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Review Article

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INNOVATIVE TECHNIQUES OF TRANSDERMAL DRUG DELIVERY SYSTEM.

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ABSTRACT

Iontophoresis is the introduction of ions into the body by using direct electrical current. It is a non-invasive process that uses locally applied continuous direct current to passively diffused ionized medication into the skin. The term Iontophoresis is simply defined as transmission of ions. Iontophoresis may be used for local anesthetic action, antibacterial, anti-inflammatory action and relief from neurogenic pain. This review provides a brief overview of the benefits and drawbacks of Iontophoretic drug delivery systems, as well as an overview of the experimental design and electrodes used in these systems.

KEYWORDS: Iontophoresis, electrical current, non-invasive, electrodes, neurogenic pain.

INTRODUCTION

Currently, the most common way of administering drugs is orally. Although this method is easy to use, it has significant drawbacks such as low bioavailability due to hepatic metabolism and the tendency to produce rapid spikes in blood levels, which can lead to frequent and high dosing. To overcome these issues, there is a need for the development of new drug delivery systems that can improve the therapeutic efficacy and safety of drugs by delivering them to specific sites in the body. New drug delivery systems are also important for delivering genetically engineered pharmaceuticals without causing immunogenicity or biological inactivation.

One method that has been used for drug delivery is transdermal delivery, which involves the transport of therapeutic substances through the skin for systemic effects. The skin has two important layers - the dermis and the epidermis. The stratum corneum, a layer within the epidermis, is important for transdermal delivery as it prevents foreign substances from entering the body. The only way to transfer normal drugs across this layer is through passive diffusion, which is too slow for practical use.

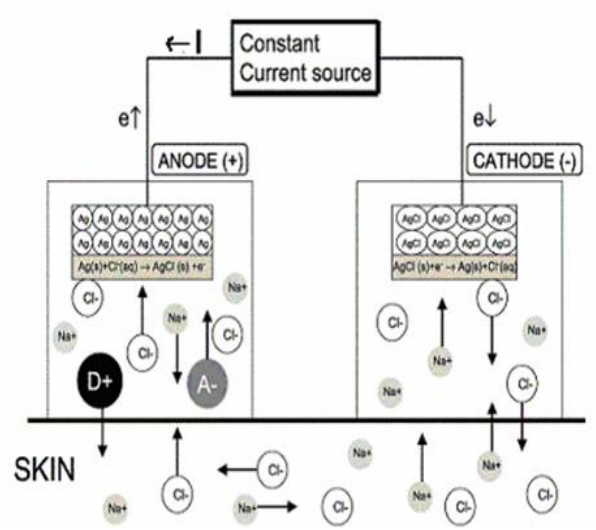
However, drugs can be engineered to be both water-soluble and lipid-soluble to allow for more efficient drug delivery. The current interest in iontophoresis can be attributed to the success of producing protein and peptide drugs using recombinant DNA technology. These drugs have a charged nature and a relatively large molecular size, making iontophoresis a promising method for their delivery.[1]

Transdermal drug delivery

The aim of transdermal therapeutic systems is to deliver drugs to the systemic circulation in a controlled and continuous manner through the skin. It is a type of medication that is applied topically through a patch, delivering drugs for systemic effects in a controlled and predetermined manner. These patches can either be active or passive, providing an alternative route for medication administration by allowing drugs to pass through the skin barrier. The process of transdermal drug delivery is relatively straightforward, with the drug being applied to the patch on the skin for an extended period of time. As a substitute for the oral route this method of drug delivery provides numerous benefits compared to traditional methods.[2]

Iontophoresis

Iontophoresis is a technique that involves the introduction of ionic medicinal compounds into the body by applying a local electric current through the skin, that utilizes an electric current to facilitate the transdermal administration of medication. Iontophoresis involves the use of an electric current to increase the penetration of drugs into surface tissues. It also involves the use of a voltage gradient applied to the skin for the delivery of drugs. This phenomenon refers to the transportation of matter that occurs as a result of an applied electric current.[9]



The device of Iontophoresis consists of two electrode compartments and a power source. The electrode compartment with the same charge is filled with the medication formulation containing the ionised molecule. At a distant location on the skin, the indifferent electrode compartment is positioned.[3]

Working / Principle

Iontophoresis works on the principle of Ionic Polarity in which the opposite charges attract each other and like charges repel each other. The electrodes are applied to skin with solution, where in day to day life the anode is denoted with red colour which has positive electrode and cathode is denoted by black colour which has negative electrode, in which the positively charged are the cation and negatively charged are anion. When the potential difference is applied across the two electrodes, once the anode is positive the anions get attracted towards the anode and the cations get attracted towards the cathode. The current applied in treatment usually should be 5mA upto 5% of low ionic concentration for average duration of 10-20 min. The preferred ions should be placed under the same polarity so it gets repelled into the skin. The preservatives and PH of the drug is essential for iontophoretic delivery of drugs and patient comfort. Iontophoresis uses direct current for penetration of Ions into the skin. Due to this non-invasive treatment of Iontophoresis the risk of infection is also reduced.[7]

Measures for Iontophoresis

There are some important rules that have to be followed during Iontophoresis that are as follows.

