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Advancements in Local Anesthesia Techniques in Dentistry: Management and Risk Communication from Traditional to Modern Technological Methods

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ABSTRACT

Local anesthesia is the cornerstone of modern dentistry, effectively managing pain from various dental procedures. This review aims to review the various modern techniques of local anesthesia used in dentistry, and complementary techniques. However, traditional methods of local anesthesia including subperiosteal injections, periodontal ligament, and regional nerve blocks, are widely used but often cause discomfort and anxiety in patients. Modern technologies such as computerized devices, The Wand, and Single Tooth Anesthesia (STA), as well as needle-free injection systems such as Jet-Injectors, have provided more precise and less painful options for anesthetizing specific areas. In addition, new techniques such as laser anesthesia, cryotherapy, and virtual anesthesia (VR) are emerging as complementary tools in pain management. This review highlights the evolution of local anesthesia methods and their potential to improve patient comfort.

KEYWORDS: Local Anesthesia, Traditional Methods, Modern Technological, Dentistry.

Introduction

Local anesthetics are among the most widely used drugs in dental clinics. Contemporary dentistry is witnessing a knowledge and technology explosion in dental treatment methods such as root canal treatment, oral and maxillofacial surgery, dental implants, and orthodontics [1]. Contemporary dentistry is impossible without the need for local anesthesia. Local anesthesia is the only, safest and most effective way to manage dental pain, as it prevents pain-causing impulses from reaching the patient's brain [2,3].

The word "anesthesia" is a combination of words that include (Greek) an-

("without") and esthesis ("sensation"). Local anesthesia is a reversible loss of sensation in a peripheral part of the body due to decreased excitation of nerve endings or inhibition of conduction in peripheral nerves [4]. For dentists to be able to inject these local anesthetics during their clinical practice, different local anesthesia techniques are applied to achieve the goal of local anesthesia, which is to make the patient lose the feeling of pain [5]. However, local anesthesia causes a feeling of fear and discomfort in patients [2]. Local anesthesia is typically used for all dental procedures except fluoride application, oral prophylaxis, and any procedure that does not require intraoral instrumentation, as well as based on the patient's pain tolerance [6].

Traditional methods of local anesthesia have been limited to injections, and although this procedure is effective, there are several risks such as anxiety and aggressive behavior, especially in children [7]. Therefore, modern techniques and methods have been developed to administer local anesthesia and manage pain effectively. Such as, local Anesthesia block and infiltration techniques [8]. In addition, The Wand is the latest digital technology in local anesthesia in dentistry [9].

This review aims to update and educate dentists on recent advances and various techniques for effective administration of local anesthesia and pain management.

Local anesthesia injection techniques

Local anesthesia techniques in dentistry vary to include different types of injections that target specific areas of the mouth and teeth. These techniques include anesthesia through the surrounding tissues or by injecting the main nerves that supply the teeth and surrounding tissues, such as subperiosteal anesthesia, injections into the periodontal ligament, and injections into the tooth pulp [10]. in addition, regional anesthesia such as infraorbital nerve blocks and maxillary nerve blocks [13].

Infiltration of local anesthesia techniques

- Subperiosteal anesthesia, Paraperiosteal anesthesia: The large terminal branches of the dental plexus are anesthetized. The areas anesthetized are the pulp, the bone covering the root of the tooth, the periosteum, the gingiva and the mucosa. It can be used for the upper teeth and the lower anterior incisors [2,10].

- Periodontal Ligament Injection: The terminal branches of the nerve at the injection site and the apex of the tooth are anesthetized, and the areas that are anesthetized are the bone, soft tissue, apex of the tooth and pulp at the injection site [11].

- Intrapulpal Injection: The terminal branches of the nerve are anesthetized at the injection site in the pulp chamber and tooth canals, and the areas that are anesthetized are the tissues inside the injected tooth [12].

