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Review Article

The Most Performed Surgery in Dentistry Under Scrutiny: A Comprehensive Review of Surgical Decision-Making, Technique Selection and Risk Stratification in Contemporary Oral Surgery

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Abstract

Background: Third molar extraction is the most frequently performed surgical procedure in dentistry worldwide, yet its clinical management remains inconsistent. Despite abundant literature on individual aspects of third molar care, a comprehensive, integrated framework combining evidence-based indications, preoperative assessment, surgical technique selection and complication risk stratification is lacking in current practice.

Objective: To critically synthesize current evidence on third molar management, with emphasis on extraction indications, classification systems, imaging selection, surgical technique, complication profiles, preventive strategies and the role of individualized risk stratification in clinical decision-making.

Methods: A narrative review was conducted using PubMed/MEDLINE, Scopus and Google Scholar. Search terms included "third molar," "impacted third molar," "wisdom tooth extraction," "inferior alveolar nerve injury," "dry socket," "CBCT," "coronectomy," and "platelet-rich fibrin," among others. Priority was given to systematic reviews, randomized controlled trials and high-impact narrative reviews published within the last five years; landmark studies were included when historically relevant. Literature was organized into thematic domains and synthesized qualitatively.

Results: Postoperative complications occur in approximately 10% of cases, with impaction depth, patient age, root proximity to the inferior alveolar canal and surgical duration as the primary predictors. Prophylactic extraction of asymptomatic, disease-free third molars lacks sufficient high-quality evidence to support or refute the practice. Traditional classification systems show limited predictive accuracy for surgical difficulty and must be complemented by selective cone-beam computed tomography imaging in high-risk cases. Coronectomy substantially reduces inferior alveolar and lingual nerve injury rates compared to complete extraction in anatomically complex cases. Minimally invasive strategies, including piezosurgery and platelet-rich fibrin socket management, demonstrate consistent benefits for postoperative morbidity reduction.

Conclusion: Evidence-based third molar management requires individualized preoperative assessment, selective use of advanced imaging, technique selection matched to anatomical complexity and operator experience and structured complication prevention protocols. Routine prophylactic extraction should give way to a risk-stratified, patient-centered approach that prioritizes informed decision-making and timely multidisciplinary collaboration.

Keywords: Third Molar Surgery; Impacted Third Molar; Inferior Alveolar Nerve Injury; Coronectomy; Evidence-Based Dentistry

The Most Performed Surgery in Dentistry Under Scrutiny: Reframing Third Molar Management Through an Evidence-Based Lens

Third molar extraction stands as the single most performed surgical procedure in dentistry worldwide, yet its indications, timing and necessity remain among the most debated topics in the field [1]. This review examines the epidemiological scope of third molar impaction, the clinical and economic burden of associated pathology and the historical shift from routine prophylactic extraction toward individualized, evidence-based decision-making. The central question this paper seeks to address is both straightforward and genuinely unresolved: are we operating on the right patients, with the right techniques, at the right time?

The third molar is the last tooth to complete development, typically reaching full maturation between the ages of 18 and 25 years. Its late eruption, combined with the limited space available within the dental arches, frequently results in impaction, whether against the adjacent second molar, within the alveolar bone or in an ectopic position altogether. The clinical consequences of impaction are well documented and span a broad spectrum, from pericoronitis and fascial space infections to osteomyelitis, carious destruction of the second molar, periodontal damage, odontogenic cysts, and, in rare cases, neoplastic transformation [2,3]. The global prevalence of third molar impaction in individuals over 17 years of age has been estimated at 24.4%, with reported rates across individual studies ranging from 3% to nearly 69%, reflecting substantial variation by race, age and dietary patterns [3].

From a clinical standpoint, sound management of third molars demands far more than a surgical decision alone. Each patient requires individualized preoperative evaluation that accounts for medical history, anatomical characteristics, anticipated surgical difficulty and the patient's own preferences and socioeconomic context. The need for general anesthesia, for example, is not a fixed threshold but a judgment call shaped by surgical complexity, the number of teeth involved and behavioral factors, all of which introduce meaningful variability into preoperative planning [4].

Postoperative morbidity remains a genuine and relevant concern. The most common outcomes following third molar surgery include pain and swelling, which are transient and expected; however, more significant complications as trismus, hemorrhage, alveolar osteitis, injury to the inferior alveolar or lingual nerve and periodontal compromise of the adjacent second molar; occur with a frequency that cannot be dismissed [4,5]. The incidence and severity of these events are shaped by surgical duration, flap design, bone removal technique and irrigation method, among other variables, underscoring the degree to which technique matters [5].

Despite this morbidity profile, significant controversy persists around the prophylactic removal of asymptomatic, disease-free third molars. Major international guidelines have taken divergent positions on this question. The National Institute for Health and Care Excellence (NICE) concluded as early as 2000 that there was insufficient evidence to support routine prophylactic removal, advocating instead for active monitoring [6]. The American Association of Oral and Maxillofacial Surgeons (AAOMS), by contrast, has long supported early extraction of impacted third molars, even in the absence of symptoms, on the basis that asymptomatic impaction does not reliably exclude underlying or progressive pathology [7]. This unresolved tension between watchful waiting and early intervention continues to shape clinical practice unevenly across institutions, countries and specialties.

