DOI: https://doi.org/10.54361/LJMR.20.2.58

Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

Original Article

Strategies to Minimise Postoperative Complications in Third Molar Surgery: A Comprehensive Review of Risk Factors and Preventive Efficacy

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ABSTRACT

Background: Third molar extraction is one of the most commonly performed oral surgical procedures and is associated with a range of postoperative complications, including pain, swelling, trismus, infection, and nerve injury. Advances in surgical techniques, diagnostic imaging, and perioperative management have introduced preventive strategies aimed at reducing postoperative morbidity and improving clinical outcomes. **Objective:** To evaluate current evidence regarding risk factors associated with postoperative complications following third molar surgery and to assess the effectiveness of preventive strategies reported in the literature. **Materials and Methods:** A nonsystematic literature review was conducted using published studies, systematic reviews, meta-analyses, and clinical reports. The review examined anatomical, patient-related, and surgical risk factors, as well as preventive approaches including advanced imaging, coronectomy, germectomy, minimally invasive surgical techniques, the Twin Mix local anaesthetic technique, and perioperative pharmacological management. **Results:** The reviewed literature indicates that postoperative complications following third molar surgery are influenced by anatomical, patient-related, and surgical factors. Major risk factors included tooth position, root morphology, proximity to vital structures, systemic health conditions, smoking, and surgical technique. Preventive strategies such as OPG and CBCT imaging, coronectomy in high-risk cases, germectomy, piezoelectric surgery, Twin Mix anaesthesia, chlorhexidine use, corticosteroid therapy, and appropriate perioperative management were associated with reduced postoperative morbidity. However, evidence regarding routine antibiotic prophylaxis remains inconsistent across studies. **Conclusion:** Postoperative complications in third molar surgery are multifactorial but can be minimised through comprehensive risk assessment, individualised treatment planning, and the application of evidence-based preventive surgical and therapeutic strategies. Current evidence supports the use of advanced imaging, minimally invasive surgical techniques, selected preventive procedures, and appropriate perioperative management to improve postoperative outcomes and reduce complication rates.

Key words: Third molar extraction, postoperative complications, risk factors, preventive strategies

Introduction

Extraction of third molars remains one of the most common procedures in general dental practice and specialised oral surgical practice, representing approximately 18% of all dental extractions [8-32]. Third molars generally begin developing between the ages of 8 and 15 and typically erupt between 17 and 22 years of age [33-70]. Due to this late eruption, third molars are frequently impacted, with studies reporting 17–69% showing some form of impaction [29]. Despite the routine nature of the procedure, it carries a range of potential complications, with incidence varying from 2% to 30% depending on case complexity, the practitioner's experience, and patient-specific factors. These complications include alveolitis, oedema, nerve injury, trismus, socket infection, haemorrhage, tooth displacement into the maxillary sinus, and jaw fractures. In recent decades, oral surgery has undergone remarkable progress, resulting in new techniques and technologies that enhance the precision, safety, and predictability of third molar extractions [61]. These developments include the introduction of minimally invasive surgical strategies, modern imaging systems, and innovative biomaterials [59]. Evaluating how these innovations influence clinical outcomes is essential for refining treatment protocols and optimising patient care [31].

Minimally invasive approaches have gained increasing attention because they tend to reduce surgical trauma, accelerate healing, and minimise postoperative pain and swelling [71]. Among them, piezoelectric surgery has proven particularly effective: by employing ultrasonic microvibrations, it enables precise bone cutting while preserving the surrounding soft tissues [1].

Similarly, laser-assisted techniques have demonstrated beneficial effects in third molar surgery, with evidence suggesting reduced tissue injury and faster wound healing

Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

DOI: https://doi.org/10.54361/LJMR.20.2.58

Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

[11]. Parallel to these surgical advancements, imaging innovations such as cone-beam computed tomography (CBCT) and orthopantomogram (OPG) provide detailed three-dimensional and two-dimensional visualisation of the maxillofacial region, allowing clinicians to assess tooth position, nearby anatomical structures, and surgical risks with greater precision [73].

In addition, the application of biologic agents such as platelet-rich plasma (PRP) and growth factors has become an increasingly valuable adjunct in surgical wound management [77]. PRP, derived from the patient's autologous blood, delivers a concentrated mix of bioactive proteins that accelerate tissue regeneration and support healing [50]. Studies conducted by Gawai, K. T., and Sobhana, C. in 2015 indicate that incorporating PRP into socket preservation protocols after extraction can promote bone regeneration and reduce postoperative complications [26].

