Multimodal Dental Pain Management: Contemporary Strategies and Future Directions

Keywords

Multimodal dental pain management, Acute dental pain, Chronic orofacial pain, Opioid-sparing analgesia, NSAID-acetaminophen combination therapy, Local anesthetics and regional nerve blocks, Orofacial neuropathic pain, Temporomandibular disorders, Nonpharmacologic pain management, Behavioral and cognitive pain interventions, Photobiomodulation therapy, Transcutaneous electrical nerve stimulation, Dental anxiety and pain perception, Enhanced Recovery After Surgery (ERAS) in dentistry, Personalized pain management strategies

Abstract

Dental pain is one of the most prevalent and clinically significant concerns in dental practice, substantially impacting patient comfort, treatment compliance, and oral health–related quality of life. Owing to its multifactorial pathophysiology, dental pain is often inadequately controlled by single-agent analgesic approaches, which are further constrained by dose limitations, adverse effects, and growing concerns regarding opioid use. Multimodal dental pain management has therefore emerged as an evidence-based strategy that integrates pharmacologic and non-pharmacologic interventions to target multiple pain pathways simultaneously.

This narrative review discusses the rationale for multimodal analgesia in dentistry with an emphasis on optimized local anesthesia techniques,non-steroidal anti-inflammatory drugs, acetaminophen, corticosteroids, and judicious opioid sparing opioid use when indicated.

Adjunctive nonpharmacologic modalities, including behavioral and cognitive interventions, photobiomodulation, cryotherapy, transcutaneous electrical nerve stimulation, acupuncture, and virtual reality based distraction are also reviewed, acknowledging variability in the strength of clinical evidence supporting their use. The application of multimodal pain management across dental specialties, including oral and maxillofacial surgery, endodontics, periodontics, pediatric dentistry, orthodontics, and prosthodontics, is discussed.

Emerging trends in dental pain management focus on personalized analgesic strategies, enhanced recovery after surgery, digital health technologies, and novel analgesic formulations. Overall, multimodal dental pain management provides a comprehensive, patient-centered approach that enhances analgesic efficacy, minimizes adverse effects, reduces opioid reliance, and improves clinical outcomes in modern dental practice.

1. Introduction

Oral health is an essential component of overall health and well-being, with conditions such as dental caries, periodontal disease, and oral malignancies representing significant worldwide health challenges. These conditions interfere with fundamental daily functions, including mastication, speech, sleep, and social interactions, thereby adversely affecting quality of life. Despite advances in preventive and restorative dentistry, oral diseases remain among the leading causes of pain and healthcare utilization globally. Among these conditions, dental pain is the most frequent and debilitating complaint, arising from diverse etiologies and consistently impairing oral health-related quality of life.[1,2]

Pain is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue injury, underscoring its multidimensional nature. Dental pain, in particular, reflects the play of nociceptive, inflammatory, neuropathic, and psychosocial mechanisms. Historically, its management has focused on single modality approaches, including local anesthesia, nonsteroidal anti-inflammatory medications, acetaminophen, and short-term opioid use for acute postoperative pain.[3,4] However, these strategies are limited by issues such as maximum dose thresholds, adverse effects, individual variability in response, and the risk of misuse related to opioids. In a broader perioperative approach,a multimodal and collaborative approach to pain control is the cornerstone of Enhanced Recovery After Surgery (ERAS), eventually reducing stress responses, lowering complication rates, and supporting faster recovery.[5,6]

Within dentistry, multimodal dental pain management integrates pharmacological approaches (e.g., combined NSAID and acetaminophen therapy, advanced local anesthetic techniques, and perioperative corticosteroids), behavioral and non-pharmacological modalities. These may include patient education, anxiety reduction strategies, photobiomodulation, cryotherapy, transcutaneous electrical nerve stimulation, acupuncture, laser-based treatments, computer-guided anesthesia delivery, and rigorously formulated herbal products like TRPV1-modulating dental gels.[1,2,7] This comprehensive, patient-centered approach aims to enhance the efficacy and safety of pain control, and reduce opioid dependence.

2. Rationale for Multimodal Pain Management in Dentistry

Dental pain is the most common symptom associated with a wide range of dental procedures and pathologies. Patients with inflammatory pathologies experience postoperative pain after clinical interventions, especially in the first 0-72 hours. This has been represented as a significant unmet clinical need, where 10-20% post surgical cases described pain as severe.[8] In the majority of dental clinics, non-steroidal anti- inflammatory drugs (NSAIDs) (the gold standard), opioids, tramadol, and AAP are most commonly prescribed for pain control.[9] However, the severity, complexity of the case, and duration of procedures may lead to increased pain perception exceeding analgesic monotherapy.