In recent years, minimally invasive surgical approaches have entered routine oral surgical practice. Piezoelectric surgery, in particular, has accumulated meaningful evidence supporting its use in third molar extraction: systematic reviews have demonstrated reductions in postoperative pain, swelling and trismus compared to conventional rotary techniques, though at the cost of longer operative time [8]. Laser-assisted procedures and image-guided navigation represent additional emerging tools that, when applied within a multidisciplinary framework, allow for more individualized surgical planning and a measurable reduction in intraoperative surprises.

Preoperative imaging anchors the entire decision-making process. Panoramic radiography remains the most widely used first-line modality given its accessibility, low radiation dose and reasonable diagnostic yield for routine cases [9]. However, when panoramic signs suggest a close relationship between the third molar roots and the inferior alveolar canal, darkening of the root, interruption of the cortical white line or deflection of the canal among them; three-dimensional imaging becomes essential [9,10]. Cone-Beam Computed Tomography (CBCT) has become the established standard for these high-risk cases, offering precise

spatial localization of the inferior alveolar nerve that panoramic radiography simply cannot provide [10]. More recently, Photon-Counting Computed Tomography (PCCT) has emerged as a technology with the potential to redefine preoperative imaging altogether: offering resolution up to 100 μm, superior soft-tissue contrast, reduced metallic artifact and faster acquisition times [11]. The integration of artificial intelligence into radiological workflows adds yet another layer, with AI-assisted CBCT analysis showing early promise in automating the detection and proximity quantification of the mandibular canal relative to impacted roots [12].

This review synthesizes current evidence across the full perioperative arc of third molar management, from patient selection and imaging strategy, through surgical technique and difficulty classification, to postoperative risk mitigation and emerging technologies, with the goal of offering clinicians a framework for more consistent, defensible and patient-centered decision-making.

Classification Systems and Radiographic Assessment: The Foundation of Surgical Decision-Making

Safe and predictable surgical management of impacted third molars depends on a structured preoperative assessment that integrates clinical findings, radiographic analysis and established classification systems. This process does not merely estimate difficulty; it drives every downstream decision, from anesthesia planning and flap design to referral thresholds and the content of informed consent. Skipping this step does not simplify the operation; it relocates the uncertainty into a phase where the consequences of surprise are far harder to manage [13].

Classification systems have long served as the primary framework for communicating surgical complexity. The most widely used are Winter's classification, the Pell and Gregory system and the Pederson Difficulty Index [14]. Winter's classification describes the angulation of the impacted molar relative to the long axis of the second molar; mesio-angular, vertical, disto-angular, horizontal, inverted or transverse, with disto-angular and horizontal impactions generally considered the most demanding, given their tendency to require sectioning and their anatomical proximity to the Inferior Alveolar Nerve (IAN) [15]. The Pell and Gregory system evaluates the tooth's spatial relationship to the ascending ramus (Class I, II, III) and its depth relative to the occlusal plane (Position A, B, C), with Class III-C impactions carrying the highest surgical burden and frequently warranting specialist referral [13].

The Pederson Difficulty Index synthesises these two systems into a composite score ranging from 3 to 10, with values in the upper range (7 to 10) traditionally associated with high surgical complexity [16]. However, the clinical utility of all three systems has been seriously questioned. García, et al., demonstrated that the Pell and Gregory classification showed a sensitivity of only 15% when Class C was used as a predictor of difficult extraction, rendering it of limited standalone value [17]. Similarly, Diniz-Freitas, et al., found that the Pederson scale fails to reliably predict extraction difficulty, in part because it does not account for root curvature, bone density or the precise buccolingual relationship between the roots and the IAN canal [18]. These are not minor omissions, they are precisely the variables that determine intraoperative difficulty in complex cases (Table 1) [16,17].

Classification System	What It Assesses	Categories / Scale	Reported Sensitivity for Difficulty	Key Limitation(s)	Clinical Takeaway
Winter's Classification (1926)	Angulation of the impacted molar relative to the long axis of the adjacent second molar	Mesio-angular; vertical; disto-angular; horizontal; inverted; transverse	Moderate; disto-angular and horizontal correlate with higher difficulty but system does not produce numeric sensitivity data	Purely angulation-based; does not account for depth, ramus relationship, root curvature or bone density	Useful for communicating tooth position and anticipating access difficulty; most meaningful when combined with Pell and Gregory

