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RECENT ADVANCES IN LOCAL ANESTHESIA: A REVIEW

Dental Science

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ABSTRACT

Painless treatment has been the milestone of dentistry. This article reviews the newly introduced local anesthetic solutions in the past few decades such as levobupivacaine, ropivacaine, and articaine. Local anesthetics remain the safest and most effective in recent dental practice.

KEYWORDS

Local Anesthetic Drugs, Lignocaine, Articaine, Complications

INTRODUCTION

Local anesthesia as the name suggests is clinically used for anesthesia and analgesia, lasting for only few hours.[1] Local anesthesia originated merely a century ago, when cocaine was extracted from coca leaves, following which after about forty-five years procaine, a synthetic local anesthetic was first prepared.[2] As it has changed the emotional appeal of dentistry from dreadful and painful experience to pleasant experience. Speaking of the history, there is mention of two important discoveries, i.e.

- Braun's Discovery – it includes addition of adrenaline in local anesthetic.
- Einhorn's Discovery of Novacain.

These discoveries played a huge role in the development of LA over the years.[3,4]

Lignocaine Hydrochloride is widely accepted and commonly used regional anesthetic agent. Considering the fact, it has higher efficacy, low allergenicity with low toxicity, it is the Gold Standard within the widest range of LA drugs.[5]

Table 1: History Of Local Anesthesia[6]

YEAR	INDIVIDUAL/ COMPANY	EVENTS
1859	Niemann	Isolation of cocaine
1884	Koller	Cocaine topical anesthesia
1884	Halstead	Cocaine regional anesthesia
1885	Corning	Tourniquet to retard absorption
1903	Braun	Epinephrine as a chemical tourniquet
1904	Einhorn	Synthesis of procaine
1905	Braun	Clinical use of procaine
1920	Cook Laboratories	Anesthetic syringe and cartridge
1943	Lofgren	Synthesis of lidocaine
1947	Novocol	Dental aspirating syringe
1948	Astra	Lidocaine for dentistry
1959	Cook-Waite	Sterile disposable needle

MECHANISM OF ACTION

Local anesthetics directly block the transmission of pain from the nociceptive afferents (pain receptors). They work by inhibiting the sodium channel and blocking the inward Na^+ influx at the sodium ionophore during depolarization. In addition, LA blocks Ca^{2+} and K^+ channels,[7,8] transient receptor potential vanniloid-1 receptors,[9] other ligand gated receptors.[10] Additionally, LA exerts anti-inflammatory effects on neutrophil priming reaction by disrupting the coupling between certain G proteins and their associated receptors.[10,11]

ARTICAINE

This newest local anesthetic came into usage in 1976 in Europe and 2000 in United States.[12] It belongs to the amide group of local anesthetic agents, consisting of a thiophene ring (causing faster onset of action and longer duration of action by increasing the lipid solubility and protein binding capacity) as an alternative to a benzene ring with an ester group, metabolized via esterases in the tissues.[3,13,14,15] Elimination of Articaine is exponential with a half-life of 20 minutes, with its metabolism mostly in liver and plasma by certain unspecified plasma esterases.[16]

FDA gave a maximum of recommended dose of articaine 4% with 1:1,00,000 epinephrine is half the number of cartridges than 2% lignocaine with 1:1,00,000 epinephrine (i.e. Articaine-72mg/cartridge, Lignocaine- 36mg/cartridge).[13]

Advantages: [5,13,14,16,17,18]

- Faster onset of action
- Longer duration of action
- Higher success rate
- Has greater potency (1.5 times more potent)
- Lower systemic toxicity
- Safer drug
- Lower lipid solubility
- High plasma protein binding rate
- Low blood levels

Disadvantages: [14,16,19]

- May cause methemoglobinemia, neuropathie.
- Paresthesia (lingual nerve)
- More neurotoxic
- Ocular complications (due to increased diffusion of drug through tissues including bone)

BUPIVACAINE

Bupivacaine more potent as it is more lipid soluble than mepivacaine, though they are chemically similar in nature. Due to the activity of its dextrorotary enantiomer on cardiac tissue, it is considered as more cardiotoxic than many other local anesthetics. It has slower onset time and is rendered inappropriate for maxillary infiltration as its diffusion is slower down by sequestration in mucosal tissues. It can cause a long lasting anesthesia (8 hours). Bupivacaine is available in cartridges of 0.5% solution with 1:2,00,000 epinephrine.[6]

CENTBUCRIDINE

It was first local anesthetic to be synthesized in 1983 at the Centre for Drug Research of India, Lucknow.[20] It is a quinolone derivative with vasoconstricting and anti-histaminic properties.

