

A

Seminar report

On

Iontophoresis

Submitted in partial fulfillment of the requirement for the award of degree
Of Electronics

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Preface

I have made this report file on the topic **Iontophoresis**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude towho assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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What is iontophoresis?

Iontophoresis is a non-invasive method to deliver medication through the skin to a specific area using a continuous direct current. Anti-inflammatory and anesthetic medications (dexamethasone and lidocaine) are the most common medications delivered using iontophoresis in physical therapy¹.

Iontophoresis requires two electrodes, one positively and one negatively charged. Placement of the electrodes is dependent on the polarity of the medication being delivered. For example, dexamethasone has a negative polarity. Therefore, the electrode containing dexamethasone will be placed over the affected body part and attached to the negative charge in the electrical circuit. The negative current repels the negative dexamethasone ions, driving them through the patient's skin.^{2,3} Conversely, lidocaine has a positive polarity so the electrode would be attached to the positive charge in the electrical circuit.

Iontophoresis or ion transfer is introduction of substances into the body for therapeutic purposes using a direct current. Each substance is separated into its ionic components by the action of the current and deposited subcutaneously according to the imposed polarity on the electrode. Therapeutic results depend on the ion introduced, the pathology present and the desired effects.

Physics:

The current required for iontophoresis is continuous direct galvanic current, which can be obtained from standard low-voltage generators. The treatment is not the current itself, but rather the ions introduced through that current. The completely non-invasive concept of iontophoresis became very

attractive to physical therapists because of the minimal ionic concentrations required for effective administration.

Formula for iontophoresis:

The basic formula for using iontophoresis is:

$$I \times T \times ECE = \text{grams of substance introduced,}$$

Where:

I : (Intensity) measured in amperes.

T : (Time) measured in hours.

ECE : (Electro-Chemical Equivalent) represents standardized figures for ionic transfer with known currents and time factors.

As the determination of the ECE for many complex substances is very difficult, fewer milligrams of these complex substances will penetrate the skin.

Principles of Ion transfer:

* Ionic polarity:

The basis of successful ion transfer lies in physics principle “like poles repel and unlike poles attract”. So, the ions are repelled into the skin by an identical charge on the electrode surface placed over it. Sub-dermally, the ions introduced re-combine with the existing ions floating in the blood stream, forming the necessary new compounds for therapeutic interactions.

* Low-level amplitude:

Most researches have indicated that low-level amplitude is more effective than high-level intensities, as higher intensities adversely affect ionic penetration. It should be put into consideration that a few ions, ready to combine, may be better than a sum of ions, repelling each other because of their similar charges. The physics involved with ion transfer necessitates low intensity (less than 5 ma) and low percentage or ion sources (1 to 5%).

Electrode size:

It was found that the negative electrode (cathode) is more irritating than the positive one (anode), due to the formed sodium hydroxide under its position. So, the negative electrode should be made larger than the positive electrode (usually twice), even if the negative electrode is the active one. According to the laws of physics, electrons flow from negative to positive, regardless of electrode size. So, enlarging the negative electrode size lowers the current density on the negative pad, leading to reduction of irritation.

Physiological changes:

1. Ion penetration: Actually, penetration does not exceed 1 mm, with subsequent deeper absorption through the capillary circulation. The bulk of deposited ions is found at the site of the active electrode, where they are stored as either soluble or insoluble compound, to be depleted by the sweep of circulating blood.
2. Acid / alkaline reactions: As the anode (+) produces an acid reaction (a weak HCL acid), it is considered sclerotic, which tends to harden tissues, serving as an analgesic agent due to local release of oxygen. On the other hand, as the cathode (-) produces an alkaline reaction (a strong sodium hydroxide), it is then considered sclerolytic, which is a softening agent due to the hydrogen release, serving in the management of scars and burns.
3. Hyperemia: Both the positive and negative electrodes produce hyperemia and heat due to the resulting vasodilatation. The cathodal hyperemia is generally more pronounced and takes more time to disappear than that of the anode. Generally, hyperemia under both electrodes lasts within one hour, causing no more discomfort to the patient.
4. Dissociation: Under normal circumstances, ionizable substances dissociate in solution releasing ions, which with the passage of direct current into the solution migrate toward the other pole. This is the concept of ion transfer. Due to the variability in resistance of various tissues to current flow, electrode placement becomes of an utmost importance.

