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Knowledge and Practice of Dentists toward Dental Lasers and Their Use during and Post-COVID-19 Pandemic Scenario in South India: A Cross-Sectional Analytical Study

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Abstract

Background The advent of dental lasers has overcome the drawbacks of conventional clinical practice. It is considered to be a safer alternative during and post-coronavirus disease 2019 (COVID-19) pandemic in terms of infection control and reduced aerosol production. The study aims to assess the knowledge and practice of dentists toward dental lasers and their use during and post-COVID-19 pandemic scenario.

Methodology This is a cross-sectional, analytical study conducted among dental professionals in South India. A total of 444 dental professionals participated in the study. A self-administered questionnaire with 15 closed questions was given to the participants. Chi-square test was used to analyze the obtained data.

Results The results indicated that the majority of the dental professionals were aware of the use, the types, watts, wavelength, and types of emission of dental lasers. They had good knowledge about the common uses of lasers in dentistry. Majority of the dental professionals had not used dental lasers anytime in their practice, but are willing to adopt it as a safer alternative option during and post-pandemic scenario.

Conclusion Application of knowledge of dental laser into clinical practice is beneficial in improving dental care and to enhance infection control.

Keywords
- COVID-19
- dentists
- knowledge
- laser
- practice
- safety

Introduction

The introduction of state-of-the-art technology has simplified the conventional dental practice with better patient acceptance.[1] One such technological development is the dental laser. Dental laser was introduced by Maiman in 1960. Acronym for laser is light amplification by stimulated emission of radiation.[2] Today, dental laser has gained a wide attention for the use of both soft tissue and hard tissue dentistry. Lasers can be used on hard tissues for caries detection, caries prevention, cavity preparation, dentinal hypersensitivity, bleaching, restoration removal, laser Doppler flowmetry, and in digital radiography.[2] Soft tissue laser applications include soft tissue incision and excision, wound healing, photodynamic therapy (PDT), photobiostimulation, periodontal surgeries, and many more.[2,3] Lasers are beneficial to dentists as they improve the efficiency, simplicity, specificity, and comfort of dental treatment.[2,3] However, there are certain drawbacks of lasers, which might limit

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their usage, like high cost of the unit, technique sensitivity, the need for education and training to operate laser, and damage inflicted to naked eyes.[3,4]

The emergence and widespread transmission of coronavirus disease 2019 (COVID-19) had a significant impact on the global health. It has been declared as a pandemic by the World Health Organization.[5,6] COVID-19 can be transmitted both directly (via aerosols, bodily secretions, and vertical transmission) and indirectly (via fomites).[7] Spread of COVID-19 in a dental setup is very common, as transmission can occur both directly and indirectly, thus subjecting both patients and the dental professionals to increased risk of exposure.[8] Dentists are recognized to be at higher risk of exposure, due to the aerosol generated during treatment procedures; face-to-face communication; contact with saliva, blood, gingival crevicular fluid, mucous membrane, and contaminated surfaces.[7–10] The reported benefits of dental lasers are helpful in overcoming the limitations of conventional dental practice in containing the infection, thus causing less viral transmission during dental treatment.[11] Considering the advantages of dental lasers and its usefulness in infection control, this study was conducted to assess the knowledge and practice of dentists toward dental lasers and its usage during and post-COVID-19 pandemic in South India.

Materials and Methods

This is a cross-sectional analytical study conducted on dental professionals like Bachelor of Dental Surgery (BDS) private practitioners, postgraduates, Master of Dental Surgery (MDS) private practitioners, and academicians in South India. A pilot study was conducted among 30 participants to evaluate the validity of the questionnaire. The questionnaire consisted of 15 closed questions with multiple options. There were four sections: demographics; awareness regarding dental lasers, its specific uses in general dentistry, periodontal surgery, orthodontics, and treatment of oral lesions; awareness regarding applications of PDT in dentistry; and use of lasers in dental practice (in the immediate post COVID-19 situation), its advantages, precautions, and drawbacks. The pilot study yielded a score between 0.87 and 0.90 (very high) in the Aiken's V index for each item and a Cronbach's alpha = 0.71 (acceptable).

The sample size for the current study was calculated using the prevalence from the pilot study (53.34%). The formula used to estimate sample size was $n = (Z1\text{-}\alpha / \delta)^2 p(1-p)$. The estimated proportion of the attribute was calculated to be 383. A 5% margin for nonresponse from the study subjects was expected. Thus, 5% of 383 was added to the sample size and rounded off making the sample size of the study to 403 subjects.