Regional local anesthesia or subarachnoid block

- Infraorbital Nerve Block: The anterior alveolar nerve, the middle alveolar nerve, the inferior palpebral, lateral nasal and nasolabial nerves (terminal branches of the infraorbital nerve) are anesthetized. The anesthetized areas are the pulp of the incisors, quadrupeds and canines at the injection site, and in 72% of cases the middle

root of the first molar, the pulp of the premolars, the gingival tissue, the bone covering the above-mentioned teeth, the upper and lower eyelids and the side of the nose [13,14].

- Tuberosity Block: The areas that are anesthetized are the pulps of the second and third molars (the first molar is completely anesthetized in 72% of cases, while in 28% of cases the mesial root of the first molar remains unanesthetized), the periocular tissues around the teeth, and the overlying bone above the molars [13].

- Nasopalatine Nerve Block: The nasopalatine nerve is anesthetized bilaterally. The anterior part of the hard palate and the overlying soft tissues are anesthetized, from the medial part of the right first premolar to the medial part of the left first premolar [13].

- Greater Palatine Nerve Block: The anterior palatine nerve (greater palatine) is anesthetized. The areas anesthetized include the posterior part of the hard palate and the soft tissues covering it up to the first premolar and towards the midline of the palatal vault [13].

- Inferior Alveolar Nerve Block: The areas to be anesthetized are the inferior alveolar nerve, the incisive nerve, the mental nerve, and the mandibular nerve. The mandibular teeth up to the midline, the body of the mandible, the lower part of the ramus, the periosteum and mucosa in front of the mental foramen, the anterior two-thirds of the dentary and the floor of the oral fossa, the periosteum and soft tissues of the dentary [14].

- Mental Nerve Block: The mental and incisive nerves are anesthetized, which are terminal branches of the inferior alveolar nerve at the mental foramen. The anesthetized areas are the demyelinated mucous membranes in front of the mental foramen from the second premolar to the midline, as well as the skin on the lower lip and chin, and the pulps of the premolars, canines, and lower incisors [14].

Indications for the Use of Local Anesthesia in Dentistry

Local anesthesia is essential in pain management in dentistry. Dental procedures may cause painful reactions to mechanical, thermal, or chemical stimuli. These procedures include oral surgery, periodontal treatments, root canal treatments, dentures, and restorative treatments. Local anesthesia is used to provide temporary loss of sensation, allowing dental procedures to be performed comfortably and painlessly [15].

Local Anesthesia Delivery Devices

Single Tooth Anesthesia

STA (Single Tooth Anesthesia) is a new technology for anesthetizing only one tooth that needs to be treated without anesthetizing the lips or other parts of the mouth. The injection is done through a very small anesthetic syringe, where the anesthetic material is inserted under the gum and the flow rate of the anesthetic material is controlled by computer-controlled to make it slower and of constant concentration so that the injection is less painful [16]. Advantages of single-tooth anesthesia (STA) include no anticipatory anxiety (due to its pen-like design), no pain, no anesthetic

effects on perioral tissues (lips, tongue, cheeks), and no damage to the crown of permanent teeth. Garrett Bernardin et al. have reported that single-tooth anesthesia is an effective alternative to traditional techniques due to less pain and discomfort [17].

Jet-injection (Medjet-III)

Jet injection technology is based on the principle of using a mechanical power source to generate sufficient pressure to force a dose of liquid medication through a small opening, creating a thin column of liquid with sufficient force to penetrate the soft tissues of the subcutaneous tissue without a needle, which achieves positive psychological results [18]. Jet injectors offer advantages over traditional needle injectors by being quick and easy to use, with less or no pain, less tissue damage, and faster absorption of drugs at the injection site [19]. This device can direct the anesthetic solution with a small opening seven times smaller than the smallest needle available in the world. It can deliver intradermal, subcutaneous, and intramuscular volumes of 0.01-1 cm3 at 2000 psi using this device [18,19].

Vibrotactile Devices

One of the newer local anesthesia systems that aims to alleviate the fear of the anesthetic needle, which suggests that pain can be reduced by simultaneous activation of nerve fibers through the use of vibration, based on the "gatecontrol" theory, which states that the neural gate can be closed during the application of pressure and vibration, reducing itching and pain perception [20]. However, studies have shown that pain reduction from harmless touch or vibration can result from inhibition of pain induced by touch within the cerebral cortex itself and that the inhibition occurs without any contribution at the spinal level, including inhibitory actions on spinal neurons [21].