The complex nature of pain involves multiple pathophysiological mechanisms, including central sensitization, descending pain modulation pathways, and peripheral nociceptor activation.[10] Since transmission of pain is through multiple neural pathways, its management via distinct mechanisms is more effective than targeting a single mechanism.[10] Analgesic monotherapy often provides pain relief in mild pain conditions, but it may be insufficient for moderate to severe pain and chronic pain management. Targeting a single pain pathway often results in suboptimal analgesia, whereas dose escalation of a single agent increases the risk of adverse effects.

Opioid analgesics are limited due to side effects like nocturnal hypoxemia, respiratory depression, adverse effects of addiction, various idiosyncratic reactions,and variable duration of action.[10,11] Similarly, nonsteroidal anti-inflammatory drugs (NSAIDs) are not efficient in providing effective pain relief for most moderate or severe pain without side effects such as bleeding,gastrointestinal irritation, vomiting, sedation, and nausea.[12] Limitations of usage of local anesthetics include unwanted motor blockade that interferes with rehabilitation efforts and postoperative mobilization.[11]

Because of this complexity, a tailored multidrug approach with different analgesics targeting different pathways of pain generation and maintenance is required for optimal outcomes across diverse clinical scenarios. Multimodal analgesia (MMA) addresses these limitations by combining drugs with different complementary mechanisms of action, such as local anesthetics, NSAIDs (non-steroidal antiinflammatory drugs), acetaminophen, and when necessary, opioids, to increase the analgesic effect and reduce the drug's side effects.[9]

This rationale for MMA creates a synergistic effect that relieves pain while reducing the side effects [Figure 1].[13] In addition, this concept of synergism and opioid sparing management aligns with principles of patient-centric care to enhance effective pain control, functional recovery, and reduce treatment-related morbidity.[10,14]

Oral multimodal pain management holds a significant role in reducing the intensity and quality of pain when combined drug doses are used.

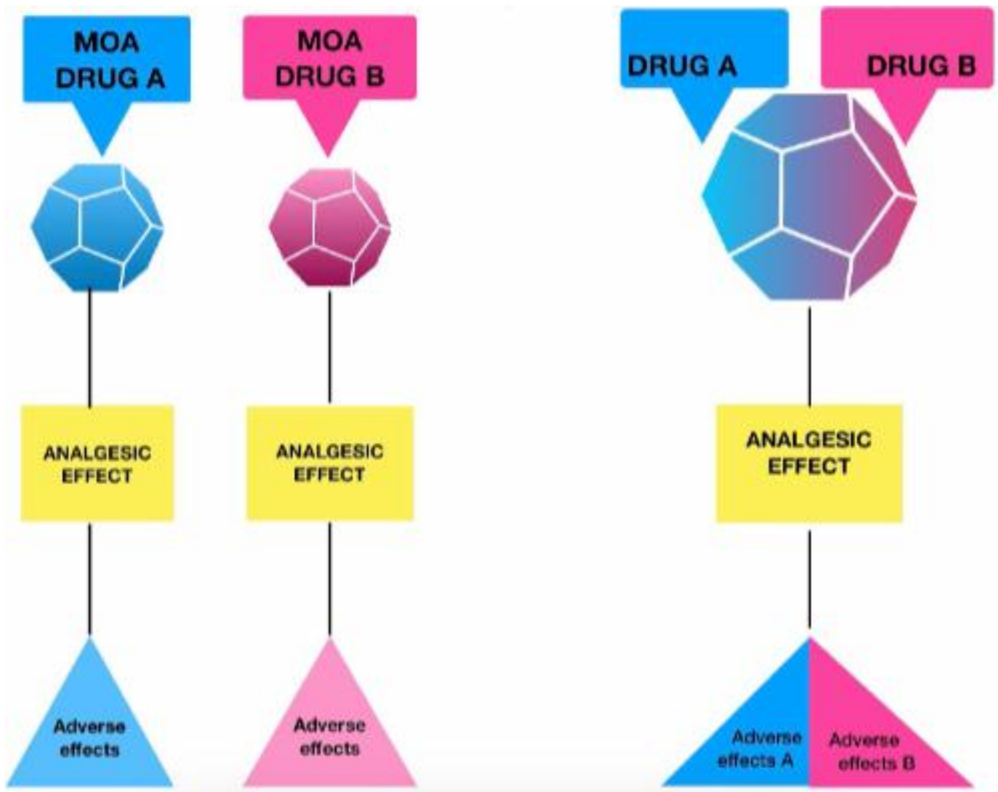

Figure 1. Hypothetical explanation of pharmacological synergism as multimodal analgesic strategy

