IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 25, Issue 7 Ser. 4 (July. 2026), PP 06-14
www.iosrjournals.org

Laser-Assisted Exodontia And Oral Surgery In The United States: Clinical Benefits, Wavelength Selection, And A Risk-Stratified Decision Framework

Paulo Vinicius De Oliveira Bastos
(Specialist In Periodontology, Odontoclínica Central Do Exército (Ocex), Specialist In Implant Dentistry, Federal University Of Rio De Janeiro (UFRJ), Master`S Degree In Orthodontics, Federal University Of Juiz De Fora, Rio De Janeiro, RJ, Brazil)

Caroline Melo Gomes Malaquias
(Specialist In Implant Dentistry, ABO, Specialist In Orthodontics, ABEPO, Vitória Da Conquista, Bahia, Brazil)

Ubyrajara Aquino De Castro Júnior
(Specialist In Oral And Maxillofacial Surgery And Traumatology, University Of Camilo Castelo Branco, SP, Brazil)

Érica Cristina Dos Santos
(Specialist In Pediatric Dentistry, Faculdade Herrero, Curitiba, Paraná, Brazil)

Sarah Frota Loiola
(Dentist, University Of Nova Iguaçu – RJ, Brazil)

Márcio Trevisan Ribeiro
(Dentist, University Of São Francisco– Bragança Paulista, SP, Brazil)

Noemi Borgas De Góes Cavalcanti
(Specialist In Oral And Maxillofacial Surgery And Traumatology – Universidade Sete Lagoas (ABO / FACSETE, Sete Lagoas, MG, Brazil)

Abstract:
Background*: Laser technology has progressively expanded within oral and maxillofacial surgery, offering hemostatic control, antimicrobial action, and enhanced soft- and hard-tissue precision relative to conventional instrumentation.*
Objective: *This narrative review synthesizes current evidence on laser-assisted exodontia and oral surgery, with emphasis on the North American, particularly United States, clinical, regulatory, and commercial landscape.*
Materials and Methods*: A narrative synthesis of peer-reviewed literature (2009–2026) indexed in PubMed, Scopus, and Web of Science was combined with industry market-intelligence reports to characterize adoption trends.*
Results*: Erbium (Er:YAG, Er,Cr:YSGG), carbon dioxide (CO2), neodymium (Nd:YAG), and diode lasers each present distinct wavelength–tissue interactions relevant to extraction and oral surgical procedures, ranging from hemostatic assistance to alveolar ridge preservation and adjunctive photobiomodulation after third-molar surgery. Evidence quality varies by clinical scenario and is frequently graded low to very low certainty, and hemostatic benefit is not absolute in anticoagulated patients. As an original contribution, this review proposes a risk-stratified clinical decision framework matching laser modality to patient- and procedure-specific risk factors, namely anticoagulation, thrombocytopenia, medication-related osteonecrosis of the jaw (MRONJ) risk, diabetes, third-molar surgical complexity, and dental anxiety, contextualized against United States market-adoption and regulatory data, and benchmarked against piezoelectric surgery as a competing energy-based technology.*
Conclusion *Laser-assisted exodontia offers measurable, procedure-specific benefits, but adoption should be guided by patient risk profile, evidence certainty, and practice-level safety capacity rather than by device-marketing claims alone; the proposed framework offers a starting point for evidence-informed, US-practice-relevant decision-making pending prospective validation.*

Key Word: *dental lasers; tooth extraction; oral and maxillofacial surgery; laser wavelength selection; dental service organizations; laser safety.*

Date of Submission: 14-07-2026 Date of Acceptance: 24-07-2026

I. Introduction

Exodontia and minor oral surgery remain among the most frequently performed procedures in general dentistry and oral and maxillofacial surgery practice across the United States. Conventional instrumentation, elevators, forceps, and the surgical scalpel, remains the standard of care, yet an expanding body of clinical literature documents adjunctive or alternative use of laser energy across the stages of extraction and soft- and hard-tissue oral surgery[1]. Proposed benefits include intraoperative hemostasis, bactericidal effects, reduced postoperative discomfort, and, in selected hard-tissue applications, stimulation of alveolar bone repair[2,3].

The United States represents the largest single national market for dental laser systems, a position attributed to early Food and Drug Administration (FDA) clearance of dental laser wavelengths, a dense private-practice and dental service organization (DSO) infrastructure, and high per-capita dental expenditure[4,5]. Despite this commercial maturity, clinical decision-making around which laser wavelength, if any, to use for a given extraction or oral surgical scenario is often guided more by equipment availability and manufacturer marketing than by patient-specific risk stratification or by the certainty of the underlying evidence.

