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Current Advances in Local Anesthetic Technique and Devices: A Review

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Abstract

The cornerstone upon which contemporary dentistry rests is arguably effective local anaesthetic. Contrarily, the local anaesthetic injection may be the biggest source of patient anxiety, and dental professionals continue to have serious concerns about their capacity to control pain effectively while minimising discomfort. Although the classic aspirating syringe is still the most popular way to give local anaesthetics, more recent developments have made it possible for dentists to provide patients greater pain relief with less painful injections and fewer side effects. Present review of literature aims to discuss the current advances in local anesthetic technique and devices in detail.

Keywords: Pain, Local anesthesia, Current advances

Introduction

Since the dawn of dentistry, effective pain treatment has been one of the profession's pillars.[1] Patients have been able to overcome their concerns and dislike of dentistry because to the effective use of local anaesthetic solutions and their careful administration. Perhaps the most common cause of patient anxiety is the injection of local anaesthetic, and dental professionals continue to have serious concerns about their patients' inability to get effective pain control with the least amount of discomfort. Knowledge of the agents being utilised, the related neuroanatomy, and the best practises and devices required for achieving excellent local anaesthetic.

Today's agents and anaesthetic administration tools give practitioners a variety of alternatives for efficiently managing the discomfort caused by dental operations.[2]

Even though local anaesthetic is still the cornerstone of pain management in dentistry, researchers are continuing to look for novel and more effective pain relief techniques. Newer methods have been developed to help dentists deliver improved pain management with less painful injections and fewer side effects. The traditional LA delivery system uses cartridges, needles, and syringes. The primary part of the local anaesthetic arsenal is the syringe, which serves as the delivery system for local anaesthetic agents into the tissues. There are numerous syringe options, including safety, non-disposable, disposable, and computer-controlled local anaesthetic delivery systems. The disposable syringes, which come in a variety of sizes and needle gauges, are the ones that are most frequently used.[3,4]

In order for local anaesthetic solution to reach the tissues around the needle tip from dental cartridges, a needle is required. Injuries from needles include pain during insertion and withdrawal, breakage, and unintentional harm to the patient or the dentist. Local anaesthetic is contained in dental cartridges, which are glass cylinders. The extruded stopper, sticky stopper, rust on the cap, injection leakage, broken cartridges, etc. are issues with these. Although the traditional aspirating syringes are still the most often used way for administering local anaesthetic agents, more recent technologies have been created that can help the dentist provide greater pain relief with less injection pain and side effects. There have been a number of innovations, such as vibrotactile devices, computer-controlled local anaesthetic delivery systems, safety dental syringes, and injections without the use of needles.[5,6]

Present review of literature aims to discuss the current advances in local anesthetic technique and devices in detail.

Recent advancement in Local Anesthetic Solution

Centbucridine: A local anaesthetic chemical known as centbucridine was created in 1983 at the Centre for Drug Research of India in Lucknow, India. It functions as a local anaesthetic and is a quinolone derivative. It naturally contains anti-histaminic and vasoconstricting effects. Centbucridine, which has an anaesthetic power 4-5 times larger than that of 2% lignocaine, can be used successfully for infiltration, nerve blocks, and spinal anaesthesia at a concentration of 0.5%. In ophthalmic procedures, centbucridine has been tested with success as a topical anaesthetic. Concentration affects the topical anaesthetic effect. It also exhibits analgesic qualities and a longer duration of action.[7]

Cetacaine: It is a topical anaesthetic solution with a distinctive triple action formula that reduces potassium and sodium ion permeability, blocks calcium ion binding and nerve impulse conduction, and blocks potassium and sodium ion conduction. With the exception of the eyes, it is intended for topical pain relief.[8] Cetacaine successfully produces a topical local anaesthetic effect compared to EMLA cream and 20% benzocaine gel in children, according to Dasarraju et al. the benefit of using this drug is avoiding the requirement to dry the mucosal surface before using cetacaine. It is therefore preferable to EMLA cream and benzocaine gel. Therefore, its use is more advantageous when it comes to children, especially when it is challenging to obtain a desired topical impact through isolation.[9]

