Dental pain in children: pharmacological management



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Abstract

Introduction The prevalence of dental pain is relatively high across the global population, primarily attributable to dental caries. School-age children and adolescents with caries, particularly those with caregivers from lower socioeconomic backgrounds, are more likely to experience dental pain. In very young children, pain modulation is not yet fully developed; thus, inadequate pain management may cause pain memory formation which can lead to altered pain responses later in life.

Methods and Objectives This review aims to provide an overview of the management of dental pain in children with pulpitis. To achieve this goal, a search was conducted in PubMed using relevant keywords. The literature investigation focused on the pharmacological management of paediatric pulpitis, including the treatment of associated complications.

Conclusions Dental pain represents a significant public health concern. Pain due to endodontic emergency is different in younger children and should to be assessed with the use of an appropriate scales and treated with NSAID and/or acetoaminophen. The combination of ibuprofen and acetaminophen at fixed doses appears to be a viable option for dental pain treatment, although further randomised controlled trials (RCTs) are needed for confirmation. Antibiotics should only be used in cases involving local and/or systemic infectious complications. Opioids are not recommended for managing dental pain. Antibiotic prophylaxis is necessary only in selected cases and should not overshadow primary prevention, which remains the only true option for reducing the development of dental complications. Antibiotic Stewardship Programs (ASPs) could play a significant role in reducing inappropriate antibiotic prescriptions.

KEYWORDS Dental pain, Paediatrics, Pain management, NSAIDs, pulpitis.

Introduction

Epidemiology

The prevalence of dental pain is notably high among children and adolescents, averaging 36.2% globally. This prevalence is consistent across European countries, including Italy, while regions such as Africa may exhibit higher rates up to 60% [Santos et al., 2022; Pentapati et al., 2021]. Despite various studies, no significant association association appears to exist between dental pain and gender, although a slight female predominance is observed [Pentapati et al., 2021]. Untreated dental caries stands as the primary cause of dental pain onset; however, other oral health conditions (e.g., traumatic dental injuries, tooth eruption, oral ulcers, etc.) contribute to 27.3% of cases. Notably, school-age girls and adolescents with cavities, as well as caregivers from lower socioeconomic strata (with less than 8 years of schooling), appear to face a heightened risk of experiencing dental pain [Santos et al., 2022; Pentapati et al., 2021].

Pain Definition

The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage" [IASP Press, Seattle, 1994]. This definition underscores the subjective nature of painful sensations, which are intertwined with a motivational-affective component influenced by individual life experiences [Magni et al., 2016]. Specifically addressing dental pain, it can be characterised as "pain originating from innervated tissues within the tooth or immediately adjacent to it" [Gibbs J et al., 2013]. Approximately 48.8% of patients presenting with pain have an endodontic emergency, with 4% of cases involving children and adolescents. Various studies have highlighted the significant impact of dental pain on children's daily activities (e.g., sleep, eating, homework, classroom attention, school absenteeism, playing, etc.), leading to a diminished quality of life [Pentapati et al., 2021].

Pain Modulation

The nociception is "the detection of potentially or actually injurious stimuli followed by a reflex withdrawal". Nociceptors are specialised receptors responsible for damage detection, that have then this information conveyed to the reflex centers and to the central nervous system for processing, which may be modulated by descending control, altering perception [Sneddon, 2018]. Examining nociception phases [Bonezzi et al., 2017] in rapid succession, the initial phase involves Transduction, during which nociceptors detect a signal (mostly chemical) at the peripheral level and convert it into an electrochemical nerve impulse then transmitted to central structures. Subsequently, Transmission of the painful stimulus to the structures of the central nervous system (CNS) responsible for pain sensation processing occurs. The third phase, Modulation, consists in control of the ascending stimulus through various mechanisms, including: the periaqueductal gray substance, descending fibers to nuclei of the bulb (endorphins), posterior spinal horns (serotonin), the gate control mechanism, inhibitory interneurons to the dorsal horns, and opioid receptors throughout the CNS; resulting in partial/total blockade of painful stimuli activated by endorphins or endogenous opioids [Bonezzi et al., 2017]. The final phase, Perception, involves the processing of nociceptive neuron transmission activity, modulated at different levels, at the associative cortex level; generating a subjective phenomenon influenced by emotional aspects, behavioural responses, attitudes, and beliefs. At birth, newborns lack this elaborate modulation system, which develops around 12 to 18 months of age [Murano, 2016]. Consequently, in very young children, modulation may not function optimally, leading to heightened pain perception. The same intensity of pain can manifest as a more significant clinical presentation. If pain is not adequately managed, it may induce a memory of pain, predisposing to altered pain responses later in life. Numerous studies [Gursul et al., 2019; Walker, 2019] have indicated that exposure to repetitive pain in early life may

