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Advances in the management of post-endodontic pain: a review

K Meghana Varma[1,*], Rajulapati Kalyan Satish[2], Girija S Sajjan[2], K Madhu Varma[2], Bhavani Panitini[1], Naveena Ponnada[1]

[1]Postgraduate Student, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.
[2]Professor, Department of Conservative Dentistry and Endodontics, Vishnu Dental College, Bhimavaram, Andhra Pradesh, India.

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*Correspondence

K Meghana Varma

Postgraduate Student,
Department of Conservative Dentistry and Endodontics
Vishnu Dental College, Bhimavaram,
Andhra Pradesh, India.
E-mail: meghanavarma2577@gmail.com
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Abstract

This review describes the management of post-endodontic pain pharmacologically and non-pharmacologically. Acute periapical inflammation brought on by endodontic treatment-related chemical, mechanical, and/or microbiological damage to the periapical region causes postoperative pain, which is multifactorial in nature. A wide range of technical and pharmacological techniques are taken into consideration and proposed to control post-operative endodontic pain, the present study primarily comprised an overview of systematic reviews, randomized clinical trials, and *in vitro* studies summarizing advancement in the management of post-operative endodontic pain.

Keywords: Post endodontic pain, PUI, LASER, Intracanal cryotherapy.

1. Introduction

A survey by the American Dental Association found that about 15.1 million Americans had root canal therapy [1]. A serious health problem that negatively impacts both short- and long-term quality of life is pain following root canal therapy. The majority of the time, root canal therapy is quite successful at relieving tooth discomfort. Postoperative discomfort from RCT may occur from 3% to 50% of instances [1].

A periapical inflammatory reaction to one or more of the following variables could be due to the apical extrusion of debris into the periapical tissues, instrumentation/ mechanical, the administration of drugs/chemical damage, and psychological factors [2].

The flare-up is influenced by variables such as preoperative symptoms, age, gender, dental anxiety, food intake, type of tooth, periapical lesions, dental anatomy, sinus tract, tooth vitality, and intracanal medicines [3,4].

2. Pharmacological management

In endodontic preparations, it has been demonstrated that prophylactic single-dose injection of NSAIDs and SAIDs reduces postoperative pain. It has been demonstrated that NSAIDs are particularly effective at treating inflammatory pain. When NSAIDs are used prior to root canal therapy, the COX pathway can be stopped, which prevents the pain sensation from starting in the first place. Various authors reported that pre-treatment and post-treatment applications of NSAIDS or NSAIDS combined with other medications (e.g., flurbiprofen with tramadol) [2] provide effective pain control. A long-acting NSAID with substantial anti-inflammatory properties equivalent to indomethacin, piroxicam also possesses strong analgesic properties.

Opioids are strong analgesics that are frequently combined with acetaminophen, aspirin, or ibuprofen in dentistry. Despite opioids' ability to effectively treat moderate to severe pain, their usage is typically constrained by their unpleasant side effects, which might include vomiting, emesis, dizziness, sleepiness, the possibility of respiratory depression, and constipation. Persistent use is linked to dependence and tolerance. Because a combined formulation allows for a lower dose of the opioid, it minimises adverse effects.

Because an afferent barrage of nociceptors might result in central hyperalgesia, it has been demonstrated that administering long-acting local anaesthetics via block injection can minimise post-treatment discomfort for 2 to 7 days after the oral procedure [5]. Block injections provide long-acting local anaesthetics with greater analgesic benefits than infiltration injections, but clinicians must be aware of potential side effects.

3. Nonpharmacological management

These tactics include pulpotomy and pulpectomy, two common dental operations for pain relief.

When there is not enough time to do a complete pulpectomy but there is acute pain with the pulpal origin, a pulpotomy is frequently performed. In an emergency, pulpotomy has been recommended, along with sealing sedative and antibacterial dressings in the pulp chamber. Pulpotomies are routinely used to treat patients who show symptoms of irreversible pulpitis or pulp necrosis with or without edema. To prevent contamination from the oral cavity, it is recommended to maintain a tight dressing following the pulpectomy.

4. Crown-down technique

The crown-down method of cleaning and shaping root canal systems decreases debris extrusion via the apical foramen by approaching the apical end from the coronal third and moving towards the apical third. This decrease in discomfort is noteworthy because periapical debris extrusion is a primary cause of pain following root canal therapy.

5. Rotary instruments

Instrumentation by a nickel-titanium engine extrudes less debris than K-files made of manual stainless steel. As a result, the prevalence of postoperative pain has been considerably reduced by this equipment [6].

Protaper Next, the design results in less post-operative pain because it includes multiple progressive tapers, which lowers the risk of taper lock, and bilaterally symmetrical rectangular cross-section, which is offset from the central axis of rotation [7] and causes precession or swagger and aids in coronal debris removal because the off-centre cross-section leaves more space around the flutes.

