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REVIEW

Evaluating the Impact of Modern Laser Technologies on Dentistry in European Union Countries

Evaluar el Impacto de las Tecnologías Modernas de Láser en la Odontología en los Países de la Unión Europea

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ABSTRACT

Introduction: in dentistry, understanding laser wavelength interactions with oral tissues enhances patient management. Over two decades, lasers have been used in dental practices for diagnostics, caries detection, calculus identification, hard tissue cutting, and root canal disinfection. They reduce patient anxiety and the need for anesthesia in hard tissue applications.
Aim: the objective of this research is to provide a review on how European dentistry has been affected by the use of modern laser technology between 2020 and 2024. This was done by classifying the types of lasers, examining their uses in different dental treatments, investigating the problems that may arise as a result, and appraising the benefits for oral health and patient outcomes.
Method: a systematic literature review was conducted from 2020 to 2024, focusing on modern laser technologies in dentistry within European countries. Using the PRISMA flow diagram, studies were identified, screened, and included based on keywords related to dentistry and laser technologies. Initial searches identified 17,130 records, narrowed down to 27 relevant studies through various criteria. Inclusion required studies to focus on dental laser applications in specified European countries, published between 2020 and 2024, and be peer-reviewed.
Results: the review covered studies from 2020 to 2024, highlighting various dental specialties and laser technologies like Erbium, CO2, Diode, Nd, Excimer, and Fiber lasers. Findings indicated lasers improved precision, reduced discomfort, and enhanced patient outcomes with minimal postoperative pain and faster recovery times. Noted risks included thermal damage and specific complications like bleeding and pain.
Conclusions: the review highlights lasers' transformative potential in EU dental care, offering precision and improved outcomes. Future research should standardize protocols, assess long-term benefits and risks, focus on safety, and integrate patient-centered outcomes to enhance the evidence base supporting laser technologies in routine dental care.

Keywords: Lasers; Dentistry; Laser Therapy; Dental Care; Dental Health Services; European Union.

RESUMEN

Introducción: en odontología, comprender las interacciones de la longitud de onda del láser con los tejidos orales mejora la gestión del paciente. Durante más de dos décadas, los láseres se han utilizado en prácticas

dentales para diagnósticos, detección de caries, identificación de cálculo dental, corte de tejidos duros y desinfección de conductos radiculares. Reducen la ansiedad del paciente y la necesidad de anestesia en aplicaciones de tejidos duros.
Objetivo: el objetivo de esta investigación es proporcionar una revisión sobre cómo la odontología europea se ha visto afectada por el uso de la tecnología láser moderna entre 2020 y 2024. Para ello, se clasificaron los tipos de láser, se examinaron sus usos en diferentes tratamientos dentales, se investigaron los problemas que pueden surgir como resultado y se evaluaron los beneficios para la salud bucal y los resultados para los pacientes.
Método: se realizó una revisión sistemática de la literatura desde 2020 hasta 2024, enfocándose en las tecnologías láser modernas en odontología dentro de los países europeos. Utilizando el diagrama de flujo PRISMA, se identificaron, seleccionaron e incluyeron estudios basados en palabras clave relacionadas con la odontología y las tecnologías láser. Las búsquedas iniciales identificaron 17,130 registros, reducidos a 27 estudios relevantes mediante varios criterios. Los estudios incluidos debían centrarse en aplicaciones láser dentales en países europeos especificados, publicarse entre 2020 y 2024, y ser revisados por pares.
Resultados: la revisión abarcó estudios desde 2020 hasta 2024, destacando varias especialidades dentales y tecnologías láser como los láseres de Erbio, CO2, Diodo, Nd, Excimer y Fibra. Los hallazgos indicaron que los láseres mejoraron la precisión, redujeron la incomodidad y mejoraron los resultados para los pacientes con un mínimo dolor postoperatorio y tiempos de recuperación más rápidos. Los riesgos observados incluyeron daño térmico y complicaciones específicas como sangrado y dolor.
Conclusiones: la revisión destaca el potencial transformador de los láseres en el cuidado dental de la UE, ofreciendo precisión y mejores resultados. La investigación futura debería estandarizar protocolos, evaluar beneficios y riesgos a largo plazo, centrarse en la seguridad e integrar resultados centrados en el paciente para mejorar la base de evidencia que respalda las tecnologías láser en el cuidado dental rutinario.