The study was carried out for a period of 2 months (January and February 2022). This study was approved by the Institutional Ethical Committee. A total of 444 dental professionals participated in the study. All the participants were informed about the aim of the study and written consent was obtained. The questionnaire was administered (self) to the participants via Google Forms. The data collected from the questionnaire were entered into Microsoft Excel and analyzed using the statistical package, BM SPSS Statistics for Windows, Version 20 (IBM Corp., Armonk, New York, United States). Descriptive statistics of the key variables were reported. Chi-square test was used to analyze the level of relationship in frequency distributions regarding various perceptions among the study population. The level of significance was determined at $p \leq 0.05$.

Results

A total of 444 dental professionals participated in the study. The response rate was 71.4%. In this study, out of 444 respondents, 38.06% were males and 61.93% were females. The study population comprised 114 BDS private practitioners (25.675%), 189 postgraduate students (42.56%), 58 MDS private practitioners (13.06%), and 83 academicians (18.69%). ►**Fig. 1** depicts the awareness of dentists regarding the use of dental lasers in clinical practice. Majority of the dentists were aware of the use ($p = 0.176$), the type of lasers ($p = 0.001$), the available watts ($p = 0.001$) and wavelength of the laser used ($p = 0.001$), and the different type of emission mode ($p = 0.000$). The participants had sufficient knowledge about the common uses of lasers in dentistry, its application in orthodontics, and in oral lesions ($p < 0.001$). They were aware about use of laser in temporomandibular disorder (59%), about low-level laser therapy (LLLT) (57.43%), about PDT (65.99%), and their applications in dentistry, which were statistically significant ($p \leq 0.05$). ►**Fig. 2** depicts practice of dental lasers among dental professionals. Note that 36.03% of the dental practitioners have used dental lasers sometime in their practice ($p \leq 0.05$), among which only 15.31% of the practitioners are currently using dental lasers during the COVID-19 pandemic ($p \leq 0.05$). The most used type of dental laser was the diode laser (85.29%), followed by Nd:YAG laser (11.76%) and Er:YAG (2.94%), which was not statistically significant ($p = 0.613$). Advantages of dental lasers felt by the practitioners were minimal/bloodless field (98.52%), enhanced wound healing (86.76%), less need of anesthetics (77.94%), reduced treatment time (86.76%), decreased postoperative time (88.23%), high patient acceptance (88.23%), and reduced postoperative edema (89.70%), which were not statistically significant. Precautions that would be taken by the dental professionals when working with dental lasers during and post-COVID-19 pandemic are use of safety eyewear (14.70%), use of wet gauze to avoid reflection from shiny surface (1.47%), use of face shield (5.88%), use of high-speed evacuation (2.94%), and 85.29% of dentists would use them all ($p \leq 0.05$). Drawbacks experienced by the dentists while using dental lasers during and post-COVID-19 pandemic were cost of the unit (55.88%), low patient acceptance due to expensive treatment (60.29%), lack of knowledge among dentists (33.82%), lack of awareness among patients (2.94%), time consuming (1.47%), and feasibility as it needs care and sterilization after every patient use (2.94%) ($p = 0.166$). When asked whether the practitioners would adopt dental lasers as a safer alternative option, 53.72% of the practitioners responded positively ($p = 0.395$) (►**Fig. 2**).