It has an anesthetic potency 4-5 times more than 2% lignocaine, which can be used in concentration of 0.5% for infiltration, nerve blocks and spinal anesthesia.[21] It has been observed to have longer duration of action and anesthetic properties.[22]

PHENTOLAMINE

Phentolamine Mesylate is indicated for the reversal of the effect of local anesthesia. It is a non-selective alpha adrenergic blocking agent which reverses (anesthesia of the soft tissue, specifically lip and tongue region) the effect of epinephrine/ nor-epinephrine on alpha one and alpha two adrenergic receptors, eventually causing vasodilatation which basically causes local anesthetic solution further away from the injection site. The elimination half-life is 2-3 hours with peak concentration after 20 minutes. Common side effects includes diarrhea, facial swelling, hypertension, jaw pain, oral pain, reaction at the injection site, tenderness and vomiting, many of them may be resolved in 48 hours. Care should be taken in case of cardiovascular diseases/strokes.[1]
It's obtainable in the form of cartridge with a concentration of 0.4mg/1.7ml. The recommended dose is based on the number of cartridges of local anesthetic with vasoconstrictor administered.[1]

LEVOBUPIVACAINE

The pure S (-) enantiomer of bupivacaine came as a safer alternative for regional anesthesia than it's than its racemic parent. Levobupivacaine showed less affinity and depressant effects on myocardial and central nervous system with a superior pharmacokinetic profile. Following the clinical comparative trials, the incidence of adverse effects were found to be similar with levobupivacaine and bupivacaine i.e. hypertension, nausea, postoperative pain, fever, vomiting, pruritus, back pain, headache, constipation, dizziness, foetal distress.[24]

For an effective postoperative analgesia, the dose of epidural levobupivacaine reaches 15mg/hour.[23]

ROPIVACAINE

It is a long-acting, enantiomerically pure (S-enantiomer) amide local anesthetic. Its efficacy is broadly similar to bupivacaine. Furthermore, it is considered as an alternative due to its reduced central nervous system and cardiotoxic potential with lower propensity for motor block. It is demonstrated to be less cardiotoxic than bupivacaine but more than lignocaine with higher threshold for CNS toxicity than bupivacaine. Many authors revealed in their clinical studies that epidural ropivacaine 0.2% is effective for the effective labour analgesia, providing pain relief after abdominal or orthopaedic surgery when used in conjunction with opioids. Though the adverse effects profile is seen similar to that of bupivacaine.[24]

Structurally Different Newer Local Anasthetics

There is an alternative substitute of influential group of local anesthetic, which is the basic esters of phenylcarbamic acid. Determining higher LA potency and lower toxicity profile are the basic esters of alkoxy-substituted phenylcarbamic acid. Phenylcarbamic anesthetic being the most potential bypass most other clinically used LA (100-300 times). There potency is inversely proportional to the pH of the external medium, with outmost importance while using LA in inflamed tissues.[25]

Butyl amino-benzoate on the other hand, is an amino ester discovered in 1923. At first it was thought to be of no use due to its extremely low pKa, low water solubility, poor dural permeability, rapid hydrolysis. However, following decades after, the manufacture of suspension preparations in polyethylene glycol and polysorbate-80, which were found to be long-lasting given epidurally to cancer patients as a substitute to alcohol or phenol neurolysis. During recent times it has also been successfully used in cancer as well as non-cancer patients for pain.[26]

Adverse Effects Of Local Anesthetic Solution[1]

1. Tachycardia
2. Separation of needle
3. Aspiration or ingestion of foreign body.
4. Pain, swelling (due to overheating of bone and macerating of overlying soft tissue)
5. Post-injection hyper-occlusion, pain, chewing soreness.
6. Dentinal tooth damage and osteonecrosis (rare)

CONCLUSION

Local anesthesia has been considered as the foundation of painless treatments in dental practice. Though the ignorance of advancements in the field of newer drugs have caused limitations in the path of pain free treatments. The search for alternatives have generated parallel areas of research, clinical and laboratory, the result of both the aspects influenced todays dental practice.

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