NFIT (Needle Free Injection Technology)

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Abstract

NFIT includes novice technology which enables the drugs to transfer directly through the skin, hardly causing breakage in the skin integrity. NFIT is a highly elaborated and sophisticated concept of drug delivery system which follows advanced method in which the drug will be delivered through the skin with the help of forces like shock waves, electrophoresis, Lorentz or pressure by gas which can deliver the drug through skin by not using hypodermic needles. NFIT employs stronger energy which is sufficient to impel a particular drug formulation with a dose which is already premeasured, laden in distinct unique "cassettes" which can be equipped with the system. The NFIT devices can be categorized based on their mechanism of drug delivery, mode of work, type of load and site of delivery. Elimination of broken needles, consistent vaccine delivery, less pain and stress are some advantages where as Higher start-up costs, higher requirements for training and maintenance and worker confidence in NFIT are some disadvantages.

Keywords: Electrophoresis, hypodermic needle, cassettes,
DOI Number: 10.48047/NQ.2022.20.13.NQ88525 **Neuroquantology 2022; 20(13):4314-4318**

INTRODUCTION

It has been more than 150 years that the hypodermic needles and syringes were used to deliver the medicines to the body. Hollow needles were fabricated in 1844 and the first injection had delivered soon. Advancement in the modern day syringe system evolved with hypodermic needles which is a medical grade stainless steel attached with plastic body ,which develops syringe as a disposable system with two part .Advancement in the medical technology and innovative bioengineering capabilities have led to the spring up of several accomplishments .NFIT includes novice technology which enables the drugs to transfer directly through the skin, hardly causing breakage in the skin integrity .It is also useful in the drug administration to the muscles either. Mass immunization and vaccination programs has attained promising mileage due to NIFT as these system are virtually painless due to the avoidance of conventional needles.[1,2,3]

DEFINITION

NFIT is a highly elaborated and sophisticated concept of drug delivery system which follows advanced method in which the drug will be delivered through the skin with the help of forces like shock waves,electrophoresis,Lorentz or pressure by gas which can deliver the drug through skin by not using hypodermic needles.[4]

PRINCIPLE

NFIT employs stronger energy which is sufficient to impel a particular drug formulation with a dose which is already premeasured, laden in distinct unique "cassettes" which can be equipped with the system. These forces may be begat from many ways which ranges from high-pressure fluids including electro-magnetic forces, gases, shock waves or any other form of

energy which has enough competency to generate motion to the medication.[5,6]

TYPES OF NFIT

I .*On the basis of mode of working*

1. Spring system-springs have been used to produce energy which is highly effective in powering NFIT devices. It is one of the simplest and most easiest system. However strict standard protocols should be followed in designing spring system. But the basic problem in relation to spring system is its gradual decrease in pressure throughout the injection process.

2.Laser powered-Prof.jackYoh and his team(Department of Mechanical and Aerospace Engineering, Seol National University, South Korea) has developed this system in which they used laser based system that blasts microscopic jets of drugs in to the skin. The laser pulse with the wavelength of about 2940nm and life span of about 250 millionth of second is embodied with an adapter that contains the medication which has to be administered. It also consists a water chamber which helps to push the drug.This fluid chamber is separated from the drug by a memebrane. The emitted laser generates vapours in the driving fluid which apply pressure on the membrane that leads the drug to be ejected forcefully from a minute nozzle of about 150 millionth of a meter of diameter with a great impinge on the skin.The drug pierce smoothly in to the skin with causing little tissue damage or drug splash back.[7]

3.Energy propelled system a.Lorentz force-This device is engineered by the researchers of MIT in which the entire process is facilitated by the Lorentz force actuator.It consist of a piston inside a drug ampule which is attached to a powerful and small magnet surrounded by a wire coil.Once the current is functional ,there is an interaction between applied current and magnetic field produces force which is capable to push the piston forward results in forcing out the flow of drug formulation as thin as mosquito's proboscis. Governing the amount of current which in turn control the speed of coil. It is a versatile NFIT system which is fit for pediatric usage and drug application in cornea.

b.Gas propelled/airforced-Gas powered NFIT offer higher energy density than a metal spring which extended its scope. These devices available as single or sometimes need to replace gas cartridge periodically. Here,the stored gas taken the role of spring which accelerates the piston to administer medication.[8]

c.Shock waves-The functionality of this system is based on the production of Shock waves due to sudden release of energy. These generated energy disturbances can be spread through a medium. A needless non invasive drug delivery system which operates energy at supersonic level has been developed by researchers at Indian Institute of Science,Bangalore. This technology includes a microblast which provoked through a controlled explosion causing waves propogated at supersonic speed produce high pressure and temperature. The drug filled in a miniature model device will be ejected out due to the strong and potent pressure generated by the explosion technique.[9]

