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Review Article

PAIN MANAGEMENT IN ENDODONTIC DENTISTRY: AN ELABORATIVE REVIEW

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ABSTRACT

This review seeks to provide a thorough overview of the latest advances regarding pharmacological, non-pharmacological, and alternative methods of management of pain in endodontics, while considering their applications in practice and future implications. We synthesized the relevant literature via scientific databases and Chapter texts on mechanisms, pharmacological control, adjunctive clinical methods, psychological contributions, and new therapeutic methods. Local anaesthesia is central to intraoperative pain control but less effective in symptomatic irreversible pulpitis. NSAIDs and corticosteroids remain the most effective systemic options for postoperative pain, especially in multimodal regimens. Intracanal medicaments and non-pharmacological methods such as occlusal reduction, cryotherapy, and laser therapy provide adjunctive benefits. Psychological factors like anxiety and pain anticipation also influence outcomes, while future research is focusing on novel drugs, regenerative approaches, and biomarker-based personalized strategies. For effective pain management in endodontics, a multifaceted and patient-centered approach that includes pharmacological agents, clinical adjunctive methods, and behavioural methods is necessary. Emerging biologically-based and technology-based therapies will continue to be avenues for future improvement of pain control and patient comfort.

Keywords: Endodontic pain, Pain management, Psychological factors, Cryotherapy, Laser therapy.

INTRODUCTION

Pain is the leading reason individuals seek emergency dental treatment, especially when related to infections in the tooth pulp or surrounding periapical tissues (Khan & Diogenes, 2021). Managing pain effectively is crucial not just to keep patients comfortable, but also to support the success of endodontic procedures and prevent potential complications (Krunić *et al*., 2019). Pain after treatment can cause considerable stress for both the patient and the dental practitioner (Krunić *et al*., 2019). Proper pain management requires a personalized evaluation of the clinical condition and a thorough understanding of pain mechanisms, particularly when pain stems from multiple sources or carries a risk of becoming chronic (Di Spirito *et al*., 2022; Khan & Diogenes, 2021; Krunić *et al*., 2019). This review discusses various methods for managing dental pain, including both pharmacological treatments and non-pharmacological techniques such as cryotherapy and low-level laser therapy (Falatah *et al*., 2023).

ETIOLOGY AND NEUROPHYSIOLOGY OF ENDODONTIC PAIN

A solid understanding of the biological basis of endodontic pain is essential for accurate diagnosis and effective treatment.

Inflammation and Chemical Mediators

Pain originating from the pulp and periapical tissues is most often linked to an inflammatory reaction triggered by stimuli within the tooth (Mehboob *et al*., 2021). The underlying mechanisms of pulpitis are highly complex, involving numerous pathways that activate immune and pulpal cells, along with the release of cytokines, chemokines, and various neuropeptides (Mehboob *et al*.,

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2021). One key neuropeptide, Substance P-produced in neurons—plays a major role in both the transmission and persistence of pain signals, as well as in the inflammatory response. Elevated levels of Substance P are commonly observed in patients suffering from dental caries, pulpitis, or periapical granulomas (Mehboob *et al*., 2021).

Nerve Pathways

Dental pulp has a complex neural network, and understanding its pain pathway is crucial for classifying various clinical conditions of pulpal inflammation and periapical diseases (Dhull *et al*., 2023).

Mechanical Allodynia and Central Sensitization

Patients frequently experience reduced mechanical pain thresholds (mechanical allodynia) in affected teeth. In cases of moderate to severe pain, this mechanical allodynia can extend to contralateral teeth due to central sensitization (Alelyani *et al*., 2020).

Endodontic Sealers and Nociception

Even the materials used in endodontic procedures can influence pain. Endodontic sealers, when extruded, can correlate with increased postoperative discomfort and persistent pain states by directly activating trigeminal nociceptors and inducing the release of calcitonin gene - related peptide, a potent modulator of neurogenic inflammation (Ruparel *et al*., 2014).

