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UPDATES ON PAIN CONTROL IN PEDIATRIC DENTISTRY: DIFFERENT APPROACHES AND TECHNOLOGIES

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Pediatric dentistry plays a crucial role in maintaining children's oral health and preventing future dental problems. However, dental procedures can be distressing and painful for young patients, potentially leading to dental anxiety and avoidance of necessary treatments.(1) To ensure positive experiences and effective dental care, pain control techniques are essential in pediatric dentistry. The field of anesthetic drugs, administration systems, and local anesthetic techniques has advanced recently, giving clinicians access to therapeutic options that improve pain management, minimize injection pain, and have fewer side effects. Current advancements have resulted in the creation of novel agents and improved devices. Their goals are to apply the drug painlessly, minimize the area and length of collateral soft-tissue anesthesia, and accelerate recovery of sensation following injections. Various approaches and technologies are employed to manage pain and alleviate anxiety in young patients.

It is important to create a comfortable and friendly environment to help children feel relaxed during dental procedures. Basic behavior management techniques such as “Tell-Show-Do” where dentists explain the procedure using simple language, demonstrate it using models or visuals, and then perform the procedure itself focus on building trust. Positive reinforcement by praising and rewarding children for their cooperation during the dental visit helps develop confidence and reduce anxiety. Moreover, distraction techniques such as using age-appropriate movies, music, toys, or visual reality headsets can divert children's attention from the dental procedure. The pediatric dentist can keep the child engaged by talking, storytelling or by commanding the child to raise their hand or leg for some tension release and drag their attention.(2)

Local anaesthesia (LA) involves the administration of drugs that temporarily block nerve impulses to numb a specific area without loss of consciousness, ensuring pain-free treatment. Lidocaine and Articaine are commonly used local anaesthetics in pediatric dentistry.(3) Local anaesthesia is generally safe and effective for routine dental procedures. The number one reason children fear going to the dentist is fear of injection. Needle phobia is common among children. It is reported to be as high as 19% among 4 to 6 years.(4) Therefore, painless injections and needle – free technologies are highly desirable.

Techniques such as topical anesthetic application, cooling the injection site using refrigerant spray or ice-filled carpules which is referred to as “cryoanesthesia” can help reduce discomfort during injection by causing neuropraxia. This reduces the threshold of tissue nociceptors and the pain-transmitting conduction nerve signals.(5) According to Hameed et al., Tetrafluorethane refrigerant spray precooling at the injection site has been shown to be substantially more effective at relieving pain in pediatric dental patients than lidocaine topical spray. Other advantages of this tetrafluorethane spray refrigerant included favorable patient acceptance because of its pleasing taste and quick action.(6)

Malamed et al., reported that buffering of local anesthetic drug immediately before injection significantly increases the active anesthetic form; additionally, it results in several clinical advantages including, more rapid onset, more comfort to the patient and less postoperative tissue injury.(3) The pH is increased by mixing Sodium Bicarbonate solution to the carpule via mixing systems such as Onpharma.(7) There are variable outcomes to this techniques and more research is needed to verify its effectiveness. (8)

Innovations like vibrating devices that provide counter-stimulation to reduce injection pain have been recently suggested. The gate control theory for pain perception has been widely accepted. It states that pain can be reduced by simultaneous activation nerve fibers using cold, hot, rubbing, pressure, or vibration stimuli.[9] In recent years, various dental devices have been created based on this theory, such as Accupal, DentalVibe, and Vibraject. These devices aim to minimize the pain of needle injections by applying pressure, vibration, micro-oscillations, or a combination of these techniques. By stimulating the neurones in the brain, these physical stimuli can disrupt or block pain signals, ultimately reducing the perception of pain through distraction. However, there is currently limited evidence from clinical trials to support the effectiveness of these devices in reducing injection pain, although some studies have reported positive outcomes.[10, 11]

A recent bee-shaped device named “Buzzy” consists of a main vibrating body and two removable ice wings inserted at the back of the body with elastic bands has been suggested in decreasing injection pain. Authors reported that combined external cold and vibratory stimuli can significantly reduce the experienced pain during maxillary infiltration anesthesia in children.[9] However, more research is needed to verify its effectiveness in other intraoral sites and anesthetic techniques.

