

# Pain Management in Dentistry

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## Overview

The management of pain in dentistry encompasses a number of procedural issues, including the delivery of anesthetic and the management of postprocedural pain, as well as pain diagnosis, management strategies for orofacial conditions that cause pain in the face and head, and the management of pain in special populations. Given the extensive nature of the topic, this article reviews pain definitions and mechanisms, acute versus chronic pain, and focuses on management strategies related to anesthetic delivery and the control of pain following dental procedures.

## Pain Definitions

The IASP has defined pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.”<sup>[1]</sup> Their published taxonomy includes a number of specific pain terms including allodynia, analgesia, anesthesia dolorosa, causalgia, central pain, dysesthesia, hyperalgesia, hyperesthesia, hyperpathia, and hypoalgesia. What is important about these terms is that they describe the sensory experience related to nerve function generally including peripheral and central activity, and they underscore the complexity of the neural phenomena involved in pain processing. These terms can be ascribed to a number of pain problems encountered by the dentist managing pain in the face and head region.

## Current Knowledge of Pain Mechanisms

For a complete understanding of pain neurophysiology, the reader is referred to the numerous texts that are available exploring both peripheral and central pain mechanisms.<sup>[1, 2, 3]</sup> For the clinician involved in the management of orofacial pain, understanding that considerable plasticity exists in the central and peripheral nervous system related to pain processing is important. Modulation of pain occurs at multiple levels along the nociceptive pathway, and numerous peripheral as well as central mechanisms contribute to both pronociceptive as well as antinociceptive activity.<sup>[4]</sup>

Thus, the management of pain not only concerns therapy related to peripheral pathology and its effect on [peripheral nerve](#) function but may also include appropriate interventions aimed at reducing the effect of synaptic nerve transmission in second and third order neurons, synaptic changes associated with excitation of nerve or a reduction in inhibitory nerve activity, the action of neurotransmitters and other endogenous pain-reducing substances (eg, endorphins), autonomic nervous system activity, and reducing potential central structural changes associated with pain transmission.<sup>[5]</sup>

## Acute Versus Chronic Pain

The mechanisms underlying acute and chronic pain are considerably different in terms of neurophysiology; hence, overall pain management needs to reflect these differences. The persistence of pain (greater than 3 months) sets into motion multiple changes in the functioning of the peripheral and central nervous system that, coupled with psychological and behavioral considerations, can make pain intervention more complex and difficult.<sup>[6]</sup>

The delivery of anesthetic and the management of postprocedural pain in a normal patient is not likely to be impacted by peripheral and central neurophysiological plasticity. However, in the patient with a history of chronic nonfacial pain or in the fearful patient, brain neurophysiology may be altered so as to facilitate pain perception. Anxiety and fear is known to activate the pituitary-adrenal axis, leading to an increased experience of pain.

Thus, effective procedural pain control should include assessment and management of the patient's emotional state and relative stress level. The patient with multiple chronic pain problems may respond to dental treatment differently than the noninvolved patient.

## Procedural Pain

Acute pain may be associated with dental procedures such as anesthetic injection, restorative treatment, periodontal procedures, implant placement, and [tooth extraction](#). Pain associated with the injection of anesthetic can be modulated by

co-administration of volatile agents such as nitrous oxide, intravenous drugs, and by the pre-application of topical anesthetic, proper injection technique including slow delivery of the drug, selection of the proper needle size, and the type of anesthetic selected for delivery. Injection pain can also be reduced or eliminated via good patient management pre-injection by way of clinician patience, gentle patient management, assurance, and other behavioral techniques such as desensitization, hypnosis, and relaxation training.

## Topical Anesthetics

Many topical formulations can be obtained via compounding or are available from commercial sources. Compounding can be associated with risk because the final topical preparation, while potentially providing deeper penetration through the mucosa, may be associated with systemic effects such as tachycardia.<sup>[7, 8]</sup> The effectiveness of a topical anesthetic in controlling injection pain depends on its absorption and the physical properties of the drug. For example, if a topical is not viscous enough to adhere to the mucosa for a long enough period of time, it may not help control pain from needle penetration.