Palabras clave: Láseres; Odontología; Terapia Láser; Cuidado Dental; Servicios de Salud Dental; Unión Europea.

INTRODUCTION

The application of laser technology in dentistry, abbreviated from "Light Amplification by Stimulated Emission of Radiation" (LASER), represents a significant advancement in both diagnostic and therapeutic practices. Lasers have revolutionized dentistry in the past few decades, originated from theories laid by Albert Einstein in 1917 and implemented by Theodore Maiman in 1960.[1] Their use has enabled precise control of oral tissues leading to reduced invasiveness with increased patient comfort as opposed to traditional tools.

Lasers are essential in contemporary European Union dentistry across various fields, ranging from screening to interventions. Some of the tasks these technologies are used for include cavity detection, subgingival calculus removal and incisional tissue cutting without anesthesia.[2] In this way, dental strain reduction, which is usually encountered with the conventional rotaries, is eased by such developments in order to improve dentist visits.

Lasers are very important in dentistry and can be used for both soft and hard tissues. In hard tissue procedures, lasers can be used to remove cavities, carry out caries prevention activities as well as treat dentinal hypersensitivity, also supporting restorative procedures such as curing and bleaching.[3] Soft tissue uses are related to healing of wounds, gingival contouring as well as the management of temporomandibular joint disorders. It has a wide scope of application including periodontics, endodontics, restorative dentistry, and aesthetic procedures that fundamentally change how treatment is given and improve clinical outcomes.

In contrast, the adoption of laser technology in dental practices within the EU still has some challenges. The worries include cost effectiveness, thermal effects and standardization in treatment protocols. Burns may be caused by these expensive treatment modalities such as CO2, Nd and Er lasers whereas diode lasers are classified under low level types or soft laser which are considered safer for use on soft tissues due to the less heat they generate.[4]

This systematic review assesses the impact of new laser techniques on dentistry in European Union countries. Among patients with carotid stenosis, advanced cardiovascular events are more common with conservative treatment as opposed to less invasive options, but they have similar outcomes.[5] It is important to guarantee that patients in Europe are protected from fake drugs during the pandemic through EU-standard laws.[6] Synthetic iron citrate can improve hematologic responses in surgical settings.[7] The aim of remote learning shift during the pandemic was to perfect the assessment process for surgical students by emphasizing interdisciplinary educational approaches and conducting elaborate researches into surgical intervention outcomes.[8,9,10] Technological advancements like AI and blockchain offer promising improvements for surgery procedures.[11]

In COVID-19-related academic disruptions, effective digital knowledge management strategies have become significant.[12] Optimal environmental protection strategies must be put in place for public safety based on emission thresholds and hazardous substance impacts. This will ensure that people's lives are not at stake due to pollution or any other factor. Therefore, optimal environmental protection strategies should thus take

into account emission thresholds and hazardous substance impacts so as to ensure public health safety.[13] Photoactivation was more effective than sandblasting/acid modification in dental implant stability studies involving 164 patients.[14] Based on Ukrainian court analyses, few medical malpractice cases reach trial but a high number of practitioners get sued.[15] This narrative review examines immune mechanisms, biomarkers and role of environmental factors in oral disease pathogenesis while evaluating immune-modulating therapies towards better patient management and diagnostic strategies.[16]

On the other hand, it is important to note that when using a laser, there can be some negative effects to the patients being attended to by dental care providers. Care should be taken in treating gums and periodontal tissues because lasers cause burns on the mucosal surfaces. The only remedy which remains after this therapy of surgical intervention is pain and sores on the skin. When treatment with laser causes some injuries, it may be due to lack of cooling or failed anesthesia administration leading to tissue necrosis. In order for these risks not to occur, there is need for proper selection of equipment and competence from those who are carrying out such activities.[17]

Furthermore, the subsequent study indicates that lasers in dentistry have progressed and obtained many other uses since the time they were initially launched in 1960s. The light amplification by stimulated emission of radiation is used to make these tools effective for dental procedures involving tissues both hard and soft. Their common use tasks are such as caries removal, cavity preparation, soft tissue surgeries, caries detection, peri-implantitis treatment, maxillofacial surgery, bonded restorations, and endodontic procedures. Consequently, laser treatments offer advantages like less pain or bleeding with lower postoperative discomfort. However, it is essential to carefully weigh these advantages against the potential risks associated with laser use.[18]

Research Aim

The objective of this research is to provide a review on how European dentistry has been affected by the use of modern laser technology between 2020 and 2024. This was done by classifying the types of lasers, examining their uses in different dental treatments, investigating the problems that may arise as a result, and appraising the benefits for oral health and patient outcomes.

