Pharmacology of Local Anesthesia

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Local anesthetic cartridge contains the following ingredients

1) Local anesthetic agent
2) Vasoconstrictor
3) Preservative for the vasoconstrictor (Reducing agent)
4) Ringers solution
5) Distilled water
6) General preservative

1-Local anesthetic agents

- Local anesthetics are drugs which upon topical application or local injection cause a reversible loss of sensory perception, especially of pain in a restricted area of the body, it provides pain control during dental therapy.
- These drugs are listed by their percentage (%) concentration. The number of mg of an agent contained in the cartridge can be calculated by multiplying the percentage (%) concentration by the number of ml in the cartridge. Thus, a cartridge containing 2ml of 2% local anesthetic solution contains 40 mg of the local anesthetic agent (2% mean that for each ml there is 20 mg, if the cartilage contains 2 ml then 20x2=40 mg of the local anesthetic agent in a single cartilage).

Classification of local anesthetics

- **1 - on the basis of occurrence in nature**

I. Natural (e.g. cocaine)

II. Synthetic (e.g. lignocaine)

- **2- on the basis of duration of action**

I. Short-acting (e.g. articaine, lidocaine)

II. Long-acting (e.g. bupivacaine)

- **3- on the basis of chemical structure**

I. Ester (e.g. Procaine, Cocaine, Benzocaine)

II. Amide (e.g. Lidocaine, Prilocaine, Articaine)

Metabolism

A-Ester local anesthetics

1) Ester local anesthetics are hydrolyzed in the plasma by the enzyme pseudocholinesterase.
2) Peoples having an atypical form of pseudocholinesterase get inability to hydrolyze ester local anesthetics, thus prolongation of higher blood levels of the local anesthetic and an increased potential for toxicity.

B - Amide local anesthetics

1) The metabolism of the amide type is more complex and somewhat slower than that of the ester type, it appears that breakdown does not occur in the bloodstream and that hydrolysis takes place mainly in the presence of catalysts in the liver, the product is then excreted in the urine.
2) **Excretion:** The kidney is the primary organ for both the local anesthetics and its metabolites. A percentage of a given dose of the local anesthetic drug will be excreted unchanged in the urine and this varies according to the drug

Lignocaine (Lidocaine, Xylocaine)

Lignocaine: is the most commonly used local anesthetic agent in dentistry, it is stable as it can be stored for a long time at room temperature, it is compatible with all types of vasoconstrictors.

- ✓Classification: Amide.
- ✓Metabolism: in the liver.
- ✓Excretion: Via the kidneys.
- ✓Vasodilating Properties: Considerably less than those of procaine; however, greater than those of mepivacaine.
- ✓The onset of Action: Rapid (3 to 5 minutes).
- ✓Effective Dental Concentration: 2%.
- ✓Anesthetic Half-Life: (90 minutes).
- ✓Topical Anesthetic Action: (with a concentration of 5% or 10%).
- ✓Availability in dentistry: dental cartridge of 2% lidocaine with or without epinephrine.

Maximum Recommended Dose

- The maximum recommended dose of lidocaine with epinephrine (1:100.000) is 7 mg/kg. While 4.5 mg/kg is the maximum dose of lidocaine without epinephrine. In all the cases not to exceed an absolute maximum dose of 500mg.
- Allergy to amide local anesthetics is extremely rare; although possible, this is a major clinical advantage of lidocaine and all amides over ester-type local anesthetics.

2-Vasoconstrictor

- **Vasoconstrictors** are drugs that constrict blood vessels thereby control tissue perfusion. They are added to the local anesthetic solutions to oppose the vasodilatation actions of the local anesthetic agent.
- After injection of the local anesthetic, blood vessels dilate in the area, resulting in an increased blood flow to the site. This increase in perfusion leads to the following reactions:

1) Increased rate of absorption of the local anesthetic into the cardiovascular system, which in turn removes it from the injection site.
2) Increased plasma level of the local anesthetic, with an increased risk of local anesthetic toxicity.
3) Decreased duration of action and decreased depth of anesthesia because it diffuses away from the injection site more rapidly.
4) Increased bleeding at the site of injection due to increased perfusion.

The advantages of additions of vasoconstrictors to the local anesthetic solution are:

- 1. Vasoconstrictors decrease blood flow (perfusion) to the site of the injection. The absorption rate of the local anesthetics into the cardiovascular system is reduced, resulting in lower anesthetic plasma levels.
- **2.** Decrease the risk of systemic toxicity (lower the local anesthetic plasma levels).
- **3.** Increase the duration of action of local anesthetics (higher volumes of the local anesthetic agent remain in and around the nerve for longer periods).
- **4.** Decrease bleeding at the site of injection, especially useful when increase bleeding is anticipated (e.g. during a surgical procedure).

Types of the vasoconstrictors

- **A - Epinephrine (adrenaline)**
- Epinephrine remains the most effective and the most commonly used vasoconstrictor in medicine and dentistry.
- **Sources:** secreted primarily by the adrenal medulla. It is available as synthetic and obtained also from the adrenal medulla of animals.
- **Mode of action:** acts directly on both alpha and beta-adrenergic receptors.

Systemic action

- **Cardiovascular system**
- It causes increased systolic and diastolic blood pressure, increased heart rate, increased cardiac output and it causes increased myocardial oxygen consumption:
- **Respiratory system**
- Adrenaline is a potent dilator of the smooth muscle of the bronchiole, so it is the drug of choice for management of acute asthma.
- **Central nervous system**
- In the usual therapeutic dosage, adrenaline is not a potent CNS stimulant, CNS stimulation occurs when an excessive dosage is given.

- **Availability in dentistry**
- Adrenaline is the most potent and widely used vasoconstrictor in dentistry. It is available in 1:50000, 1: 80000, 1:100000, 1:200000 dilution.
- **Maximum dosage:**
- This drug is potent and can produce undesirable results if used in large volumes or if inadvertently injected intravascularly. So, these drugs should be used with consideration to their benefits and risks. The maximum doses are as follows:
- **A -** For normal healthy adult patient the maximum recommended dose **of a 1:100000 dilution (10 cartridges)**
- **B-** For patient with clinically significant cardiovascular disease the max dose is of a 1: 100 000 dilution (2 cartridges)

- **B. - Felýpressin**
- **Source:** it is a synthetic analog of the anti-diuretic hormone (vasopressin).
- **Mode of action:** it acts as a direct stimulant of vascular smooth muscle.
- **Systemic action**:
- **Heart:** no direct effect.
- **Blood vessel:** in high doses induces vasoconstriction.
- **CNS:** no effect.
- **Uterus:** it has oxytocic action (promotes rapid labor) so it is contraindicated in pregnant patients.

3. Preservative for the vasoconstrictor (Reducing agent)

- Vasoconstrictors in local anesthetic solution are unstable and maybe oxidize especially on prolonged exposure to sunlight and this will lead to brown discoloration of the solution. To overcome this problem a small quantity of antioxidant as sodium bisulfite is added to the cartridges. This substance reacts with Oxygen before oxygen can destroy the vasoconstrictor so it protects their stability.
- **Preservative"**
- These are added to increase the shelf life and include:
- **1.** Methylparaben which is bacteriostatic and fungistatic agent
- **2.** Thymol which is antiseptic, fungistatic

4. Ringers solution

- The anesthetic agent and the additives are dissolved in modified ringer solution. It is added to the content of the cartridge to make the solution isotonic with the tissue of the body. This isotonic vehicle minimizes the discomfort during injection of local anesthesia.

5-Distilled water

- It is used as diluents to provide the volume of solution in the dental cartridge.

Thank you