Pell and Gregory Classification (1933)	Spatial relationship of the tooth to the ascending ramus (Class I/II/III) and depth relative to the occlusal plane (Position A/B/C)	Class I-A (easiest) through Class III-C (most complex)	Sensitivity of only 15% when Class C is used as predictor of difficult extraction	Poor sensitivity renders it unreliable as a standalone predictor; does not capture root morphology or nerve proximity	Class III-C impactions should prompt specialist referral; the system describes anatomy, not difficulty and must not be used in isolation
Pederson Difficulty Index	Composite score synthesising Winter's angulation and Pell and Gregory classification	Score range 3 to 10: minimally difficult (3-4); moderately difficult (5-6); very difficult (7-10)	Shown to fail as a reliable predictor of actual extraction difficulty	Omits root curvature, bone density, buccolingual root position and exact root-to-nerve canal geometry	Provides a structured starting point for communication; should be supplemented with individual radiographic variables and clinical judgment
Juodzbalys and Daugela Index (2013)	Multi-factor radiological and anatomical assessment including relationship to ramus, second molar, alveolar ridge and mandibular canal	Composite score across anatomical sub-domains; no single numeric threshold widely validated	Outperforms Pell and Gregory and Winter in comparative studies; validation ongoing	Less widely adopted in routine practice; requires familiarity; normative data across populations still limited	Most anatomically comprehensive of the established indices; worth incorporating in complex cases and specialist settings
Note: No single classification system reliably predicts surgical difficulty in isolation. These systems should be used as structured communication frameworks, not as definitive risk calculators. Root curvature, bone density and the three-dimensional root-to-nerve relationship remain the variables most predictive of intraoperative complexity and are best evaluated with three-dimensional imaging in selected cases.					

Table 1: Comparative overview of established third molar classification systems, including the assessed parameters, categorical structure, reported sensitivity, principal limitations and clinical interpretation. No single system reliably predicts surgical difficulty in isolation; all three should be understood as descriptive frameworks rather than definitive predictors [16,17].

A fundamental structural limitation of all three systems is their reliance on two-dimensional radiography, which cannot resolve buccolingual root position or the three-dimensional geometry of the root-to-nerve relationship. This is where imaging selection becomes clinically critical.

The Orthopantomogram (OPG) remains the recommended first-line imaging modality. It provides a bilateral overview of both arches, demonstrates the ramus relationship required for Pell and Gregory classification and offers adequate visualization of the IAN canal in the majority of routine cases [9]. Periapical radiographs offer improved resolution of individual root morphology but remain inherently limited by anatomical superimposition and their inability to convey depth [19]. Both modalities are susceptible to geometric distortion and neither can definitively confirm or exclude cortical perforation of the mandibular canal (Table 2) [20].

Imaging Modality	Radiation Dose (relative)	Spatial Resolution	Key Advantages	Key Limitations	When to Use in Third Molar Surgery
Periapical Radiograph	Low (lowest of dental X-rays)	High for individual tooth	Excellent root morphology detail; minimal distortion when properly angulated; low dose; widely available	Limited field of view; anatomical superimposition; cannot assess ramus relationship or IAN canal in full; no three-dimensional depth	Adjunct to OPG for specific root detail in straightforward cases; rarely sufficient as the sole modality for impacted third molars
Panoramic Radiograph (OPG)	Low-moderate	Moderate; sufficient for routine classification	Bilateral field of view; establishes Pell and Gregory ramus relationship; visualizes IAN canal; widely available; first-line standard of care	Geometric distortion; anatomical superimposition; no buccolingual information; cannot confirm cortical integrity of mandibular canal	First-line imaging for all impacted third molar cases; use to classify impaction and screen for IAN proximity signs (darkening of root, canal deflection, white line interruption)
Cone-Beam Computed Tomography (CBCT)	Moderate to high (significantly higher than OPG; varies by field of view)	High; true three-dimensional; typically, 75-400 microns depending on protocol	Three-dimensional spatial localization of roots relative to IAN canal; identifies cortical perforation; guides coronectomy decisions; superior to OPG for complex anatomical relationships	Higher radiation dose than OPG; higher cost; SEDENTEXCT and EADMFR guidelines advise against routine use; not consistently shown to reduce neurosensory injury rates versus OPG alone	Selectively indicated when OPG shows two or more high-risk signs of IAN proximity (root darkening, canal narrowing, white line interruption, canal deflection); complex impactions; coronectomy planning; cases where three-dimensional anatomy would change the surgical plan

Photon-Counting CT (PCCT)	Similar to conventional CT; potentially reducible with optimized protocols	Up to 100 microns; superior to standard CT and comparable to high-resolution CBCT	Superior soft-tissue contrast; reduced metallic artifact; faster acquisition; potential for reduced scan repetition; emerging evidence in dental imaging	Limited clinical availability; predominantly in specialist or research centers; limited dental-specific outcome data; not yet standard of care	Currently an emerging tool; most relevant for complex cases requiring superior soft-tissue and cortical bone detail; not yet recommended for routine third molar imaging
Magnetic Resonance Imaging (MRI)	None (no ionizing radiation)	Moderate for bone; high for soft tissue	No radiation; superior soft-tissue characterization; useful for associated cysts, neoplasms and soft-tissue pathology; identifies neurovascular structures directly	Long acquisition time; high cost; limited availability; poor cortical bone resolution; motion artefact; contraindicated with certain implants	Reserved for cases with suspected associated soft-tissue pathology, neoplasia or when radiation minimization is a priority (e.g., pregnancy, paediatric patients)
Abbreviations: OPG, orthopantomogram; IAN, inferior alveolar nerve; CBCT, cone-beam computed tomography; PCCT, photon-counting computed tomography; MRI, magnetic resonance imaging; SEDENTEXCT, Safety and Efficacy of a New and Emerging Dental X-Ray Modality; EADMFR, European Academy of DentoMaxilloFacial Radiology. Imaging selection should always follow the ALARA principle (as low as reasonably achievable) and be justified by clinical need.					