METHOD

Study design

A systematic literature review from 2020 to 2024.

Search strategy and databases used

Figure 1 PRISMA flow diagram outlines the process of identifying, screening, and including studies for a systematic review using the keyword “Dentistry” AND “Modern Lasers” OR “Laser Technologies” AND “Italy” OR “France” OR “Germany” OR “Sweden” OR “United Kingdom” OR “Spain”. Initially, 17,130 records were identified through searches in Dimensions.ai (n = 16,408) and Google Scholar (n = 722). After applying a year filter (2020-2024), 14,760 records were removed.

Further filtering by research categories (Dentistry) eliminated 1,847 records, and applying the publication type filter (Article only) removed 85 records. An additional 128 records were removed after applying the ALL OA filter, and 187 irrelevant records were excluded. This process resulted in 123 records eligible for assessment, from which 27 highly relevant studies were included in the final review.

Inclusion and Exclusion Criteria

The inclusion criteria for the systematic review required studies to be focused on the application of modern laser technologies in dentistry within European countries, specifically Italy, France, Germany, Sweden, the United Kingdom, and Spain, published between 2020 and 2024. Eligible studies needed to be peer-reviewed articles, available in full text, and written in English. The exclusion criteria involved removing studies that did not pertain to dentistry or laser technologies, were not conducted in the specified European countries, were published outside the specified timeframe, were not peer-reviewed articles, were not available in full text, or were considered irrelevant based on the content. This ensured that only the most relevant and high-quality studies were included.

Data Extraction

To obtain a complete picture of the situation, data extraction was performed in accordance with some aspects of the included studies. The main facts obtained were the type of study, sample size, country of research, publication year, various types of laser technologies used in dentistry, oral procedures performed using laser technology and any complications reported as well as other oral health outcomes. In order to review all important aspects of each study and provide an extensive analysis and synthesis of findings on the impact of new dental technologies in European Union countries, this detailed process aimed at extracting information from every available source about them.