1) The selected molecule must be ionized.
2) The ion must be water-soluble because electricity is only transmitted through aqueous solutions and not lipids.
3) The appropriate electrical current must be used.
4) The current should balance between effectiveness and safety, as higher currents promote faster movement of ions.
5) Intermittent current is more effective than continuous current.
6) The treatment duration should be typically between 10 and 30 minutes.

Advantages[4]

1) It is simple, versatile, effective and reliable.
2) Onset and offset times are faster.
3) Improved effectiveness
4) Reduction in adverse effect
5) It is Non-invasive process.
6) Self-medication is possible

Limitation

1) Itching, erythema and general irritation.
2) Iontophoresis may be contraindicated in patients who have a broken or damaged skin surface.
3) Excessive current through the heart during iontophoresis may potentially lead to cardiac arrest.
4) It is important to use iontophoresis under the supervision of a qualified healthcare professional to minimize the risk of such complications.

Iontophoresis Devices

The primary manufacturing considerations for any or/and Iontophoresis devices should prioritize safety, convenience, reliability, and reproducibility. The device mainly consists of two components that are as follows[5]

a) Electrical Circuit
b) Electrodes
1) DC Power supply
2) Rheostat
3) Timer
4) Milliammeter
5) +ve and –ve electrodes.

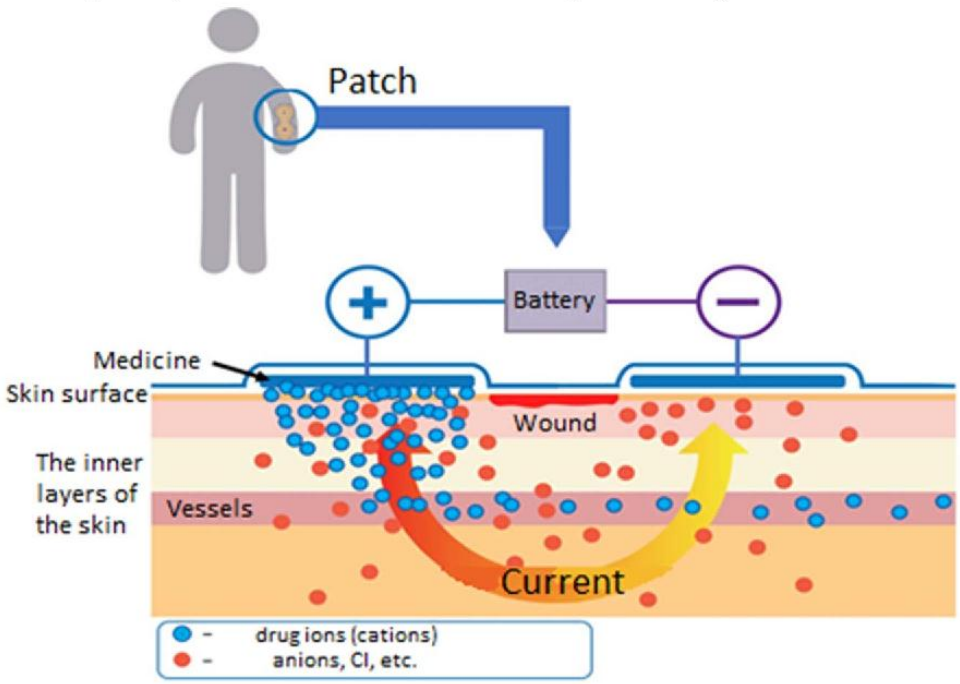


Fig. 1. The principle of operation of the patch for iontophoresis.

Application

It has wide application in Dermatology and in allergic conditions. Iontophoresis has also found its applications in cosmetic procedures where devices are affixed to the skin and in the treatment of eye-related conditions. It is useful technique for the transdermal delivery of protein or peptide drugs that are otherwise difficult to transport due to their hydrophilicity and large molecular size.[6,8]

CONCLUSION

Iontophoresis is the technique of promoting ion migration across a membrane under the impact of an externally supplied electrical potential voltage. Iontophoresis allows for planned medication administration and promotes the penetration of charged substances. Iontophoresis can potentially improve skin permeability when an electric current passes across it. In physical therapy, iontophoresis has been used to transdermally give ionic medicines, mostly for localised effects. Iontophoresis has recently attracted more attention as a method of transdermal drug delivery for both ionic and nonionic medicines and treatments. Iontophoresis allows for planned medication administration and promotes the penetration of charged substances.

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