This narrative review has three explicit objectives. First, it aims to synthesize the physical basis, regulatory context, and clinical evidence supporting laser use in exodontia and oral surgery. Second, as an original contribution, it aims to propose a risk-stratified clinical decision framework for laser selection, explicitly contextualized against United States market-adoption data and benchmarked against piezoelectric surgery as a competing bone-conserving technology. Third, it aims to critically examine, in the discussion, the certainty of the evidence underlying each proposed indication, in order to help bridge the gap between device availability, marketing claims, and patient-specific clinical indication. The literature-identification and synthesis process used to support these objectives is described in Section II.

II. Material And Methods

Study design

This work is a narrative literature review rather than a systematic review or an original clinical trial. It synthesizes existing peer-reviewed clinical, regulatory, and industry literature relevant to laser-assisted exodontia and oral surgery in the United States and proposes, as an original contribution, a risk-stratified clinical decision framework derived from that synthesis. No original patient data were collected, and no institutional review board approval was required, as the review relied exclusively on previously published, de-identified literature.

Data sources and search strategy

A structured, though not exhaustive, search was conducted across PubMed/MEDLINE, Scopus, and Web of Science, covering publications from January 2009 through July 2026. Search terms combined controlled vocabulary and free-text keywords, including "dental laser," "Er:YAG," "Er,Cr:YSGG," "Nd:YAG," "diode laser," "CO2 laser," "exodontia," "tooth extraction," "oral surgery," "hemostasis," "medication-related osteonecrosis of the jaw," "alveolar ridge preservation," "photobiomodulation," "low-level laser therapy," "third molar," "piezoelectric surgery," and "laser safety," combined with Boolean operators (AND/OR). Reference lists of retrieved systematic reviews and clinical guidance documents were hand-searched for additional eligible sources (backward citation tracking). Institutional and regulatory sources, namely the American Dental Association, the Academy of Laser Dentistry, and the United States Food and Drug Administration's Center for Devices and Radiological Health, were consulted directly for regulatory and safety content not indexed as primary research. Two proprietary industry market-intelligence reports were additionally consulted to characterize commercial adoption trends, since this information is not available through peer-reviewed sources and is explicitly flagged as such throughout the text.

Inclusion and exclusion criteria

Eligible sources included peer-reviewed randomized controlled trials, systematic reviews and meta-analyses, prospective and retrospective comparative studies, case series with a clearly defined clinical protocol, and clinical guidance or position statements issued by recognized professional bodies, published in English between 2009 and 2026. Priority was given to evidence generated in, or directly applicable to, United States clinical and regulatory practice; non-US studies were included when they addressed a wavelength-tissue interaction, clinical outcome, or safety principle without a documented North American equivalent, and are identified as such in the text. Sources were excluded if they were non-peer-reviewed opinion pieces without original data or a defined clinical protocol, addressed laser applications unrelated to exodontia or oral surgery (e.g., purely cosmetic or orthodontic laser use), or were available only as conference abstracts without a

corresponding full-text manuscript. Industry market reports were included only when directly relevant to laser-system adoption in dentistry and are explicitly identified in the text as non-peer-reviewed sources.

Data extraction and synthesis

Given the heterogeneity of study designs, outcome measures, and laser parameters across the identified literature, a narrative rather than quantitative (meta-analytic) synthesis was performed. For each clinical domain addressed in Section III, namely hemostasis, antimicrobial and soft-tissue effects, postoperative sequelae of third-molar surgery, MRONJ management, and alveolar ridge preservation, the authors extracted study design, population, laser wavelength and parameters where reported, comparator, principal outcomes, and, where available, the certainty of evidence as graded by the primary source (for example, GRADE ratings reported within the included systematic reviews). These graded certainty ratings were not independently re-assessed by the authors but were taken directly from the cited systematic reviews and meta-analyses, and are reported as such throughout Sections III and V. The risk-stratified decision framework presented in Section IV was then constructed by the authors through a structured mapping exercise, in which each patient- or procedure-level risk category was cross-referenced against the wavelength(s) with the strongest supporting rationale identified during data extraction, together with the practical caution warranted by the certainty and design of the corresponding supporting evidence.

Ethical considerations

As this review synthesizes previously published literature and does not involve human participants, patient records, or original data collection, institutional review board approval and informed consent were not applicable. Case-level information cited from previously published case series (Section III) is reported exactly as de-identified in the original publications, with no additional identifying detail introduced by the authors. Methodological limitations specific to the narrative, rather than systematic, nature of this review, including the absence of a pre-registered protocol and of bias assessment, are discussed in detail in Section V.