DentalVibe

It is another system that uses vibration based on the recently scientifically recognized theory of nerve pain gate. It is a wireless, rechargeable, handheld device that delivers soothing, pulsating micro-vibrations to the target area where the injection is given. The U-shaped vibrating tip connected to the microprocessor-controlled Vibra-Pulse motor effectively stimulates the sensory receptors at the injection site, effectively closing the nerve pain gate, preventing the painful sensation of the injection. It also illuminates the injection area and has a special attachment to retract the lip or cheek into the position that suits the doctor to begin his work comfortably [22,23].

The Wand - Used in Local Anesthesia

The Wand is a computerized device that injects local anesthetic into the patient in the area surrounding a tooth that needs treatment without the patient feeling any pain from the needle. The Wand is radically different from traditional medical syringes. It is a portable pen-like device that injects the local anesthetic slowly and gently so that the patient does not feel the pain from the needle, unlike traditional local anesthesia using a regular medical syringe. The Wand is an excellent technology for use on patients who suffer from phobias and nervousness and are afraid of dental injections. It is also safe and easy for the doctor to use and provides the same degree of anesthesia compared to traditional local anesthesia [9].

Orthopedic (IO) Anesthesia Devices

Stabident System: Several studies have shown that the Stabident System is safe and effective when used according to the doctor's instructions and directions. The advantages of the product are that it is relatively inexpensive and can be used with equipment already present in any dental clinic such as handpieces with anti-puncture angles and dental anesthesia injections [24]. The only negative point of the device is that the puncture must be made in a reasonably accessible and visible place in the attached gum away from the tooth to be anesthetized. If the penetration area is located in the alveolar mucosa that moves once the puncture is withdrawn, it can be very difficult to locate the puncture with the anesthetic needle [25]. X-Tip System: In light of the above mentioned problem of the Stabident system for locating the hole to be made in the gum, the X-Tip solves this problem by making the pilot drill itself a hollow tube through which a 27 gauge needle can be passed so that the initial drill remains in place, allowing the anesthetic to be applied without searching for the hole that has just been made. Patients usually experience post-operative pain, specifically in males, for a period of one to three days after the completion of the treatment [26].

Alternative dental anesthesia

These techniques are used as a supplement to local anesthesia, not as a substitute for traditional dental anesthesia. They aim to reduce pain during the local anesthetic administration process.

Laser Analgesia

Low-level laser therapy (LLLT) is a non-thermogenic, noninvasive biomodulation technique used to treat dental pulp. Unlike infiltrative local anesthesia, LLLT does not induce complete loss of sensation or profound anesthesia. It works by temporarily disrupting the sodium-potassium (Na-K) pump through modifications in the neuronal cell membrane, which prevents impulse transmission and produces an analgesic effect. This mechanism makes LLLT particularly effective in reducing anxiety among children and adolescents undergoing dental treatment [27]. Further suggesting that laser therapy could be a novel, noninvasive alternative for treating needle-phobic children. Additionally, it demonstrated that photo biomodulation therapy using lasers is effective in producing adequate pulpal anesthesia during cavity preparation in decayed permanent teeth [28].

Cryoanesthesia

This procedure involves cooling a narrow area of the body with ice or sprays of refrigerants to prevent nerves from transmitting pain signals. Thus, the local administration of cold can stimulate pain inhibitory pathways and excite myelinated A fibers. By reducing the threshold of pain receptors in the tissue and the signals of the pain transmitting nerves, cooling leads to neurological dysfunction [29,30].