heighten the risk of developing increased sensitivity to pain and chronic pain syndromes later in life. Therefore, in paediatrics, effective pain management, particularly for dental pain, is crucial compared to adult treatment.

Causes

Dental Caries

Dental caries is a chronic multifactorial condition influenced by various factors, including socioeconomic and environmental conditions. Often, parents or caregivers from lower socioeconomic backgrounds encounter challenges in understanding preventive measures and the importance of oral healthcare. The prevalence of this condition is exceedingly high, affecting both deciduous and permanent teeth, to the extent that it can be considered a significant public health issue in all respects [Fernandes et al., 2023]. Dental caries can also serve as a predictor for the development of other caries and future dental pain. For instance, a study by Correa-Faria et al. [2016] involving 381 children aged 1 to 5 years (with 184 having dental caries and 197 with no caries experience), demonstrated that children with dental caries were more likely to develop new caries. Brushing with fluoride toothpaste – with different concentrations depending on the age of the patient – stands as one of the primary preventive measures in paediatric dentistry. Particularly younger children dental hygiene necessitates supervision from parents or caregivers due to their inadequate, as they may not always be able to brush effectively. Preventing caries in deciduous teeth proves beneficial in reducing the incidence of caries in permanent teeth. Indeed, a correlation has been established between early childhood caries and the prevalence of caries in teeth at 15 years [Alm et al., 2008]. Dietary habits can also play a contributing role. Research by Alm et al. [2008] indicates that in overweight or obese children, the prevalence of caries is higher compared to normal weight children of the same age. Moreover, it has been suggested that high intake of simply carbohydrates may contribute to the association between dental caries and a higher BMI. Chronic malnutrition, as well as overweight, can also serve as contributing factors to dental caries. This could be attributed to a reduction in saliva flow [Johansson et al., 1992]. Unhealthy dietary habits can lead to hypomineralisation, a qualitative defect of dental enamel. Hypomineralisation in deciduous teeth appears to be a predisposing factor for the development of caries. A study conducted in Brazil involving 216 children aged 4 to 6 years attending public schools [Costa-Silva et al., 2020] demonstrated that children with hypomineralisation of the second primary molar (HSPM) have an increased likelihood of developing dental caries. In conclusion, dental caries and the resultant dental pain contribute to a decline in the quality of life for both children and their parents in terms of perception and overall well-being [Banto et al., 2014].

Pulpitis

Pulpitis refers to an inflammation of the dental pulp caused by untreated caries, trauma, or multiple restorations. Dental pain represents the primary symptom of pulpitis. The most concerning complication is bacterial superinfection, which poses a risk of local and/or systemic dissemination. Pulpitis can be classified into reversible and irreversible forms: reversible pulpitis, if detected early and managed appropriately, can lead to the healing of the pulp, while irreversible pulpitis represents the progression of untreated reversible pulpitis, culminating in the necrosis of the dental pulp [Hennessy, 2023].

