

Botulinum toxin A dissolving microneedles for hyperhidrosis treatment: design, formulation and *in-vivo* evaluation

Supporting information

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1. CAD models of two microneedle structures:

Considering effective parameters to have maximum microneedle capacity and effective penetration efficacy, two geometrical structures were chosen and designed through SolidWorks software, which is illustrated in Fig S1.

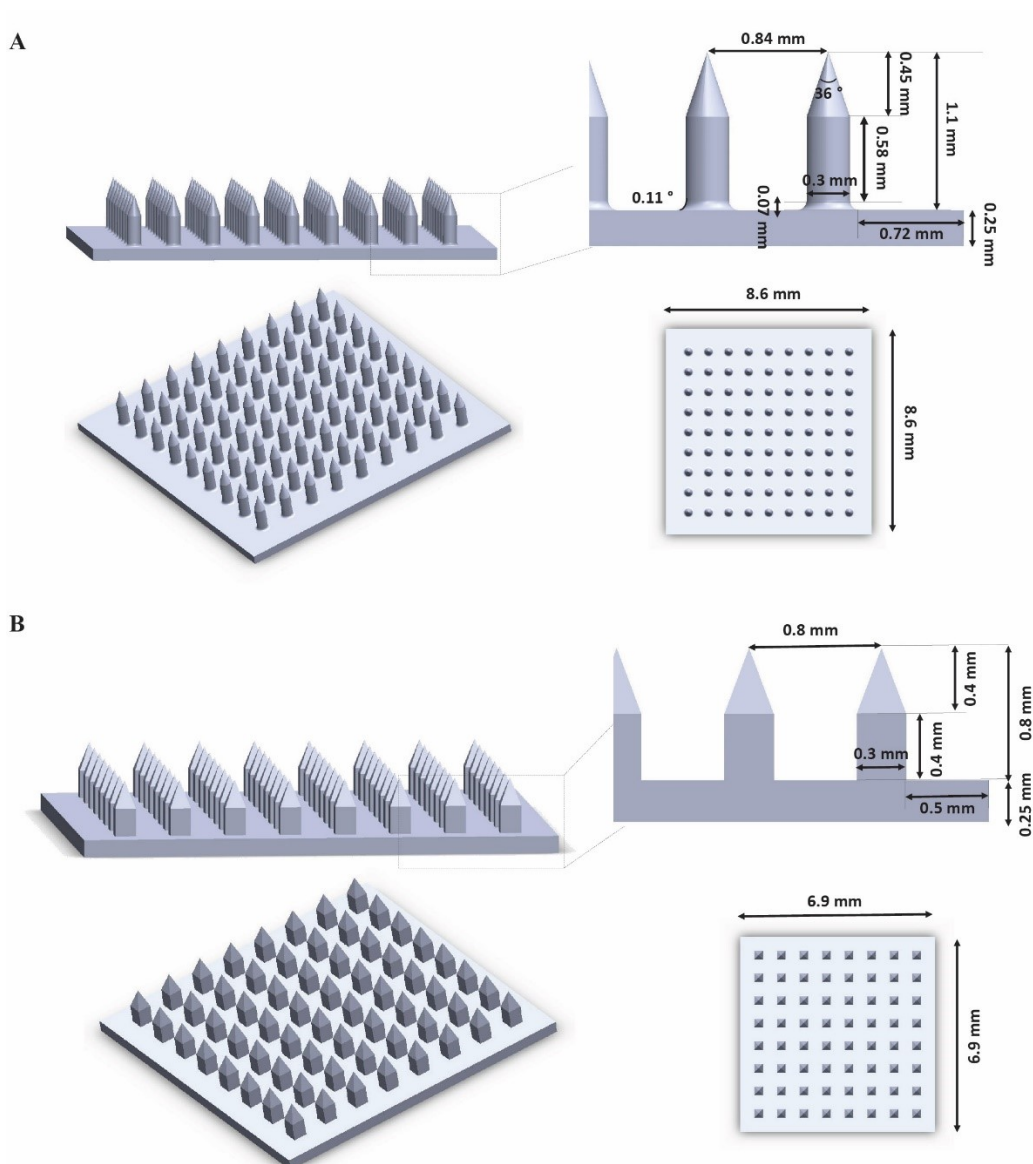


Fig. S1. CAD of two different MN structures, (A) Cylindrical-cone design and (B) Cubical-pyramid design.