III. Result

Physical principles of wavelength selection

Laser effect on oral tissue depends on the interaction between a given wavelength and the dominant tissue chromophore, namely water, hemoglobin, melanin, or hydroxyapatite. Diode wavelengths (810–980 nm) are preferentially absorbed by hemoglobin and melanin, favoring soft-tissue cutting and coagulation with limited penetration into hard tissue[2]. Erbium wavelengths (Er:YAG, 2,940 nm; Er,Cr:YSGG, 2,780 nm) are strongly absorbed by water and hydroxyapatite, enabling ablation of both soft and hard (bone, enamel, dentin) tissue with comparatively limited thermal spread. Carbon dioxide lasers (9,300–10,600 nm) are also water-absorbed and are considered a reference standard for soft-tissue oral surgery, with coagulation depth sufficient to seal superficial gingival vessels[6]. Neodymium (Nd:YAG, 1,064 nm) wavelengths penetrate more deeply and are used both for surgical cutting and, at sub-ablative fluence, for photobiomodulation (PBM).

Regulatory history and adoption in the United States

The FDA cleared the first laser designed specifically for general dental use, an Nd:YAG system, in the early 1990s; subsequent clearances expanded to CO2, additional Nd:YAG platforms, argon, diode wavelengths (810, 940, 980, and 1,064 nm), Er:YAG, Er,Cr:YSGG, and potassium titanyl phosphate (KTP) systems[2]. This sequential regulatory pathway underlies the current diversity of commercially available systems in the US market, discussed further in Section IV.

Comparative characteristics of dental laser wavelengths relevant to exodontia

Table 1: Comparative characteristics of dental laser wavelengths relevant to exodontia

Laser type	Representative wavelength	Primary chromophore	Principal role in exodontia / oral surgery
Diode	810–980 nm	Hemoglobin, melanin	Soft-tissue incision, hemostasis of gingival tissue, adjunctive photobiomodulation
Nd:YAG	1,064 nm	Hemoglobin, pigmented tissue	Deep coagulation, surgical cutting, low-level laser therapy (LLLT/PBM)
Er:YAG	2,940 nm	Water, hydroxyapatite	Bone and hard-tissue ablation, socket debridement, minimal thermal damage
Er,Cr:YSGG	2,780 nm	Water, hydroxyapatite	All-tissue (hydrokinetic) cutting of bone and soft tissue
CO2	9,300–10,600 nm	Water	Soft-tissue excision with superficial vessel coagulation

Note. Wavelength ranges and chromophore associations synthesized from refs. [1,2].

Laser safety and regulatory compliance in United States practice

Clinical adoption of any laser wavelength in the United States operates within a defined regulatory and safety framework rather than as an unregulated equipment choice. All dental laser systems marketed in the United States are classified under the Federal Laser Product Performance Standard administered by the FDA's Center for Devices and Radiological Health, with hazard classes ranging from Class I devices posing no implicit risk to Class IV surgical lasers requiring dedicated protective eyewear, a designated Laser Safety Officer, engineering controls such as remote door interlocks, and written standard operating procedures specific to each practice setting[7].

The Academy of Laser Dentistry's position paper on laser safety specifies wavelength-specific ocular and cutaneous hazards for each of the systems reviewed in Section 3.3, ranging from retinal injury with diode and Nd:YAG wavelengths to corneal and lenticular injury with Er:YAG, Er,Cr:YSGG, and CO2 systems, and recommends administrative controls including a defined Nominal Hazard Zone, laser-specific protective eyewear for staff and patients, mandatory operator training, and periodic recertification[7]. These requirements carry direct implications for the decision framework proposed in Section IV: adopting a given wavelength in a general practice setting is not solely a matter of acquisition cost or clinical indication, but also of the practice's demonstrated capacity to meet the safety-officer, training, and engineering-control requirements attached to that laser's hazard class, a dimension largely absent from device-marketing literature.

Hemostasis and bleeding control

Erbium laser use across sequential stages of extraction (ligament separation and socket curettage) has been reported to shorten hemostasis duration relative to conventional technique in patients with thrombocytopenia (80.9 ± 35.9 versus 175 ± 67 minutes), alongside reduced postoperative pain and edema[8]. However, hemostatic benefit is not absolute: a retrospective comparative study of Nd:YAG laser-assisted versus conventional local hemostasis in cardiac-risk patients maintained on uninterrupted anticoagulant therapy found that laser assistance did not eliminate bleeding complications and was not superior to conventional measures in preventing them[9]. Independently of laser technique, a retrospective study of 418 simple extractions in anticoagulated and/or antiplatelet-treated patients found a low but non-negligible severe bleeding rate (2.11%), concentrated disproportionately among patients taking newer direct oral anticoagulants[10]. This body of evidence argues against treating laser-assisted hemostasis as a substitute for standard perioperative anticoagulation management.