Trauma

The incidence of traumatic dental injuries in childhood has been on the rise in recent years. Head injuries caused by dental trauma can occur, contributing to various issues such as infections during sports-related activities. In immature teeth, pulp hypomineralisation has been reported in 35% to 42% of cases following intrusive luxation [Sarao et al., 2023]. In these cases, early diagnosis is imperative due to the risk of tooth structure breakdown with acute symptoms, which can complicate treatment [Rai et al, 2018].

Clinical of dental pain.

Dental pain can be somatic (mucosal, periodontal, alveolar), visceral (pulpal) or neuropathic (trigeminal neuralgia). Typically, it is characterised by severe pain (NRS 7-8) in both adults and children, with younger children possibly experiencing heightened levels due to incomplete pain modulation. Pain may occur intermittently or continuously, spontaneously, and/or be exacerbated by thermal, physical, or dietary stimulus. Nocturnal onset can negatively impact both the quantity and quality of sleep. In paediatric cases, localising the pain can be challenging, especially in younger children, where behavioural assessment is the only possibility for determining its origin. Dental roots receive innervation from branches of the trigeminal nerve (cranial nerve V), potentially causing dental pain to radiate along the sensory fibers of this nerve. Therefore, it is crucial to distinguish dental pain of odontogenic origin from neuropathic pain. In conclusion, dental pain leads to a decline in both children's and their parents' quality of life, affecting their perception thereof [Banto et al., 2014].

Pain Estimation

Generally, dental pain is classified as severe even in adults (VAS 7-8). Pain estimation poses challenges in children, especially in younger patients who may struggle to localise pain, therefore various pain assessment scales tailored to the patient's age are utilised in paediatric settings. The most employed scales in paediatrics include the FLACC scale, the WBFPRS, and the NRS. The FLACC (Face, Legs, Activity, Cry, Consolability) Scale, initially introduced in 1997 [Merkel et al., 1997], involves observational assessment by parents and/or specialist doctors to assign a score to pain. It evaluates pain intensity based on 5 behaviours (face, legs, activity, consolability, and crying), yielding a score out of 10. Each aspect considers characteristic behaviours exhibited by children in pain, with escalating scores correlating with increased pain intensity [Crellin et al., 2018]. The Wong-Baker FACES Pain Rating Scale (WBFPRS) facilitates pain assessment through a child's selection of a face from a series of 6 drawn faces representing varying pain intensities [Garra et al., 2010]. Lastly, the Numerical Scale (NRS) involves patients indicating their pain level on a numerical scale ranging from 1 to 10 [Childs et al., 2005]. NRS and WBFPRS allow for self-assessment and are suitable for patients over 3 years of age. For children under 3 years old, observational assessment using the FLACC Scale is recommended instead [Crellin et al., 2018; Garra et al., 2010; Childs et al., 2005]. The initial evaluation of pain, facilitated through the use of an appropriate scale tailored to age and cognitive capacity, is imperative for the accurate management and selection of the most suitable treatment [Sansone et al., 2023].

Methods and purpose of the review

This review aims to examine dental pain management in children with pulpitis. A PubMed search was conducted using

keywords such as "dental pain and children", "paediatric dental infections", "cellulitis and children", "paediatric dentistry", "NSAIDs and children", "opioids and children", "dental caries and dental pain", "trauma and dental pain", "pulpitis and dental pain", and so forth. No exclusion criteria were applied. Literature concerning the pharmacological management of dental pain in paediatrics, including the treatment of associated causes and complications, was investigated.