Table 2: Comparative overview of imaging modalities in third molar surgical planning, including radiation dose, spatial resolution, key advantages, principal limitations and evidence-based indications for use. Imaging selection should follow the ALARA principle and be guided by clinical need; CBCT is not recommended for routine use and should be reserved for cases where two-dimensional findings raise unresolved concern regarding inferior alveolar nerve proximity.

Cone-Beam Computed Tomography (CBCT) addresses these limitations directly, providing true three-dimensional spatial relationships between the roots and the IAN canal, information that, in high-risk cases, can fundamentally alter the surgical approach [21].That said, CBCT is not a routine screening tool and the evidence for its universal use in third molar planning is not as strong as its adoption might suggest. The SEDENTEXCT guidelines established that CBCT should not be used routinely for third molar assessment and the European Academy of DentoMaxilloFacial Radiology has further clarified that the available evidence does not support CBCT as a routine adjunct because it has not been shown to consistently reduce postoperative nerve injury rates compared with conventional two-dimensional radiography [22,23]. Its role is best understood as a problem-solving tool: when panoramic signs raise genuine concern; darkening of the root, interruption or deflection of the mandibular canal, narrowing of the canal, CBCT provides the anatomical resolution needed to make an informed decision about technique modification or coronectomy candidacy [21,22].

Once the preoperative assessment is complete, its findings must directly govern the surgical plan. Straightforward impactions may require only modest bone removal and limited flap design, whereas deep horizontal or Class III-C cases typically demand extensive osteotomy, crown and root sectioning and potentially general anaesthesia; decisions that should be made at the planning stage, not improvised intraoperatively. Preoperative assessment also forms the clinical and ethical foundation of informed consent: it allows the clinician to communicate individualized risk estimates for IAN injury, alveolar osteitis, periodontal damage to the adjacent second molar and mandibular fracture, rather than quoting generic population-level figures. When preoperative imaging demonstrates direct contact between the roots and the IAN canal, particularly with loss of cortical integrity, coronectomy should be discussed as a well-supported surgical alternative. Meta-analytic evidence consistently

demonstrates that coronectomy substantially reduces the rate of IAN injury compared with complete extraction in high-risk cases, with transient neurosensory disturbance rates of 0 to 2.2% after successful coronectomy versus up to 16.7% following extraction in comparable cases [24,25].

To summarize: classification systems provide a structured common language for surgical difficulty, but they are screening frameworks, not predictors. Their limitations are well established in the literature and no single index captures the full complexity of what the surgeon will encounter. Thoughtful image selection; beginning with OPG and escalating to CBCT when clinical or radiographic signs justify it, is what bridges the gap between a classification score and a genuinely informed surgical plan.

Evidence-Based Indications and Contraindications: Rethinking the Extraction Decision

For much of the twentieth century, prophylactic third molar extraction was standard practice across most dental systems, driven by the assumption that retained impacted molars would inevitably cause harm. Contemporary dentistry has moved decisively away from that position, not because the risks of impaction have disappeared, but because the evidence base has matured sufficiently to demand a more discriminating, patient-specific framework for the extraction decision [26,27].

Established indications for extraction. The clinical indications that consistently withstand scientific scrutiny are those tied to demonstrable, present or highly probable pathology. Recurrent pericoronitis is among the clearest: persistent pericoronal inflammation significantly impairs quality of life and, if episodes are frequent or severe, conservative management offers no durable resolution [28,29]. Caries affecting the third molar itself, particularly when restoration is not feasible or the distal surface of the adjacent second molar constitutes a well-supported indication; Toedtling, et al., identified a meaningful association between impacted third molars and distal surface caries of the second molar, with extraction justified when the lesion is progressive and restoration of the affected surface would require removal of the third molar regardless [30,31]. Periodontal involvement affecting the second molar, the presence of an associated odontogenic cyst or tumor and orthodontic or prosthetic treatment requirements complete the core list of evidence-supported indications [28,32].

The prophylactic extraction debate. The question of whether asymptomatic, pathology-free impacted third molars should be removed remains genuinely unresolved in the literature and clinicians should approach it as such rather than defaulting to either position. The most recent Cochrane review on the subject concluded that current evidence is insufficient to support or refute prophylactic extraction of disease-free impacted third molars [29]. Importantly, the same review noted very low-certainty evidence suggesting that long-term retention may be associated with an increased risk of periodontitis affecting the adjacent second molar; an observation that complicates the straightforward argument for conservative management [29]. Hounsome, et al., added a health-economic dimension, finding that prophylactic removal does not demonstrate clear clinical benefit and is not cost-effective at a population level [30]. More recently, Louizakis, et al., in a 2025 systematic review and meta-analysis, reinforced the conservative position, concluding that observation and active monitoring remain appropriate fundamental strategies for asymptomatic impactions without associated pathology [32].

Spontaneous eruption and retention outcomes. It is worth noting that not all impacted third molars remain impacted indefinitely. Several observational studies have documented late spontaneous eruption, particularly in younger patients with mesio-angular impactions and adequate posterior space and eruption potential should be factored into the timing decision [33]. At the same time, longitudinal data from Alfurhud and Alouthah demonstrate that asymptomatic retained third molars do not uniformly produce progressive bone loss at the distal surface of the second molar, supporting a monitoring approach in carefully selected, compliant patients [34].