Despite the procedural and technological advancements, the most effective approach for wisdom tooth extraction and post-extraction therapy remains a subject of debate and uncertainty. As a result, a detailed evaluation of current evidence is essential to define the most common and frequent complications and effective ways for their prevention.

The aim of this article is to critically analyse the risk factors contributing to these complications and to outline evidence-based preventive strategies derived from current research and updated clinical practices.

Materials and Methods

A nonsystematic literature review was conducted to evaluate risk factors and preventive strategies associated with postoperative complications following third molar surgery. Relevant literature was identified through searches of major scientific databases, including PubMed, Scopus, Google Scholar, and ScienceDirect. Preference was given to English-language articles published between 1964 and 2025. The review included clinical studies, systematic reviews, meta-analyses, and relevant clinical reports addressing factors that influence surgical outcomes and complication rates following third molar extraction. The analysis focused on four main domains. Anatomical risk factors included third molar position, root morphology, bone density, and the proximity of the tooth to critical anatomical structures such as the inferior alveolar nerve, lingual nerve, and maxillary sinus. Patient-related factors included age, systemic conditions such as diabetes mellitus and hypertension, and lifestyle habits, particularly smoking. Surgical factors included extraction techniques, flap design, osteotomy and odontosection procedures, operative time, and surgeon experience. In addition, preventive and minimally invasive approaches such as coronectomy, germectomy, piezoelectric surgery, laser-assisted techniques, and the Twin Mix local anaesthetic technique were evaluated. The review also examined the role of advanced imaging and surgical planning technologies, including panoramic radiography (OPG), cone-beam computed tomography (CBCT), CAD/CAM systems, and three-dimensional printing applications for guided surgery. Perioperative preventive strategies reported in the literature were assessed, including chlorhexidine mouthrinses, antibiotic prophylaxis, corticosteroids, nonsteroidal anti-inflammatory drugs, and smoking cessation protocols.

The selected literature was reviewed to identify the main risk factors associated with postoperative complications and to evaluate the effectiveness of preventive strategies aimed at improving clinical outcomes following third molar extraction.

Result

The reviewed literature identified postoperative complications following third molar surgery as being influenced by three principal categories of risk factors: anatomical, patient-related, and surgical factors. Anatomical factors included the position and depth of impaction, root morphology, bone density, and the proximity of third molars to critical structures such as the inferior alveolar nerve, lingual nerve, and maxillary sinus. Patient-related factors, particularly advanced age, systemic diseases including diabetes mellitus and hypertension, smoking, and poor oral hygiene, were consistently associated with delayed healing and increased complication rates. Surgical factors such as operative difficulty, flap design, osteotomy, odontosection, prolonged surgical time, and operator experience were also identified as significant contributors to postoperative morbidity. The literature demonstrated that several preventive strategies may reduce complication rates and improve postoperative recovery. These included advanced preoperative imaging with OPG and CBCT, coronectomy in cases with a high risk of nerve injury, germectomy in selected young patients, minimally invasive approaches such as piezoelectric surgery and laser-assisted techniques, and the Twin Mix local anaesthetic technique. Perioperative measures, including chlorhexidine application, corticosteroid therapy, smoking cessation, and appropriate analgesic protocols, were also associated with reduced pain, swelling, trismus, and alveolar osteitis. In contrast, evidence regarding routine antibiotic prophylaxis remained inconsistent, with studies reporting conflicting findings regarding its overall benefit.

Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

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Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

Dissuasion

Anatomical Risk Factors:

Third molars, especially in the lower jaw, occupy a unique position in the jaw, often adjacent to the inferior alveolar and lingual nerves. Their proximity to these structures requires even experienced surgeons to act with extreme caution. Research done by Murad et al, has shown that deeply impacted lower third molars, fully embedded in bone, or horizontally positioned teeth present additional challenges, often necessitating excessive bone removal, which may cause damage to the inferior alveolar nerve or result in iatrogenic fractures of the mandible [48]. Roots may be located in proximity to the mandibular canal, occasionally resulting in temporary numbness of the lip or chin post-extraction, and in rare cases, this condition may persist long-term.