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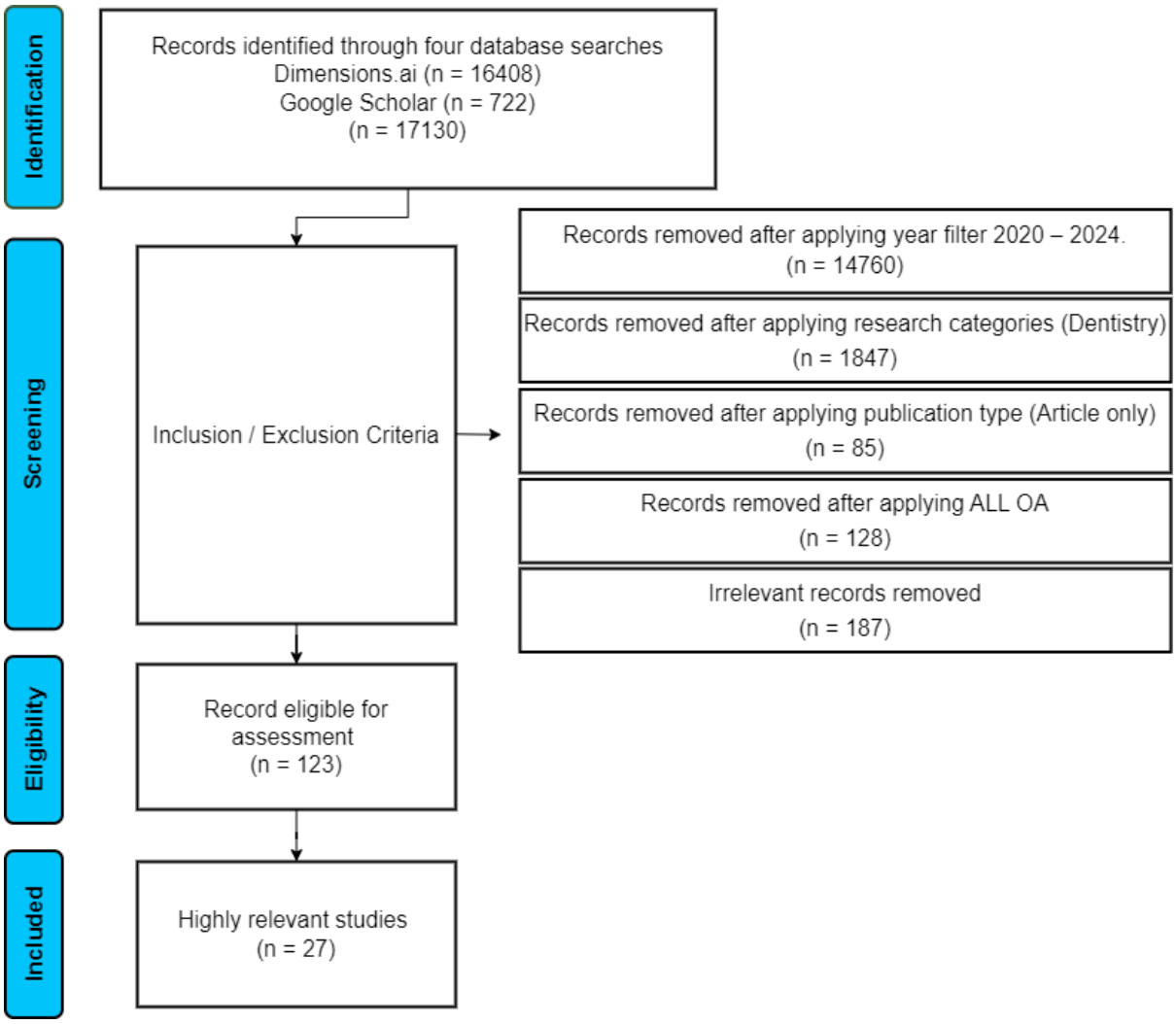

Figure 1. PRISMA flow diagram

RESULTS

Studies regarding the impact of modern laser technologies on European dentistry are summarized in Table 1. The present study has different kinds of designs, which were conducted in Europe from 2020 to 2024. Studies encompass different methodologies: Comparative studies, observational studies, case reports, randomized controlled trials, narrative reviews, systematic reviews, and other types of studies, providing a comprehensive overview of current research on laser applications in dentistry within the EU context.

Table 1. Study Characteristics

Studies	Study Design	Sample Size	Country	Year
Anton y Otero et al. 2021[19]	Comparative Study	72	Switzerland	2021
Mourouzis et al. 2021[20]	Observational Study	1,000	Greece	2021
Pereira et al. 2024[21]	Clinical study	-	Portugal	2024
Robin et al. 2024[22]	Comparative Study	-	France	2024
Bechir 2023[23]	Comparative Study	14	Romania	2023
Kwaśna et al. 2024[24]	Observational Study	-	Poland	2024
Vitale et al. 2022[25]	Case report	1	Italy	2022
Crippa et al. 2020[26]	Case report	1	Italy	2020
Fornaini et al. 2021[27]	Narrative Review	47	France	2021
Belloni et al. 2024[28]	Prospective study	7	Italy	2024
Mocuta et al. 2022[29]	Comparative Study	10	Romania	2022
Sfasciotti et al. 2020[30]	RCT	26	Italy	2020
Meisgeier et al. 2024[31]	RCT	40	Germany	2023
Polymeri et al. 2022[32]	Observational Study	100	Netherlands	2021

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Heyder et al. 2022[33]	Clinical study	75	Germany	2022
Msallem et al. 2024[34]	Comparative Study	10	Germany	2024
Mihai et al. 2024[35]	Case report	1	Romania	2024
Lin et al. 2021[36]	SLR & MA	8	Switzerland	2020
Deppe et al. 2021[37]	In vitro study	10	Germany	2021
Friedrich et al. 2020[38]	Experimental Study	55	Germany	2020
Munteanu et al. 2022[39]	RCT	18	Romania	2022
Lazăr et al. 2022[40]	RCT	32	Romania	2022
Sfasciotti et al. 2020[41]	RCT	125	Italy	2020
Impellizzeri et al. 2021[42]	Case series	9	Italy	2021
Šimunović et al. 2022[43]	Prospective Study	140	Croatia	2022
Jażdżewska et al. 2023[44]	SLR	12	Poland	2023
Anagnostaki et al. 2023[45]	SLR	39	UK	2023