Virtual Anesthesia

Behavioral distraction techniques are among the most popular approaches to reducing dental anxiety, with virtual reality (VR) devices being the most engaging and engaging tool for this purpose. Despite some limitations, several studies have shown that VR reduces pain and anxiety and increases patient satisfaction during

medical procedures, including pediatric dental treatment [31]. Clinical findings suggest that VR not only reduces discomfort but can also be used as a non-pharmacological pain relief aid, termed virtual anesthesia .Studies have shown that VR is an effective way to help children cope with treatments such as fillings and tooth extractions in a less stressful and more enjoyable way than traditional methods, making this technology an exciting addition to the field of non-pharmacological treatment [31,32].

Conclusion

Advances in local anesthesia technology have improved dentists' ability to effectively manage pain while reducing patient discomfort and anxiety. Traditional injection methods remain reliable, but innovations such as The Wand, STA, jet injections, and vibration-based devices are paving the way to deliver more comfortable and targeted anesthesia. Additionally, alternative technologies such as laser analgesia, cryotherapy, and virtual reality offer exciting new options to enhance pain control and reduce patient stress. As technology continues to evolve, it is essential that dentists stay up-to-date on these developments to provide the most effective, patient-centered care. By combining traditional methods with these new approaches, dentists can improve pain management, enhance patient outcomes, and increase satisfaction, making modern dentistry a more convenient and less intimidating experience for everyone.

References

Decloux D, Ouanounou A. Local anaesthesia in dentistry: a review. Int Dent J. 2020 Sep 17;71(2):87–95. doi: 10.1111/idj.12615. Epub ahead of print. PMID: 32944974; PMCID: PMC9275172.

Logothetis, Demetra Daskalo. Local Anesthesia for the Dental Hygienist-E-Book. Elsevier Health Sciences, 2021.

Reed KL, Malamed SF, Fonner AM. Local anesthesia part 2: technical considerations. Anesth Prog. 2012 Fall;59(3):127-36; quiz 137. doi: 10.2344/0003-3006-59.3.127. PMID: 23050753; PMCID: PMC3468291.

Lee HS. Recent advances in topical anesthesia. J Dent Anesth Pain Med 2016;16(4):237–244. DOI: 10.17245/jdapm.2016.16.4.237.

Renton, Tara. "Optimal local anaesthesia for dentistry." Optimal Pain Management for the Dental Team. Cham: Springer International Publishing, 2022. 101-121.

Hollins, Carole. Basic guide to dental procedures. John Wiley & Sons, 2024.

Rao, Ashwin, and Shweta Tiwari. "Local Anesthetic Techniques in Children." Midazolam in Pediatric Dentistry. Cham: Springer Nature Switzerland, 2024. 91-117.

Wu, Zehao, and Yun Wang. "Development of guidance techniques for regional anesthesia: past, present and future." Journal of pain research (2021): 1631-1641.

Banerjee, Madhulika. "The Wand Anesthesia: Pain-free Dentistry." International Journal of Medical and Oral Research 5.1 (2020): 12-15.

Calatayud, Jesús, and Mana Saraghi. Local Anesthesia in Dentistry: A Locoregional Approach. John Wiley & Sons, 2024.

Chitre, A. P. Manual of Local Anaesthesia in Dentistry. JP Medical Ltd, 2016.

Ghavimi, Mohammad Ali, et al. "Overview of local anesthesia techniques." A Textbook of Advanced Oral and Maxillofacial Surgery Volume 2. IntechOpen, 2015.

Suresh, Santhanam, David M. Polaner, and Charles J. Coté. "Regional anesthesia." A practice

of anesthesia for infants and children. Elsevier, 2019. 941-987.

Brown, David Lee. Atlas of regional anesthesia. Elsevier Health Sciences, 2010.

Pahade A, Bajaj P, Shirbhate U, John HA. Recent Modalities in Pain Control and Local Anesthesia in Dentistry: A Narrative Review. Cureus. 2023 Nov 7;15(11):e48428. doi: 10.7759/cureus.48428. PMID: 38073986; PMCID: PMC10701765.