The best formulation for injection pain control is the gel or paste topical anesthetic. These include products with viscous lidocaine or benzocaine in ointment form. The latter can contain from 7.5% to 20% anesthetic. Lidocaine preparations produce surface tissue numbness in approximately 3 minutes. Another topical, tetracaine, which is combined with benzocaine as an anesthetic spray, produces rapid numbness within one minute. If sprayed on a cotton swab and applied to the specific injection site, this reduces generalized spread and the potential for adverse reactions.

Needle stick pain can also be eliminated by activation of the syringe plunger just prior to insertion into the tissue. Other techniques include pinching the lip or cheek region being held by the fingers, holding these structures during the injection, and/or stretching the tissue preinsertion. Both serve to distract the patient, with the latter also allowing the clinician to better visualize the actual point at which the needle penetrates the mucosa. Tissue that is thickened by scarring should be avoided because needle penetration pressure is difficult to control.

Pain associated with additional needle insertion can be eliminated by slow injection of the anesthetic in advance of additional penetration and, in the case of the [mandibular block](#), understanding the anatomy of the region and avoiding the medial pterygoid and the inferior alveolar nerve during drug delivery and, in the case of delivery in the maxillary arch, not allowing the needle to come into direct contact with the periosteum.<sup>[9]</sup>

Several interesting developments have occurred with injection technology. For example, Nordson Micromedics has introduced a product that is purported to improve the rate of anesthetic delivery called the Artiste Assisted Injection System. The clinician uses foot pressure to drive CO<sub>2</sub> through a handpiece connected to the dental syringe. Precise control of the pressure can be essentially dialed in by the operator.<sup>[10]</sup>

Another novel innovation for controlling injection pain is a recently patented device based on the gate-control theory of pain, which suggests that stimulation of large diameter fibers by vibration (other stimulants include cold, heat, rubbing, and pressure) serves to close the neural gate involving pain transmission. This device, termed a micro vibrator, can be placed on any standard dental syringe to provide ultra high-frequency and ultra low-amplitude stimulation, which allegedly reduces pain.<sup>[11]</sup>

## Local Anesthetics

The effectiveness of a local anesthetic in controlling procedural pain depends on factors such as the precision of the injection, the relative acidity of the tissue injected, the type of anesthetic injected, bone density at the site of the injection, nerve anatomy, and the patient's relative stress level. Mandibular nerve blocks are known to be less effective than those delivered into the maxillary region, primarily because of variances in nerve anatomy and bone density.

The standard mandibular nerve block may not be effective, and providing additional anesthetic coverage via lingual injection in the region of the floor of the mouth (to block accessory sensory branches of the mylohyoid nerve that can innervate the posterior mandibular first molar) or including buccal infiltration in the region of the mesial root of the first molar may be necessary. Providing incisive infiltration for complete coverage of the anterior teeth may also be necessary.

In an attempt to improve the efficacy of the mandibular block, 2 other injection techniques have been advocated: the Gow-Gates mandibular nerve block and the Akinosi-Vazirani closed-mouth mandibular nerve block.<sup>[12]</sup> Both are recommended for patients with a history of standard inferior alveolar nerve block failure. In the Gow-Gates technique, the patient's mouth must be fully open, and the local anesthetic is delivered to the neck of the condyle, where the mandibular branch of the [trigeminal nerve](#) exits the foramen ovale. In contrast, during the Akinosi-Vazirani technique, the patient's mouth is closed, and the anesthetic is delivered to fill the pterygomandibular space.

Although few studies exist that actually compare the 3 techniques in terms of

mandibular nerve pain management, at least one published study suggests that significant differences may not exist between the 3 strategies.<sup>[13]</sup> Of potential clinical significance, one study reported that the Gow-Gates and Vazirani-Akinosi techniques demonstrated a statistically slower onset of pulpal anesthesia than the standard inferior alveolar nerve block. However, the results of another study suggest that, in cases of pulpitis, the Gow-Gates approach may be superior to the other techniques in providing anesthesia.<sup>[14]</sup>

With the exception of the introduction of articaine, few changes occurred in the anesthetics recommended for use in controlling procedural pain over the last 20 years.

Articaine is an amide with a thiophene ring (versus a benzene ring). It has a half-life of 20 minutes and is hydrolyzed quickly in the blood, so the risk of systemic intoxication appears lower than with the other dental anesthetics. This is useful if repeated injections are necessary. The anesthetic was initially approved by the FDA in 2000, with articaine (Articadent) available in the US in October 2010.