Table 2 categorizes studies investigating the impact of modern laser technologies on dentistry within European Union countries, focusing on various types of lasers. Erbium (Er) lasers, including 2,94 µm and ErCr variants, are studied, highlighting their application diversity. CO2 lasers, ranging from 9,3 µm to Er CO2 combinations, are examined. Diode lasers that range from 445 nm to 810 nm are of paramount importance in exploring their clinical utility. There is also an analysis of Nd Lasers mostly at 1064 nm. Furthermore, Excimer and Fiber lasers among other laser types are explored thus presenting a holistic view of various laser technology roles in enhancing EU treatment outcomes through dentistry.

Table 2. Types of Lasers

Group	Types of Lasers	Studies
Erbium (Er) Lasers	2,94 µm Er laser, Er laser, ErCr laser (2780 nm), Er,Cr laser	(19, 20, 26, 29, 33, 34, 36, 44)
CO2 Lasers	9,3 µm CO2 laser, CO2 laser, CO2 laser (10600 nm), CO2 lasers, Er CO2 laser	(19, 20, 22, 24, 30, 44)
Diode Lasers	Diode laser, diode laser (810 nm), blue-violet diode lasers (450 nm and 405 nm), 445-nm diode laser	(20, 22, 25, 27, 31, 35, 36, 37,40,41, 42, 43, 45)
Nd Lasers	Nd laser, Nd laser (1064 nm)	(20, 21, 23, 32, 36, 44)
Other Laser Types	Excimer lasers, Fiber lasers, LPSSLs, DPSSLs, Disk lasers, VCSELs, Synthegra laser, Picosecond infrared laser, Red light laser at 635 nm, Laser (various wavelengths 445–980 nm)	(22, 28, 38, 39, 45)

A variety of dental procedures were examined under Table 3. Some of them encompassed cavity preparation, restoration, and root canal therapy that indicated developments in terms of effectiveness and patient outcomes. Also discussed are uses of laser for surgery on gum, periodontal treatments as well as scaling and root planing in relation to changes in the patients' periodontal health and improvement in treatment time. Researches on dental implants and surgical procedures have been conducted which sought to provide more precision with less invasion.

Besides, studies on cosmetic procedures such as whitening and bleaching showed the aesthetic benefits and satisfaction of patients through laser-assisted therapies' investigations. Overall, these findings emphasize how the latest technological advancements may be applied to improve dental care services within EU countries.

Table 3. Types of Dental Procedures

Types of Dental Procedures	Studies
Cavity preparation, restoration, root canal therapy	(19, 20, 24, 33, 36, 41, 43)
Gum surgery, periodontal treatments, scaling and root planing (SRP), laser therapy	(20, 23, 24, 27, 29, 31, 35, 39, 40)
Dental implants, implant surface modification, abutments	(21, 26, 28, 37, 44)
Surgical procedures, tissue cutting, extractions, reconstructions	(22, 25, 30, 34, 38, 42)
Whitening, bleaching, aesthetic treatments, patient education, plaque control	(20, 27, 32, 43, 45)

The findings as well as complications from studies assessing the effects of present laser technologies on dentistry in EU countries are summarized by table 4. Concerns include that of marginal deterioration and a decline in bonding. On the other hand, for example it is known from here that there are some advantages such as having less pain after an operation and insignificant side effects which could easily suggest better patient comfort.

This implies that thermal damage plus temperature concerns demand proper management during operations. In this regard, there are specific problems like loss of substance, bleeding, and suffering among others that call

attention to possible pitfalls related to laser therapies. Although occasional complications are acknowledged in some researches portraying positive outcomes regarding post-surgical effects; this has slightly clarified the perception of effectiveness and safety of laser techniques in EU dental practices.