3. Contemporary Strategies in Multimodal Dental Pain Management

3.1 Pharmacologic Approaches

The pharmacological approaches to treat dental pain are influenced by the availability of definitive dental treatment addressing the root cause. It must be individualized based on patient age, comorbidities, allergies, and drug history. When immediate treatment of the underlying etiology is not feasible, analgesic therapy plays a central role in symptom control while minimizing adverse effects.

Historically, opium is derived from poppy seeds, and salicin from the willow bark were used to relieve pain, and later the active ingredients morphine and aspirin were extracted, respectively. We have come a long way in understanding these drugs. The non-opioid analgesics, due to their efficacy and safety profiles, are the most commonly used analgesics in dentistry. Opioids are reserved for severe, refractory to first-line therapy or when other analgesics either fail to control the pain or are contraindicated. In several instances where a multimodal approach is required, both non-opioids and opioids are used concurrently.[15]

Acute Dental Pain

Acute dental pain without immediate dental treatment, and postoperative pain associated with patients (above 12 years of age) who have undergone simple or surgical tooth extractions are prescribed NSAIDs as first-line therapy. Common regimens include either Ibuprofen 400 mg or Naproxen sodium 440 mg. To achieve enhanced analgesic efficacy, both NSAIDs with acetaminophen (Ibuprofen 400mg or Naproxen Sodium 440mg and Acetaminophen 500mg) are prescribed as a multimodal approach.[16]

If the pain is severe, persisting beyond two or three days, prompt management of the root cause should be addressed. If the treatment option is temporarily unavailable, opioids like Hydrocodone (up to 7.5 mg) or oxycodone (5 mg) with acetaminophen (325 mg) may be prescribed for not more than three days. This combination could also be taken along with the first-line therapy, ie, along with the NSAIDs in case of severe pain.[16]

If the patients have contraindications to NSAIDs, acetaminophen (1000 mg) is prescribed as first-line therapy. If the pain is severe, the combination of acetaminophen (325 mg) with Hydrocodone up to (7.5 mg) or oxycodone (5 mg) and acetaminophen (325 mg) is used for not more than three days.[16]

During the Multimodal approach, adherence to the maximum recommended daily dose for these medications should be taken into consideration: Ibuprofen is 2.400 mg/day, Naproxen Sodium is 1,100 mg/day, and Acetaminophen is 4000 mg /day.[16]

Opioids should be prescribed with informed consent, and the adverse effects should be provided to the patient in advance, which include respiratory depression, substance misuse, and physiological dependence.[16]

In some instances, local anesthetics could be supplemented to mitigate the pain before other analgesics come into effect. The anesthetics like Lidocaine 2% with 1:100,000 epinephrine or Articaine 4% with 1:100,000, are effective for acute pain control on presentation, while longer-acting agents, Bupivacaine 0.5% with 1:200,000 epinephrine or Articaine 4% with 1:100,000/200,000 epinephrine post-operatively.[16]

Anxiety and Pain

Multimodal treatment options for patients with anxiety and pain are very commonly seen in every dental practice. These include local anesthetics, nitrous oxide sedation, and sedatives like Benzodiazepines. This pharmacological approach has shown a substantial reduction in anxiety and pain, although mild, transient side effects may occur.[17]

A combined approach with non-pharmacological methods has shown greater reductions in anxiety and pain have been reported, albeit with longer recovery times in highly anxious individuals.[17,18]

Orofacial Neuralgia

Post-traumatic trigeminal neuropathic pain (PTTNP), where somatosensory nervous system damage occurs due to a lesion or disease. The lesion could be due to post-endodontic treatment, post-tooth extraction, or implant placement. Any branches of the trigeminal nerve are affected, commonly the inferior alveolar nerve (IAN) and the lingual nerve (LN).[19]

