

Recent advancements and different types of local anesthesia in dental procedure: A comparative study¹Dr Shreya Pote, BDS, Bharati Vidyapeeth Dental College and Hospital, Sangli²Dr Anoli Agrawal, BDS, MDS, Public Health Dentistry, ACPM Dental College and Hospital, Dhule. Department of Dentistry, Goregaon Dental Centre, Mumbai, India**Corresponding Author:** Dr Shreya Pote, BDS, Bharati Vidyapeeth Dental College and Hospital, Sangli.**Citation of this Article:** Dr Shreya Pote, Dr Anoli Agrawal, “Recent advancements and different types of local anesthesia in dental procedure: A comparative study”, IJDSIR – September – 2026, Volume – 9, Issue – 4, P. No. 01 – 08**Copyright:** ©2026, Dr Shreya Pote, et al. This is an open access journal and article distributed under the terms of the creative common’s attribution non-commercial License. Which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given, and the new creations are licensed under the identical terms.**Type of Publication:** Original Research Article**Conflicts of Interest:** Nil**Abstract**

The use of local anesthesia in dentistry highlights the importance of identifying potential and effectiveness in releasing the pain and make the procedure less painful. The lignocaine is most commonly used anesthetics with epinephrine, the most commonly used vasoconstrictor. However, with time some complications were analysed, hence some recent modification and advancements were done. The principal aim is to prevent complication, ensure patient safety and make the procedure more convenient. The review analyzes clinical data from the international literature on history of local anesthesia, its recent advancement and techniques of administration.

A structured search was conducted in the Google scholar using defined descriptors and Boolean operators. The search was conducted without language restriction and publication year restricted upto 10 years. Despite their widespread use, topical anesthetics have got few citations. Our findings suggest a research preference for studies over pain management, in field of local anesthesia

and its recent advancements. This highlights the need of further research and progress in this important field.

Keywords: Local Anesthesia, Lignocaine, Administration Techniques, Recent Advancements, Articaine.**Introduction**

Local anesthesia is a medication used to temporarily numb a small, specific area during minor surgical or dental procedure without feeling pain. Intraoral local anesthesia is considered as most frequently used drug in dental care. Due to the fear of experiencing pain, many patients delay, neglect or avoid treatment, at such times local anesthesia acts as significant factor. The most commonly used local anesthetics are lidocaine, articaine, mepivacaine, bupivacaine, prilocaine, which are administered in procedures to eliminate pain and reduce anxiety.¹ Local anesthesia is mainly safe but there are several incidences reported causing neurological complication which range from mild to severe and sometimes long lasting. The local anesthesia aims to reduce anxiety and fear through various conventional and

computerized systems, also administration through various nerve blocks. The most common uses of local anesthesia includes in various procedure like restoration, root canal, crowns and simple teeth extraction.¹

There are two ways in which Local anesthesia can be broadly classified. First one is Chemical structure which is mainly classified as either esters or amides. Second one is Duration of action which is based on the duration of action local anesthetics that can be classified as short acting, intermediate acting and or long acting.

In dentistry, the injectable anesthetics have a common core structure which consists Hydrophilic amino terminal, Intermediate chain and lipophilic aromatic terminal.¹

Chemical Classification and duration of action of local anesthetic agents:²

Local anesthetic	Classification	Duration
1. Lidocaine	Amide	Intermediate
2. Prilocaine	Amide	Intermediate
3. Mepivacaine	Amide	Intermediate
4. Bupivacaine	Amide	Long – acting
5. Etidocaine	Amide	Long – acting
6. Articaine	Amide with an ester side chain	Intermediate
7. Procaine	Ester	Short – acting

There are various techniques that are used to diminish the pain during the administration of local anesthesia which includes application of different anesthetic gels, warming the anesthetic agents, reducing the speed of injection and buffering local anesthetic agents.

Articaine and centbucidine are recently developed medications proved to be as effective or even more effective than lignocaine. Another recent advancement does not involve conventional anesthesia which includes Electric Dental Anesthesia, Laser analgesia, Virtual anesthesia, Cryoanesthesia. Local anesthesia is used in

almost all the procedures which includes cavity preparation, essential pulp therapy, tooth preparation, scaling and root planning. The different methods of administration include Topical, Infiltration, Nerve Block and Epidural/ Spinal.¹

Different techniques used for local anesthesia administration –

The fifth cranial nerve commonly known as trigeminal nerve plays an important role in administration of local anesthesia. The nerve exits from brain through the area between pons and middle cerebral peduncles.