Table 4. Distribution of Complications

Complications	Studies
Marginal degradation, impaired adhesion	(19)
Minimal postoperative pain, minor complications	(20, 27, 39, 44)
Thermal damage or temperature issues	(34, 37, 38)
Specific complications like material loss, bleeding, pain	(33, 35, 41, 43)
Focus on post-operative outcomes, rare mentions of complications	(24, 26, 30, 32)

Modern dental laser technologies in European Union countries are associated with oral health benefits found in table 5. The research is based on a few aspects of the positive impacts of this technology which include; healing and satisfaction, high precision and less damage to tissues, periodontal healthiness and reduction in bacteria, making it easier to eat as well as reducing pain experienced during mastication, aesthetic improvements during surgical procedures. In summary, such discoveries therefore point out that laser technology has numerous advantages across different domains of dental cares that produce superior results for patients.

Table 5. Oral Health Outcomes

Outcomes	Studies
Enhanced Healing and Patient Satisfaction	(20, 34, 36, 37, 42, 44)
Improved Precision and Reduced Tissue Damage	(22, 28, 29, 38, 43)
Periodontal Health and Bacterial Reduction	(23, 24, 35, 39, 40)
Functional Improvement and Reduced Pain	(21, 30, 31, 32, 41)
Aesthetic and Procedural Improvements	(19, 25, 26, 27, 33, 45)

DISCUSSION

This current study was aimed at providing a broad categorization of studies assessing the effect of different modern laser technologies in Europe Union countries. The versatility and clinical use of various laser types are highlighted in these studies. The varied applications for erbium (Er) lasers such as 2,94 μm and ErCr variant were considered. Additionally, CO2 lasers ranging from 9,3 μm to combination with Er were looked into. Also, the diode lasers whose wavelengths range from 445 nm to 810 nm are recognized for their usefulness in clinics. Nd lasers (mainly at 1064 nm) are explored together with others like Excimer, Fiber etc. This categorization underscores the broad spectrum of laser technologies shaping advancements in dental treatment outcomes across the EU.

Similarly, another study shows EU dental practices use various lasers, including Erbium, CO2, Diode, Nd, Excimer, and Fiber, for diverse treatments. Robust regulations, training, and clinical guidelines ensure safe and effective laser integration.[46] another study covering wavelengths from 445 nm to 810 nm, diode lasers have demonstrated clinical effectiveness in areas like endodontics, periodontics, and tooth whitening and primarily operating at 1064 nm, Nd lasers are used for various dental procedures, including soft tissue management and tooth whitening. In this way EU's experience with laser dentistry can inform future developments, including advancements in laser system technologies, refinement of treatment protocols, broader integration into general and specialized dental clinics, and improved practitioner and patient acceptability.[17]

The systematic literature review on modern laser technologies in dental procedures within the EU highlights significant advancements in efficacy, patient outcomes, and treatment efficiency. Laser applications in cavity preparation, restoration, and root canal therapy have improved precision, reduced discomfort, and increased success rates. In gum surgery and periodontal treatments, lasers enhance periodontal health and efficiency, with quicker recovery times. Laser use in dental implants and surgical procedures offers greater precision and reduced invasiveness, improving overall outcomes. Additionally, laser-assisted aesthetic treatments, such as whitening, provide superior results and higher patient satisfaction. These findings underscore the transformative potential of lasers in advancing dental care. Similarly, another study revealed that Laser technologies have revolutionized dental care in the EU, enhancing precision, efficiency, and patient outcomes.

Key advancements include precise cavity preparation, effective periodontal therapy, minimally invasive gum surgery, and improved dental implant procedures. Laser-assisted teeth whitening also yields superior results and higher patient satisfaction, transforming aesthetic dental treatments.[47] Furthermore, a study shows European dentists use a variety of lasers for different purposes. Nd:YAG lasers for soft tissue operations and

tooth whitening, diode lasers for gingival and tissue treatments, CO2 lasers for soft tissue surgery. European dentistry uses laser technology for several clinical objectives.