A common complication during maxillary third molar extraction is the formation of an oroantral perforation. An oroantral perforation is an abnormal connection between the oral cavity and the maxillary sinus, which can lead to maxillary sinusitis or the development of an oroantral fistula associated with oral bacterial infection [41]. Bone structure additionally influences outcomes. With age, alveolar bone becomes denser, particularly after 40 years, complicating tooth extraction and increasing the risk of damage to surrounding tissues. Anatomical features are unique to each patient, often determining whether the procedure proceeds smoothly or results in complications [41-48].

Patient-Related Risk Factors:

Patient-specific variables such as age, systemic health, and lifestyle habits play a critical role in determining the outcome of third molar extractions. Systemic diseases further contribute to postoperative complications. Diabetes mellitus, a metabolic disorder resulting from insufficient insulin production or resistance, leads to poor glycemic control and a cascade of vascular and neuropathic changes [51]. In diabetic individuals, thickening of the capillary basement membrane alters vascular permeability, restricts leukocyte migration, and disrupts hyperemic response, leading to tissue hypoxia and inadequate perfusion during stress [72]. Consequently, these factors contribute to delayed wound closure and a higher risk of infection.

Smoking is another critical determinant of healing efficiency [74]. Evidence shows that tobacco use significantly increases the incidence of intraoperative and postoperative complications by modulating inflammatory pathways [63]. The harmful constituents of cigarette smoke, particularly nicotine, carbon monoxide, and hydrogen cyanide, interfere with tissue repair through multiple mechanisms [68]. Nicotine induces vasoconstriction, limiting oxygen and nutrient supply to tissues. Carbon monoxide reduces oxygen-carrying capacity, while hydrogen cyanide (HCN) inhibits cellular enzymes essential for oxidative metabolism [58]. Together, these effects compromise tissue regeneration and prolong post-extraction recovery time.

Hypertension is also an important systemic factor that may adversely affect surgical outcomes. Elevated blood pressure damages endothelial cells within arterial walls, promoting lipid deposition and loss of vascular elasticity [68]. This condition can result in prolonged intraoperative bleeding and, in some cases, recurrent postoperative haemorrhage [6]. Additionally, hypertension is associated with heightened stress responses, which may exacerbate pain perception and delay the healing process [6].

Surgical Technique-Induced and Iatrogenic Complications:

Third molar extraction is a technique-sensitive procedure, as the surgical approach plays a key role in determining postoperative outcomes. Research has shown that using high-speed drills without proper cooling can cause excessive bone heating, potentially resulting in persistent inflammation. Moreover, many studies have reported that patients who underwent osteotomy and odontosection, as well as those who experienced longer procedures, had a higher incidence of complications than expected. Cumulative evidence suggests that flap design and flap selection are related to surgical difficulty, which is mainly determined by the location of the tooth to be extracted. Therefore, the dental surgeon chooses the technique based on clinical experience or surgical preference [2].

Complications that are induced by the surgical technique include:

- Paresthesia or permanent injury to the inferior alveolar or lingual nerve during mandibular third molar (MTM) extraction;
- Mandibular fracture;
- Displacement of the third molar, a root fragment, the crown, or the entire tooth;
- Parts of dental equipment or burs may also be displaced or lost in the adjacent tissues of the upper or lower jaw [7].

Strategies to Reduce Post-Operative Complications:

Smoking is strongly associated with poorer surgical and oral healing outcomes due to both local and systemic effects of tobacco. Research on mandibular third molar removal indicates a strong link between tobacco use and the development of dry socket. In a clinical study by Al-Belasy, outcomes were compared between non-smokers and users of cigarettes and shisha. The findings showed a markedly lower incidence in non-smokers (7%) compared

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Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

with smokers. Among smokers, the risk varied depending on cessation timing: 31.6% in those who continued smoking on the day of surgery, 17.9% when smoking was stopped until the second postoperative day, and 10.5% when abstinence was maintained for three days or more after extraction. This pattern suggests that both smoking status and the duration of postoperative abstinence play an important role in the likelihood of developing dry socket [5]. Rosen et al. also reported that periodontal regenerative outcomes were less favourable in smokers compared with non-smokers. At one-year follow-up, smokers showed a 29% gain in clinical attachment levels, while non-smokers achieved 42% [56]. A similar difference remained over time, with improvements of 31% in smokers versus 42% in non-smokers over a 2–5-year period [56].