The trigeminal nerve has three major divisions – ophthalmic, maxillary and mandibular.

Maxillary anesthesia technique includes Supraperiosteal injection (infiltration), Maxillary nerve block, High – Tuberosity approach, nasopalatine nerve block,

The Vazirani- Akinosi mandibular block, Gow gate mandibular nerve block, Buccal nerve block, Mental and incisive nerve block are commonly administered types of mandibular nerve block.^{3,1}



The aim and the objective of the study is to explore different types of local anesthesia and gain more knowledge about the recent advancements in the world of local anesthetics.

Material and methodology

The studies for this review literature were selected from Scopus, Google Scholar, PubMed, Web of science with restriction of 10 years of publication year, to provide comprehensive study of Local Anesthesia – its different types and research advancements. The study focused on the history of local anesthesia and its efficacy and how can be made more efficient through advancement.

The term searched includes Local anesthesia, Lignocaine, Articaine, Nerve block techniques, coenaesthesia, anesthetic agents.

The Local Anesthesia plays a specific role in prevention or reducing the amount of pain during minor procedures. The commonly used anesthetics include topical anesthetics which includes creams, sprays, drops; infiltration and nerve blocks. The nerve blocks commonly used are lidocaine, bupivacaine, benzocaine.

The factors that play an important role in reducing the pain perception during injection of local anesthesia are the type of anesthetic solution, the size of the needle, the speed of injection and using topical anesthesia. The most widely used local anesthetic is two percent lidocaine with 1: 100000 epinephrine. Dentists also combine the solution with vasoconstrictor.⁴ It is perceived that lower pH value anesthetic solution might cause burning sensation while administration due to its acidic nature. The site of injection also plays an important part in pain perception. Study shows that maxillary buccal injection was associated with comparatively less pain when 2% lidocaine with 1: 80000 epinephrine was used instead of plain 2% lidocaine. But on palatal site no significant changes were noticed with same anesthetic agents. No changes were reported between maxillary buccal infiltration and IANB. The site with less connective tissue is administered with anesthetics, no impact is noticed with injection pain. In adults the size of the

needle has no impact on pain perception, though in children the site of injection may have an effect on size of needle on pain during administration of local anesthesia. Study showed that in adults there is no any significant change seen when 25 or 27 gauge needle were used for IANB. Also there was no significant change in pain when 25, 27 or 30 gauge needle were used for palatal infiltration or buccal infiltration. In children a 30 gauge needle caused less behavioral change compared to a larger 30 gauge needle. The higher speed of injection causes increased distribution of drug. more pain and discomfort is observed during faster injections. The speed of injection has no major impact on success rate of anesthesia, but greater speed of injection provides more discomfort and pain.⁴

1. Classification of local anesthesia - The Anesthesia is basically categorized in two types; Amides are metabolized in liver and are the most common type of anesthesia used in modern medicine. The examples include Lidocaine, Bupivacaine, Articaine and Prilocaine. While the Esters are metabolized in blood plasma. The esters are less commonly used due to higher rate of allergic reactions, the examples include Procaine, Cocaine, Tetracaine, Benzocaine.^{1,2,4}

2. Techniques of administration of local anesthesia - There are various Techniques of administering local anesthesia. The topical anesthesia that involves creams, ointments, sprays or drops are applied directly to the skin, gums, or eyes to numb the surface before surgery or procedure. It reduces the chances of needle stick injury and helps in reducing anxiety.¹ the topical anesthetics include water soluble salts, dissolved in organic solvents mixture, as oil water emulsion, incorporated into patches and controlled release device using iontophoresis and phonophoresis in liposomes. Topical anesthesia reduces discomfort during painful dental procedures.⁴ With

combination of lidocaine and prilocaine a euteric mixture of local anesthesia (EMLA) is produced, which can achieve a concentration of 80 %. Meechan and Thomason found that pain from periodontal ligament injection was less following a 5 min application of EMLA compared to an application of 5% lignocaine. The infiltration technique means injecting the anesthesia directly into the tissue to block nerves in localized area. Intravenous regional anesthesia is a specialized type of injection into a vein while a tourniquet stops blood flow, often used for arm or hand surgeries.⁵

The Lidocaine is most widely used agent often used with combination with adrenaline to extend duration. The articaine is used frequently in dentistry for superior ability to diffuse through bone. The bupivacaine, levobupivacaine, ropivacaine are commonly used for longer lasting pain relief⁴

3. Components of Local Anesthesia - The components of local anesthesia are Vasoconstrictors and pH adjusters. Adrenaline is frequently used in anesthesia to counteract vasodilation, reducing bleeding and prolonging the effect. The pH adjusters are sometimes added to improve stability even though many are unstable in solution specially esters.

