42 Microneedle Dermatotoxicology

Boen Wang
Lynbrook High School, San Jose, California

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42.1 INTRODUCTION

Microneedles (MNs), minimally invasive devices designed to painlessly penetrate the stratum corneum, were developed and patented in 1976 as a means for more efficient transdermal drug delivery (Ma and Wu 2017). Subsequent advancement in MN technology and manufacturing led to the development of several MN types, including hollow, solid, dissolving, coated, and hydrogel forming (Nguyen and Park 2018). Hollow MNs deliver drugs through a channel in a similar manner to hypodermic needles, while solid MNs are more frequently used in pretreatment to enhance skin permeability before application of a topical product. Dissolving MNs are constructed from a biodegradable polymer or polysaccharide with therapeutic molecules contained within; coated MNs contain the drug formulation on the outside surface of the needles. Lastly, hydrogel-forming MNs are composed of expanding material with an active agent attached to the baseplate (Nguyen and Park 2018). The following briefly states the promising potential applications of MNs, including dermal and intrascleral drug delivery, vaccine administration, blood and interstitial fluid extraction, and numerous uses in cosmetics (Ma and Wu 2017; Ramaut et al. 2018). All will eventually increase in use, should they be well tolerated by most users.

MNs allow delivery of higher-molecular-weight and hydrophilic drugs that would otherwise be unable to significantly diffuse across the stratum corneum. In contrast to enteral drug delivery, dermal drug delivery avoids stomach degradation and hepatic first-pass metabolism, while it may also produce higher drug concentrations in the dermis and other target tissues. MN transdermal drug delivery is a continually growing field with increasing patents filed every year for numerous drugs.

Here, we briefly discuss a few of the many studies involving MN drug delivery. Badran et al. (2009) demonstrated effective penetration of radiolabeled mannitol, a hydrophilic drug expected to have poor penetration into the stratum corneum, in full-thickness human skin grafts when combined with microneedling. Dhurat et al. found enhanced effectiveness of minoxidil in men with