A number of studies suggest that this anesthetic is superior to conventional anesthetics in controlling procedural pain when delivered via block injection or by infiltration,<sup>[15, 16, 17]</sup> although at least one systematic review suggests that the evidence of superiority of this anesthetic is inconsistent and of limited quality.<sup>[18]</sup> In contrast, another meta-analysis suggests its superior effectiveness in providing anesthesia in the first molar region.<sup>[19]</sup> Adverse effects of articaine, based primarily on anecdotal evidence and a review of 304 people who received the anesthetic for dental treatment, include mandibular nerve injury (17), hypoesthesia (51), pain (44), and tinnitus (2).<sup>[20, 21]</sup>

Another potential improvement in procedural pain control arises from a study recently published involving the preoperative administration of lornoxicam and diclofenac potassium oral medication prior to inferior alveolar nerve block in patients with irreversible pulpitis. One hundred and fourteen patients participated in this double-blind, randomized controlled clinical trial. It was found that pre-injection coverage with lornoxicam (but not diclofenac potassium) significantly improved the efficacy of the inferior alveolar block in comparison to placebo,<sup>[22]</sup> suggesting that preadministration of this NSAID may be useful in establishing good anesthesia in patients with irreversible pulpitis.

## Behavioral Management

Fear of the needle or dental treatment in general is commonplace.<sup>[23]</sup> Numerous factors are associated with dental anxiety, including the memory of prior painful dental experiences, conditioning, pain expectation, and other psychological factors. All may impact the pain experience.<sup>[24, 25]</sup> Reducing dental anxiety can profoundly reduce an individual's pain threshold.<sup>[26]</sup>

Simple behavioral strategies for managing anxiety vary between children and adults but typically include the provision of a warm and caring clinical environment, assurance, an unhurried clinical atmosphere, slow introduction, and nontraumatic explanation of the anticipated procedures; for children, inclusion of a parent or guardian with hand-holding, if necessary can also help. Evidence even exists that pleasant ambient fragrances as well as musical intervention can alter dental fear.<sup>[27, 28]</sup>

Other fear-reducing and anxiety-reducing interventions include those used to manage pain patients generally, such as distraction, desensitization, and relaxation training with mental imaging. Limited research also suggests that biofeedback may help to reduce dental anxiety and improve the pain experience.<sup>[29]</sup> Acupuncture may also be considered as a behavioral management strategy, as studies suggest that it can be effective in reducing anxiety and procedural pain.<sup>[30]</sup> Only a limited number of clinical trials with randomization of patients exist that support the above behavioral strategies for reducing facial pain associated with dental procedures. Also, an absence of randomized clinical trials exists for strategies such as homeopathy, naturopathy, chiropractic, massage, meditation, or herbal remedies that might also be considered as intervention during anesthetic delivery or dental treatment.

## Postprocedural Pain Management

Presently, no published guidelines exist for the dental management of postprocedural pain. Best practice is based on anecdotal reports, case studies, RCTs, and the opinions of experts.

Current practice involves using individual drugs or multimodal analgesic combinations to treat postprocedural pain.<sup>[31]</sup> Presumably, the use of multiple drug combinations improves efficacy while minimizing potential adverse consequences. However, as suggested by Barkin,<sup>[32]</sup> work needs to be done in defining the most efficacious dose combinations of the medications currently prescribed.

These drugs include acetaminophen, aspirin, and NSAIDs.<sup>[33]</sup> In patients with GI or kidney problems without sulfa allergy, a Cox-2 inhibitor such as Celebrex can be prescribed to reduce potential adverse effects. Moderate postprocedural pain may necessitate the prescription of an opioid drug or tramadol combined with an acetaminophen or a NSAID.

Thirty-five Cochrane reviews have evaluated randomized trials that have been published, assessing the analgesic efficacy of medications used after dental treatment.<sup>[34]</sup>

The most recent systematic review addresses acute pain in adults with moderate to severe pain following oral surgery in which single dose therapy of a single drug has been prescribed.<sup>[34]</sup> A number of drug/dose combinations were found to have demonstrated over 50% reduction in postprocedural pain including ibuprofen 400 mg, diclofenac 50 mg, etoricoxib 120 mg, codeine 60 mg plus paracetamol 1000 mg, celecoxib 400 mg, and naproxen 500/550 mg.