Salivary Biomarkers

Endodontic treatment can even affect salivary levels of neuropeptides like CGRP and Substance P, providing potential biomarkers for inflammatory responses (Arslan *et al*., 2020).

PHARMACOLOGICAL APPROACHES FOR PAIN CONTROL

Local Anesthesia

Achieving profound local anesthesia is paramount. However, certain conditions, such as "hot teeth" (symptomatic irreversible pulpitis), pose significant challenges, with conventional inferior alveolar nerve blocks having a high failure rate (Anirudhan *et al*., 2024). Strategies to enhance local anesthesia include:

Premedication

Administering medication before a dental procedure can help reduce patient anxiety and raise the pain threshold, which enhances the effectiveness of local anaesthesia (Jain *et al*., 2013).

Alternative Anaesthetic Agents

In certain cases, such as irreversible pulpitis, using anaesthetics like articaine can be advantageous. Due to its higher lipid solubility and unique chemical structure, articaine penetrates tissues more effectively than lidocaine (Närhi *et al*., 2016).

Supplemental Injections

When standard nerve blocks are insufficient, additional techniques like intrapulpal injections (directly into the pulp) or intraligamentary injections can be employed to achieve adequate anaesthesia (Penukonda *et al*., 2024)

Systemic Analgesics:

Nonsteroidal Anti-inflammatory Drugs (NSAIDs)

Ibuprofen is commonly used and highly effective for managing pain after procedures. Compared to opioids, NSAIDs are generally preferred for acute dental pain due to their more favourable safety and efficacy profile (Carrasco-Labra *et al*., 2024; Vinicius So, 2020). Corticosteroids Single oral premedication doses of corticosteroids (e.g., dexamethasone, prednisolone) are an effective method of significantly decreasing post endodontic pain, particularly within the first few hours (4-12 hours) (Pochapski *et al*., 2009; Tanwir, 2022). Dexamethasone, delivered via periapical infiltration, has also shown effectiveness in reducing postoperative pain, sometimes even more so than morphine (Shantiaee *et al*., 2012). Corticosteroids can also be used as intracanal medicaments to control inter-appointment pain (Pai and Nivedhitha, 2020). Combination Therapies: Multimodal approaches combining different classes of analgesics are often more effective than single-drug regimens (Falatah *et al*., 2023). Antibiotics: While not directly analgesic, antibiotics are used to manage infection, which is a significant source of pain (Falatah *et al*., 2023).

Intracanal Medicaments

Beyond systemic administration, some medications can be placed directly into the root canal system to manage pain and infection between appointments. Corticosteroids, for instance, have shown analgesic efficacy when used as intracanal solutions (Pai & Nivedhitha, 2020). It has also been shown that the systemic administration of ibuprofen is useful to manage postoperative discomfort, and NSAIDs are often the most commonly prescribed approach to prevent and manage postoperative endodontic pain (Uysal *et al*., 2022; Vinicius So, 2020). While pharmacologic medication management, whether systemic or intracanal, can be effective, other key individual components and risks must be taken into consideration in order to ensure optimal patient outcomes (Di Spirito *et al*., 2022; Elmsmari *et al*., 2024). An appropriate choice of pharmacologic agents must also be based on a comprehensive understanding of their efficacy and pharmacologic action, side effects, and polypharmacy, especially when considering challenging endodontic pain management (Shantiaee *et al*., 2012). For example, dexamethasone can mitigate pain and inflammation post-endodontic therapy, due to its ability to suppress the release of inflammatory mediators like bradykinin, with little risk of adverse events (Rana *et al*., 2018; Shantiaee *et al*., 2012).

NON-PHARMACOLOGICAL AND ADVANCED STRATEGIES

An increasing number of innovative and non - pharmacological methods are being explored and utilized to manage pain in endodontic. (Falatah *et al*., 2023).

Clinical Techniques

Occlusal Reduction: Occlusal reduction on the targeted tooth reduces the forces of biting and can alleviate pain (Falatah *et al*., 2023). Trephination: A surgical procedure for relieving pressure, commonly employed in instances of acute periapical abscess (Falatah *et al*., 2023).