Antimicrobial effect and soft-tissue healing

A 2024 narrative review of 67 studies published between 2018 and 2023 concluded that photobiomodulation reduces inflammation and accelerates tissue repair following oral and periodontal surgery, alongside bactericidal effects at the treated site[1]. In patients with type 2 diabetes mellitus, a population with well-documented delayed post-extraction healing, diode laser therapy applied after extraction has been reported to accelerate blood clot formation and reduce postoperative complications relative to no laser treatment, an effect attributed to stimulation of fibroblast and macrophage activity and suppression of pro-inflammatory cytokines.

Photobiomodulation for pain, swelling, and trismus after third-molar surgery

Postoperative pain, facial swelling, and trismus following surgical removal of impacted third molars represent the most extensively studied outcome domain in laser-assisted oral surgery, reflecting both the high volume of third-molar extractions performed in United States practice and nearly three decades of accumulated low-level laser therapy (LLLT) and photobiomodulation (PBM) trials. A 2017 systematic review update, commissioned as part of an ongoing evidence-based series in the Journal of the American Dental Association, pooled 33 randomized controlled trials (23 in meta-analysis, 1,347 participants) and found a statistically significant reduction in pain on the third postoperative day, a modest reduction in edema on the second postoperative day, and a modest reduction in trismus on the seventh postoperative day among patients receiving adjunctive PBM, with the certainty of evidence graded low to very low across all three outcomes[11].

A subsequent 2025 update in the same journal, restricted specifically to split-mouth randomized trials and pooling 18 studies out of 803 initially identified references, reaffirmed a significant reduction in pain and swelling at 48 hours and in trismus at 7 days with adjunctive diode LLLT, while again rating the overall certainty of evidence as low and explicitly cautioning that heterogeneity across protocols, wavelengths, and dosimetry parameters limits the strength of any firm practice recommendation[12]. Taken together, these two Journal of the American Dental Association-published reviews, separated by nearly a decade of additional trial data, reach a strikingly consistent conclusion: adjunctive PBM after third-molar surgery produces a statistically detectable but modest-magnitude, low-certainty benefit, one that is most defensibly framed to patients as a plausible adjunct rather than as a substitute for standard postoperative analgesic and anti-inflammatory management.

Management of patients at risk for medication-related osteonecrosis of the jaw (MRONJ)

Trauma from dental extraction is a recognized predisposing factor for MRONJ in patients receiving antiresorptive or antiangiogenic therapy. In a case series of 589 extractions performed in 217 patients under bisphosphonate therapy, a protocol combining antibiotic coverage with Nd:YAG low-level laser therapy was associated with only minimal bone exposure in five extractions, all of which subsequently healed after Er:YAG laser vaporization[13]. More recently, a combined surgical approach using piezoelectric osteotomy, Er:YAG laser ablation of necrotic bone, and Nd:YAG photobiomodulation achieved complete mucosal healing without recurrence over more than four years of follow-up in a high-risk oncologic patient with established stage 3 MRONJ[14]. These findings, while largely derived from case-series-level evidence, support laser-adjunctive protocols as a reasonable component of extraction planning in antiresorptive-treated patients, particularly given the absence of formally agreed extraction guidelines for this population.

Alveolar ridge preservation

A 2026 systematic review and meta-analysis of laser-assisted alveolar bone preservation after extraction found that Er:YAG laser therapy, surgically applied Nd:YAG, and Nd:YAG-based photobiomodulation each produced statistically and clinically significant preservation of alveolar ridge dimensions compared with standard care, with mean differences of approximately 1.12 mm, 1.15 mm, and 1.20 mm respectively, and the largest effects observed within the first month after extraction[3]. The overall certainty of evidence was rated moderate, reflecting methodological heterogeneity and incomplete reporting across the included primary studies, a limitation that should temper enthusiasm pending further randomized trials.

Patient comfort and reduced anesthesia requirements

Pulsed CO2 systems marketed for combined hard- and soft-tissue use are frequently promoted for enabling extraction-adjacent soft-tissue procedures with reduced or no local anesthesia, an attribute of particular relevance to anxious or pediatric patients. While plausible on the basis of wavelength-specific tissue interaction, this specific claim currently rests more on manufacturer and clinical-adoption literature than on independent randomized comparative trials, and should be interpreted with corresponding caution.

IV. Original Contribution:

A risk-stratified clinical decision framework contextualized to the United States market.

Rationale

Section III illustrates that the clinical case for laser assistance in exodontia is wavelength- and scenario-specific rather than uniform, and that the certainty of the underlying evidence ranges from moderate (ridge preservation) to low or very low (hemostasis in special populations, PBM for third-molar sequelae). A clinician selecting a laser system, or deciding whether to use one at all, benefits from a framework that maps patient- and procedure-level risk factors onto the wavelength(s) with the strongest supporting rationale, while remaining explicit about the limits of current evidence and the practice-level safety obligations described in Section 3.4.