Multimodal approach with drugs such as anticonvulsants, gabapentinoids; gabapentin (300-3600 mg/day), pregabalin (150-600 mg/day), inhibits excitatory neurotransmitter release via modulation of $\propto 2\ \delta$ subunit of voltage-gated calcium channels. Tricyclic antidepressants such as amitriptyline (10-75mg/day) exert analgesic effects through sodium channel blockade and inhibit reuptake of norepinephrine and serotonin. Benzodiazepines such as clonazepam 0.25-1.5mg/day may be used selectively for associated insomnia (due to cognitive and dependence-related risks). Dosages should be altered in those patients with renal or cardiovascular diseases. Topical application with 5% Lidocaine patches or 0.025-0.075% Capsaicin cream can also be used along with drugs as a multimodal approach.[19]

Chronic Orofacial neuropathic pain affects a patient's day-to-day activities and psychological well-being. Early treatment within three months leads to a better prognosis; delayed treatment leads to chronic pain resulting from central sensitization and persistent ectopic activity of the nerve.[19]

Temporomandibular disorders (TMD)

Oro-facial pain arising from Temporomandibular disorders (TMD) could be due to degenerative or musculoskeletal conditions. As an initial multimodal therapy, NSAIDs and muscle relaxants such as carisoprodol, cyclobenzaprine, and metaxalone (rarely Benzodiazepines and Cyclobenzaprine <10mg) are used to improve the overall well-being of the patient by improving joint movement and also reducing the hyperactivity of the muscles. Selective serotonin-norepinephrine reuptake inhibitors (SNRIs) and Tricyclic antidepressants (TCAs) like amitriptyline, nortriptyline, and desipramine have been used as second and third lines of treatment options, respectively, for TMD due to their side effects. Drug interactions should be taken into considerations when patients have comorbidities.[20]

Opioids are used for severe pain, and the most commonly used are codeine, oxycodone, and hydromorphone. Fentanyl patches are also used if medications cannot be administered orally. Corticosteroids are used either orally or injected intra-articularly with a local anesthetic.[20]

3.2 Nonpharmacologic Modalities

While pharmacologic interventions such as local anesthetics, non-steroidal anti-inflammatory drugs (NSAIDs), and opioids remain central to dental pain management, contemporary strategies emphasize **multimodal approaches** that integrate both pharmacologic and non-pharmacologic modalities.[20]

Non-pharmacologic strategies are essential components of multimodal pain management, providing complementary approaches that target **sensory, cognitive, and emotional dimensions** of pain. They help reduce nociceptive signaling, alleviate anxiety, minimize physiologic stress responses, and prevent the progression from acute to chronic pain. Furthermore, these interventions support opioid-sparing practices, enhancing patient safety and reducing the risk of medication-related complications. This review outlines the contemporary non-pharmacologic strategies employed in dental pain management, emphasizing their mechanisms, applications, and clinical evidence.[21-23]

Behavioral and Psychological Interventions

a) Patient Education and Management

Effective patient education is one of the most accessible and impactful non-pharmacologic interventions. Studies indicate that patients who receive structured preoperative counseling, regarding procedural steps, anticipated sensations, recovery timelines, and postoperative care experience lower anxiety levels, pain perception and demonstrate better adherence to postoperative instructions compared to those who do not receive counseling.

Visual aids, written instructions, and videos can complement verbal explanations, helping patients anticipate sensations such as pressure, vibration, or mild discomfort. By reducing uncertainty, education and expectation management modify the cognitive appraisal of pain, reducing the emotional and behavioral burden associated with dental procedures.[23-25]

b) Cognitive-Behavioral Strategies

Cognitive-behavioral interventions, including relaxation techniques, mindfulness, guided imagery, and coping skills development, directly influence how patients perceive and respond to pain. For instance, guided imagery allows patients to mentally visualize calming scenarios, which decreases stress hormone levels and reduces nociceptive sensitivity. Relaxation techniques, including diaphragmatic breathing and progressive muscle relaxation, lower sympathetic nervous system activity, which in turn decreases heart rate, blood pressure, and the physiological manifestations of pain.