Moreover, the effectiveness of CHX in preventing alveolar osteitis (dry socket) and postoperative infection has been widely investigated. Early evidence from a randomised controlled trial by Larsen showed that using 0.12% CHX before and after third molar extraction reduced the incidence of alveolar osteitis by approximately 60% [38]. Further, a meta-analysis by Caso et al. found that rinsing with CHX only on the day of surgery did not produce a statistically significant benefit, although extended use during the postoperative period appeared to reduce the risk of dry socket [17]. Similarly, Minguez-Sera et al. reported that repeated application of 0.2% CHX gel after extraction was associated with a lower incidence of alveolar osteitis [42].

Although prophylactic antibiotics are commonly prescribed in contemporary third molar surgery, their routine use remains controversial. Research evaluating antibiotic prophylaxis before third molar surgery has produced conflicting results, and differences in study design, antibiotic type, dosage, and route of administration make interpretation challenging. Several studies have reported positive outcomes with prophylactic antibiotic administration. Monaco et al. found that a preoperative dose of amoxicillin was associated with lower rates of postoperative pain, fever, wound infection, and analgesic consumption [44]. Halpern and Dodson observed fewer surgical site infections among patients receiving antibiotics compared with placebo [28]. A meta-analysis by Ren and Malmstrom concluded that antibiotics reduced the incidence of dry socket and postoperative infection [55]. In contrast, several well-designed clinical trials have failed to demonstrate a significant benefit. Bezerra et al., Siddiqi et al., and Kaczmarzyk et al. reported no meaningful reduction in postoperative inflammatory or infectious complications with either preoperative or extended postoperative antibiotic regimens. These findings suggest that routine antibiotic use may not be necessary for all patients undergoing third molar extraction. [12-34-60]. Evidence from large retrospective studies indicates that the effectiveness of antibiotics may depend on the type and complexity of impaction. Piecuch et al. found that infection rates after maxillary third molar removal were very low regardless of antibiotic use [53]. For mandibular third molars, systemic antibiotics provided only a modest reduction in postoperative infections, whereas topical tetracycline appeared to be more effective. However, concerns have been raised regarding tetracycline-associated nerve irritation when applied near exposed neural structures. Experimental studies suggest that this risk is primarily associated with direct contact between tetracycline and a damaged nerve, rather than an intact one [45-76].

Another widely used supplements are corticsotoriods to reduce postoperative inflammation and improve patient comfort following third molar extraction. Several randomised controlled trials have reported significant reductions in postoperative oedema and trismus among patients receiving corticosteroids. Ross and White found that hydrocortisone significantly decreased swelling and jaw stiffness following oral surgical procedures [57]. Nathanson and Seifert observed reduced postoperative oedema in patients treated with betamethasone, leading to recommendations that corticosteroid therapy should begin before surgery and continue for a short period afterwards [49]. Hooley and Francis later confirmed these benefits in a large clinical trial, reporting substantially less swelling, reduced trismus, and lower analgesic consumption in patients receiving betamethasone compared with controls [30].

Some researchers have also evaluated the combined use of corticosteroids and nonsteroidal anti-inflammatory drugs (NSAIDs). Buyukurt et al. reported that prednisolone significantly reduced swelling and trismus, while the addition of diclofenac provided further improvement in postoperative pain control [14]. Similarly, Dionne et al. found that a combination of dexamethasone and ketorolac produced greater pain reduction than corticosteroid therapy alone, suggesting a potential synergistic effect between these medications [23].

Gyrectomy:

Gyrectomy refers to the surgical removal of the third molar at an early developmental stage, before complete root formation [69]. It is considered a preventive approach in selected young patients to reduce the risk of complications associated with fully developed impacted third molars [69]. Evidence suggests that early removal

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Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

may be associated with lower neurosensory risk, reduced surgical difficulty, and decreased postoperative morbidity when compared with conventional late extraction in fully formed third molars. The procedure is generally indicated during the developmental stages of the third molar when root formation is incomplete and spatial or orthodontic considerations are present. It may also be recommended in cases where future impaction, infection risk, or damage to adjacent structures is anticipated [69].