II.On the basis of type of load

1.Liquid-It based on the application of fluid mechanics;

- Registration-It is keeping the device in such a manner that its orifice should be place exactly over the skin pores.
- Exact pressure-The pressure applying on the fluid should be optimium and strong enough to open the skin holes and to be consistent which avoids resealing of skin holes.
- Channel drilling-A channel is drifted by the initial fluid pulse in to the fat layer which is deep enough that facilitates the dose to be shifted from the hole to skin
- Quicker pressure fall:This will be attained by the quick and sufficient drop in pressure which prevents the

fluid from penetrating the muscles under the skin.[10]

2. Powder-These technology depends upon the ability on the formulation of particles with sufficient density and acceleration with adequate velocity which have enough strength for skin penetration and enough quantity to reach therapeutic level. The drug stored in the 'cassette' which is capped with polymeric lid is designed so as to keep the drug in the centre. The drug forward by the specially designed convergent-divergent type nozzles due to force produced from the rupture of lid by the gust of helium gas upon activation. The drug penetrates the skin by attaining the speed of near about that of sound. It is very effective to the candidates who needs about 1mg maximum dose. This system is so fit for DNA vaccines and the administration of local skin and ora-mucosal anesthesia.[11,12]

3.Projectile/depot-It is in cylindrical form measuring about 1mm in diameter and few millimeter in length. The pay load quantity is appropriate enough for many new therapeutic proteins, antibodies and other small molecules. The device would facilitate the transfer of energy from a suitable spring upon the depot.

III. On the basis of mechanism of drug delivery

1.Nanopatches-Nanopatches projections are invisible to the naked eye and doesn't inflict fear in to the people.These have shown a great effectiveness in the administration of vaccines where it reaches the key immune cell without causing pain.

a.Sand paper assisted delivery-Microdermic abarasion caused by the rubbing of Sand paper like agent results in removal of superficial skin layer which eases the entire drug delivery process.This method has been successful for several vaccines and drugs like 5-flurouracil and lidocane .Eventhough the clinical trial is still proceeding,this technique also used in the development of traveller's diarrhea and influenza vaccinations.[13,14,15]

b.Iontophoresis enabled-This technique utilizes a small electric current of about 0.5mA/cm^2 which pushes a few molecules of drug across the skin.It operates with the help of two patches of electrodes in which one act as drug reservoir with positive or negative charge depends on drug's nature.To complete the circuit another patch is located any other part of the body .These system have shown excellent results in the drug delivery system of peptides,therapeutic proteins ,vaccines and oligonucleotides.[16,17]

c.Microneedle-This method make use of thousands of tiny spikes of about 750 micron long.The patches contain spikes which intrude the skin outermost layer and administer the drug.Its painless as the spikes in the patches will not pierce the blood vessels and receptors of pain.Various types of microneedles have developed in which some are just coated with drugs where as others are hollow having the formulation filled inside or a liquid vaccine.

IV.On the basis of site of delivery

1. Intradermal injector-It facilitates the administration of comparatively newer, DNA-based vaccines at a very shallow depth that is between the skin layers.[18]

2. Intramuscular injector-These have shown great success in case of vaccinations and it is the deepest drug delivery system among all.[19]

3. Subcutaneous injector-Human growth hormone which is a therapeutic protein is being delivered by this system. In this the drug is administered to the adipose layer just below the skin layer [19]

ADVANTAGES

- Broken needles can be eliminated
- Consistency in the delivery of vaccine
- Lower volume of vaccine
- Higher dispersion of antigen
- Worker needle sticks can be eliminated
- Needle disposal can be eliminated
- Painless which in turn less stress

DISADVANTAGES

- Start-up cost is high
- Need of infrastructure of exhaustible gas systems

- Training and maintenance need higher requirements
- No one-size-fits-all NFID
- Confidence of worker in NFIT is really matters if he is not trained well

CONCLUSION

Associated pain is one of the major drawbacks of traditional method of drug delivery system and other probems like needle phobia and accidental needle stick injuries have worsen the condition. Needle free technology are highly effective in the administration of a wide spectrum of medicament into the body without inflating unnecessary pain to the patients.It has found that these devices are so effective in the drug delivery to some of the most sensitive parts of the body such as cornea. These are capable to deliver intra-dermal,intra-muscular and subcutaneous injections.

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