The integration of cognitive-behavioral strategies into routine dental practice are particularly valuable for anxious, pediatric, or chronic pain patients, who may be more susceptible to heightened pain perception. By addressing both psychological and physiological aspects of pain, cognitive-behavioral strategies complement pharmacologic interventions and enhance overall pain management outcomes.[23,24]

Technology-Assisted Pain Modulation

a) Low-Level Laser Therapy (LLLT)

LLLT, or photobiomodulation, employs low-intensity laser light to enhance cellular metabolism, modulates inflammation, and promotes tissue healing. The therapeutic effects of LLLT include increased ATP production, enhanced fibroblast proliferation, and release of anti-inflammatory mediators. In dental contexts, LLLT is beneficial for postoperative pain relief, mucosal lesion healing, and management of TMD-related discomfort. Its non-invasive nature and minimal side effect profile make it a desirable adjunct to conventional analgesics, contributing to opioid-sparing multimodal strategies.[25,26]

b) Virtual Reality (VR) Distraction

VR distraction utilizes immersive digital environments to divert attention from nociceptive stimuli, reducing the perceived intensity of pain and anxiety. VR has been applied effectively in pediatric dentistry, oral surgery, and invasive dental procedures resulting in enhanced cooperation from anxious and phobic patients. VR's integration into dental practice represents a shift toward leveraging technology to enhance non-pharmacologic pain modulation.[26]

Physical and Sensory Techniques

a) Acupuncture and Acupressure

Acupuncture and acupressure have become increasingly recognized for their analgesic effects in orofacial and dental pain. By stimulating specific points along meridians, these techniques influence the central and peripheral nervous systems by modulating neurotransmitter release. Systematic reviews indicate that acupuncture reduces both acute procedural pain and chronic orofacial pain syndromes, including TMD and post-extraction discomfort. Acupuncture can be combined with standard care to enhance pain control, particularly in patients with contraindications to pharmacologic therapy or those who prefer integrative approaches.[27]

b) Transcutaneous Electrical Nerve Stimulation (TENS)

TENS involves delivering low-voltage electrical currents to the skin overlying affected regions to stimulate peripheral nerves. This technique operates through the gate control theory of pain, whereby stimulation of larger sensory fibers inhibits nociceptive transmission in the spinal cord. Additionally, TENS promotes the release of endogenous endorphins, contributing to analgesia. In dental procedures, TENS has been shown to reduce intraoperative pain during extractions, endodontic treatment, and temporomandibular disorder (TMD) therapy. It is a safe, well-tolerated, and non-invasive option suitable for patients seeking adjunctive pain control.[28]

c) Cryotherapy

d) Cryotherapy, or the application of localized cold, is widely utilized in post-dental surgical care, particularly after tooth extractions, periodontal procedures, or implant placements. Cold therapy induces vasoconstriction, slows nerve conduction, and decreases tissue metabolism, reducing the inflammatory response and subsequent pain. Clinical trials demonstrate that patients receiving cryotherapy report significantly lower postoperative pain scores and reduced analgesic consumption during the first 24–48 hours post-surgery. Cryotherapy can be applied through ice packs, cold compresses, or specialized dental cryotherapy devices.[28]

Rehabilitation and Supportive Practices

a) Mind–Body Interventions

Yoga, meditation, and mindfulness-based stress reduction, provide additional benefits in dental pain management. These interventions modulate the autonomic nervous system, reduce cortisol levels, and improve patient resilience to stress and pain. Integrating mind–body interventions supports a holistic approach, addressing both psychological and physical components of pain, while also promoting long-term oral health by reducing stress-related TMD, such as bruxism.[29]

b) Physical Therapy-Jaw Exercises

Physiotherapy interventions and postoperative jaw exercises support functional recovery, reduce muscle stiffness, and enhance circulation. These interventions are particularly important in patients undergoing extensive oral surgery, TMD therapy, or dental implant procedures. Massage, gentle stretching, and range-of-motion exercises help prevent chronic pain, maintain temporomandibular joint mobility, and facilitate early return to normal function. Evidence suggests that early initiation of jaw exercises is associated with improved outcomes and reduced postoperative pain.[30]

Integration into Multimodal Management

Nonpharmacologic modalities are valuable because they target multiple pathways of pain perception, including sensory, emotional, and cognitive components. Their integration reduces the overall need for systemic analgesics, especially opioids, minimizing side effects and improving patient safety. Modern dental pain management prioritizes individualized, multimodal strategies that combine pharmacologic and non-pharmacologic interventions. For example, combining preoperative patient education with cryotherapy, VR distraction, and LLLT can provide additive analgesic effects, reduce postoperative swelling, and improve overall patient satisfaction, Figure 2.[31,32]

