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"LIDOCAINE IN DENTAL SCIENCE"

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ABSTRACT

General anaesthesia is a state of unconsciousness and loss of protective reflexes resulting from the administration of one or more general anaesthetic agents. Lidocaine is a local anesthetic drug used in minor dental surgery. It is also used topically to relieve itching, burning and pain from skin inflammations. Lidocaine can also be used as Topical anesthesia, Infiltration, Plexus block, Epidural block and Spinal anesthesia. A review of some patents on lidocaine is also provided that summarizes the recent technical advancements taken place in this area.

KEY WORDS: Local anaesthesia, Lidocaine, Indications, Patents

1. INTRODUCTION

General anaesthesia is a state of unconsciousness and loss of protective reflexes resulting from the administration of one or more general anaesthetic agents. Different drugs can be used for this purpose. General anesthesia has many purposes like Analgesia (loss of response to pain), Amnesia (loss of memory), Immobility (loss of motor reflexes), Hypnosis (loss of consciousness), skeletal muscle relaxation, etc. General anaesthesia depresses the cardiovascular and respiratory systems. For some groups of medically compromised patients, it is contraindicated for elective procedures. It is also not recommended for routine dental work like fillings. For things like fillings, a breathing tube must be inserted, because otherwise, little bits of tooth, other debris or saliva could enter the airway and produce airway obstruction or cause illnesses like pneumonia[1].

Lidocaine is a common local anesthetic and antiarrhythmic drug. It is injected as a dental anesthetic for minor surgery and is used topically to relieve itching, burning and pain from skin inflammations. Its melting point is 68 °C (154 °F) with a molecular mass of 234.34 g/mol. Its formula is $C_{14}H_{22}N_2O$. It has a half life of 1.5-2 hrs. When given orally, it has 35% of bioavailability but topical it has only 3%. Its metabolism is hepatic and it is excretion renally. Lidocaine as an antiarrhythmic drug is used intravenously for the treatment of ventricular arrhythmias and in refractory cases of status epilepticus. Lidocaine is effective in treating jellyfish stings by both numbing the affected area and preventing further nematocyst discharge[2].

2. LOCAL ANESTHETICS

A local anesthetic is a drug that causes reversible local anesthesia, generally for the aim of having local analgesic effect.

When it is used for nerve block, loss of muscle power can be seen[1].The most commonly used local anesthetic is lidocaine (also called xylocaine or lignocaine) which is a modern replacement for Novocain and procaine. Its half-life in the body is about 1.5–2 hours. Other local anesthetics used include septocaine, marcaine (a long-acting anesthetic), and Mepivacaine. A combination of these may be used depending on the situation. Most agents come in two forms: with and without epinephrine[3].

Amino amide and amino ester are the two classes of clinical local anesthetics. Synthetic local anesthetics are structurally related to cocaine. They differ from cocaine mainly in that they have no abuse potential and they do not produce hypertension or local vasoconstriction, with the exception of Ropivacaine and Mepivacaine that do produce weak vasoconstriction[4].

Local anesthetics vary in their pharmacological properties and they are used in various techniques of local anesthesia such as Topical anesthesia, Infiltration, Plexus block, Epidural block, Spinal anesthesia etc[5].

3. DOSAGE FORMS[6]

Lidocaine in the form of lidocaine hydrochloride is available in various forms like:

- Injected local anesthetic
- Dermal patch
- Intravenous injection
- Intravenous infusion
- Nasal instillation/spray
- Oral gel
- Oral liquid
- Topical gel
- Topical liquid
- Topical patch
- Topical aerosol spray
- Inhaled via a nebulizer

4. PHARMACOKINETICS

Lidocaine is approximately 95% metabolized in the liver by CYP3A4 to the pharmacologically-active metabolites monoethylglycinexylidide (MEGX) and then subsequently to the inactive glycine xylidide. MEGX has a longer half life than lidocaine but also is a less potent sodium channel blocker. The elimination half-life of lidocaine is approximately 90–120 minutes in most patients. This may be prolonged in patients with hepatic impairment (average 343 minutes) or congestive heart failure (average 136 minutes) [7].