To the authors' knowledge, existing narrative and systematic reviews describe wavelength-specific evidence in isolation; none couples this evidence into a single risk-stratified decision aid, nor situates it against United States market-adoption and safety-compliance realities that determine which systems a given practice is actually likely to have access to and be equipped to operate safely. This section proposes such a framework as the original contribution of this review

Proposed decision framework

Table 2: Risk-stratified clinical decision framework for laser selection in exodontia and oral surgery

Patient / procedural risk category	Principal concern	Laser(s) with strongest supporting rationale	Practical caution
Thrombocytopenia / impaired platelet hemostasis	Prolonged intra- and postoperative bleeding	Er:YAG (non-contact mode, staged use)	Evidence is limited to small comparative cohorts[8]; does not replace hematologic clearance
Anticoagulant / antiplatelet therapy (uninterrupted)	Bleeding despite local hemostatic measures	Nd:YAG as adjunct only	Not shown to be superior to conventional local hemostasis[9]; continue standard perioperative anticoagulation protocols
Antiresorptive/antiangiogenic therapy (MRONJ risk)	Delayed healing, osteonecrosis	Er:YAG (bone ablation) + Nd:YAG low-level laser therapy / PBM	Evidence largely case-series level[13,14]; requires antibiotic coverage and close follow-up
Diabetes mellitus / impaired wound healing	Delayed socket healing, infection	Diode PBM as postoperative adjunct	Benefit reported mainly in small clinical reports; glycemic control remains the primary determinant of healing

Impacted third-molar surgery (routine or surgically complex)	Postoperative pain, swelling, trismus	Diode PBM as postoperative adjunct	Statistically significant but low-certainty, modest-magnitude benefit[11,12]; not a substitute for standard analgesia
Dental anxiety, pediatric or special-needs patients	Behavioral tolerance, anesthesia aversion	Pulsed CO2 (all-tissue systems)	Anesthesia-reduction claims are largely industry-sourced; confirm with case selection and backup anesthesia plan
Elective ridge preservation for future implant	Post-extraction bone resorption	Er:YAG, surgical Nd:YAG, or Nd:YAG-PBM	Moderate-certainty evidence[3]; largest effect within first postoperative month
Routine extraction, no elevated risk factors	Standard efficiency and patient comfort	Conventional technique, piezosurgery, or diode as low-cost adjunct	Laser use should be justified by an identified risk factor or patient preference, not by default

Laser-assisted versus piezoelectric bone surgery: a competing energy-based technology

Er:YAG and Er,Cr:YSGG laser systems are not the only energy-based alternative to conventional rotary instrumentation for bone-involving extractions and osteotomies; piezoelectric ultrasonic surgery represents a well-established competing technology with an independent and substantial evidence base. A 2023 meta-analysis published in the Journal of Oral and Maxillofacial Surgery, the official journal of the American Association of Oral and Maxillofacial Surgeons, found that piezoelectric osteotomy for impacted lower third-molar removal was associated with statistically significant reductions in postoperative pain, facial swelling, and trismus relative to conventional rotary burs, at the cost of a longer average operating time[15].

This evidence profile is notably similar in direction, though not always in magnitude, to that reported for erbium laser-assisted extraction technique in Section 3.5. Piezoelectric units are generally available at a substantially lower acquisition cost than all-tissue erbium laser platforms and, being ultrasonic rather than optical devices, do not carry the Class IV laser safety, protective-eyewear, or Laser-Safety-Officer requirements detailed in Section 3.4, which may make piezosurgery the more practically accessible option for practices whose primary interest is bone-sparing extraction technique rather than the additional soft-tissue, hemostatic, and photobiomodulatory applications that laser platforms uniquely offer. The risk-stratified framework in Section 4.2 should therefore be read as identifying scenarios in which laser-specific properties, most notably simultaneous hemostasis, bactericidal effect, and PBM, provide an advantage that piezosurgery cannot replicate, rather than as a blanket recommendation for laser over all alternative bone-conserving technologies.

United States market context and practical feasibility

The clinical relevance of the framework above depends on which laser systems a given United States practice can realistically access. Industry market-intelligence estimates vary in magnitude but converge on several directional trends. One 2026 forecast estimated the global dental lasers market at approximately USD 401 million in 2026, growing to nearly USD 590 million by 2031, with oral surgery accounting for the largest application-based share (31.56% in 2025) and diode systems holding the largest technology share (36.54%), while erbium (Er:YAG) systems were projected to grow fastest (10.65% CAGR, 2026–2031); this same source placed North America's regional market share at 40.34% in 2025[5]. A separate market report projected North America's global value share at 47.3% in 2026, attributing regional leadership to dental-care spending, technological infrastructure, and early adoption of FDA-cleared systems[4]. The differing percentage figures across these two industry sources reflect divergent proprietary estimation methodologies rather than a documented discrepancy in underlying adoption; both, however, agree that North America, led by the United States, is the leading regional market and that oral surgery is among the top clinical-application segments.