The longest duration of action ( $\geq 8$  hours) was found to occur for etoricoxib 120 mg, diflunisal 500 mg, oxycodone 10 mg plus paracetamol 650 mg, naproxen 500/550 mg, and celecoxib 400 mg. The authors of this study note that reviews existed but no trial data for a number of single-use drugs such as acetaminophen (a NSAID), meloxicam, nabumetone, nefopam, sulindac, tenoxicam, and tiaprofenic acid and inadequate data related to dexibuprofen, dextropropoxyphene 130 mg, diflunisal 125 mg, etoricoxib 60 mg, fenbufen (UK), and indomethacin. The authors note that adverse events were more likely to be associated with aspirin and the opioids.

Any of the over-the-counter medications taken for postprocedural pain can be misused by patients. In a study of unintentional acetaminophen overdose, data collected by querying the French Pharmacovigilance database over a 9-month period, 13 patients were identified as having mild unspecific clinical symptoms and 4 of 10 had abnormal liver enzyme activity. The median dose of acetaminophen was 137mg/kg per 24 hours.<sup>[35]</sup> Opioids are another class of pain relievers that have potential for misuse. Dentists prescribe approximately 12% of the immediate release opioids in the United States, presumably for postprocedural pain.<sup>[36]</sup> The potential for abuse can be minimized by limiting the amount prescribed, patient education, monitoring for substance abuse, and appropriate referral if it is suspected.

Tanner et al investigated the accuracy with which parents measured doses of over-the-counter liquid oral pain medications when administering pain medications to their children to control postoperative pain. A total of 120 parent-child pairs participated. Parents were instructed to measure 5 milliliters of liquid using a medicine cup with clear markings, a medicine cup with printed markings, a cylindrical measuring spoon, and an oral syringe. Medicine cups were the most frequently used measuring device by parents, and dosing errors occurred more frequently with their use than with the use of other measuring devices. The investigators concluded that dentists can improve pain management in their pediatric patients by educating parents about accurate measuring devices, weight-based dosing, and the correct interpretation of medication dosing charts.<sup>[37]</sup>

Adverse effects can be associated with any of the pain medications typically prescribed for postprocedural pain, and the treating clinician should be aware of these and any other drug interactions that have been documented in the literature. Special care needs to be taken in prescribing for patients with various medical conditions, including renal failure<sup>[38]</sup> and liver cirrhosis—particularly in those patients who also drink alcohol.<sup>[39]</sup>

The short-term use of aspirin has not been shown to cause serious gastrointestinal abnormality,<sup>[40]</sup> but this pain relief medication has been associated with risk of dyspepsia relative to placebo. Long-term use of NSAIDs has been associated with both stomach and kidney problems and can impact platelet synthesis. Hence, NSAIDs are contraindicated for patients who have known nephropathy, who have any erosive or ulcerative condition of the GI mucosa, who are on anticoagulant therapy or have hemorrhagic disorders, or who have an intolerance or allergy to any previously prescribed NSAID.<sup>[41]</sup> The potential interaction between the SSRI medications and NSAIDs should also be appreciated, even for short-term postprocedural use.<sup>[41]</sup>

A novel product that has demonstrated efficacy in reducing pain following dental extraction involves a combination of a NSAID, ketorolac tromethamine (KT) with an adhesive film that is applied to the mucosa. Such use may overcome the limitations connected with oral or sublingual delivery of drug.<sup>[42]</sup>

A recent study of dental attitudes with respect to prescribing for pregnant patients suggest that there is lack of consensus about what medications are acceptable to prescribe for pregnant patients. Female dentists were less likely to prescribe ibuprofen than their male counterparts. Additionally, many surveyed dentists did not appear to follow medication-prescribing guidelines for this patient population. The CDA has published guidelines on treating the pregnant patient that can be accessed online.<sup>[43]</sup>

Generally, physician consult is recommended for prescription of ibuprofen, codeine, hydrocodone, oxycodone, and propoxyphene for female patients during pregnancy. Aspirin and ibuprofen should be avoided throughout pregnancy. Acetaminophen can be prescribed any time during pregnancy. Penicillins, erythromycin (except the estolate form), and cephalosporins can be taken during pregnancy, but tetracyclines and clindamycin should be avoided. The prescription of sedative hypnotics should also be avoided.<sup>[44]</sup>

A number of studies suggest that several preprocedural and actual procedural factors may influence the experience of pain postdental treatment.