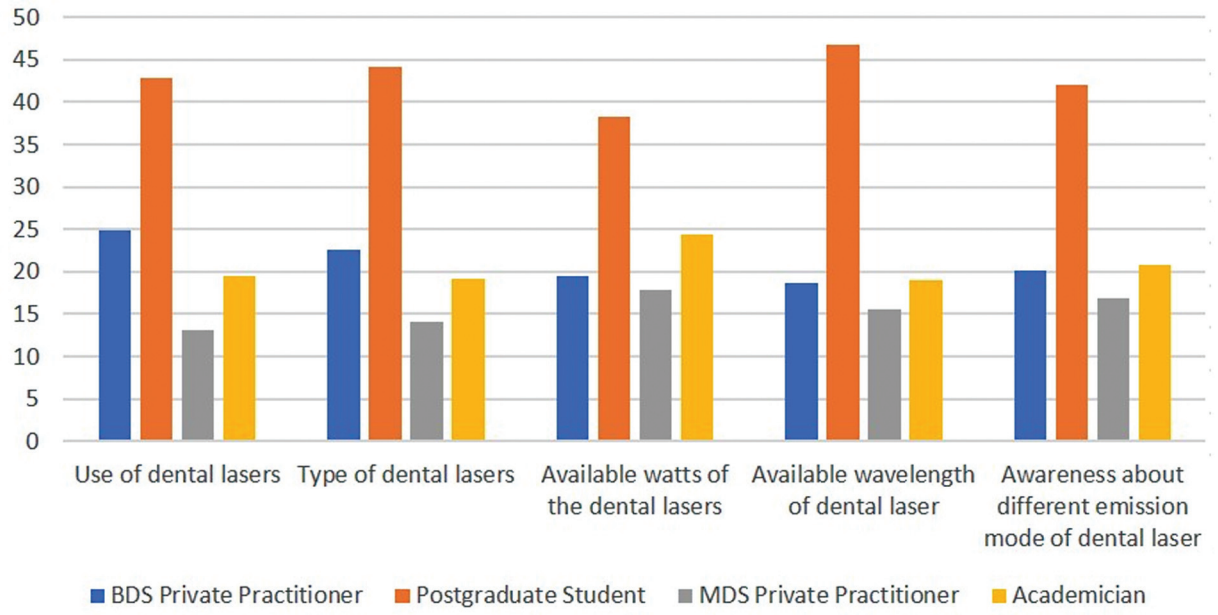

Fig. 1 Awareness of dentists toward dental laser.

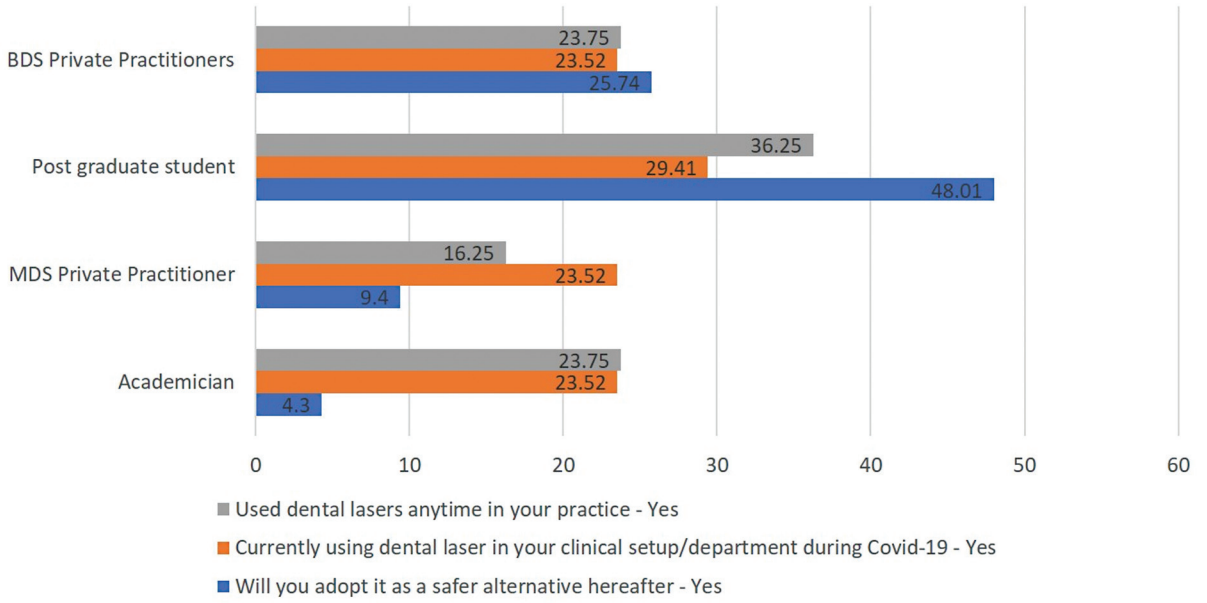

Fig. 2 Practice of dentists toward dental laser.

Discussion

This study assessed the knowledge and practices of dental practitioners who are BDS graduates, postgraduate students, MDS graduates, and academicians in South India, toward dental lasers. The questionnaire was sent to more than 600 dentists, out of which 444 responded, which is greater than the estimated sample size ($n = 403$). In our study, we achieved a response rate of 71.4%, which is considered to be good, as e-mail surveys employing multimode approaches may achieve a response rate of 70%.[12] In our study, higher number of female dentists (61.93%) participated than male dentists (38.06%). The difference in gender distribution did not seem to influence the results of the current study.