Buffering the Local Anesthesia: Buffering of local anesthetics (alkalinization) has been suggested to achieve pain control.[11] Buffering will increase the dissociation rate of the local anesthetic molecule and

thus increase the uncharged base form that crosses the nerve membrane to the intra- neuronal site where it exerts its action.[12] The most common method for buffering of local anesthetics is with the addition of sodium bicarbonate. It is an alkalinizing agent, which is most used for the treatment of metabolic acidosis. The addition of sodium bicarbonate to local anesthetics not only will increase the pH of the solution but will also result in the production of carbon dioxide and water. Several authors have reported on the effect of carbon dioxide on local anesthetics and anesthesia. Condouris et al. reported that carbon dioxide potentiated the action of local anesthetics by showing that in the presence of carbon dioxide, nerve conduction blockade was significantly greater than in its absence.[13]

Betacaine: It comprises phenylephrine, lignocaine, and prilocaine. Because to the higher concentrations of lignocaine and prilocaine compared to EMLA, it is not recommended for use on children or on areas bigger than 300 cm2.[15]

Oraqix: 2.5% of prilocaine and 2.5% of lidocaine are present. During the root planning and scaling process, it is deposited into the periodontal pockets. Its effectiveness in relieving discomfort during the installation of orthodontic bands has been thoroughly proven.[14]

Recent advances in Local Anesthetic Technique

Precooling (Cryo Anaesthesia): Precooling is the process of applying cold to a specific area of the body in order to prevent the local nerves from transmitting painful signals. It activates pain-inhibitory pathways by stimulating myelinated A fibres, which in turn raises the pain threshold. Cooling is said to reduce or stop the transmission of pain signals, according to a study.[19] It comes as ice (crushed or cubed ice), refrigerant spray, and other forms. The commercial names for refrigerant spray are Gebauer's Pain Ease and Pharma Ethyl. It takes two to five minutes to apply and has a brief acting duration.[16]

Intranasal Sprays: The maxillary anterior teeth, canines, and premolars are anaesthetized in this procedure by administering an anaesthetic solution through a metered device into the nostrils. These are a blend of 0.05% oxymetazoline and 3% tetracaine hydrochloride. It tightens the vessels, which lessens bleeding and improves the operating environment.[17]

Electric Dental Anesthesia: Electronic Dental Anaesthesia involves the use of the principle of transcutaneous electrical nerve stimulation (TENS) which has been used for the relief of pain. Transcutaneous electrical nerve stimulation, sometimes known as TENS, is an alternative non-pharmacological pain management technique. In 1972, the FDA approved TENS as a pain-relieving technique and designated it as a class II device. TENS therapy uses electrodes to provide pulsed electrical current over intact skin to stimulate superficial nerves for localised pain relief. The electrical current can be generated from batteries or A.C. mains. Health care practitioners frequently employ TENS to alleviate both acute and long-term pain. Although TENS has potential benefits in dentistry, it is not widely employed.[18,19]

Dhindsa A et al. (2011) found a significant reduction in pain during all the dental procedures conducted under TENS, even though comparable with 2% lignocaine injection, and the patient was more comfortable when TENS was used. They found that TENS should be considered as a useful adjunct in the treatment of pediatric patients during various minor dental procedures.[20]

Dentipatch: A 15-minute application of dry mucosa to a dentipatch containing 10-20% lidocaine. Using this

patch to achieve topical anaesthetic for injections in the maxilla and mandible was advised by Hersh et al. in their 1996 study on the patch's efficacy. There are drawbacks, such as issues with the cardiovascular and central nervous systems. Shehab LA et al. (2015) effectiveness of the lidocaine Denti-patch ® system versus the lidocaine topical anesthetic gel in children concerning pain reaction during injection and found Denti-patch ® system can significantly reduce the needle injection pain more than the gel.[21]

Computer Controlled Local Anesthetic Delivery System: For the patient's comfort, local anaesthetic solution must be administered slowly and steadily at a steady rate. Conventional syringes struggle to establish precise flow rate control, and it is challenging to inject into dense tissues like the palate with conventional syringes. A new delivery system known as computer controlled local anaesthetic delivery systems was developed as a result of research in 1997.[22] It uses computer technology to regulate the rate and flow of anaesthetic solutions.