Pharmacological management of dental pain in children

NSAIDs

When reviewing the drug classes utilised in paediatric pain management, non-opioid medications, namely nonsteroidal anti-inflammatory drugs (NSAIDs), come to the fore. They are indicated for mild to moderate pain of various etiologies and are employed in severe pain management, often in conjunction with opioid medications. The preferred NSAIDs for paediatric use are ibuprofen and paracetamol. NSAIDs undeniably remain the primary choice medications. They act by inhibiting the prostaglandin cascade through the inhibition of COX1 and COX2. Indomethacin and diclofenac exhibit potent anti-inflammatory properties and are primarily utilised for severe pain management (e.g., renal colic). For acute pain management, such as dental pain, ibuprofen or naproxen are highly effective [Bonezzi et al., 2017]. Conversely, paracetamol lacks anti-inflammatory activity but, on the other hand, it primarily exerts its effects centrally, as it readily crosses the blood-brain barrier, interacting with the pain modulation system: it enhances serotoninergic tone in the posterior horns of the spinal cord, accentuating the opioid system in the central nervous system. Due to their differing mechanisms of action, a synergistic action is conceivable with a combination of ibuprofen and paracetamol, both peripherally and centrally [Parri et al., 2022]. As for Italian ministerial guidelines, paracetamol is administered orally at a loading dose of 20 mg/kg followed by maintenance doses of 10–15 mg/kg every 4–6 hours. For rectal administration, the loading dose corresponds to 30–40 mg/kg with subsequent doses of 15–20 mg/kg, at 4–6 hours intervals. Irrespective of the route of administration, the recommended maximum daily dose should not exceed 30mg/kg/die if weight is under 10 kg, 60 mg/kg/die from 10 kg to 50 kg. Chronic intoxication is characterised by the repeated ingestion of doses surpassing therapeutic levels. In children under 6 years of age, a dose surpassing 200 mg/kg within a single 24-hour period is deemed toxic, as is a dose surpassing 150 mg/kg/24 hours within the preceding 48 hours, and a dose surpassing 100 mg/kg/24 hours within the preceding 72 hours. For children aged 6 and above, a dose surpassing 200 mg/kg or 10 g within the previous 24 hours, or exceeding 100 mg/kg in high-risk patients (such as those with liver diseases, anorexia, uncontrolled diabetes, or concurrent use of other medications) is considered toxic. Liver disease results from chronic intoxication. Acute intoxication in young children is uncommon and largely attributable to the accidental ingestion of a single dose surpassing 150 mg/kg (100 mg/kg if risk factors are present) [Newsletter SIMYoung, 2023]. Regarding ibuprofen, it is administered orally at a dose of 10 mg/kg every 6–8 hours, with a maximum daily dose of 40 mg/kg. The use of some NSAIDs in paediatric age is off-label, and the Italian Health Ministry has formulated some recommendations for their use in children. A systematic review conducted in 2023 [Miroshnychenko et al., 2023] reveals that studies investigating the efficacy of paracetamol and ibuprofen in dental pain management demonstrate the superiority of both agents over placebo in providing analgesia at four hours, as anticipated. However, when comparing ibuprofen to paracetamol, studies suggest the superior efficacy of ibuprofen, indicating the significant inflammatory component in dental pain that requires suppression. According to guidelines issued in 2023 [Carrasco Labra et al., 2023] in the USA, ibuprofen is recommended as the first-line agent in cases where immediate definitive dental treatment is not feasible, in the absence of strong contraindications to NSAID use. Naproxen is also deemed a viable alternative. In cases of monotherapy failure, combination therapy by adjunctive administration of paracetamol is advocated [Carrasco Labra et al., 2023].

