories in Malibu, ca, built the first functioning laser, by using a helium and neon. A laser consists of a grain media, a mechanism to energize it, and something to provide optical feedback to it. The grain medium is a material with unique properties that allows the amplification light by way of stimulated emission. Light of a specific wavelength that passes through the grain medium is amplified (power increases).

Laser: is the acronym for “light amplification by stimulated emission of radiation”.

The heat released by the laser devices aids in conversion the electromagnetic energy into thermal energy. The laser follows the principle first given in 1917 by Albert Einstein –“proposed that light consists of mass-less particles known as photons”. The energy of the photons corresponds to the wave’s frequency modulation. Charles Townes and co-workers first demonstrated the action of laser in the microwave region of research.

Three factors are needed in the characteristics of the laser emitting device:
1. Composition of the laser medium,
2. Energy source, and
3. Design of the resonating chamber

Laser classification:
A) Based on different range of wavelengths:
1. The ultraviolet spectrum i.e. 100- 400 nm
2. The visible spectrum i.e. 400-700 nm
3. The infra-red spectrum i.e. 700 nm to the microwave spectrum

B) Depending on the extent of action lasers, they can be of classified into two types:
(i) Deep penetrating ones
(ii) Superficially absorbed ones.
Effect of lasers on bacteria and calculus:

Most laser bactericidal studies reported that when the density of the energy is enhanced results in decreased bacterial load. Cobb cm et al 1992 reported that a decrease in periodonto pathogens followed by the use of nd: yag laser shows reduction in p.gingivalis, p. intermedia and a. Actinomycetem-comitans.

However, recolonization of multiple morph types of bacteria was observed postoperatively in laser-treated subgingival root surfaces moritz et al (1997) proposed that er: ysgg laser in 8238 indian journal of forensic medicine & toxicology, december 2020, vol. 14, no. 4’ adjunct to srp enhanced healing of periodontal pockets. Aoki et al (2000) suggested that er: ysgg laser has the proficiency to remove calculus which is at par with ultrasonic scaling.5,7

What is waterlase dentistry?

Waterlase: er, cr: ysgg (erbium-chromium doped: yttrium-selenium gallium-garnet) laser is available commercially as periodontal waterlase md™ and the waterlase® c100 it utilizes a patented amalgamation of laser energy and water by a process called hydro photonics12. Hydrokinetic energy is produced by combining a spray of atomized water with laser energy8. The resulting hydrokinetic energy gently and precisely removes a wide range of human tissue including tooth enamel and soft tissue with no heat and no pain in most cases. It works in the absence of heat, vibration, and drilling uses of waterlase laser.

Mechanism of action: During the waterlase irradiation, the waterlase energy is absorbed selectively by water molecules and hydrous organic components by water molecules and hydrous organic components of biological tissues, causing evaporation of water and organic components and resulting in thermal effects due to the heat generated by this process (photothermal vaporization)8.

In hard tissue procedures, the water vapor production induces an increase of internal pressure within the tissue, resulting in explosive expansion called ‘micro-explosion’. These dynamic effects cause mechanical tissue collapse, resulting in ‘thermomechanical’ or ‘photomechanical’ ablation. This phenomenon has also been referred to as ‘water mediated explosive ablation’.9

Two key features are10:
1. Reduces bleeding in the operative field
2. Decreased post-operative pain and discomfort in comparison to traditional procedures

Advantages10:
- alleviate patient’s anxiety
- carry out minimally-invasive procedures
- significantly reduce the need for retreatment
- comfortably prepare patients for invasive treatments
- perform treatment without anaesthesia
- reduce post-treatment bleeding and swelling, and pain
- provide effective treatment in minimal time

Uses in periodontics:9
1. Incisions for full thickness/ partial thickness flap
2. Laser soft tissue curettage
3. Removal of granulation tissue from bony defects
4. Sulcular debridement
5. Ostectomy (resection of bone to restore bony architecture, resection of bone for grafting, etc.)
6. Osteoplasty and osseous recontouring
7. Osseous crown lengthening
8. Soft tissue procedures such as gingivectomy, gingivoplasty, depigmentation, frenectomy.