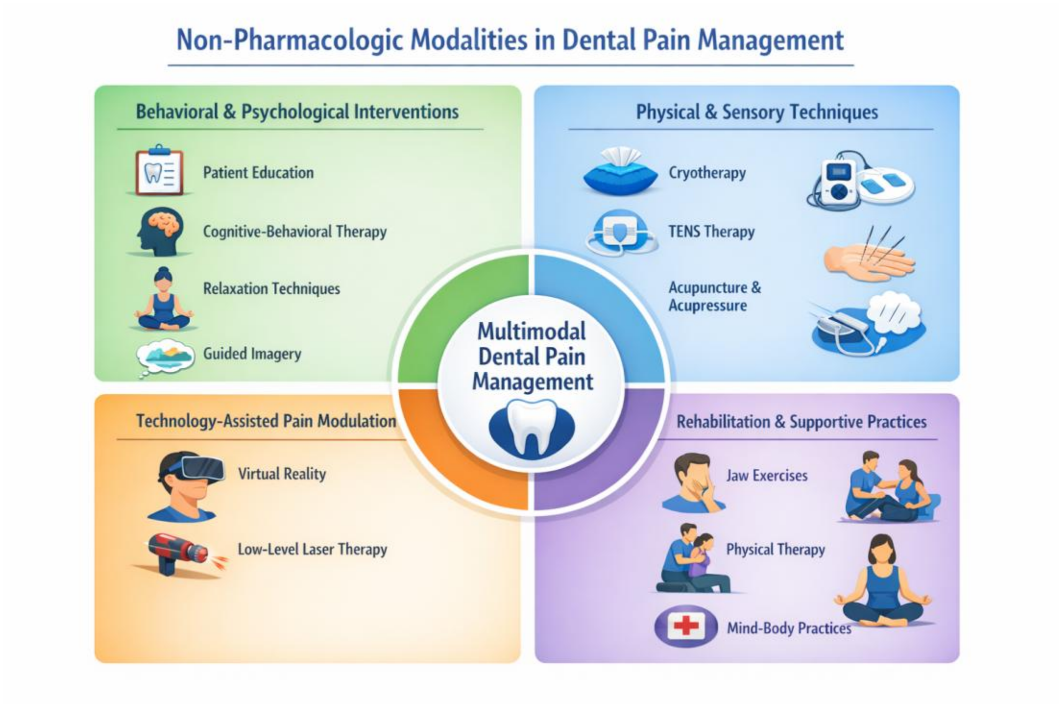

Figure 2. Nonpharmacologic Modalities in Dental Pain Management

4. Multimodal Pain Management Across Dental Specialties

Multimodal pain management in different dental procedures involves the use of pharmacologic agents, anesthetic techniques, minimally invasive procedures, behavioral interventions, and enhanced recovery strategies (ERAs). These combined techniques optimize analgesia, minimize opioid exposure, and improve patient-centered outcomes. Individual patients' pain perception, nature of procedures vary considerably across dental specialties; therefore, pain management protocols must be tailored according to specialty-specific clinical demands while adhering to opioid-sparing principles.

Oral and Maxillofacial Surgery

Oral and maxillofacial surgery involves extensive soft- and hard-tissue manipulation. This requires robust perioperative pain control. Multimodal strategies often use NSAIDs and acetaminophen with regional anesthesia. Opioids are limited to situations where indicated.[35]

The ibuprofen–acetaminophen combination provides superior postoperative analgesia.[34]

Regional nerve blocks—including inferior alveolar and maxillary blocks—reduce postoperative pain. Long-acting local anesthetics, such as bupivacaine (0.5% with epinephrine 1:200,000), are effective for this purpose.[33]

General anesthesia protocols often include propofol induction with inhalational nitrous oxide.[33]

Enhanced Recovery After Surgery (ERAS) measures, minimally invasive techniques (laser-assisted surgery, piezosurgery) patient-controlled analgesia, and non-pharmacologic interventions further enhance early recovery and patient satisfaction.[36-38]

Endodontics

Endodontic pain is inflammatory and nociceptive, frequently exacerbated by anxiety. A structured “3D approach” (Diagnosis, Dental treatment, and Drugs) supports effective pain management.[43]

NSAIDs are first-line agents, with ibuprofen-alone or combined with acetaminophen, demonstrating superior efficacy in irreversible pulpitis and apical periodontitis. Acetaminophen is an alternative for patients with NSAID contraindications.[39-40]

The inferior alveolar nerve block (IANB) remains the primary anesthetic technique for mandibular teeth. Buccal infiltration with 4% articaine significantly improves anesthetic success when used adjunctively with IANB.[41] In cases of persistent anesthetic failure, supplemental anesthetic techniques, including intraosseous (X-Tip®, Stabident®), periodontal ligament, intrapulpal injections, and articaine infiltration, enhance anesthetic success.