This market structure has direct implications for the framework in Section 4.2. Diode systems (e.g., AMD Lasers Picasso/Pioneer lines), being the lowest-cost and most widely distributed category, are the most realistic option for diode-appropriate indications (soft-tissue adjuncts, diabetic PBM, third-molar postoperative PBM) across general practice settings, including smaller independent offices. All-tissue erbium and dual-wavelength systems (e.g., BIOLASE Waterlase, Fotona LightWalker), relevant to MRONJ management and ridge preservation, represent a substantially higher capital investment and are disproportionately concentrated in oral surgery, periodontal, and larger DSO-affiliated practices, consistent with the fast projected growth of the erbium segment as DSOs standardize equipment across multi-site footprints. Pulsed CO2 systems marketed for anesthesia-reduced extraction workflows (e.g., Convergent Dental Solea) occupy an intermediate niche, typically found in cosmetically or technologically differentiated general practices. Clinicians and practice administrators applying the framework in Section 4.2 should therefore weigh not only the strength and certainty of supporting evidence for a given wavelength, and the safety-compliance burden described in Section 3.4, but also the realistic likelihood that the indicated system is available in their practice setting, or whether referral to a better-equipped colleague is the more appropriate course.

Limitations of the proposed framework

The framework proposed here is a literature-derived synthesis intended to structure clinical reasoning; it has not itself been prospectively validated, and several of its supporting citations are case-series or small comparative studies rather than randomized controlled trials. It should be regarded as a starting decision aid for further empirical testing, ideally through prospective, US-practice-based cohorts stratified by the risk categories proposed, rather than as a clinical practice guideline.

V. Discussion

The evidence reviewed supports a nuanced, rather than categorical, view of laser-assisted exodontia and oral surgery. Hemostatic, antimicrobial, hard-tissue regenerative, and postoperative-comfort benefits are documented across several laser wavelengths, but the magnitude and reliability of these benefits vary considerably by clinical scenario, and in at least one well-designed comparative study, a commonly cited benefit (Nd:YAG hemostasis in anticoagulated patients) failed to demonstrate superiority over conventional technique[9]. This heterogeneity underscores the value of matching laser selection to patient-specific risk rather than assuming uniform benefit across indications, the premise underlying the risk-stratified framework proposed in Section IV.

A recurring pattern across nearly every clinical-evidence domain reviewed in Section III deserves explicit discussion: the certainty of evidence, when formally graded, is rarely higher than moderate and is frequently low or very low. Ridge preservation carries the strongest evidence base reviewed here, rated moderate certainty[3], reflecting a relatively recent, well-conducted systematic review and meta-analysis. By contrast, the two most methodologically rigorous bodies of evidence on adjunctive photobiomodulation for third-molar postoperative sequelae, both commissioned within the same evidence-based series of the Journal of the American Dental Association and separated by eight years, each explicitly rated their pooled effect estimates as low or very low certainty despite reaching statistically significant point estimates[11,12]. Hemostasis evidence in special populations is smaller in scale still, resting on individual comparative cohorts rather than systematic synthesis[8,9,10], and MRONJ-protocol evidence is case-series level almost by necessity, given the rarity and ethical constraints of randomizing high-risk oncologic and osteoporotic patients to alternative extraction protocols[13,14]. This gradient in evidence certainty matters clinically: a statistically significant reduction in pain of modest magnitude, graded low certainty across repeated independent reviews, warrants a materially different conversation with a patient, and a materially different weight in a purchasing decision, than would a large, moderate- or high-certainty effect. Clinicians applying the framework in Section 4.2 should communicate this distinction explicitly rather than allow a single significant p-value to imply a settled clinical question.

A second dimension warranting discussion is the economic and practice-management context in which these certainty gradients are weighed. Section 4.3 introduced piezoelectric surgery as a direct competitor to erbium laser platforms for bone-involving procedures, with a broadly similar direction of postoperative benefit over conventional rotary technique[15] but a substantially lower acquisition cost and none of the Class IV laser safety obligations detailed in Section 3.4. Set against the market-adoption data in Section 4.4, in which erbium systems are projected to be the fastest-growing laser technology segment even as dental service organizations standardize equipment across multi-site footprints[4,5], this raises a genuine practice-management question that the existing literature does not resolve: whether the incremental benefit specific to laser energy, principally simultaneous hemostasis, bactericidal action, and photobiomodulation, justifies its additional acquisition, training, and regulatory-compliance burden relative to piezosurgery for practices whose primary procedural need is bone-conserving extraction technique rather than these laser-specific properties.

