Refinement of microneedle application – a comparative study regarding species variation in skin histology

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1. INTRODUCTION

Microneedles (MN) have been used for different applications, from drug and vaccine delivery systems to cosmetics, among other new technologies. Microneedles penetrate the skin, avoiding contact with nerve fibres and blood vessels in the dermal layer, inducing no pain. The aim of this study was to refine the procedures of MN design and application protocols regarding the dimensions/thickness of the epidermis and dermis of species commonly used in animal experimentation.

2. MATERIALS AND METHODS

Skin samples from several animal species and body sites, (i.e. pig's ear, sheep's podal extremity, rat's and dog's abdominal area) were collected and a MN device was applied manually (Figure 1 A and B). Samples were formalin-fixed, routinely processed for histology (Figure 1 C) and sections stained with HE. Measurement of the different skin structures was assessed by microscopy and DinoCapture 2.0 software (Figure 2).

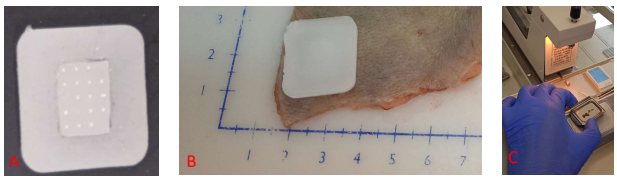

Figure 1. Microneedle device (A), application onto a skin sample (B) and routine processing for paraffin embedding (C).

3. RESULTS

The histological examination revealed variations in the thickness of the epidermis and dermis between the studied species (Figure 2). The epidermis was thickest in the pigs' ear skin (A, B) where the corneal layer thickness (B) is thicker than the epidermis of the other studied species. Dog (C, D), rat (E, F) and ovine skin (G, H) showed thinner epidermis, with some individual variability. The perforation of a MN of the used MN device is displayed in G (arrow) and H (black) across the epidermis and the dermal layer of the ovine skin.

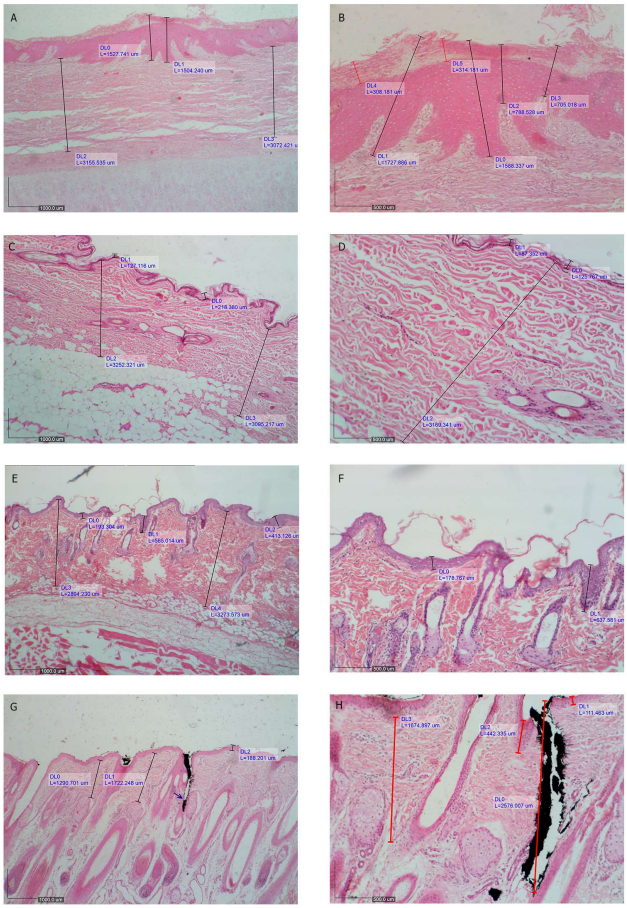

Figure 2. Skin sections from different studied species with measurements (DL) of the epidermis and dermal thickness. **A** - DL 0 and DL1 epidermis; DL2 and DL3 dermis; **B** - DL0, DL1, DL2 DL3 epidermis magnification, DL4 and DL5 corneal layer; **C and D** - DL0 and DL1 epidermis thickness, DL2 and DL3 dermal thickness; **E and F** - DL0 DL1 and DL2 epidermis thickness, DL3 and DL4 dermal thickness; **G** – DL2 epidermis thickness, DL0 and DL1 dermal thickness; **H** - DL0 MN perforation, DL1 epidermis thickness, DL2 and DL3 dermal thickness.

4. CONCLUSION

This study provides valuable data for optimization of MN design based on specific animal species and the desired point for drug delivery. This optimization process allows the refinement and standardization of MN devices, ultimately leading to enhanced precision and effectiveness in drug administration.

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