Non-pharmacologic strategies, preemptive analgesia, cryotherapy, and adjuncts such as corticosteroids or platelet-rich fibrin further reduce postoperative pain. Antibiotics are reserved strictly for cases with systemic involvement and do not substitute for analgesics.[42]

Pharmacologic Modalities Across Dental Specialties

Specialty	First-Line Analgesics	Adjuncts	Opioid Role
Oral Surgery	Ibuprofen + acetaminophen	Long-acting LA, corticosteroids	Limited, short-term

Endodontics	NSAIDs, acetaminophen	Corticosteroids, ketorolac	Refractory cases
Periodontics	NSAIDs, acetaminophen	Dexamethasone	Rare
Pedodontics	Acetaminophen, ibuprofen	Ketorolac (select cases)	Rare, supervised
Orthodontics	NSAIDs, acetaminophen	Short-term NSAID for severe pain	no routine role
Prosthodontics	NSAIDs, acetaminophen	Short-term NSAID for severe pain	no routine role

Periodontics

Periodontal procedures, ranging from nonsurgical therapy to regenerative and implant surgeries, are associated with inflammatory and procedural pain.[47]

Local anesthesia with vasoconstrictors remains a fundamental pain management technique, while long-acting anesthetic agents are essential following extensive surgery.[44]

NSAIDs and acetaminophen are first-line postoperative analgesics. Corticosteroids such as dexamethasone reduce postoperative edema and discomfort.[44]

Supplemental topical and intra-sulcular anesthetics (e.g., Oraqix®), intraosseous anesthesia, and minimally invasive approaches (microsurgery, laser therapy, piezosurgery) significantly reduce tissue trauma and pain .[45,48] Sedation strategies are guided by the ASA physical status classification, with ASA I–II patients suitable for office-based care and higher-risk patients requiring additional evaluation and in hospital settings.[44]

Pedodontics

Pediatric dental pain is influenced by developmental, emotional, and psychosocial factors. Multimodal, opioid-sparing strategies are the standard care.

Acetaminophen and ibuprofen are first-line analgesics. Opioids are rarely indicated and prescribed under strict supervision.[46]

Behavioral interventions; including distraction, parental involvement, imagery, hypnosis, and virtual reality, play a central role in pain modulation.[46]

Preemptive analgesia and careful use of local anesthesia reduce postoperative discomfort while minimizing soft tissue injury risks associated with residual numbness.[46]

Nonpharmacologic Modalities

Modality	Oral Surgery	Endodontics	Periodontics	Pedodontics
Counselling	+	+	+	+
CBT	+	+	+	+
Distraction	-	-	-	++
Hypnosis	-	-	-	+
Virthual Reality	Emerging	Emerging	Emerging	++

++ = Strong evidence/primary use

Prosthodontics and Orthodontics

Prosthodontic procedures, often non-surgical, may cause pain due to prolonged chair time, tooth preparation, gingival manipulation, and occlusal modification.

Local anesthesia, NSAIDs, and acetaminophen form the basis of pain control, while opioids have no routine role.[51]

Occlusal adjustment is a critical pain-modulating strategy, preventing occlusal trauma, periodontal ligament inflammation, muscle hyperactivity, and temporomandibular joint discomfort.[52]

Adjuncts such as dentin desensitizers, immediate dentin sealing, and occlusal splints further enhance comfort.

Orthodontic pain primarily results from periodontal ligament inflammation following force application. Acetaminophen is preferred due to concerns regarding NSAID-related inhibition of tooth movement. Short-term NSAID use may be considered for severe pain.[49]

Non-pharmacologic modalities—including low-level laser therapy, vibrational devices (e.g., AcceleDent®), bite wafers, and patient education—play a pivotal role in improving compliance and quality of life.[50]

Anesthetic and Procedural Modalities

Specialty	Primary Anesthesia	Supplemental Techniques	Devices
Oral Surgery	Regional nerve blocks	Site infiltration	EXPAREL®, piezosurgery
Endodontics	IANB, infiltration	IO, PDL, intrapulpal	X-Tip®, Stabident®, EndoVac®
Periodontics	Infiltration, blocks	IO, intraseptal	Oraqix®, lasers
Pedodontics	Infiltration, GA (select)	Preemptive LA	The Wand®, VR tools
Prosthodontics	IANB, infiltration	IO, intraseptal	