Complications and the role of anatomy. Third molar surgery is safe in the hands of a trained clinician, but it is not without meaningful risk and the decision to operate must account for what that risk represents for each individual patient [35]. Inferior alveolar nerve injury is the most clinically significant complication, arising from the anatomical proximity of mandibular third molar roots to the inferior alveolar canal; a systematic review by Raj, et al., identified root proximity to the canal, darkening of the root on panoramic imaging and diversion of the canal as the anatomical risk factors most consistently associated with neurosensory disturbance [36,37]. Naruse, et al., reported that most neurosensory disturbances following third molar extraction are transient, resolving within weeks to months, though a subset persist beyond twelve months and may become permanent

[36]. Beyond nerve injury, serious complications including infection, fascial space involvement, delayed healing and mandibular fracture, while uncommon in straightforward cases; are disproportionately represented in late extractions performed in older patients with denser, less vascularized bone [35].

Patient age and bone density. The timing of extraction is not a neutral decision. The evidence is consistent that complication rates increase with age, driven principally by changes in bone density and vascularity, reduced healing capacity and greater surgical difficulty from root completion and bone maturation [33,35]. The practical implication is that when extraction is indicated or when the risk-benefit calculation favors intervention, earlier surgery, ideally before the mid-twenties, is generally associated with better outcomes and fewer complications. This does not justify routine prophylactic extraction in all young patients; it informs the timing decision when extraction is already being considered on clinical grounds.

Special Medical Populations

Systemic health profoundly modifies the risk calculus in third molar surgery and cannot be treated as a secondary consideration. Patients on antiresorptive therapy, bisphosphonates or denosumab, represent a particularly important group. The risk of Medication-Related Osteonecrosis of the Jaw (MRONJ) following dental extraction differs substantially by indication and route of administration: patients receiving high-dose intravenous bisphosphonates for oncological indications carry MRONJ incidence rates following extraction ranging from 11% to 50% in some series, while those on low-dose oral bisphosphonates for osteoporosis face a much lower, though not negligible, absolute risk [38]. In either case, thorough preoperative dental evaluation, ideally before antiresorptive therapy is initiated, is the single most effective risk mitigation strategy [38]. Patients on anticoagulation therapy present a different set of challenges: a systematic review by Inchingolo, et al., confirmed that while bleeding risk is elevated, most dental extraction procedures including third molar surgery can be performed safely in anticoagulated patients with appropriate local hemostatic measures and without routine anticoagulation reversal [39]. Similarly, Pippi, et al., demonstrated in a retrospective study that ambulatory oral surgical procedures, including third molar extraction, can be performed safely in medically compromised older patients when appropriate precautions are in place [40].

In summary, current evidence strongly supports a selective, risk-stratified approach to third molar management. Extraction is clearly indicated when documented pathology is present or when anatomical progression poses a demonstrable threat to adjacent structures. Prophylactic extraction of asymptomatic, disease-free impacted third molars cannot be universally justified; however, neither can universal retention. The decision must integrate the patient's age, systemic health, bone anatomy, eruption potential, access to follow-up and individual preferences and it must be revisited over time as clinical circumstances evolve.

Surgical Technique Selection: From Flap Design to Sectioning Strategies

Surgical technique in third molar surgery is not a fixed protocol, it is a sequence of individualized decisions, each of which carries downstream consequences for tissue trauma, healing and the patient's postoperative experience. The appropriate approach must integrate the depth and angulation of the impaction, the three-dimensional relationship between the roots and the inferior alveolar canal, the patient's age and bone density and the operator's own training and experience. When any one of those variables is underestimated, the complication profile expands predictably [41-43].

Flap Design

The choice of flap is the first intraoperative decision and establishes the surgical field for everything that follows. The two most widely used designs are the envelope flap, which follows the gingival margin without a releasing incision and the triangular flap, which adds a vertical releasing incision to improve access, particularly in deeper impactions [43]. The clinical literature comparing these designs is more equivocal than is sometimes assumed. Multiple systematic reviews and meta-analyses have found no consistent, statistically significant differences in postoperative pain, swelling or alveolar osteitis between the two approaches [41,42]. The envelope flap has been associated with faster recovery of mouth opening in shallower, more accessible impactions; the triangular flap, by contrast, showed a higher rate of postoperative ecchymosis and lower periodontal probing depth at seven days but equivalent values at three months [42]. What this means in practice is that neither design is universally superior; flap selection should be driven by the surgical access requirements of the specific impaction, with the goal of achieving adequate visualization while minimizing the extent of soft tissue manipulation [41,44]. Trapezoidal flap designs, which include two releasing incisions, have been associated with greater loss of clinical attachment at the distal surface of the second molar and are generally not preferred for routine cases [41].