MATERIALS AND METHODS:
The questionnaire based cross sectional study was carried out in different dental practitioners in Pune city. The sampling technique used was convinience sampling. Multiple choice based questionnaire was developed and used for assessment of understanding and efficacy and: awareness and practice regarding conventional lasers and waterlase lasers among dentists. The questionnaire was reviewed by the subject matters experts who judged the questionnaire for its relevance, understanding and clarity for corrections to be made accordingly. Internal consistency was analysed using cronbach’s alpha. Reliability is calculated by using cronbach calculator. Thus, the cronbach α was equal to 0.807.

Sample size is calculated using input parameter pertaining ‘g’ power software version 3.1.9.4. Effective size of the sample was 0.5 (medium). Power of the study was 80%. The threshold for statistical significance i.e. (α value) was 0.05. Degree of freedom of sample size was 5. Hence calculated sample size is 289. Considered sample size was 300.

Subjects satisfying the inclusion criteria were asked to fill the questionnaire which was distributed manually and through an online link shared by the corresponding author to the different dental practitioners in pune. The purpose of the questionnaire was explained to respondents beforehand and filling it out was considered as consent. Inclusion criteria included dentists who had graduated in bds & mds and were currently doing dental practice.

The questionnaire comprised of knowledge attitude practice based multiple choice questions with four or five options were formulated by corresponding author. Total 300 responses were collected through the medium of online form (google form). Data entry was done in microsoft excel sheet. For technical aspects, we have utilised ibm spss inc, chicago, il windows version 21.
June software to prepare statistical table. 31 questions were considered meticulously for 25 size study population. Results were documented on excel sheet. Tables were made to holistically determine the value of validity and reliability.

**RESULT:**

Table 1: Demographic distribution of participants

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>191</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Designation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post graduate</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Dental Practitioner</td>
<td>219</td>
<td></td>
</tr>
<tr>
<td>Mean Age (in years)</td>
<td>37.36 ± 7.79</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>299</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Distribution of scores for knowledge, attitude and practices among participants

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Good (&gt;14)</td>
</tr>
<tr>
<td></td>
<td>Fair (7-14)</td>
</tr>
<tr>
<td></td>
<td>Poor (&lt;7)</td>
</tr>
<tr>
<td>Attitude</td>
<td>Good (24-35)</td>
</tr>
<tr>
<td></td>
<td>Fair (13-24)</td>
</tr>
<tr>
<td></td>
<td>Poor (&lt;12)</td>
</tr>
<tr>
<td>Practices</td>
<td>Good (7-10)</td>
</tr>
<tr>
<td></td>
<td>Fair (4-6)</td>
</tr>
<tr>
<td></td>
<td>Poor (&lt;3)</td>
</tr>
</tbody>
</table>

Figure 1: Percentage distribution of study participants in all three domains
Table 3: Comparison of mean scores (SD) of knowledge, attitude and practice among different demographic variables by using unpaired ‘t’ test

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Knowledge</th>
<th>Attitude</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14.26 (2.92)</td>
<td>22.15 (5.41)</td>
<td>5.06 (1.67)</td>
</tr>
<tr>
<td>Female</td>
<td>16.51 (3.37)</td>
<td>23.36 (2.83)</td>
<td>6.03 (1.14)</td>
</tr>
<tr>
<td>p-value</td>
<td>0.024*</td>
<td>0.028*</td>
<td>0.041*</td>
</tr>
<tr>
<td>Designation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post graduate</td>
<td>16.48 (2.65)</td>
<td>23.84 (3.50)</td>
<td>6.42 (1.18)</td>
</tr>
<tr>
<td>Dental Practitioner</td>
<td>14.29 (3.64)</td>
<td>21.67 (4.74)</td>
<td>4.67 (1.63)</td>
</tr>
<tr>
<td>p-value</td>
<td>0.021*</td>
<td>0.01*</td>
<td>0.029*</td>
</tr>
<tr>
<td>Total</td>
<td>15.38 (3.15)</td>
<td>22.75 (4.12)</td>
<td>5.54 (1.41)</td>
</tr>
</tbody>
</table>