Third, the safety and training dimension introduced in Section 3.4 is not a peripheral regulatory footnote but a material input to the risk-stratified framework itself. A Class IV surgical laser carries defined ocular, cutaneous, plume, and fire hazards that require a designated Laser Safety Officer, wavelength-specific protective eyewear for every person in the treatment area, and documented operator training and recertification[7]. A practice that acquires an all-tissue erbium or CO2 system to access the MRONJ- or ridge-preservation-relevant indications identified in Section 4.2, without also investing in the associated safety infrastructure, has not meaningfully implemented the evidence reviewed in Section III; it has merely acquired equipment. Any prospective validation of the proposed framework, called for throughout this review, should therefore measure not only clinical outcomes but also documented compliance with these safety and training requirements as a precondition for interpreting outcome data as representative of appropriately delivered laser-assisted care.

Fourth, the gap between industry-sourced claims and independently replicated clinical evidence, most visible in Section 3.10's discussion of anesthesia-reduction marketing for pulsed CO2 systems, carries a patient-communication obligation. Clinicians who adopt laser technology on the basis of manufacturer literature or trade-show demonstrations, rather than the graded evidence summarized in Section III, risk overstating expected benefit to patients at the point of informed consent. This is not a hypothetical concern specific to this review: the low-certainty grading attached to even the best-studied laser indication in this literature, adjunctive PBM after third-molar surgery, was reached independently by two separate JADA-commissioned systematic reviews eight years

apart, despite an expanding trial base[11,12], suggesting that additional primary studies alone, without harmonized dosimetry and outcome-reporting standards, may not resolve this uncertainty. Consistent, non-inflated communication of expected benefit magnitude, and explicit acknowledgment when a claim (such as anesthesia-free extraction) rests on industry rather than peer-reviewed evidence, should be considered part of the standard of care for laser-adopting practices.

Several limitations apply to this review itself. First, as a narrative rather than systematic review, source selection, while broad and spanning regulatory, clinical, and market-intelligence literature, was not exhaustive nor governed by a pre-registered protocol, and is therefore subject to selection bias in ways a PRISMA-guided systematic review would constrain, as noted in Section 2.5. Second, much of the supporting clinical evidence, particularly for MRONJ management and hemostasis in special populations, derives from case series or small comparative cohorts rather than randomized controlled trials, limiting the strength of causal inference; even where systematic reviews and meta-analyses were available, as for third-molar PBM and ridge preservation, the authors of those primary sources themselves graded certainty as low to moderate, a limitation this review has inherited rather than resolved. Third, the market-adoption data presented in Section 4.4 originate from proprietary industry reports rather than peer-reviewed sources and should be interpreted as directional rather than precise; the two sources cited here diverge in specific percentage estimates despite agreeing on overall direction, underscoring that these figures should not be treated with false precision. Fourth, the comparative discussion of piezosurgery in Section 4.3 draws on a single meta-analysis specific to third-molar surgery and may not generalize to other bone-involving procedures such as ridge preservation or MRONJ management, for which head-to-head laser-versus-piezosurgery trials do not yet exist. Finally, the proposed decision framework itself requires prospective validation, ideally through a multi-site United States DSO-based cohort that stratifies patients by the risk categories proposed in Section 4.2, tracks both clinical outcomes and safety-compliance measures as discussed above, and reports outcomes using harmonized PBM dosimetry parameters, before adoption as formal clinical guidance.

VI. Conclusion

In conclusion, laser-assisted exodontia and oral surgery offer measurable, procedure- and population-specific benefits within the United States dental care landscape, a market characterized by substantial device diversity, an active competing technology in piezoelectric surgery, and continued growth, particularly in oral surgery applications. Rather than treating laser adoption as a uniform technological upgrade, clinicians are better served by risk-stratified selection, informed by patient bleeding risk, MRONJ risk, glycemic status, third-molar surgical complexity, behavioral factors, and future restorative planning, weighed against the certainty of the underlying evidence, the practice's capacity to meet applicable laser-safety obligations, and the realistic availability of appropriate systems within their practice setting. The framework proposed in this review offers an initial, literature-grounded structure for that decision-making process, pending further prospective validation that should test not only clinical effectiveness but also the framework's practical feasibility under real-world United States regulatory and practice-management constraints.