Early evidence supporting the safety of germectomy was provided by Bjørnland et al., who evaluated 86 patients aged 8–17 years who underwent bilateral removal of mandibular third molar germs under local anaesthesia [13]. The authors reported a low incidence of postoperative complications and acceptable psychological responses among patients, suggesting that germectomy is a well-tolerated procedure when performed in carefully selected young individuals [13]. More recently, Monaco et al. demonstrated that the risk of delayed postoperative infection following lower third molar germectomy is influenced by the amount of distal space available behind the second molar [44]. In their retrospective analysis of 218 germectomies performed for orthodontic reasons, delayed-onset infections occurred in 20 cases between 2 and 8 weeks after surgery. The authors found a significant inverse correlation between distal space and infection risk ($P = 0.004$), with most infections occurring in patients who exhibited minimal space distal to the second molar [44]. These findings suggest that radiographic assessment of the distal space may be useful for identifying patients at increased risk of postoperative infection and for improving treatment planning and patient counselling [44]. Overall, the available evidence indicates that germectomy may represent a safe preventive strategy in selected patients when appropriate clinical and radiographic assessment is performed. However, the timing and indications for germectomy remain subjects of debate, and careful case selection is essential to balance potential benefits against surgical risks.

Twin Mix Local Anaesthetic Technique:

The Twin Mix local anaesthetic technique combines a local anaesthetic solution with dexamethasone in a single injection, providing both anaesthetic and anti-inflammatory effects. In a systematic review and meta-analysis of eight randomised controlled trials, Eszter Hardi and colleagues reported that Twin Mix significantly reduced postoperative pain, facial swelling, and trismus following mandibular third molar surgery compared with conventional local anaesthetic solutions [24]. Patients receiving Twin Mix demonstrated significantly lower levels of swelling, trismus, and pain on postoperative days 1 and 3, while reductions in swelling and trismus remained evident on day 7 [24]. The technique also reduced pain during local anaesthetic administration, shortened the latency period, and prolonged the duration of anaesthesia. Based on these findings, the authors concluded that Twin Mix is a beneficial adjunct for minimising postoperative complications after mandibular third molar removal [24].

Coronectomy in High-Risk Third Molar Surgery:

Coronectomy, or intentional partial odontectomy, was developed specifically to eliminate the primary mechanism of IAN injury during third molar extraction: the mechanical forces exerted on the roots during elevation and luxation [3]. By deliberately removing only the crown of the tooth while leaving the roots undisturbed within the alveolar bone, the procedure avoids any direct or indirect force transmission to the adjacent mandibular canal [35-54].

The procedure is indicated when CBCT confirms direct root-canal contact, an interradicular canal position, or the complete absence of a cortical bone barrier between the nerve and the root apex, rendering total extraction an unacceptably high-risk procedure in the surgeon's clinical judgment [35-54-75].

The clinical success of coronectomy is critically dependent on precise execution. The crown must be transected at a level approximately 2 mm below the crest of the buccal bone plate to ensure adequate soft-tissue coverage of the root stump without leaving exposed enamel remnants, which would prevent proper mucosal healing and predispose to chronic infection [9-35]. A fundamental prerequisite for proceeding with the technique is that the root complex must be completely immobile after crown separation; any detectable mobility of the root fragment mandates conversion to total extraction, as a mobilised root loses its vitality and carries a markedly elevated failure rate [35]. Technological refinements, including the use of custom individual drilling sleeves or guided cutting jigs, have been introduced to improve the precision of the transection level and minimise the risk of accidental root mobilisation through uncontrolled bur slippage [54]. The use of piezosurgery for the osteotomy component further enhances precision and eliminates the risk of inadvertent soft-tissue trauma [4].

Minimally Invasive Techniques for Third Molar Surgery:

In recent years, minimally invasive surgical methods have become increasingly common in oral surgery, especially for third molar extractions, as they are associated with reduced postoperative discomfort, oedema, and complications [41-46]. Among these methods, piezoelectric surgery, which uses ultrasonic

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Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

microvibrations for bone cutting, has demonstrated clear benefits compared with traditional rotary drills, mainly in preserving soft and hard tissue integrity and minimising surgical trauma [4].
In a randomised split-mouth study conducted by Keyhan, S. O. and his colleagues, patients treated with the piezoelectric technique for impacted mandibular third molars experienced significantly less pain and swelling after surgery than those treated with rotary osteotomy [36]. Likewise, an erbium-doped yttrium aluminium garnet (Er: YAG) laser has been applied in third molar extraction, showing promising outcomes such as reduced postoperative pain and accelerated healing compared to conventional surgical methods [36].