A total of 299 study participants were included in the study out of which 191 males were males, while 108 females. Similarly, 80 were Post graduate and 219 dental practitioners. Knowledge, attitude and practice scores were categorized as ‘good’, ‘fair’ and ‘poor’ by dividing the score range by 3, and it was found that in all the three domains i.e. Knowledge, attitude and practices maximum participants were under good category (60.9%, 58.2% and 63.9 %). Respectively [Table 3] Correlation analysis revealed that there was statistically significant association between the three variables among study subjects (p<0.05) [Table 4]

**DISCUSSION:**

**Laser is the acronym for “light amplification by stimulated emission of radiation”**. The heat released by the laser converts the electromagnetic energy into thermal energy. Laser technology has come up as a useful and skillful tool with a wide range of applications in ambient fields. This survey delves into the current level of laser research, highlighting its significance, recent advancements, and potential future directions. Lasers have evolved from theoretical concepts to practical devices that shape our daily lives, making this an exciting and dynamic field of study. This Laser research holds significant importance due to its myriad applications. It plays a pivotal role in fields such as medicine, industry, tele-communications, and scientific surveys.

The most popular tool used for educational research and understanding is the questionnaire. Since our study is well-established, reliable, and valid technique of assessment of knowledge of, waterlase and conventional laser use, multiple choice questions were chosen as the methods to assess the knowledge, attitude, and practice of efficacy of conventional and waterlase laser systems. Following review, the dentist is questioned extensively, and the validity and reliability of the questionnaire was checked before any data were collected, as this allows for the retention of valuable things and the discarding of less valuable ones.

**Future Directions:** Laser research is destined to continue enhancing in several different outposts. The cumulative need of more exactness of laser sources will simplify access to laser technology, fostering innovation across industries. Advances in laser trapping techniques are expected to enable greater precision in atomical and molecular physics.

A statistical significant difference in mean scores was observed in all three domains when compared against the demographic variables (p<0.05). [Table 3] Correlation analysis revealed that there was statistically significant association between the three variables among study subjects (p<0.05) [Table 4]

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the need for acid etching and neg- atively influenced the marginal sealing, with the appearance of marginal micro- infiltrations. The dentinal surface does not show signs of melting or carbonization, it has open dentinal cans and the absence of the state of smear layer. The absence of smear layer could lead to the use of newer systems in the treatment of carious lesions and ablation of infected dentinal tissues by using waterlase lasers with wavelength specific to these treatments is superior in that they significantly re- duce the use of local anesthetics, making possible treatments in situations where anesthetic proce- dures are prohibited or limited. Symptomatic pain control during ablative maneuvers may make it safe to preserve pulpal vitality.

Results show that elimination of various tooth with waterlase laser is not accompanied by bacterial contamination and seems to be an effective way of treatment without causing excessive temperatures, which could nega- tively affect the vitality of the pulp.

There is also less post-treatment sensitivity in waterlase laser-treated teeth compared to traditional cavity preparation methods. Lasers can also treat hypersensitive root surfaces with minimal inva- siveness, demon- strating effective results. Although some authors believe that there is insuffi- cient evidence to show that laser light removal of cavities is more effective than traditional me- chanical technique, they have shown that the tech- nique has safe advantages, related pain controlling action, haemorrhage control and decrease of the need for anesthesia during procedures, hence, providing more patient comfort.

**CONCLUSION:**

Waterlase lasers are a valuable state-of-the-art tool that has been shown to be effective in eliminating carious lesions and treatment of periodontal diseases which require surgical procedures. They have advantages over the classic method, which include increasing the strength of dental structures by reducing the occurrence of secondary caries, lack of cracks in the enamel and detritus in the teeth. The treatment of deep caries can be done by preserving the dental vitality and facilitating the reaction den- tin deposition at the level of the dental pulp.

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