Complications:

- Chemical burns:

They are generally due to excessive formation of the strong sodium hydroxide at the cathode. Immediately after treatment, the skin becomes pinkish, to be grayish and oozing wound few hours later. As these burns take a long time to heal, they are best treated with antibiotics and sterile dressings. Conversely, burns under the anode are rare, causing a hardened red area similar to a scab. The line of treatment is similar to that caused by the cathode.

- Heat burns:

Such a type of burns occurs due to excessive heat buildup in areas with high resistance, found mainly around the freckles and other sclerotic zones. Most of these burns occurs when the electrodes are not moist enough, when they are not fitting well or not in good contact with the skin. Similar treatment is recommended.

- Sensitivities and allergic reactions to ions:

Although they are rare, they cause systemic effects in contrast to chemical and heat burns, which cause local effects. Some instructions have to be followed in such cases:

- If the patient is allergic to seafood, “iodine” should not be used.
- Patients with an active peptic ulcer or gastritis, react poorly to “hydrocortisone”.
- Patients, who have problems with aspirin, react poorly to “salicylates”.
- Patients sensitive to metals may react to “copper, zinc or magnesium”.

Advantages:

Safer than the needle as there will be **no**:

- Pain or needle phobia.
- Joint capsular erosion from repeated injection.
- Bleeding.
- Risk of contamination.
- Side effects of medication.
- Problem of local application for small areas.

Disadvantages:

- Skin burns.
- Limited penetration.
- Long time for application.

Indications:

- Local anesthesia.
- Inflammatory conditions.
- Relief of pain.
- Skin conditions.
- Tension headache.
- Inhibition of spasticity.

Contraindications and precautions:

- Open wounds or burns.
- Patients with cardiac pacemakers.
- Allergy to medication.
- Loss of sensation.
- Greasy or dirty skin.
- Sole of foot (hard for the ions to pass inside).
- Don't use two chemicals under the same electrode, even if they are of the same polarity.
- Don't administer ions with opposite polarities during the same treatment session.

Treatment procedures:

1. Pathology and ion selection:

Pathology	Ion selection
Pain	Lidocaine , hydrocortisone
Inflammation	Hydrocortisone , salicylates
Spasm	Magnesium , calcium
Ischemia	Magnesium , iodine
Edema	Magnesium, salicylates
Calcific deposits	Acetic acid
Fungi	Copper
Open lesion	Zinc
Allergic conditions	Copper
Scars or adhesions	Chlorine , iodine , salicylates
Hypo/hyper-irritability	Calcium

2. Preparation of the electrodes:

- The electrodes should be fabricated from absorbent material, covered with aluminum foil.
- The aluminum foil should be folded to size and rolled flat, to be smaller than the towel.
- The towels should be folded and soaked in warm water; and the metal / skin contact should be avoided.
- Electrode units should be secured in position on the patient using securing devices.

3. Preparation of the patient:

- Patients should never lie with their full body weight on an electrode.
- Patients must be in the “sitting position” when treating: shoulder, elbow, hand, brachial regions, face and neck.
- Patients are better in “prone, supine or side-lying positions” when treating trunk, lower back, chest, abdomen and thigh.
- Patients should be “seated on a plinth” while treating: leg, knee ankle and foot.

4. Application of iontophoresis:

- The target area should be thoroughly cleaned by alcohol.
- The medication is then injected in the active electrode by plastic syringes.
- Adjust the dose of medication according to the size of the area of pathology.
- The wires should be attached to the electrodes.
- Time and intensity should be adjusted.
- The skin and patient’s feelings have to be checked regularly.
- The current should be turned down slowly at the end of treatment.
- Special care should be directed to the area of skin under the electrodes, especially the negative one.

Conclusion

- Iontophoresis is suitable for applications such as acetic acid (calcific tendinitis and myositis ossificans), calcium chloride and magnesium sulfate (control of musculoskeletal spasms), dexamethasone (inflammation), lidocaine (inflammation of soft tissues), zinc oxide (rheumatoid arthritis).
- It is also used in cosmetic applications with devices attached to the skin and for eye treatment aimed at specific tissues of the eye, providing a treatment option for various eye diseases, reducing the complications secondary to traditional methods of treatment. The advantages are the significant increase in the release and control of therapeutic agents, including drugs with high molecular weight. The disadvantages of iontophoresis are the complexity of the drug release system and prolonged exposure of the skin to an electrical current.

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