Osteotomy and tooth sectioning. Once the flap is elevated, the osteotomy strategy must be tailored to the anatomy of the impaction. Conventional high-speed rotary instruments remain the standard for bone removal in most clinical settings: they are fast, familiar to most operators and effective across the full range of impaction complexity [45.] Their principal limitation is heat generation; without adequate, continuous saline irrigation, thermal injury to the surrounding bone, adjacent soft tissues and the inferior alveolar nerve becomes a meaningful risk, particularly in deeper, longer procedures [43]. Tooth sectioning is often required to reduce the force needed for delivery and to limit the bone removal necessary to create an exit path. The sectioning strategy should be determined preoperatively, not improvised. Mesio-angular impactions frequently require a single horizontal or oblique crown section; disto-angular and horizontal impactions often demand more extensive sectioning, including separation of crown from root and, in some cases, division of multi-rooted segments individually. Root morphology; specifically, curvature, dilaceration and proximity to the canal, is the variable that most often converts a planned straightforward sectioning into an unexpectedly demanding one, reinforcing the importance of three-dimensional imaging in selected cases [44,45].

Piezosurgery as an alternative. Piezoelectric surgery has accumulated a meaningful body of evidence over the past decade supporting its use as an alternative to conventional rotary instruments, particularly in cases where proximity to neurovascular structures is a concern. By generating ultrasonic microvibrations that selectively cut mineralized tissue while sparing soft tissue structures, piezosurgery reduces the risk of inadvertent damage to the inferior alveolar nerve, adjacent vessels and the mucoperiosteum [43,44]. Multiple randomised split-mouth trials and systematic reviews consistently report reductions in postoperative pain, swelling and trismus with piezosurgery compared to conventional instruments [43-46]. The trade-off is well established and should be honestly communicated: operative time is consistently longer with piezosurgery, the equipment cost is substantially higher and the learning curve is real [44,45]. It is also worth noting that the current evidence base, while directionally consistent, rests primarily on small randomised trials and systematic reviews of limited sample sizes; the Mancini, et al., systematic review, for example, included only seven studies following screening of over 766 articles [44]. Piezosurgery is best understood as an evidence-supported tool for selected cases, particularly those involving deep impactions, high-risk IAN proximity or split-mouth procedures where minimizing bilateral postoperative morbidity is a priority, rather than a universal replacement for conventional technique [43,44].

Operator experience and the referral threshold. Technique selection does not occur in a vacuum; it is bounded by the operator's experience and this is a variable the literature has historically underweighted in difficulty classification systems. Gay-Escoda, et al., proposed a comprehensive preoperative evaluation framework that explicitly incorporates operator-specific factors alongside radiological and anatomical variables, recognizing that a case classified as moderately difficult by Pederson criteria may be genuinely high-risk in the hands of a less experienced clinician [47]. Operator experience has been shown to significantly influence intraoperative time, anaesthetic volume administered and postoperative pain and trismus outcomes, even in cases of equivalent radiographic complexity [48]. The decision to refer to oral and maxillofacial surgery should therefore not wait for a complication; it should be made preoperatively, when the complexity of the case as assessed across anatomical, radiographic and patient-specific variables exceeds the clinician's reliable competence. Clear referral triggers include Class III-C impactions with high Pederson scores, panoramic or CBCT evidence of direct root contact with the inferior alveolar canal, patients with relevant medical comorbidities that amplify surgical risk and any case where the clinician cannot form a confident surgical plan before the first incision [47,49].

The central message of this section is straightforward: technique selection modulates the complication profile directly and the best surgical technique for any given case is the one the operating clinician can execute competently, with appropriate imaging, in a setting equipped to manage intraoperative complications when they arise.

Complication Profiles, Risk Stratification and Prevention Protocols

Third molar extraction carries a well-documented and clinically relevant complication profile, regardless of how routine the procedure may feel in a busy practice. A large multicenter prospective study conducted across 20 Japanese institutions found an overall postoperative complication rate of 10.0% in 1,826 consecutive extractions, with alveolar osteitis, wound infection and persistent pain representing the most frequent adverse events [49,50]. These figures are consistent with data from other populations and study designs, including a retrospective series from a tertiary centre in Oman, where similar complication patterns were observed across varying levels of surgical complexity [51,52]. The critical point is that a 10% complication rate in

the most commonly performed oral surgical procedure translates to an enormous absolute number of patients affected annually, making complication prevention not a secondary consideration but a primary clinical obligation [53].

Complication taxonomy and incidence. The most clinically significant complications warrant individual consideration rather than collective treatment. Alveolar osteitis occurs in 1% to 30% of cases depending on patient and procedural risk factors, with smoking, female sex, oral contraceptive use, traumatic extraction and inadequate socket irrigation among the consistently identified predictors [54,55]. Inferior alveolar nerve injury, whether from direct mechanical trauma, thermal injury or compression during root delivery, remains the most consequential complication, with reported incidence ranging from 0.5% to 8% in the general third molar population and approaching 20% in cases with confirmed root contact with the mandibular canal; the majority of these injuries are transient, but permanent neurosensory deficit occurs in approximately 1% of cases [37]. Lingual nerve injury, while less frequently discussed, is not rare: its incidence ranges from 0.5% to 2% and it can occur even without direct instrumentation near the lingual plate, as retractor placement alone carries risk in certain anatomical configurations [50]. Hemorrhaged, infection extending to fascial spaces, delayed healing and injury to the adjacent second molar including periodontal and endodontic damage, complete the spectrum of complications that must be addressed in preoperative counselling [49,55].