The local anesthesia can last from 30 minutes to 12 hours or more, the duration of action depends on the affected area, the dose, the types of local anesthetic and the use of additives like epinephrine or steroids.¹

4. Recent advancement in local anesthesia

4a - Articaine and centbucridine are two relatively recent medications that have been proved to be more or as effective than lignocaine. Articaine is a member of amide family. It also contains ester groups that is possessed by tissues esterases and a thiophene ring in place of benzene ring. Articaine has a higher success rate than lignocaine and has strong effects.^{6,1} Centbucridine is

a local anesthetic that is a quinolone derivative. It contains vasoconstricting and antihistaminic effects. It has a high anesthetic power. Articaine is mainly used for routine dental procedures (restoration and crown) and also during oral surgery. It is high fat soluble which makes it better to diffuse through bone, making it effective for buccal mandibular infiltrations. It should be cautiously used in patients with severe diabetes, hypertension or children under 4 years. Centbucridine is developed in India (CDRI Lucknow). It is 5-8 times more potent than lidocaine, used frequently as an alternative for patients allergic to conventional amides. It tends to block sodium channels in nerve cells to prevent neural signal transmission. It is frequently used with Feracrylum for enhanced wound healing, hemostasis and infection control. Centbucridine does not show any significant changes in cardiovascular parameters. It is widely used in minor surgeries, sometimes for subarachnoid or regional anesthesia and for local infiltration anesthesia in dentistry.⁶

4b- The virtual anesthesia is commonly used behavioral strategies for reducing dental anxiety and distraction tactics. It is claimed to lessen discomfort and increase patient satisfaction during treatment. It helps in reducing anxiety among patients and makes the treatment less stressful for patients. It performs as distraction tool for acute pain by engaging patients in immersive 360-degree interactive environment during medical procedure.^{6,7} It can be used as an alternative to narcotics and heavy sedation, allowing patients to remain awake during minor surgeries. It is also widely used in pediatric pain management for anxiety inducing medical interventions.^{8,9} Electric dental anesthesia is a frequently employed non-pharmacological approach for treating pain. The electric nerve stimulation uses an electric current generated mechanically. This method is highly beneficial for

pediatric patients as it does not involve syringes. Moreover it is also effective in adult patients during different dental procedures. In 18 – 19 century, electricity was used for pain relief, but specific dental use was documented in 1850's.⁶ J.B Francis and J.D. White used electrogalvanic current for teeth extraction. EDA then again got highlighted after the controversy against its use in 1960-70's via Gate control theory. Wall and Sweet provided a scientific basis that low voltage currents can block pain signals reaching brain. After late 1980's modern innovations like Soan Electronic Dental Anesthesia Pen provide effective treatment specifically for pediatric dentistry. It is also used interchangeably with TENS (transcutaneous electrical nerve stimulation) which delivers small – amplitude electrical pulses, mostly for controlling chronic Temporomandibular joint (TMJ) pain and also acute post operative pain.⁶ TENS was invented by Shealy in 1967.¹⁰ The pain gate mechanism and the endogenous opioid system are the two primary mechanism by which TENS causes pain relief. The pain gate mechanism involves excitation of A beta fibers reducing the transmission of noxious stimulus from the c fibers through the spinal cord and on to higher centers. In the endogenous opioid system, due to the release of electric stimulation, there is a release of pituitary and hypothalamic opioid peptides into the blood circulation or cerebrospinal fluid. It provides immediate effect, avoid the needles in most cases and avoids post procedure face numbness. It is proven most effective for reducing anxiety and pain for patients allergic to routine local anesthetics.^{6,7}