Computer - controlled local anesthesia delivery (CCLAD) systems, help minimize needle-related discomfort by controlled slow rate of drug administration [12]. The STA (single tooth anesthesia) system is an intraligamentary CCLAD with dynamic pressure sensing technology, providing real time feedback to the operator. The advantage is the rapid onset of anesthesia, with reduced injection pain due to its pen like design. Precautions should be considered when it is used to anesthetise primary teeth close to developing buds of permanent successors, as some researchers reported risk of enamel hypoplasia occurrence.[13, 14] Clinical trials report significant benefits of the technology in performing more comfortable injections than traditional techniques. [12, 15, 16]

Intraosseous anesthesia is considered a successful substitute for traditional anesthetic infiltration, as the anesthetic drug is injected straight into the cancellous bone next to the tooth that needs to be anesthetized using a handpiece that drills and injects the drug .[5, 14] It has been discovered that computer-controlled intraosseous anesthesia (QuickSleeper system), administered with constant anesthetic solution velocity and pressure, shortens the time between injection pain and drug onset. [17] Carugo et al., in a systematic review, stated that CCLAD demonstrated less pain during anesthesia compared to conventional techniques in children.[18] Since the needle is drilled into the bone, consideration should be given to the location of permanent teeth germs to prevent their injury.

Jet injectors are needle free devices that create pressure with enough force that it can penetrate soft tissue through a very small orifice with little or no pain. With its quick onset of soft tissue anesthesia, and the fact that the manipulation doesn't involve a needle raises the possibility of a beneficial psychological impact, but data from pediatric clinical trials indicate that conventional syringe injection is more preferred, acceptable, and effective than needleless injection.[19] The device is bulky and the large size makes it difficult to place in the posterior region. It is contraindicated in nerve blocks. It is reported that it is traumatic to the tissues and hematomas are among the method's drawbacks.[14]

Laser technology offers a minimally invasive alternative to traditional dental tools. In pediatric dentistry, lasers can be used for cavity detection, soft tissue procedures, and even pain control. Laser dentistry reduces the need for anesthesia and promotes faster healing and blood coagulation, making it a valuable tool in managing pain for children.[20] Moreover, Laser analgesia is a method of non-invasive pain relief that involves using a laser to stimulate the dental pulp. This technique is based on the idea that, in addition to its ablative effects, the laser also produces low-level laser therapy (LLLT). However, this is not the same as complete anesthesia achieved through infiltrative local anesthesia. Instead, the laser pulses cause a temporary disruption of the sodium-potassium pump in neuronal cells, leading to a loss of impulse conduction and resulting in an analgesic effect.[21] This, combined with the absence of contact and vibration during the procedure, makes laser treatment a viable option for reducing anxiety in children and adolescents undergoing dental treatment.

The prolonged duration of soft-tissue numbness caused by local anesthetic injections such as inferior alveolar nerve blocks in dental patients can be an unwanted side effect. It can lead to self-inflicted tissue damage, changes in facial appearance, and difficulties with speech and mastication after the procedure. These effects can be especially troublesome for younger age groups. To help patients recover from the anesthesia more quickly, various methods have been developed to reverse its effects. One such method is the use of phentolamine mesylate (OraVerse), a short-acting

drug that blocks the effects of adrenaline and helps clear the anesthetic solution from the injection site faster. While it is not effective for surgical procedures, studies have shown that both patients and dentists are generally satisfied with its use. [22] Despite some limitations, phentolamine mesylate is considered a safe and effective option for reducing the duration of soft-tissue numbness caused by local anesthesia in adults and children over 6 years old.[23]

A new approach to achieving local anesthesia for maxillary teeth involves the use of "intranasal spray". It is a metered device used to infiltrate an anesthetic solution through the nostrils. This method relies on the diffusion of the solution through the nasal mucous walls to reach the structures involved in innervation of the maxillary teeth. The solution is a combination of 3% tetracaine hydrochloride and 0.05% oxymetazoline, which not only provides anesthesia but also reduces bleeding by constricting blood vessels without causing significant cardiovascular effects in healthy patients.[5] This technique is suitable for performing conservative dental procedures that require pulpal anesthesia in adults and children over 40 kg.[24] However, further research is needed to evaluate its effectiveness and safety in pediatric patients.

Conscious sedation can be used by inducing a relaxed state while maintaining consciousness. This technique is suitable for mildly anxious or uncooperative children, allowing them to undergo dental procedures without fear or discomfort. It can be achieved by administering oral medications or via inhalation of Nitrous oxide, also known as laughing gas. Nitrous oxide sedation is a safe and effective method to reduce anxiety and pain during dental procedures. It induces a state of relaxation while allowing children to remain conscious and responsive. If most of the previously mentioned approaches fail, general anesthesia is reserved for complex dental procedures or cases where children cannot cooperate due to age, physical or mental medical conditions, or severe dental anxiety. Under general anesthesia, children are completely unconscious and unaware of the dental procedure.

In the end, pain control techniques in pediatric dentistry are crucial for ensuring positive dental experiences and maintaining children's oral health. By employing various approaches such as behavior management techniques, local anesthesia, sedation, needle-free technologies, and laser dentistry, dental professionals can alleviate pain and anxiety in young patients, fostering a lifetime of good oral health habits.

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