5. PHARMACODYNAMICS

Lidocaine alters signal conduction in neurons by blocking the fast voltage gated sodium (Na^+) channels in the neuronal cell membrane that are responsible for signal propagation. With sufficient blockage the membrane of the postsynaptic neuron will not depolarize and will thus fail to transmit an action potential. This creates the anaesthetic effect by not merely preventing pain signals from propagating to the brain but by stopping them before it begins[8].

6. MECHANISM OF ACTION

They are membrane stabilizing drugs and they reversibly decrease the rate of depolarization and repolarization of excitable membranes. Anesthetic drugs act mainly by inhibiting sodium influx through sodium-specific ion channels in the neuronal cell membrane. When the influx of sodium is interrupted, an action potential cannot arise and signal

conduction is inhibited. The receptor site is thought to be located at the cytoplasmic (inner) portion of the sodium channel. Local anesthetic drugs bind more readily to sodium channels in activated state, thus onset of neuronal blockade is faster in neurons that are rapidly firing. This is referred to as state dependent blockade[9].

They are weak bases and are formulated as the hydrochloride salt to render them water-soluble. At the chemical's pKa the protonated (ionized) and unprotonated (unionized) forms of the molecule exist in equilibrium but only the unprotonated molecule diffuses readily across cell membranes. Once inside the cell the local anesthetic will be in equilibrium, with the formation of the protonated (ionized form), which does not readily pass back out of the cell. This is referred to as "ion-trapping". In the protonated form, the molecule binds to the local anesthetic binding site on the inside of the ion channel near the cytoplasmic end[10].

Acidosis caused by inflammation at a wound partly reduces the action of local anesthetics. This is partly because most of the anesthetic is ionized and therefore unable to cross the cell membrane to reach its cytoplasmic-facing site of action on the sodium channel[11].

7. TECHNIQUES OF DENTAL LOCAL ANESTHESIA[11, 12, 16, 14]

Regional dental anesthesia can be divided into component parts, depending on the technique employed. There are three different techniques used in dental anesthesia: local infiltration technique, nerve block and periodontal ligament injection. In local infiltration technique, small nerve endings in the area of the dental treatment are flooded with local anesthetic solution, preventing them from becoming stimulated and creating an impulse. Local infiltration technique is commonly used in anesthesia of the maxillary teeth and the mandibular incisors. In nerve block anesthesia (conduction anesthesia), the local anesthetic solution is deposed within close proximity to a main nerve trunk, and thus preventing afferent impulses from traveling centrally beyond that point. Nerve block is used in anesthesia of the inferior mandibular nerve, the lingual nerve, the buccal nerve, the greater palatine nerve and the nasopalatine nerve. Nerve block technique is required for anesthesia of mandibular molars and premolars because anesthetic solution is not able to penetrate the compact vestibular bone. Thus, local infiltration technique does not provide a successful anesthesia.

Disadvantage of nerve block technique is an increased risk of traumatisation of the nerve trunk and an accidental intravascular injection of the local anesthetic solution. In periodontal ligament (PDL) technique (intraligamentary injection), the local anesthetic solution is injected into the desmodontal space. The PDL technique is useful for anesthesia of mandibular molars as an alternative to the nerve block technique. The injection is painless and the anesthetic effect is limited to the pulp and desmodontal nerve of the tooth anesthetized. Duration of anesthesia is in the range of 15 to 20 minutes, which allows most routine dental treatment. The PDL injection is useful for extremely anxious patients and children, who do not tolerate conventional technique. The dose of anesthetic solution, which is required for complete anesthesia, is lower than in infiltration technique. For PDL technique, a high concentration of the local anesthetic is required due to the limited

volume, which can be injected into the narrow desmodontal space.

8. INDICATIONS

Lidocaine is suitable for infiltration, block and surface anesthesia. Topical lidocaine is used to relieve post herpetic neuralgia. Lidocaine as an antiarrhythmic drug is used intravenously for the treatment of ventricular arrhythmias and in refractory cases of status epilepticus. Inhaled lidocaine can also be used as a cough suppressor acting peripherally below the larynx. Lidocaine is effective in treating jellyfish stings by both numbing the affected area and preventing further nematocyst discharge[15, 16].