In the present study, almost all dentists were aware of the uses of dental laser (96.17%) and the types of lasers (90.76%). The results were in accordance with the study conducted by Harini and Arjunkumar (96%),[3] and higher than the awareness recorded by Yadav et al (57%).[13] Almost half of the dentists (51.8%) were aware of the available watts of dental lasers, among which 38.26% were postgraduate students ($p \leq 0.05$). A laser is a monochromatic, coherent, unidirectional, collimated, focused

form of light.[14–16] The power of the laser is the measure of energy emitted per unit time. It is measured in watts (W). The higher the power, the quicker the effect on the tissue.[16,17] About 66.44% of the dentists were aware of the available wavelength of the dental lasers used. Wavelength is the horizontal distance between two corresponding points on wave.[18] Wavelengths of laser used in clinical dental practice fall under the spectrum of visible light and infrared rays (range 488–10,600 nm).[17,19] It determines the deliverance of energy to the treatment site and its effect on tissue.[16] Overall, the effect of laser on target tissue depends on properties like power, wavelength, exposure duration, and amount of energy delivered to tissue.[19] About 62.61% of the dentists were aware about the emission modes of dental lasers. The method of emission of laser can be categorized into continuous mode, gated pulsed mode, and free-running pulsed mode.[20–22] Continuous mode tends to deliver excessive thermal energy onto the target tissue, hence this mode is not preferred. In gated pulsed mode, the energy delivered to the target tissue is minimized using a shutter, thus avoiding the undesirable effects of continuous mode. Free-running pulsed mode emits laser of very large energy for a short duration, followed by long intervals of no emission.[16,22] It demonstrates better efficiency than the other two types, as it allows better control of thermal effect.[23]

When questioned about the common uses of dental lasers, the highest positive response was recorded for gingivectomy/frenectomy (98.42%), followed by flap surgery (94.14%), and lowest response for dentinal hypersensitivity treatment (58.55%). This indicates that the practitioners have better knowledge about the soft tissue applications of laser than its endodontic applications, which is in accordance with the study conducted by Al-jobair.[1] Dental lasers are commonly used for periodontal soft tissue procedures, biopsy, and sterilization of treatment site. Hard tissue applications of lasers include caries removal and cavity preparation, and also for the treatment of dentinal hypersensitivity, enamel etching, root conditioning, bleaching, composite curing, root canal disinfection, etc.[2,15,21,22,24]

Just over half of dentists (57.43%) were aware of LLLT, among which majority of them were postgraduates. LLLT is a low-intensity light therapy, which uses nonthermal irradiation of photos to stimulate biochemical actions at the molecular level within cells and tissues.[25–28] LLLT is known to induce a wide variety of cellular functions including stimulation of intracellular metabolic changes, increase cell proliferation rate, and enhances wound healing by promoting neovascularization, angiogenesis, and collagen synthesis.[27,28]

Around 66% of the professionals had knowledge about use of laser in tooth exposure and had less knowledge about laser-stimulated orthodontic tooth movement. Dental lasers are beneficial in all stages of orthodontic treatment. The biostimulatory effects of LLLT enhances tooth movement during orthodontic treatment and accelerates bone regeneration.[19,29] Lasers-assisted periodontally accelerated osteogenic orthodontics have proven to enhance orthodontic tooth movement while reducing treatment time and damage to the periodontium, which is in agreement with Seifi et al.[30] Lasers have also been successfully used in enamel etching during bonding and during ceramic brackets debonding, exposure of unerupted or impacted tooth, frenectomy, papillectomy, gingival recontouring, crown lengthening, and removal of inflamed tissue. They are reported to minimize bleeding, tissue damage, enamel damage, secondary caries formation, and postoperative pain, while improving convenience and accuracy during surgery.[19,31]

Roughly about 40% of the participants are aware of the applications of laser in oral mucosal lesions. LLLT when applied to lesions like oral lichen planus, aphthous ulcers, recurrent herpetic lesions, and oral mucositis, has reported to significantly reduce the pain, inflammation, infection, and the immune response associated with the lesion and also accelerates wound healing. Lasers can also be used to excise exophytic lesions and Fordyce granules, without compromising on the esthetics.[32,33]

In our study, around 59% of the dentists have answered that lasers can be used to treat temporomandibular disorder, where a large part of the respondents were postgraduates. LLLT has been effective in reducing the clinical signs and symptoms of temporomandibular disorders due to its analgesic, anti-inflammatory, biostimulatory actions.[34,35] It has also been shown to improve functional movements of temporomandibular joint.[34–36]