In a study of 50 patients assessing the effect of their presurgical dental extraction, oral hygiene, and smoking, postextraction, those patients who had poor oral hygiene (ie, defined by poorer brushing frequency) before the surgery and smoked postsurgery had significantly more pain than those who had better oral hygiene and did not smoke.<sup>[45]</sup>

The length of the surgical procedure appears to also impact the patient's postprocedure pain perception.<sup>[46]</sup> The presence of preoperative pain has also been correlated with persistent postendodontic therapy pain. Other factors include female gender and treatment involving the mandibular molars or maxillary premolars.<sup>[47]</sup> Another factor that could influence postendodontic pain experience appears to be associated with the technique used to obturate the pulpal canals. A recent study found that endodontic treatment using a nickel-titanium (NiTi) rotary PathFile resulted in significantly less postprocedural pain than when a stainless-steel k-file was used.<sup>[48]</sup>

With respect to restorative care and the materials used to maintain pulp vitality and prevent postoperative pain following intervention, a recent Cochrane systematic review was able to identify only 4 randomized controlled trials investigating the most commonly used materials. The interventions that were examined included Ledermix, glycyrrhetic acid/antibiotic mix, zinc oxide eugenol, calcium hydroxide, Cavitec, Life, Dycal, potassium nitrate, dimethyl isosorbide, and polycarboxylate cements. The only cement that was shown to significantly reduce postprocedural clinical symptoms was potassium nitrate/polycarboxylate cement or polycarboxylate cement alone when used for pulp capping.<sup>[49]</sup>

Restorative and periodontal surgical treatment may result in tooth sensitivity because of post-treatment gingival recession. This dentinal sensitivity is caused by exposure of soft-tissue tubules that extend to the periphery within the dentin and their activation via the contained mechanoreceptors in response to various stimuli. Pain is typically sharp and of short duration but may be persistent. A desensitization of the tubules can be established by coating, plugging, or sealing of the exposed dentin. Materials on the market include toothpastes containing fluorides or combinations of arginine, calcium carbonate, and fluoride as a monofluorophosphate,<sup>[50]</sup> strontium acetate pastes,<sup>[51]</sup> and fluoride rinses. All appear to be useful the management of postprocedural dentinal sensitivity.

## Chronic Postprocedural Pain

Persistent pain following dental extraction or periodontal procedures suggests the possibility of infection or in cases of endodontic therapy an unrecognized diagnosis or the development of an atypical or neuropathic pain problem. A recent systematic review and meta-analysis suggests that persistent chronic nonodontogenic pain that appears to develop after root canal treatment is not entirely uncommon.<sup>[52]</sup> In cases involving infection, pain management must include antibiotic coverage. Management of chronic atypical or neuropathic pain presents multiple challenges that may necessitate referral to a pain specialist or pain clinic.

However, the first step in managing chronic postprocedural pain is to revisit the pain symptomatology and examination findings in order to re-establish a comprehensive differential diagnosis. Persistent pain localized to the teeth may be caused by continuing periapical pathology, but it can also be caused by intracranial, vascular/myofascial, neurogenic, TMJ, ear, eye, nasal, paranasal sinus, lymph node, and salivary gland pathology,<sup>[53]</sup> as well conditions such as untreated coronary vasospasm and refractory angina.<sup>[54]</sup>

Management of atypical facial pain or atypical odontalgia of unknown etiology (termed persistent facial pain of unknown etiology [PFPUE]) can be managed by the knowledgeable dentist via multimodal drug therapy, cognitive/behavioral intervention, and other non-invasive strategies helpful in treating chronic pain. NSAIDs combined with tricyclic antidepressants or anxiolytics can be useful in treating PFPUE.<sup>[55]</sup> Anticonvulsant and opioid medication has also been suggested as helpful in some cases.<sup>[56]</sup> Given the often complex nature of PFPUE, multidisciplinary management that includes psychological support should be a necessary component of treatment. Only dentists with advanced training should attempt to manage these problematic patients.

Persistent dental hypersensitivity can occur after restorative care. In these cases the exposed cementum can be treated with a desensitization agent with fluoride or strontium chloride, and/or a topical application of resin.

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