Fixed-dose combination of Ibuprofen/Acetaminophen

Ibuprofen and acetaminophen combination therapy is presently under scrutiny, as a fixed-dose combination product of the two molecules has recently been introduced to the market. The ratio between the molecules is 33:1, resulting in 12 mg/kg of paracetamol and 3.6 mg/kg of ibuprofen [Tachifenekid, Angelini Pharma]. This combination permits the use of considerably lower doses of ibuprofen, thus appearing to be a promising option for reducing the side effects associated with NSAID use, particularly gastrointestinal events and acute kidney injury (AKI). An initial study in adults [Stamos et al., 2019] aimed to establish the superiority of the combination product over ibuprofen monotherapy; however, no superiority was observed. Encouraging results emerge when evaluating its non-inferiority compared to either ibuprofen or paracetamol monotherapy. Indeed, as indicated in the 2023 paediatric review by Miroshnychenko et al. [2023], it appears that anti-inflammatory therapy plays a central role in managing dental pain (the paracetamol/ibuprofen combination was significantly more effective than paracetamol alone), yet the combination product does not demonstrate inferiority to ibuprofen alone. Consequently, by utilising a seemingly non-inferior agent in pain management, it is feasible to reduce the dosage of the anti-inflammatory drug, thereby lowering the risk of classical NSAID therapy side effects. Excessive anti-inflammatory potency also elevates the risk of dental complications, particularly infections. Thus, this combination product emerges as a promising option in dental pain management. Its efficacy has been assessed in other paediatric studies regarding pain management in otitis media: a review from 2023 [de Sévaux et al., 2023] suggests that even in these cases, the non-inferiority of the product is established. Nonetheless, further specific randomised studies are warranted for confirmation. In any case, particularly in children under 5 years of age, in whom modulation may not function optimally, this product could prove to be a convincing strategy. It may also find utility in other forms of typically paediatric pain such as headache, earache, and sore throat.

Opioids

The Food and Drug Administration (FDA) issued clear guidance in 2017 and reiterated it in 2022 [FDA drug safety communication, 2017 and 2022]: opioids are contraindicated in paediatric patients for managing intermittent acute pain, particularly those under 12 years of age. The risk of side effects, especially concerning central nervous system depression, is deemed too high, given that analgesic therapy in dental pathology aims to provide short-term relief while awaiting definitive dental intervention, which represents the only truly resolving therapy.

Corticosteroids

Preoperative administration of corticosteroids appears to be

effective in managing postoperative pain in patients with irreversible symptomatic pulpitis, as demonstrated by a randomised study involving 398 young adults [Elkhadem A et al., 2018]. Prednisolone exhibited a significant reduction in pain intensity at six, twelve, and twenty-four hours compared to placebo. At six hours, the observed relative risk reduction was 20.31% (95% CI [12.03%–27.82%]), at twelve hours 23.39% (95% CI [14.75%–31.16%]), and at twenty-four hours 28.85% (95% CI [18.08%–38.20%]). Further studies would be necessary to evaluate the use of corticosteroids in paediatric age.

Antibiotic Therapy in Pulpitis

Antibiotics may be warranted if an infection develops that affects surrounding structures, especially facial cellulitis and neck abscess, with a risk of hematogenous or lymphatic spread. It should be noted that in very young children, such spread is facilitated due to the immaturity of the immune system. Comparing the clinical presentation of cellulitis [Słotwińska-Pawlaczyk et al., 2023] based on the site of development (upper or lower portion of the face), it was observed that involvement of the upper face often implicates deciduous teeth, while involvement of the lower face predominantly affects permanent teeth. Notably, systemic clinical symptoms (intra-extraoral oedema, lymph node involvement, and fever) frequently recur when permanent teeth are affected, unlike in cases involving deciduous teeth, which are less readily detected by clinicians. Antibiotic treatment may become necessary before systemic involvement occurs. According to a study examining antibiotic prescription patterns among 382 Italian dentists [D'ambrosio et al., 2022], the primary reason for prescribing antibiotic therapy is dental abscess and only 35.6% prescribed antibiotics in cases of pulpitis. The most commonly prescribed antibiotic was found to be a macrolide. Based on the findings of a study involving 58 patients with symptomatic apical periodontitis [Skucaite et al., 2010], streptococcus was identified as the primary pathogen implicated in dental primary infection, while enterococcus faecalis was highlighted in secondary infections. In the paediatric population, the preferred drug of choice should be penicillin, especially amoxicillin/clavulanic acid, because of its large spectrum of sensitive pathogens (almost 100%). The recommended dosage for amoxicillin should be 50–100 mg/kg administered in two or three doses daily for at least 7 days [Baumgartner et al., 2003]. In case of older children with permanent teeth involvement, Evidence-Based clinical guidelines outlined in 2019 [Lockhart et al., 2019] regarding antibiotic therapy in adults could be applied: antibiotics should not be used when irreversible pulpitis or symptomatic apical periodontitis is identified in immunocompetent patients. Therefore, these patients should be referred for definitive dental treatment. Antibiotic therapy is warranted only in the presence of local and/or systemic complications or when definitive dental treatment needs to be delayed. Antibiotic prophylaxis is warranted in situations where there are predisposing factors for infections in patients undergoing invasive procedures. It's important to note that in paediatrics, even a known unoperated heart condition could necessitate prophylaxis. The preferred antibiotic of choice is amoxicillin [Lafaurie et al., 2019].