Suturing Techniques:

The method used to close the surgical wound after tooth removal has a measurable impact on the early postoperative inflammatory profile. Secondary closure, which leaves a portion of the posterior socket deliberately open to facilitate natural drainage, has been shown by systematic review and meta-analysis to produce significantly less facial swelling on both the first and third postoperative days compared to primary closure [10]. The proposed mechanism is the prevention of hematoma accumulation beneath a sealed wound, which secondary closure avoids by permitting direct drainage of inflammatory exudate. However, secondary closure may be associated with a slightly elevated rate of early postoperative bleeding compared to complete primary closure, and is not universally applicable in all clinical cases [10]. The choice of closure technique should therefore be individualised based on the surgeon's assessment of bleeding risk, hematoma likelihood, and the patient's wound healing capacity.

Surgical Drainage:

The placement of a surgical drain within the alveolar wound or submandibular space provides an additional mechanism for reducing postoperative inflammatory accumulation. Evidence from meta-analyses indicates that drainage significantly improves maximal mouth opening by a mean of approximately 4.44 mm and reduces measurable facial swelling compared to non-drained controls [25]. Drainage does not appear to exert a significant independent effect on postoperative pain scores, suggesting its primary benefit is mechanical decompression of edematous tissue rather than modulation of the nociceptive inflammatory cascade [25].

Advanced Imaging and Technology:

The integration of advanced imaging modalities such as cone-beam computed tomography (CBCT) with computer-aided design/computer-aided manufacturing (CAD/CAM) technology has revolutionised the planning and execution of wisdom tooth extractions. CBCT provides detailed three-dimensional images of the maxillofacial region, enabling precise assessment of tooth position, proximity to vital structures, and surgical planning [15]. CAD/CAM technology allows for virtual surgical planning and the fabrication of patient-specific surgical guides, leading to improved accuracy and efficiency during the procedure. A study evaluating the use of CAD/CAM-guided bone resection in oral surgery reported high precision and accuracy, resulting in favourable surgical outcomes [62]. The use of 3D printing technologies for guided extraction combined with piezosurgical instrumentation enables the controlled removal of deeply impacted third molars. This allows for highly accurate preoperative planning, precise intraoperative localisation, and predictable repositioning and stabilisation of the surrounding hard and soft tissues [62].

Conclusion

Postoperative complications following third molar surgery are multifactorial and are influenced by anatomical characteristics, patient-related factors, and surgical variables. The reviewed evidence demonstrates that the risk of adverse outcomes can be significantly reduced through comprehensive preoperative assessment, careful treatment planning, and the application of evidence-based preventive strategies. Advanced diagnostic imaging, particularly CBCT in selected cases, allows for more accurate evaluation of tooth position and its relationship to adjacent anatomical structures, thereby improving surgical planning and reducing the risk of nerve injury and other complications. Preventive approaches such as coronectomy, germectomy, the Twin Mix local anaesthetic technique, piezoelectric surgery, and minimally invasive surgical protocols have shown promising results in reducing surgical trauma and postoperative morbidity. In addition, perioperative measures including chlorhexidine use, corticosteroid therapy, appropriate analgesic protocols, and smoking cessation have demonstrated beneficial effects on postoperative recovery.
Continued advances in imaging technologies, digital surgical planning, guided surgery, and personalised treatment approaches are expected to further improve the safety, predictability, and clinical outcomes of third molar extraction procedures. Future research should focus on refining preoperative risk assessment and surgical planning through the integration of three-dimensional imaging, virtual surgical simulation, and patient-specific 3D-printed anatomical models. These technologies have the potential to enhance surgical precision, reduce

Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

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Libyan Journal of Medical Research

www.lmjr.ly/ eISSN: 2413-6096

operative risks, and improve postoperative recovery. Furthermore, increasing knowledge of the genetic and molecular mechanisms involved in wound healing may enable the identification of patients at greater risk of complications and support the development of individualised treatment strategies. As these innovations become more widely available, they may contribute to safer, more efficient, and more predictable third molar surgery.

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Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

DOI: https://doi.org/10.54361/LJMR.20.2.58

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Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

DOI: https://doi.org/10.54361/LJMR.20.2.58

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Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026

DOI: https://doi.org/10.54361/LJMR.20.2.58

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Received: 02-05-2026-**Accepted:** 26-06-2026 -**Published:** 01-07-2026