Anatomical and patient-related risk factors. The evidence consistently identifies impaction depth, root proximity to the inferior alveolar canal, surgical duration and patient age as the primary predictors of postoperative complications [49,50]. Operator experience; particularly in supervised training environments, also influences complication frequency, even after controlling for case complexity; studies evaluating resident surgeons have demonstrated higher complication rates compared to experienced operators managing equivalent cases, supporting the argument that referral thresholds should account for operator-specific factors.[51] Sex and systemic comorbidities show inconsistent associations across studies and their predictive value appears highly context-dependent [49].

Risk Stratification

Preoperative risk stratification integrates these variables into a structured decision support framework, enabling the clinician to identify high-risk patients before the first incision rather than recognizing them retrospectively. A risk stratification model proposed for preoperative evaluation combines anatomical, radiographic and patient-specific variables to generate a composite risk profile that guides both surgical planning and the intensity of postoperative monitoring [52]. While no single tool has achieved universal adoption, the principle of systematic preoperative risk assessment; rather than case-by-case intuition, is supported across the literature as a driver of more consistent clinical outcomes [47,52]. Antibiotic prophylaxis and the antimicrobial resistance concern. The prescription of perioperative antibiotics for third molar surgery is one of the most debated topics in oral surgery and the evidence does not support the reflexive, routine approach that many clinicians still practice. Antibiotics do reduce surgical site infection rates in healthy patients undergoing third molar extraction, with amoxicillin-clavulanic acid demonstrating the most consistent efficacy [53]. However, number-needed-to-treat values across systematic reviews range from 17 to 97, meaning that many patients must be exposed to antibiotic therapy to prevent a single infection and no consistent benefit has been demonstrated for dry socket prevention [53]. Postoperative continuation of antibiotics beyond the perioperative window carries additional risk, including antimicrobial resistance, adverse drug reactions and Clostridioides difficile infection, without proportionate benefit in healthy, immunocompetent patients [53]. The emerging consensus is that antibiotic prophylaxis should be reserved for patients with elevated infection risk: those with deep impactions requiring extensive osteotomy, immunocompromised patients and individuals with systemic conditions that impair healing [53]. Routine prescription in healthy patients undergoing straightforward extraction is no longer defensible in the context of the global antimicrobial resistance crisis.

Chlorhexidine Irrigation

Topical Chlorhexidine (CHX) represents an effective and antibiotic-sparing strategy for reducing alveolar osteitis incidence. A systematic review and meta-analysis demonstrated that CHX gel applied to the extraction socket reduces alveolar osteitis incidence by approximately 57%, with a relative risk of 0.43 compared to placebo and no reported adverse reactions in the included trials [54]. Unlike systemic antibiotics, CHX carries no antimicrobial resistance implications and is inexpensive and widely available, making it an appropriate routine adjunct in cases with identifiable dry socket risk factors [54].

Platelet-Rich Fibrin (PRF)

The incorporation of PRF into socket management represents the most biologically driven evolution in postoperative complication prevention over the past decade. PRF, derived from the patient's own blood through centrifugation, provides a fibrin matrix rich in growth factors that promotes angiogenesis, tissue regeneration and early clot stabilization. A PROSPERO-registered systematic review published in 2024 found that PRF significantly reduces postoperative pain, accelerates socket healing and lowers the incidence of alveolar osteitis across multiple clinical trials and comparative studies [55,56]. The caveat; and it is an important one, is that the evidence base remains built primarily on small studies with heterogeneous methodologies; the same review calls explicitly for further large-scale randomised trials before PRF can be recommended as a universal standard of care [56]. Nevertheless, in high-risk sockets, those with established alveolar osteitis risk factors, complex osteotomies or patients with compromised healing capacity; PRF application represents a well-supported adjunct with a compelling biological rationale and a favorable risk profile.

Corticosteroids for Oedema Control

Perioperative corticosteroids, most commonly dexamethasone administered preoperatively or intraoperatively; represent a well-established pharmacological strategy for reducing postoperative swelling and trismus. Their mechanism is straightforward: suppression of the arachidonic acid cascade reduces prostaglandin and leukotriene production, attenuating the inflammatory response to surgical trauma. Multiple systematic reviews support their efficacy for oedema and trismus reduction in the first postoperative week, with a single preoperative dose of 4 to 8 mg dexamethasone generally considered effective without clinically significant systemic effects in healthy patients [50]. Their routine use alongside NSAIDs and appropriate socket management represents current best practice for postoperative morbidity reduction in more complex extractions.

MRONJ as a complication modifier. As discussed in detail in Section 3, medication-related osteonecrosis of the jaw remains a critical risk modifier in patients on antiresorptive therapy and the extraction decision in these patients requires a distinct risk-benefit framework [38]. Identified medications now include not only bisphosphonates and denosumab but also antiangiogenic agents, with the risk profile varying substantially by drug class, route of administration and underlying indication [57].

In summary, the complication profile of third molar surgery is multifactorial and largely predictable when the preoperative assessment is thorough. The most preventable complications, alveolar osteitis, wound infection and excessive postoperative oedema; respond to a structured prevention protocol that integrates selective antibiotic use, topical chlorhexidine, PRF in selected sockets and perioperative corticosteroids. The less preventable complications, nerve injury and adjacent tooth damage, are best mitigated by imaging-guided surgical planning, technique selection appropriate to the anatomy and timely referral when the case exceeds the operator's competence.