References

[1]. Sachelarie L, Cristea R, Burlui E, Hurjui LL. Laser Technology In Dentistry: From Clinical Applications To Future Innovations. Dent J. 2024;12(12):420. Doi:10.3390/Dj12120420

[2]. Gutiérrez-Corrales A, Rizcala-Orlando Y, Montero-Miralles P, Volland G, Gutiérrez-Pérez JL, Torres-Lagares D, Serrera-Figallo MA. Comparison Of Diode Laser–Oral Tissue Interaction To Different Wavelengths. In Vitro Study Of Porcine Periodontal Pockets And Oral Mucosa. Med Oral Patol Oral Cir Bucal. 2020;25(2):E224–E232. Doi:10.4317/Medoral.23317

[3]. Gryka-Deszczyńska M, Dembicka-Mączka D, Fiegler-Rudol J, Skaba D, Wiench R. Laser-Assisted Strategies For Alveolar Bone Preservation After Tooth Extraction: A Systematic Review And Meta-Analysis. J Clin Med. 2026;15(4):1447. Doi:10.3390/Jcm15041447

[4]. Persistence Market Research. Dental Lasers Market Size, Share & Growth Report, 2033 [Industry Market Report]. 2026. Available From: Https://Www.Persistencemarketresearch.Com/Market-Research/Dental-Lasers-Market.Asp

[5]. Mordor Intelligence. Dental Lasers Market Size, Share & Trends Report, 2031 [Industry Market Report]. 2026. Available From: Https://Www.Mordorintelligence.Com/Industry-Reports/Dental-Lasers-Market

[6]. Lightscalpel. Comparing Surgical CO2 Laser Technologies [Industry Technical Resource, Citing The American Dental Association Guide To Dental Lasers]. 2025. Available From: Https://Www.Lightscalpel.Com/Products/Co2-Laser-Surgery-Technology/Surgical-Co2-Laser-Technologies/

[7]. Sweeney C, Coluzzi DJ, Parker P, Parker SPA, Sulewski JG, White JM; Laser Safety Committee, Academy Of Laser Dentistry. Laser Safety In Dentistry: A Position Paper. J Laser Dent. 2009;17(1):39–49.

[8]. Larionova EV, Diachkova EY, Morozova EA, Davtyan AA, Tarasenko SV. Laser-Assisted Tooth Extraction In Patients With Impaired Hemostasis. Biomedicine (Taipei). 2021;11(2):51–60. Doi:10.37796/2211-8039.1072

[9]. Deppe H, Mücke T, Auer-Bahrs J, Wagenpfeil S, Kesting M, Sculean A. Bleeding Complications Following Nd:YAG Laser-Assisted Oral Surgery Vs Conventional Treatment In Cardiac Risk Patients: A Clinical Retrospective Comparative Study. Quintessence Int. 2013;44(7):513–520. Doi:10.3290/J.Qi.A29508

[10]. Martínez-Moreno E, Martínez-López F, Rodríguez-Lozano FJ, Oñate-Sánchez RE. Bleeding Complications In Anticoagulated And/Or Antiplatelet-Treated Patients At The Dental Office: A Retrospective Study. Int J Environ Res Public Health. 2021;18(4):1609. Doi:10.3390/Ijerph18041609

[11]. Dawdy J, Halladay J, Carrasco-Labra A, Araya I, Yanine N, Brignardello-Petersen R. Efficacy Of Adjuvant Laser Therapy In Reducing Postsurgical Complications After The Removal Of Impacted Mandibular Third Molars: A Systematic Review Update And Meta-Analysis. J Am Dent Assoc. 2017;148(12):887–902.E4. Doi:10.1016/J.Adaj.2017.06.043
[12]. Ferreira González F, Caponio VCA, López-Pintor RM, Kemcha N, Torres J, Leco Berrocal I. Effectiveness Of Low-Level Diode Laser In The Management Of Complications After Third-Molar Surgical Extraction: Systematic Review And Meta-Analysis. J Am Dent Assoc. 2025;156(3):211–224.E11. Doi:10.1016/J.Adaj.2024.12.008
[13]. Vescovi P, Meleti M, Merigo E, Manfredi M, Fornaini C, Guidotti R, Nammour S. Case Series Of 589 Tooth Extractions In Patients Under Bisphosphonates Therapy. Proposal Of A Clinical Protocol Supported By Nd:YAG Low-Level Laser Therapy. Med Oral Patol Oral Cir Bucal. 2013;18(4):E680–E685. Doi:10.4317/Medoral.18812
[14]. Vescovi P, De Francesco P, Giovannacci I, Leão JC, Barone A. Piezoelectric Surgery, Er:YAG Laser Surgery And Nd:YAG Laser Photobiomodulation: A Combined Approach To Treat Medication-Related Osteonecrosis Of The Jaws (MRONJ). Dent J. 2024;12(8):261. Doi:10.3390/Dj12080261
[15]. Nogueira DGM, Leão JC, Sales PHDH, Silva PGB, Gomes ACA. Piezoelectric Surgery Is Effective In Reducing Pain, Swelling, And Trismus After Removal Of Impacted Lower Third Molars: A Meta-Analysis. J Oral Maxillofac Surg. 2023;81(4):483–498. Doi:10.1016/J.Joms.2022.10.020