About 65.93% of dentists were aware of PDT and roughly half of the participants had adequate knowledge about its applications, where majority of positive responses were from postgraduates. PDT involves the use of a photosensitizer, which is activated by a low-level laser, in the presence of oxygen. It leads to the generation of singlet oxygen and oxygen-free radicals.[37–39] Some of the photosensitizers that are available are Photofrin and derivatives, Foscan, 5-aminolevulinic acid (ALA), and Visudyne.[37,38] PDT finds several applications in dentistry. It is used in the diagnosis and treatment of oral cancer lesions.[37,39] ALA-based photodynamic diagnosis is a method to diagnose oral cancer lesions. Photosensitizer ALA is topically applied to the suspected site, which intensifies the tissue fluorescence when illuminated. The difference in tissue fluorescence helps in the identification of malignant sites, as evidenced by de Bruijn et al and Sharwani et al.[40,41] PDT has been clinically used in the treatment of head and neck squamous cell carcinoma, either as an alternative or in combination with conventional treatment. It is advantageous as it is minimally invasive and selectively destroys tumor without damaging the healthy tissue.[37–39] Photodynamic antimicrobial chemotherapy (PACT) is effective against bacterial, viral, fungal, and protozoal infections by generating singlet oxygen and reactive oxygen species. It is effective against antibiotic-resistant bacteria and dental biofilms. The development of resistance to PACT is rare.[37,38] Recent studies have proven its role as an adjunct to scaling and root planing and in the treatment of peri-implantitis.[42–44]

The present study noted that around 36% of the participants have used dental lasers in their practice and only 15% of them are using lasers. Diode lasers are the most commonly used type of laser (85%). Majority of the dentists felt that the advantages of laser are useful in times of COVID-19 and they would take sufficient precautions against laser, although they acknowledge that there are certain drawbacks to having laser in dental practice. Note that 53.72% of the dentists answered that they would adopt laser as a safer alternative option.

Dental lasers have simplified and have raised the standards of dental treatment, overcoming the downsides of conventional treatment. Dental personnel are at a high risk of contamination due to aerosol production and exposure to biological materials.[45] There is an elevated risk of contracting the infection by inhalation, direct touch, or autoinoculation.[46] A survey reported that about 20% of the dental professionals were infected in the dental office.[47] Maximum aerosol is generated when using high-speed rotary handpiece and ultrasonic equipments.[48] This bioaerosol contains saliva, blood, tooth particles, organic matter, dental plaque, bacteria, viruses, fungi, and restorative materials,[48,49] which can spread up to tens of meters and can stay suspended in air for several hours.[50] The half-life of severe acute respiratory syndrome coronavirus 2 in dental aerosol is approximately 1.2 hours.[51] Dental lasers can be considered as an alternative to rotary instruments to reduce the amount of aerosol produced. Abdelkarim-Elafifi et al reported that Er,Cr:YSGG reduced the contaminated area by 70% compared to high-speed air turbine.[48] Similarly, aerosol produced by Er:YAG produces less aerosol during orthodontic bracket debonding and root canal irrigation than initial aerosol quantity.[52] However, among dental lasers, high power lasers generate more aerosol or laser plume than low power lasers.[45] This laser plume is also capable of carrying biologic materials like bacteria and viruses.[53] Nevertheless, exposure to laser plume can be minimized by undertaking safety measures, such as using goggles, plastic visor or face shield, fitted N-95/N-99/FFP-3 face mask, high vacuum aspiration system, and high-volume saliva ejector. For operative procedures, rubber dam with plastic antireflective or sandblasted clamp is recommended. Use of disposable optic fiber laser system and disinfection of laser device is preferred to avoid cross-contamination.[53,54] Additionally, low-level lasers are effective in reducing bacterial and viral loads prior to the treatment, hence it can be used as a potential preprocedural tool.[55] Other advantages of dental lasers include reduced pain, minimal bleeding, sterilization of the surgical site, minimal postoperative pain and swelling, better wound healing, reduced treatment time, reduced patient anxiety, and high patient acceptance.[11,21,55,56]

This study provides a general outlook of dental lasers and its uses among dentists. The results of the present study reveal that postgraduates have more knowledge about the physics and the application of dental lasers. This indicates that more education and training is needed at an undergraduate level. This study also reports that practicing dentists benefit from the advantages of dental laser during the times of COVID-19 and would consider it as a safer modality in routine practice in future.

Conclusion

The results of the present study concluded that the dental practitioners have good knowledge about dental lasers in general. However, dentists needed to be educated on an in-depth level about the various applications of dental lasers at a collegiate level. Furthermore, dental lasers can be considered as a safer alternative to conventional dental treatment as they reduce the risk of contamination.

Ethical Approval

Ethical clearance was obtained from the Institutional Ethical Committee. This study was conducted in accordance to the principles of Declaration of Helsinki.

Conflict of Interest

None declared.

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