4c- Laser analgesia is used in low level non thermogenic, noninvasive procedure to modulate the tooth pulp. The Na-K pump is temporarily disrupted by modification of cell activity which produces analgesic effect and prevents impulse transmission.⁶ 4d- The cryoanesthesia includes

cooling an affected area with ice or sprays so that it does not transmit pain signals. By reducing the threshold of pain carrying nerve signals, cooling leads to neuropraxia. Bose et al. claimed that precooling the soft tissue area before routine dental operations decreases the pain. The technique includes the ice application, along with special vapocoolant sprays (Gebauer's pain ease) or cooled anesthetic cartridges (4-5 degrees) can also be used for intra-ligamentary injections. It is proved to be highly effective when applied to mucosa before local anesthetic injections mainly for palatal injections which are often painful due to tight tissues.⁸ Its benefits include reduced injection pain, rapid action and psychological distraction. Care has to be taken that it should not be over cooled as it can cause tissue damage. The application duration should be short. Also it should not be used on patients with allergy to cold.^{6,8,11}



4e- Quick sleeper is a technique to lessen the pain of injection. In this technique, the anesthesia is administered through steady velocity and pressure. It contains a control box and handpiece, the signal is transmitted through Bluetooth to the main control box.

The solution is injected through cancellous bone after handpiece drills the bone, after the circuit is complete to produce the greatest anesthetics effect. It also proves to be effective in young and adolescent patients as it helps in reducing anxiety.⁶ Periodontal ligament injection or intraligamentary injection is also considered as most effective when only one tooth of mandible needs to be sedated. There is no extraoral or lingual numbness with periodontal ligament injection.⁶ High pressure is mandatory to inject anesthesia into thick oral tissues at the PDL injection site using a standard syringe. The benefits of quick sleeper anesthesia are its rapid onset of action, its versatile delivery, no collateral numbness, it is effective on molars, painless, and its versatile delivery.^{7,12} It can be widely used to reduce dental fear in pediatric patients. Though it is not always recommended for long – duration anesthesia in extensive surgeries.

4f- Recent advancements in local anesthesia delivery technique include Single tooth anesthesia that includes a 30 – G needle that is extra short and inserted into gingival sulcus parallel to the long axis of teeth.¹³ To inject sufficient anesthetics the needle should be placed into the tissue pulp up until it reaches the periodontal ligament. It does not hurt, and has no effect on lips, tongue or cheeks and not damaging permanent teeth crown. Intranasal Tetracaine / Oxymetazoline spray is metabolized in plasma and is utilized as a nasopharyngeal and nasal anesthetic drug. The dynamic pressure – sensing (DPS) technology is incorporated that checks the exit pressure of local anesthetic solution continuously.

STA (single tooth anesthesia) has three rate modes of injection –

- 1- STA mode – single, slow rate of injection
- 2- Normal mode – emulates the compudent device

- 3- Turbo mode – faster rate of injection – 0.06 ml/s^{14,15,16}

The adaptation of DPS technology helps in overcoming the difficulties associated with different injection techniques like PDL, AMSA, and P-ASA injection. 4g - The wand - It primarily has three components base unit, foot pedal, and disposable handpiece assembly. Base unit consists of a microprocessor and connects to foot pedal and handpiece that has LA cartridge.¹⁷ LA solution passes from the cartridge to the handpiece and attached needle to the target tissue. The foot pedal controls the rate on injection and it prevents inadvertent intravascular injection. The major advantage of wand is it provides greater control over syringe and fixed flow rate of LA drug. It is more beneficial for pediatric patients. Koyuturk et al proved that wand is more comfortable than traditional syringe, helps in reducing anxiety and inappropriate behavior among children.^{18,19}

Conclusion

Pain is a certain type of human experience of perception, although many different other species too experience pain. Pain cause human increase obnoxious behavior and anxiety which needs to be controlled. In dentistry, pain management involves pain diagnosis, management techniques, pain management which includes anesthetic delivery and post operative pain management. Several techniques are developed to subside pain which are mainly classifies into pharmacological and non-pharmacological modalities. Local anesthesia is considered as popular modality which is used in topical and injectable forms. Non pharmacological modalities include behavior control methods based on several theories.

With time, several advance techniques are invented and modified to make the amount of pain negligible and the dental procedure hassle- free, convenient and effective. The painless approach for dental procedure makes the

experience more enjoyable for both patient and the dentist which helps in creating a strong patient – dentist bond and makes good impact. The traditional approach for administering local anesthesia seemed to be less effective as the modern methods developed. The recent advancement in local anesthesia has helped both the dentist and the patients to have a good experience while getting procedure done and it is important to upgrade to the recent advanced methods to make a strong and powerful impact.

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