Recent reciprocation procedures were observed to produce severe postoperative discomfort as compared to rotary instrumentation techniques, according to Krithikadatta *et al.* [8]. In contrast, Neelakantan *et al.* [9] and Shokraneh *et al.* [10] reported that postoperative pain was significantly lower in patients treated with reciprocating instrumentation techniques in comparison to rotary instruments.

The reciprocating single-file approach was reported to cause more severe postoperative discomfort because it permits the file to move apically during the clockwise angle of release, increasing the likelihood that debris will be pushed apically. In comparison to one curve utilised in a continuous rotation system, the reciprocating file system wave one gold produced a higher incidence of postoperative pain [11].

There was no difference in postoperative pain at 12, 24, and 48 hours after non-surgical root canal treatment and retreatment, using reciprocating or rotary instrumentation motions.

6. Sodium hypochlorite concentrations

In mandibular molars with nonvital pulp treated in two visits, 1.3% NaOCl was associated with less severe post-endodontic discomfort than 5.25% NaOCl [12]. In contrast, within the first 72 hours after a single visit root canal treatment of mandibular molars with irreversible pulpitis, 5.25% NaOCl was linked to significantly less postoperative discomfort than 2.5% NaOCl [13].

7. Irrigation activation devices

In various studies of computational fluid dynamics (CFD), irrigant flow is simulated in a model of a root canal while variables such as canal taper, apical pressure, and irrigant exchange at the apical third of the root are assessed [14]. Side-vented needles (tip) may offer a safer irrigation option for positive pressure irrigation than open-ended needles [14].

There are more opportunities for irrigation solutions with various levels of cytotoxicity to extrude during typical needle positive pressure irrigation. According to a study by Topcuoglu *et al.*, conventional needle irrigation caused more post-operative discomfort in mandibular molars with symptomatic irreversible pulpitis during the first 24 hours than sonic or ultrasonic irrigation [15]. Studies comparing the post-operative pain levels between passive ultrasonic irrigation and continuous ultrasonic irrigation found that passive ultrasonic irrigation had a lower pain score than conventional needle irrigation [16].

7.1 Endovac irrigation system

Irrigants are safely delivered to the apical endpoint of root canals by the endovac system. The irrigant is delivered into the pulp chamber using a combination of a macro- or a microcannula attached to the suction device. It is then drawn by negative pressure down the canal into the tip of the cannula and withdrawn by a coronally positioned suction hose. With a low risk of periapical extrusion, Endovac can deliver the irrigating fluid to the working length. Endovac is more effective than syringe irrigation at clearing the apical part of the root canal of debris. In contrast to conventional syringe irrigation, endovac demonstrated noticeably greater effectiveness in eliminating the smear layer [17]. When compared to a closed-ended needle and Endoactivator, irrigation activation using an open-ended needle exhibited a higher incidence of postoperative discomfort [18].

7.2 Sonic and ultrasonic agitation

Ultrasonic activation of irrigant in the centre of the instrumented root canal by a noncutting, oscillating instrument. The primary mechanism of operation is the creation of acoustic microstreaming or the continuous, unidirectional circulation of fluid around the vibrating instrument. Yet, during UAI, transitory cavitation has also been seen inside the confinement of the root canal [19].

In multiple laboratory tests, UAI has been proven to be more effective than standard syringe irrigation for the removal of pulp tissue and hard tissue debris [20].

Continuous Ultrasonic Irrigation (CUI), which involves delivering the irrigant solution into the canal while concurrently activating it. Acoustic streaming results from the ultrasonic tips vibrating, which creates shear stress and pushes the debris out of the channel.

7.3 Passive Ultrasonic irrigation

PUI is more effective than conventional needle irrigation at removing vapour locks. Passive Ultrasonic Irrigation (PUI) introduces the ultrasonic tip without touching the canal walls after first delivering the irrigation solution into the root canal [14]. A thorough evaluation of *in vitro* studies concluded that PUI disinfected the root canal system more efficiently than conventional needle irrigation [14].

7.4 Laser-activated irrigation systems

Laser light can penetrate areas of canals where irrigating and disinfecting solutions cannot reach, such as fins, deltas, and lateral canals. When a root canal system is exposed to laser radiation, selective photothermolysis happens.

Shock wave-enhanced emission photo-acoustic streaming (SWEEPS), photon-induced photoacoustic streaming (PIPS), low-level laser therapy (LLLT), and laser-activated irrigation (LAI) using pulsed Er: YAG, Nd: YAG, KTP, and near-infrared diode lasers are all examples of laser-activated irrigation systems.

According to Jaramillo, PIPS (photon-induced photoacoustic streaming) activation of a buffered 0.5% sodium hypochlorite solution greatly enhanced its antibacterial capacity compared to traditional irrigation [20].