Biologically-based therapies

Platelet-rich fibrin: Employed for its regenerative and anti-inflammatory properties (Falatah *et al*., 2023). Cryotherapy*:* Application of intracanally cold temperatures to a tooth has shown promise in reducing pain after endodontic treatment (Falatah *et al*., 2023; Hespanhol *et al*., 2022; Paredes Vieyra, 2019).

Advanced modalities

Low-level laser therapy: Lasers have been looked at for their anti-inflammatory, and pain-modulating properties and have shown effectiveness in managing postoperative pain after endodontic treatment (Elmsmari *et al*., 2024; Falatah *et al*., 2023). Acupuncture: An ancient practice is being investigated for its applications in dental pain (Falatah *et al*., 2023). Modulation of GABAergic signalling: Research into GABAergic signalling modulation may provide future treatments for pain control (Falatah *et al*., 2023). In silico modulation: Computational methods may offer a new method of developing new pain management techniques (Falatah *et al*., 2023).

Irrigant Activation Methods

The method of irrigant activation may also have an effect on postoperative pain and outcomes. Techniques like passive ultrasonic activation have been associated with less postoperative pain compared to manual dynamic agitation (Elzainy *et al*., 2022).

Psychological Factors and Pain Perception

The patient's psychological state significantly influences their experience of dental pain. Anxiety and Fear: Dental anxiety and fear are widespread, affecting both adults and children, and can profoundly impact treatment outcomes (Cristea *et al*., 2025; Muneer *et al*., 2022). Anxiety can lead to avoidance of dental treatment, exacerbate pain perception, and make patients uncooperative (de España *et al*., 2022; Heidari *et al*., 2023). Pain Anticipation and Self-Efficacy: The anticipation of pain and a patient's self-efficacy (belief in their ability to cope) play roles in their experience of pain and avoidance behaviors during and after endodontic therapy (Santos-Puerta & Peñacoba-Puente, 2022). Behavioral Interventions: Psychological behavior management techniques are crucial, especially in pediatric dentistry, to alleviate fear and anxiety, aiming to change a child's attitude towards treatment (Kohli *et al*., 2022). For adults, strategies for managing dental anxiety in the clinic include various behavioral approaches to help patients cope with stress (Hoffmann *et al*., 2022). Factors like age and gender can influence dental anxiety, with younger individuals and females often reporting higher levels of fear (Muneer *et al*., 2022).

Preoperative, Intraoperative, and Postoperative Protocols

Effective pain management requires a holistic approach across all phases of treatment. Preoperative: Includes thorough diagnosis, patient education, and prophylactic use of analgesics or corticosteroids to prevent anticipated pain (Pochapski *et al*., 2009; Tanwir, 2022). Intraoperative: Focuses on achieving profound local anesthesia, utilizing supplemental techniques when necessary, and minimizing procedural trauma (Penukonda *et al*., 2024). Postoperative: Involves appropriate analgesic prescription, often NSAIDs, and patient instructions for managing discomfort (Vinicius So, 2020). The choice of instrumentation technique and endodontic sealer can also influence the incidence and severity of postoperative pain (Kapoor, 2023; Monteiro *et al*., 2023).

Challenges and Future Directions

Despite advancements, managing endodontic pain remains a complex challenge due to its multifactorial nature (Krunić *et al*., 2019). Future research is exploring: Novel Drug Targets: Modulating thermo-sensitive transient receptor potential cation channels with new drugs (Schuh *et al*., 2019). Regenerative Approaches: Utilizing novel biomaterials, stem cells, exosomes, and physical stimulation to induce pulp regeneration, which could ultimately reduce pain (Schuh *et al*., 2019). Systematic Reviews: These continue to be vital in synthesizing evidence and guiding clinical practice, helping practitioners adapt to new research (Krunić *et al*., 2019).

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declare that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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