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# MICRONEEDLE: AN EFFECTIVE DELIVERY SYSTEM

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**ABSTRACT**

A microneedle is a non-invasive based drug delivery system which is a great advantage towards pain-free administration, easy handling and a controlled release system. It is the technique which only penetrates the dermal layer of the skin without stimulating the dermal nerve. When compared to other inject able methods it is pain-free, effective, and safe route of drug delivery. Due to its painless technique it is the most demanding technique in the near future.

**KEYWORDS:** Microneedles, non-invasive, controlled release system, penetrates.

## INTRODUCTION

Microneedles device consists of needles of micron size, which are arranged on a small patch. Microneedles are a type of micro-machined structure that promotes the transport of substance through an interface or media, via enhanced permeability or micro channels.[1]

The arrays used are a collection of microneedles, ranging from only a few microneedles to several hundred, applied to an applicator sometimes a patch or other solid stamping device. The arrays are applied to the skin of patients and are given time to allow for the effective administration of drugs.[2]

Microneedles devices typically consist of hundreds, or even thousands, of tiny microscale needles that are spaced into an orderly array of columns and rows.

Each microneedle is just long enough to break through the outer layer of a person's skin, and is thinner than a human hair.[3]

By 1995, a new technique was discovered by Dr Desmond Fernandes for the treatment of wrinkles and scars with the use of hypodermic needles. Around the same time, Dr Fernandes developed a small needle stamp to induce collagen production. This later led to the dev elopment of our modern micro needling devices.[4]

It's considered effective in treating minor scarring related to acne, wounds, and aging. You'll likely notice brighter, firmer skin, too. Ideal results are achieved after multiple sessions. Microneedling is far more effective than at-home rollers.[5]

Microneedles are widely used in transdermal drug delivery systems (TDDS) because they are efficient, safe, convenient and painless.

### Types of Microneedles

**Morphologically, microneedles are divided into four types**

1. Solid microneedles,
2. Coated microneedles
3. Dissolving microneedles
4. Hollow microneedles.

### 1. Solid microneedles

**They are of three types**

- Polymer
- Metal
- Silicon

Used as a pretreatment for pore formation in skin in order to make holes through which drugs can transport. Increase the permeability by pocking the holes in skin, rub drug over area or coat needle with drug.

### 2. Coated microneedle

Pierce the skin surface and also carry drugs across the membrance.

**Coating solution contains**

Drugs, Exipients (like thickening agent, surfactant, stablizers etc.). One example of coating solution of Minoxidil, used in the treatment of Alopecia

### 3. Dissolving microneedle

It involves encapsulating the drug within the biodegradable,polymeric microneedles, followed by the

insertion into the skin for drug release. Polymers used: PLA, PGA, PLGA, PVP, Polycarbonate.

**4. Hollow microneedle:** Hollow microneedles (HM) can be fabricated from a commercially available 30 gauge hypodermic needles . Pressure, and thereby flow rate, can be changed in HM for a rapid bolus injection, a slow infusion or a varied delivery rate6

**Advantages of microneedles**

**The advantages of microneedles are**

(1) large molecules can be administered,
(2) painless administration of the active pharmaceutical ingredient,
(3) first-pass metabolism is avoided,
(4) faster healing at injection site than with a hypodermic needle7-8
(5) no fear of needle, ease of administration,
(7) decreased microbial penetration as compared with a hypodermic needle, the microneedle punctures only the epidermis,
(8) specific skin area can be targeted for desired drug delivery,
(9) enhanced drug efficacy may result in dose reduction,
(10) good tolerability without long-term oedema or erythema,
(11) rapid drug delivery can be achieved by coupling the microneedles with an electrically controlled micropump, and
(12) the rate of drug delivery can be controlled more effectively by this system as compared with drug delivery via the stratum corneum.

**Disadvantages of microneedles**

**The disadvantages of microneedles are**

(1) dosage accuracy may be less than with hypodermic needles,
(2) careful use of the device may be needed to avoid particles'bouncing off' the skin surface; if the device is not held vertically, the dose may
escape or can penetrate the skin to differing degrees,
(3) the thickness of the stratum corneum and other skin layers varies between individuals and so penetration depth of particles could vary too,
(4) the external environment, like hydration of the skin, could affect delivery,
(5) repetitive injection may collapse the veins,
(6) the tip of the microneedle may break off and remain within the skin on removal of the patch,
(7) a small amount of drug (less than 1 mg) can be given by bolus, and
(8) compressed dermal tissue can block hollow microneedles.

**Mechanism of Action**

The mechanism of action depends on the type of microneedle design. The general mechanism of delivery via microneedles is based on mechanical disruption of the skin and application of the drug or vaccine within the epidermis, from where it can more readily reach its targeted site of action. The drug is entrapped within the microneedles, which when inserted into the skin and releases the drug into the layers of skin which are highly vascularized. In some cases the needles dissolve within minutes, releasing the entrapped drug at the intended site of delivery from where they reach the target site

**Applications of microneedles**

In the fields of genetic engineering and molecular and cell biology, it is desired to develop a method to introduce peptides, proteins, oligonucleotides, DNA, and other probes into cells to alter their functions. For this purpose, microneedles can be applied for the delivery of molecules through impermeable membranes into cells. It has been demonstrated that microfabricated needle arrays could be used to deliver DNA into plant and mammalian cells, inducing cell transformation.

Another important application of microneedles is minimally invasive drug delivery. The small cross-sectional area of microneedles, typically several hundreds of square micrometers, reduces any possibility of detrimental effects. At the same time, the drug delivery can be limited to a specific and localized region or tissue in the body. For this reason, microneedles have been used to study neural activities with very limited trauma to the tissue.[9]

The short shaft of microneedles presents another advantage in drug delivery. Microfabrication technology allows the length of needle shafts to be controllable at a microscopic scale. The needles can be designed to penetrate just under the stratum corneum (the outer layer of the skin that has very low permeability). Since the nerve endings occur at a depth of about 100 mm, delivery at this location will reduce pain, infection, or injury as well. In addition, because of the presence of a large number of capillaries in this layer of skin, the drug will be readily absorbed into the body, thereby enabling rapid treatment. Microneedles can also be used to extract samples, thus finding significant applications in the field of health monitoring and biochemical analysis. For example, with diabetic patients, frequent use of needles is necessary for blood sampling to test glucose levels and to administer multiple doses of insulin. The use of microneedles can make it a virtually pain-free and a much more palatable experience to patients.

The applications of microneedles have expanded into electronics and sensors. They have been used as probes for surface modification and profiling, for example, in atomic force and scanning tunneling microscopes, and Millipede data storage. Microneedles have been applied in microdialysis where the microneedles are made permeable only to small-molecular-weight compounds. This protects the sensors from higher-molecular-weight compounds like proteins helping maintain the operational viability of the medical monitors. Other applications include printer heads and electrospray emitter nozzles.

## CONCLUSION

Microneedles are ought to be the prominent carriers for enhancing the permeation deep into the systemic circulation and providing a painless, effective and safe route for the drug delivery. These painless systems are slowly gaining importance and would qualify to be one of the important devices for controlled drug release in future.

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