Giannetti L, Forabosco E, Spinas E, et al. Single tooth anaesthesia: a new approach to the paediatric patient. A clinical experimental study. Eur J Paediatr Dent 2018;19(1):40–43. DOI: 10.23804/ ejpd.2018.19.01.0

Al-Obaida MI, Haider M, Hashim R, et al. Comparison of perceived pain and patients' satisfaction with traditional local anesthesia and single tooth anesthesia: a randomized clinical trial. World J Clin Cases 2019;7(19):2986–2994. DOI: 10.12998/wjcc.v7.i19.2986

Peedikayil F, Vijayan A. An update on local anesthesia for pediatric dental patients. Anesth Essays Res 2013;7(1):4–9. DOI: 10.4103/0259- 1162.113977. 40.

Arapostathis KN, Dabarakis NN, Coolidge T, et al. Comparison of acceptance, preference, and efficacy between jet injection INJEX and local infiltration anesthesia in 6 to 11-year-old dental patients. Anesth Prog 2010;57(1):3–12. DOI: 10.2344/0003-3006-57.1.3

Ungor C, Tosun E, Dayisoylu EH, et al. The effects of vibration on pain and anxiety during local anaesthesia administration. JSM Dent 2014;2:1022.

Hollins M, McDermott K, Harper D. How does vibration reduce pain? Perception. 2014;43(1):70-84. doi: 10.1068/p7637. PMID: 24689133.

Ching D, Finkelman M, Loo CY: Effect of the DentalVibe injection system on pain during local anesthesia injections in adolescent patients. Pediatr Dent. 2014, 36:51-5.

Ungor C, Tosun E, Dayisoylu EH, Taskesen F, Senel FC: The effects of vibration on pain and anxiety during local anesthesia administration. JSM Dent. 2014, 2:1022.

Idris M, Sakkir N, Naik KG, et al. Intraosseous injection as an adjunct to conventional local anesthetic techniques: a clinical study. J Conserv Dent 2014;17(5):432–435. DOI: 10.4103/0972-0707.139828

Kumar, Santosh. "Newer delivery systems for local anesthesia in dentistry." J Pharm Sci Res 7.5 (2015): 252-5.

Razavian H, Kazemi S, Khazaei S, Jahromi MZ. X-tip intraosseous injection system as a primary anesthesia for irreversible pulpitis of posterior mandibular teeth: A randomized clinical trail. Dent Res J (Isfahan). 2013 Mar;10(2):210-3. doi: 10.4103/1735-3327.113346. PMID: 23946738; PMCID: PMC3731962.

Chan A, Armati P, Moorthy AP, et al. YAG laser induces pulpal analgesia: a randomized clinical trial. J Dent Res 2012;91(7_suppl):79–84. DOI: 10.1177/0022034512447947.

Seraj B, Bavaghar A, Hakimiha N, Hosseini Z, Kharazifard MJ, Ghadimi S. Effect of Photobiomodulation Therapy With an 810-nm Diode Laser on Pain Perception Associated With Dental Injections in Children: A Double-Blind Randomized Controlled Clinical Trial. J Lasers Med Sci. 2023 Jun 19;14:e19. doi: 10.34172/jlms.2023.19. PMID: 37583496; PMCID: PMC10423958.

Lathwal G, Pandit IK, Gugnani N, et al. Efficacy of different precooling agents and topical anesthetics on the pain perception during intraoral injection: a comparative clinical study. Int J Clin Pediatr Dent 2015;8(2):119–122. DOI: 10.5005/jp-journals-10005-1296.

.Malanga GA, Yan N, Stark J. Mechanisms and efficacy of heat and cold therapies for musculoskeletal injury. Postgrad Med 2015;127(1):57–65. DOI: 10.1080/00325481.2015.992719.

Atzori B, Lauro Grotto R, Giugni A, et al. Virtual reality analgesia for pediatric dental patients. Front Psychol 2018;9:226. DOI: 10.3389/ fpsyg.2018.02265.

Nunna M, Dasaraju RK, Kamatham R, et al. Comparative evaluation of virtual reality distraction and counter-stimulation on dental anxiety and pain perception in children. J Dent Anesth Pain Med 2019;19(5):277–288. DOI: 10.17245/jdapm.2019.19.5.277