The anaesthetic cartridge's integration into the main unit, drug injection speed and mode, aspiration risk, weight, and simplicity of infection control are design considerations for CCLAD devices. Several companies have since created the computer-based, speed-controlled local anaesthetic devices used today, including the Quicksleeper® and Comfort Control Syringe (CCS®) in use abroad; and the Comfortin®, Deninjection®, iCT injection®, No Pain III®, Meg-inject®, and Smartject® devices used in South Korea. Milestone Scientific (Piscataway, NJ, USA) first introduced the Wand® in 1997. Because these devices differ in terms of design, injection speed, shape, weight, and the potential for aspiration, it's critical to select the right one based on operator choice.[23]

Jet Injection: With jet injectors, the pressure is released mechanically, allowing the liquid medication to pass through a small opening and into the body. Without the need of a needle, the anaesthetic solution can be deposited into the subcutaneous tissue by forming a thin column of fluid. Jet injections have the advantages of causing little tissue damage, quick drug administration and absorption, and reduced pain. Jet injectors are the most effective way to treat patients who are afraid of needles and anxious. Jet injections are frequently purchased under the names SyrijetMarkII, MED H JETIII, etc.[24]

Iontophoresis: Iontophoresis was originally presented as a viable substitute for the administration of a medication to achieve surface anaesthesia in 1993. The compounds in many therapeutically effective medications have high molecular weights and are hydrophilic. The skin's high lipophilicity limits its ability to pass through the stratum corneum and into the bloodstream.[25]

Iontophoresis is the process of applying an electrical potential that keeps the voltage low and consistent in order to improve the delivery of both unionised and ionised molecules. By extending its sensory component and delivering medications into the area-surface, it is a type of active transport.[26] An electrochemical polarisation takes place in the skin when a direct current electric field is applied for a longer period of time, which reduces the amount of current flowing through the skin. The quantity of medication ions transported over the skin is impacted by this. Use with caution since it can irritate the skin at higher current voltages or after prolonged application.[27]

Single Tooth Anaesthesia (STA): Milestone Scientific unveiled the Single Tooth Anaesthesia in 2006. During all stages of the drug's administration, STA uses

dynamic pressure-sensing (DPS) technology to continuously measure the exit pressure of the local anaesthetic solution in real time. In order to determine the best needle location for PDL injections, DPS also continuously feeds back to the user about the pressure at the needle tip. Since the system calculates the pressure rather than the operator, the STA system allows for the administration of a large volume of LA while causing less tissue damage than a typical syringe or PDL pressure device.[28]

Safety Syringes: In both medicine and dentistry, there has been a movement in recent years toward the creation and adoption of "safety" syringes. The danger of an unintentional needle-stick injury to a dental healthcare professional after the administration of LA is reduced by using a safety syringe. The sheath on these syringes "locks" over the needle when it is taken out of the patient's tissues, eliminating unintentional needle sticks.[29]

Intraflow: The IntraFlow device, made by Pro-Dex Medical Devices in Irvine, California, USA, is essentially a dental handpiece with an injectable system integrated inside the body. The IntraFlow anaesthetic system's main benefit is that it enables entry into the penetration zone, injection, and withdrawal in a single continuous phase without requiring the perforation site to be moved. The second and sometimes first molar areas, as well as situations where there is horizontal bone loss or only a small band of connected gingiva exists in the intended penetration zone, are examples of penetration zones that may be challenging to see or reach. The IntraFlow has drawbacks including start-up and maintenance costs and the potential for anaesthetic leakage, especially if improperly installed.[30]

Vibrotactile Devices: Vibrations or pressure act as non-noxious stimuli, which modify or interfere with pain signals by closing the neural gate of cerebral cortex. As cerebral cortex gets focused on vibration, there is less perception of pain. Studies suggested that pain reduction due to non-noxious touch or vibration results from tactile induced pain

inhibition within the cerebral cortex itself and that the inhibition occurs without any contribution at spinal level, including descending inhibitory actions on spinal neurons. Vibrotactile devices includes vibraject, dentalvibe, accupal.

Conclusion: Dentistry has long placed a premium on treating patients' pain and anxiety. Dentists use a needle injection to deliver local anaesthesia to block discomfort. Unfortunately, many children and adults still avoid getting dental care because of worry and fear that develop before and/or during injection. The most popular alternative dental anaesthesia delivery techniques are topical anaesthesia, electronic dental anaesthesia, jet injectors, iontophoresis, and computerised control local anaesthesia delivery systems. Although patients have generally embraced these methods, the authors believe that there are certain limitations to the usefulness and practicality of such techniques in general dentistry.

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