Conclusion From Routine to Precision: Redefining the Standard of Care in Third Molar Surgery Through Evidence, Risk Stratification and Clinical Judgment

Third molar surgery has reached an inflection point. The evidence reviewed across the preceding sections converges on a single, clinically actionable conclusion: the era of routine prophylactic extraction as a default strategy is scientifically indefensible and the era of precision-guided, individualized management has already begun, even if clinical practice has not yet caught up uniformly with the literature.

This review has traced that argument through a deliberate sequence. The epidemiological and historical framing established that third molar impaction is nearly universal in prevalence and globally variable in its outcomes; a pattern that immediately argues against any one-size-fits-all management policy [1,3]. The critical appraisal of classification systems revealed that Pell and Gregory, Winter and the Pederson Difficulty Index remain useful as descriptive communication frameworks, but that none reliably predicts surgical difficulty in isolation and that the two-dimensional limitation of the radiographic systems they depend on creates a structural ceiling on their clinical utility [17,18]. The transition to cone-beam computed tomography in selected, high-risk cases, guided by specific panoramic warning signs rather than routine protocol, represents the current best practice for bridging that gap, with the SEDENTEXCT and EADMFR guidance providing the evidence-based threshold [22,23].

The indications review confirmed that extraction is clearly warranted when documentable pathology is present and equally clear

that prophylactic extraction of asymptomatic, disease-free impacted third molars cannot be universally justified [29,32]. The Cochrane review on this question does not simply absolve retention, it finds insufficient evidence for either position at high certainty and importantly notes that long-term retention carries its own risk of periodontitis affecting the adjacent second molar [29]. The honest clinical position is that neither extraction nor retention is inherently safe; both require active monitoring and a decision-making framework that integrates age, anatomy, eruption potential, systemic health and access to follow-up [33,35].

In high-risk mandibular third molars with intimate root proximity to the inferior alveolar canal, coronectomy has emerged from a weak alternative to a well-supported option, with a 2025 meta-analysis in the Journal of Oral and Maxillofacial Surgery demonstrating a relative risk of 0.1 for inferior alveolar nerve injury and 0.2 for lingual nerve injury compared to complete extraction [58]. Success depends critically on accurate case selection, operator experience and a structured follow-up plan capable of managing root migration and the small but real risk of reoperation [3,58].

On the surgical technique side, the evidence supports a shift toward minimizing trauma as the primary technical goal, whether through flap design that prioritizes soft tissue preservation, osteotomy strategies tailored to the specific impaction geometry or piezosurgery in cases where IAN proximity makes soft tissue selectivity a clinical priority [43-45]. The complication prevention literature is unambiguous that a structured protocol; integrating selective antibiotic use in genuinely high-risk patients, topical chlorhexidine, PRF in appropriate sockets and perioperative corticosteroids for morbidity reduction, outperforms the historical default of broad antibiotic prescription paired with passive postoperative management [53,54,56].

When nerve injury does occur, the clinical response matters as much as the surgical cause. Kämmerer, et al., documented that severity classification, early neurosensory testing, structured follow-up and in appropriate cases timely surgical nerve exploration all influence long-term recovery outcomes and that the absence of a systematic postoperative nerve assessment protocol remains a persistent failure in routine practice [59]. Most injuries are transient, but the subset that persists beyond three to six months carries a materially higher risk of permanent dysfunction and warrants escalated intervention rather than continued watchful waiting [36,59].

Limitations

This review has limitations that must be stated. The evidence base for several clinical recommendations, particularly PRF application, the optimal CBCT threshold and long-term coronectomy outcomes, rests on studies with significant heterogeneity, small sample sizes and follow-up periods that may not reflect the true long-term trajectory of retained impacted third molars. The translation of population-level evidence to individual patient decisions will always involve a degree of clinical judgment that no systematic review can fully codify. Additionally, as with all narrative reviews, the selection and weighting of included evidence is inevitably influenced by the authors' clinical perspective and readers should consider this in interpreting the conclusions.

Future Directions

The most important research gaps identified by this review are prospective long-term data on the natural history of retained asymptomatic third molars with serial monitoring, adequately powered RCTs on coronectomy outcomes beyond twelve months and standardized neurosensory assessment protocols following third molar surgery that would allow genuinely comparable complication reporting across institutions. The integration of artificial intelligence into radiographic classification and nerve proximity assessment represents the most promising near-term technological development, with early systematic reviews already demonstrating accuracy in automated IAN localization that approaches expert human performance [12,60].

Conclusion

The standard of care in third molar surgery is not a technique; it is a process. That process begins with a thorough, imaging-supported preoperative assessment; proceeds through a technique selection grounded in the specific anatomy of the case and the real capabilities of the operator; and concludes with a postoperative monitoring protocol structured enough to detect and manage complications early. Interdisciplinary collaboration, between oral surgeons, general dentists, radiologists and restorative clinicians, is not a bureaucratic aspiration but a clinical necessity for optimizing case selection and minimizing preventable morbidity. The evidence is sufficient to act on. The question now is whether practice will follow.

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All authors contributed equally to this paper.

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