9. CONTRAINDICATIONS[17, 18, 19, 20]

- Heart block of second or third degree.
- Severe sinoatrial block (without pacemaker)
- Serious adverse drug reaction to lidocaine or amide local anaesthetics.
- Concurrent treatment with quinidine, flecainide, disopyramide, procainamide (Class I antiarrhythmic agents).
- Prior use of Amiodarone hydrochloride.
- Hypotension not due to Arrhythmia
- Bradycardia.
- Accelerated idioventricular rhythm.
- Pacemaker.

10. ADVERSE EFFECTS

Adverse drug reactions are not generally seen when lidocaine is used as a local anesthetic. Most reaction occurs due to systemic exposure or pharmacological effects of anesthesia, but allergic reactions only rarely occur. Systemic exposure to excessive quantities of lidocaine mainly result in CNS effects which occur at lower blood plasma concentrations and additional cardiovascular effects present at higher concentrations, though cardiovascular collapse may also occur with low concentrations. CNS effects may include CNS excitation (nervousness, tingling around the mouth, tinnitus, tremor, dizziness, blurred vision, seizures) followed by depression, and with increasingly heavier exposure: drowsiness, loss of consciousness and respiratory depression). Cardiovascular effects include hypotension, bradycardia, arrhythmias, and/or cardiac arrest some of which may be due to hypoxemia secondary to respiratory depression. Common adverse reaction includes headache, dizziness, drowsiness, confusion, visual disturbances, tinnitus, tremor, and/or paraesthesia. Infrequent reactions associated with the use of lidocaine include hypotension, bradycardia, arrhythmias, cardiac arrest, muscle twitching, seizures, coma, and/or respiratory depression[21, 22, 23, 24].

11. OVER DOSAGE

Over dosage with lidocaine can occur due to of excessive use via topical or parenteral routes. Lidocaine over dose may be seen if accidental oral ingestion of topical preparations by children, accidental intravenous injection or prolonged use of subcutaneous infiltration anesthesia during cosmetic surgical procedures occurs. These occurrences may lead to severe toxicity or death in both children and adults. Treatment with intravenous lipid emulsions can be done to reverse the effects of local anaesthetic toxicity[25, 26].

12. INSENSITIVITY TO LIDOCAINE

Lidocaine relative insensitivity is genetic and also in people who have attention deficit hyperactivity disorder. In dental anesthesia, a relative insensitivity to lidocaine can occur for anatomical reasons due to unexpected positions of nerves. Some people with Ehlers-Danlos syndrome are insensitive to lidocaine[27, 28].

13. ADULTERANT IN COCAINE

Lidocaine as a diluent is generally added to cocaine. Cocaine numbs the gums when applied, and since lidocaine causes stronger numbness, users get the impression of high-quality cocaine when in actuality; the user is receiving a diluted product[29, 30].

14. SOME PATENTS ON GENERAL ANAESTHESIA

14.1 Airway anaesthesia

The present invention provides an improved delivery of anesthetic to an airway. A method in accordance with the invention provides good release of a suitable anaesthetic agent in an aerosolized form [31].

14.2 Device for controlled anaesthesia, analgesia and /or sedation

A device for inducing anaesthesia, analgesia and/or sedation is described which comprises of a container holding an inert gas-containing liquid preparation, allowing for the controlled administration of the preparation to a patient [32].

14.3 Method of inducing local anesthesia using micro droplets of a general anesthetic

Local anesthesia is induced using micro droplets of a general anesthetic in liquid form. As an example, micro droplets of the general anesthetic methoxyfluorane coated by a unimolecular layer of dimysistoyl phosphatidylcholine are prepared by sonication. The micro droplets are so prepared and were found to remain stable in nature [33]

14.4 Controlled drug releasing preparations

A drug delivery preparation with controlled release time and rate, comprising a therapeutic agent being encapsulated in or coated by a solvent membrane, as well as a process for the manufacture thereof, are disclosed [34].

15. CONCLUSION

Lidocaine is a local anesthetic and antiarrhythmic drug and is used for infiltration, block and surface anesthesia. It is widely used in dentistry prior to tooth extraction to anaesthetize the area. Lidocaine can also be used as Topical anesthesia, Infiltration, Plexus block, Epidural block and Spinal anesthesia. Hope this review will be helpful in providing some useful information related to lidocaine to dental students.

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