It accurately removes pyogenic granulomas from the maxillary molars and premolars during surgical excisions. Lasers help wound healing and tissue regeneration in soft and hard dental tissues via photobiomodulation therapy. Lasers cut tissue precisely, making them useful for minor dental operations such impacted lower third molar extractions. The different ways lasers are used in European dentistry show how important they are for improving precision, efficiency, and therapeutic results in a wide range of clinical applications, from soft tissue procedures to hard tissue ablation and wound healing.[46]

The current systematic review shows that, even though new dental laser technologies are advantageous in terms of low postoperative pain and improved overall patient outcomes, some important issues must be noted. These include: marginal degradation, impaired adhesion, thermal damage; specific risks like material loss, bleeding and pain. Dental practitioners are required to use a careful technique combined with strict control of laser parameters in order to balance these risks. The overall results positive outcome was that the European Union countries can meaningfully enhance their dental treatment through the adoption of proper skill acquisition and accurate handling of different types of laser technologies.

Nonetheless, further research is required to optimize these advantages while reducing potential hazards. In another study, CO2 laser surgery was also used for craniofacial skin lesions inside and outside of the mouth with melanocytic nevi as the most common. However, carbon dioxide laser surgery has other advantages providing an ideal solution which is best for this complication.[48] Furthermore, epidemic like COVID-19 pandemic necessitated added precautions for dental laser use. Low-energy laser applications remain beneficial with standard precautions, suggesting lasers can enhance dental practice even during the pandemic.

The common complications in laser dentistry, including marginal degradation, impaired adhesion, thermal damage, material loss, bleeding, and pain. Mitigating these risks requires meticulous techniques, stringent control, and proper training. Ongoing research and refinement are essential to balance laser dentistry's benefits with potential complications.[49]

The current systematic literature review also highlights the broad advantages of modern laser technologies in dentistry across European Union countries. Key benefits include faster healing times, higher patient satisfaction, and greater precision, which reduces tissue damage and enhances recovery.[50] Lasers improve periodontal health by reducing bacterial presence and provide functional improvements with less pain during and after procedures. Additionally, lasers offer superior aesthetic results and more efficient treatments, requiring fewer follow-up visits. Overall, these findings underscore the significant improvements in dental care and patient outcomes achieved through the adoption of laser technologies in dentistry.[51]

Similarly other study shows that among the main challenges in adopting laser technologies in dental practices across the EU include the high upfront cost of purchasing and installing laser systems can be a significant barrier for many dental practices, especially smaller clinics. Careful financial planning and exploring financing options are necessary to manage these costs. Integrating laser technology into dental workflows requires specialized training for practitioners. Ensuring adequate training programs and a culture of continuous learning within practices is crucial for the effective and safe use of lasers.[50]

Another study shows that there are the diverse range of laser wavelengths used in dentistry, from visible to infrared spectra, ensures non-ionizing radiation with beneficial effects. Specific lasers like Nd and diodes target precise dental applications, such as caries detection and surgical procedures, while avoiding destructive effects like necrosis and DNA mutagenesis. This technology allows for tailored treatments, enhancing safety and efficacy in dental care.[51]

Furthermore, a study shows that the use of lasers in periodontal and peri-implant therapy aims to enhance treatment outcomes by targeting bacterial reduction, inflammation suppression, and potentially promoting periodontal regeneration. Systematic reviews suggest comparable or slightly better clinical results compared to traditional therapies, albeit with short-term benefits. However, inconsistencies in study protocols and endpoints highlight the need for refined laser treatment protocols to fully harness their therapeutic potential in dental practice.[52]

CONCLUSIONS

This systematic review examined studies examining contemporary laser technologies used in dentistry in European Union countries. Evidently, these technologies have led to significant progress and advantages in diverse dental procedures. The research shows that lasers like Erbium, CO2, Diode, Nd etc are applied for different purposes from cavity preparation or periodontal treatment to dental implants or aesthetic treatments. Benefits included improved precision; reduced tissue damage; better postoperative comfort leading to minimal pain; and aesthetic enhancements.

Though there are few concerns such as thermal damage and material complications, the overall picture is a positive advancement in dental care practices. In conclusion, the use of modern laser technologies by EU

dentist has the potential of transforming both patient experiences and treatment outcomes. The study findings emphasize on the importance of further inquiry into aspects related to safe clinical integration strategies and also optimizing Laser applications across multiple dental procedures. With ongoing developments, therefore it would be essential to investigate long-term results and wider clinical uses as this will enable complete realization of laser technology benefits within the European Union nations' current dental practice systems.

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