5. Future Directions

Future advances in multimodal dental pain management are expected to emphasize precision-based and patient-centered analgesic strategies. While current protocols largely rely on standardized combinations of non-opioid analgesics, local anesthetics, and adjunctive agents, growing evidence supports tailoring pain control regimens according to individual patient characteristics, including genetic variability, psychological status, systemic comorbidities, and prior pain experiences. The integration of biopsychosocial pain assessment tools alongside conventional numerical rating scales may enhance analgesic efficacy and reduce the transition from acute postoperative pain to chronic orofacial pain syndromes.[53]

Digital health technologies are anticipated to play a transformative role in future pain management models. Wearable biosensors, mobile pain-tracking applications, and electronic patient-reported outcome measures may facilitate continuous pain monitoring and enable real-time adjustment of analgesic regimens. In parallel, artificial intelligence–driven decision-support systems may assist clinicians in predicting analgesic response, optimizing multimodal drug combinations, and minimizing opioid exposure, aligning dental pain management with broader public health efforts to reduce opioid-related morbidity.[53]

From a procedural standpoint, the adoption of enhanced recovery after surgery (ERAS)–based protocols within dental and maxillofacial surgery is likely to expand. These pathways integrate multimodal pharmacologic analgesia with regional nerve blocks, perioperative patient education, and early functional rehabilitation. Emerging data suggest that ERAS-informed multimodal strategies can significantly reduce postoperative pain intensity, shorten recovery time, and improve patient satisfaction following invasive dental procedures, including orthognathic and implant surgery.[54]

Ongoing research into novel analgesic combinations and delivery systems also represents an important future direction. Fixed-dose multimodal formulations, such as low-dose opioid–NSAID combinations, demonstrate effective analgesia with improved safety profiles compared to traditional opioid monotherapy. Continued clinical trials are required to establish optimal dosing, long-term safety, and comparative effectiveness in routine dental practice.[10]

Finally, the role of non-pharmacological adjuncts, including cognitive-behavioral interventions, photobiomodulation, cryotherapy, and virtual-reality-based distraction techniques, warrants further exploration. When combined with pharmacological modalities, these approaches may enhance analgesic outcomes, reduce anxiety-related pain amplification, and improve overall patient experience.[54]

6. Conclusion

Multimodal dental pain management marks an important shift away from traditional single-drug approaches toward a more holistic, patient-focused model that better reflects the multifaceted nature of dental pain. By integrating optimized local anesthesia, scheduled non-opioid analgesics, behavioral support, and adjunctive techniques such as laser therapy, neuromodulation, virtual reality–based distraction, and evidence-supported herbal gels, clinicians can address multiple pain mechanisms simultaneously. This approach improves pain control while reducing dependence on opioids and other medications associated with significant adverse effects and dose-limiting toxicities.

Emerging options, including targeted sodium channel inhibitors and TRPV1-oriented formulations containing agents such as eugenol, menthol, and camphor, further broaden treatment choices and align with patient interest in safer, well-tolerated alternatives, provided their use is supported by sound clinical evidence.[1,7] In parallel, digital health technologies such as mobile pain-tracking applications, wearable biosensors, and artificial intelligence-assisted decision-support tools offer new opportunities to individualize multimodal regimens according to each patient's risk profile, comorbidities, and pain trajectory.[26,53] Future progress in dental pain care will depend on personalized, multimodal strategies that combine pharmacological, technological, and psychosocial interventions tailored to individual patient needs and preferences.

Incorporating principles from Enhanced Recovery After Surgery (ERAS), such as structured preoperative education, standardized opioid-sparing analgesic pathways, and early return to function, can help optimize outcomes in invasive dental procedures while addressing broader public health concerns related to opioid use.[53] Continued research, high-quality clinical trials evaluating fixed-dose multimodal combinations and non-pharmacological adjuncts, and ongoing professional training are essential to ensure these advances are effectively translated into routine practice.[10] Ultimately, well- designed multimodal pain management has the capacity not only to improve the safety and effectiveness of dental pain relief but also to enhance patient comfort, reduce dental anxiety, and support better oral- health related quality of life and long- term oral health outcomes at the population level.

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