Recent updates to the American Heart Association (AHA) guidelines advise against the use of clindamycin due to its frequent and severe side effects including death, from Clostridioides difficile infection. According to the latest guidelines, doxycycline appears to be a suitable alternative in cases of intolerance to penicillins, cephalosporins, and macrolides. Nonetheless, primary prevention, including maintaining proper oral hygiene and adopting healthy dietary habits, remains increasingly crucial [AAPD,2022].

In the USA, the concept of Antibiotic Stewardship Programs (ASPs) in paediatrics has emerged to aid in determining the appropriate timing and usage of antibiotic therapy, even in Emergency Department and community settings [AAPD,2022]. ASPs primarily rely on two key principles: "Prospective audit with intervention and feedback" and "Preauthorisation". The former involve collaboration between the prescribing physician and an ASP team, comprising other healthcare professionals such as a clinical pharmacist with infectious diseases expertise, a microbiologist, and an epidemiologist; the latter imply that antibiotic prescriptions necessitate approval from a specialised ASP team [Brigadoi et al.,2023]. These programmes should be complemented by other fundamental aspects of proper antibiotic prescription management, such as physician and patient education, access to rapid diagnostic tests for timely diagnosis, dosage optimisation, and rationalisation of therapy [Brigadoi et al.,2023].

Conclusions

Dental pain is a significant public health concern, affecting even preschool-aged children, whose clinical presentations may differ from adults. According to AAPD (American Academy of Paediatric Dentistry), the first examination is recommended at the time of the eruption of the first tooth and no later than 12 months of age. In Italy, dental visits are recommended for children aged 18–24 months, regardless of potential dental problems, or earlier in case of abnormalities in deciduous teeth. [Clinical Recommendations in Odontostomatology; Ministry of Health, 2017]. Oral hygiene practices are often inadequate in children, who may not fully understand the concept of brushing [Paglia, 2018]. Pain associated with endodontic emergencies varies in younger children and should be evaluated using appropriate scales according to age and cognitive abilities. NSAIDs and/or paracetamol remain the first-line therapies. The fixed combination of ibuprofen and paracetamol represent a new possible way of pain management in children, but further randomised controlled trials (RCTs) are necessary to assess its efficacy or non-inferiority compared to ibuprofen monotherapy. However, it can be concluded that in children aged 2 to 12 years, this combination could serve as a viable alternative for short-term treatment of mild to moderate acute pain [Parri et al., 2023]. Instead, opioids are contraindicated in paediatric patients for managing intermittent acute pain due to their high risk of side effects on central nervous system depression. Preoperative administration of corticosteroids could be an effective alternative treatment in managing postoperative pain in patients with irreversible symptomatic pulpitis, as shown in adults studies [Elkhadem et al., 2018]. Antibiotics should be reserved for cases involving local and/or systemic infectious complications. Antibiotic prophylaxis is indicated only in select cases and should not overshadow primary prevention, which remains the most effective approach to reducing the development of dental complications. Antibiotic Stewardship Programs (ASPs) should be implemented beyond hospital settings, extending to community medicine and the Emergency Department, to facilitate the establishment of local guidelines for appropriate medical prescribing.

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