After examining the effects of Er: YAG laser irradiation using the SWEEPS and PIPS techniques on dye penetration depth following root canal preparation, Kosarieh *et al.* concluded that the results from the conventional and Sweeps techniques were comparable, while PIP had more effective penetration into dentinal tubules [21].

Another technique for activating irrigation is laser-activated irrigation (LAI), which uses a pulsed Er: YAG laser. Pulsed erbium lasers cause optical cavitation in the irrigant, which causes smaller secondary bubbles further in the canal to undergo acoustic streaming. This causes expanding and exploding vapour bubbles at the fibre tip [22]. Olivi *et al.* (2014), who were unable to find any bacteria following LAI, confirmed that LAI can reduce the bacterial burden of diseased root canals by 99.5% [23]. Laboratory studies have shown that LAI with Er: YAG is more effective than ordinary irrigation and UAI at clearing debris from fabricated or natural channel complexities [23]. After a single visit root canal treatment, PUI and laser disinfection are both equally efficient in minimising postoperative discomfort. Laser disinfection has a significant advantage over PUI in the early hours [11].

With the use of light to stimulate host cells, low-level laser therapy (LLLT) has been utilised in dentistry to increase analgesia, inflammation control, and tissue healing. Several biological mechanisms, including vasodilation, a rise in adenosine triphosphate (ATP) and cortisol levels, and the suppression of the generation of inflammatory cytokines, contribute to the analgesia caused by LLLT [24].

Low-power lasers inhibit mediator release from injured tissues. In other words, they reduce the concentration of chemicals that act as pain mediators, including histamine, acetylcholine, serotonin, H^+, and K^+ [6]. With increased acetylcholine esterase activity, low-power lasers block the levels of acetylcholine, a pain-mediating substance [5]. These lasers reduce the transmission of impulses as well as the sensitivity of pain receptors [6].

8. Intracanal cryotherapy

Cold saline was used as the final irrigation in root canals to lessen postoperative discomfort. Vasoconstriction results from cryotherapy's restriction of tissue metabolism and blood flow to tissues.

In the medical literature, cryotherapy has been additionally linked to decreased postoperative opioid use. The basis for this investigation was developed by Vera *et al.*, who demonstrated that irrigation of root canals with 2.5°C cold saline solution for 5 min decreased the external root surface temperature and 5 minutes of application time with a cooling agent of a 2.5°C cold saline solution [25]. To avoid the vapour lock effect and guarantee continuous delivery of the cold irrigant to the apical third, Vera et al. also used the EndoVac system from Kerr Endo, Orange County, CA, USA. EndoVac usage has been shown to decrease the probability of periapical inflammatory reactions by reducing apical extrusion.

9. Photodynamic therapy (PDT)

A soft tissue laser is used in photodynamic treatment (PDT) to activate a photosensitizer (PS), which is supposed to have an antibacterial effect. Low-power lasers do not, when used alone, produce either disinfection or morphological changes in tooth structure due to their extremely small temperature increase of 0.5°C. Reactive oxygen species are harmful to tumour cells, bacteria, and fungi and are produced as a result of a series of photochemical reactions that begin when exogenous photosensitizers (PS) are present.

Photodynamic therapy, also known as light-activated disinfection, photoactivated disinfection, or photodynamic antimicrobial chemotherapy, works (PACT). PSs generated from phenothiazines have been used in endodontics to the therapeutic window, also known as the wavelength range between 600 and 660 nm (red light), which is needed for effective light penetration in biological tissues, and phenothiazines exhibit strong absorption in this wavelength range [26]. Photosensitizers like methylene blue (MB) and toluidine blue (TB) make bacteria more sensitive to diode light, which causes singlet oxygen to be produced. The heat effects from the laser on the root canal walls were adequate to eliminate the smear layer and debris without producing any carbonization or melting.

10. Phototherapy

Phototherapy involves exposure to specific wavelengths of light using lasers, light-emitting diodes, or polychromatic polarised light, as opposed to photodynamic therapy, which uses photosensitizing drugs. In recent years, phototherapy has become a successful treatment option in the management of numerous oral problems in dentistry. Moreover, phototherapy is utilised to lessen discomfort, speed up wound healing via dilatation of blood vessels, and effectively control inflammatory parameters. On a cellular level, phototherapy alters processes such as adenosine triphosphate (ATP) generation, protein and prostaglandin synthesis, neurotransmitter release, cell proliferation and differentiation, and phagocytosis. According to studies, phototherapy can be used to manage PEP with positive results [27].

11. Conclusion

For effective endodontic pain management, the causative factors and treatment methods should be given due consideration to help the patient get rid of the unpleasant feeling of pain. Many advances in endodontic therapy, described above reduce the incidence of post-operative endodontic pain.

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