2. Optical microscopic images from intact and destroyed BTX-A/DMNPs

For better and initial visualization of the BTX-A/DMNPs before FE-SEM imaging, they were imaged and investigated by optical microscope. The magnification of 10- and 40-fold lenses were used. Figures S2A and S2B show the intact BTX-A/DMNPs. Also, Figures S2C and S2D show the BTX-A/DMNPs after exposure to mechanical force.

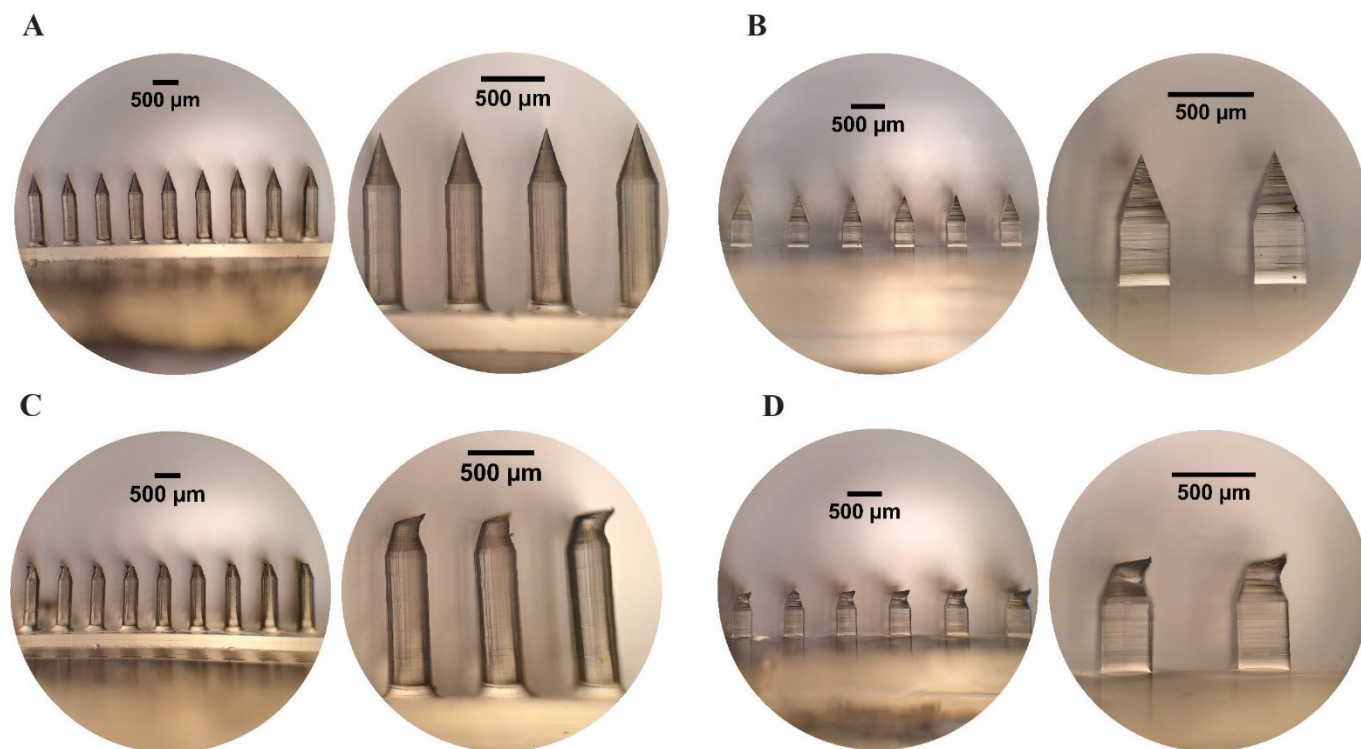


Fig. S2. Optical microscopic images of DMNs: (A) Intact microneedles of the cylindrical-cone design, (B) Intact microneedles of the cubic-pyramid design, (C) Images of the cylindrical-cone design after applying mechanical force and (D) Images of the cubic-pyramid design after applying mechanical force.

3. Investigation of the drug diffusion kinetics through skin layers

CLSM imaging was used to illustrate the kinetics of drug diffusion across skin tissue. Fig S3 shows further details of IgM diffusion into the skin layers. According to the pictures, the fluorescent emission of each needle insertion at the skin's surface from the XY axes can be traced in-depth and depicted on both the XZ and ZY axes. All the images of three-time points of an hour, 4 hours and 24 hours are shown in Fig S3.

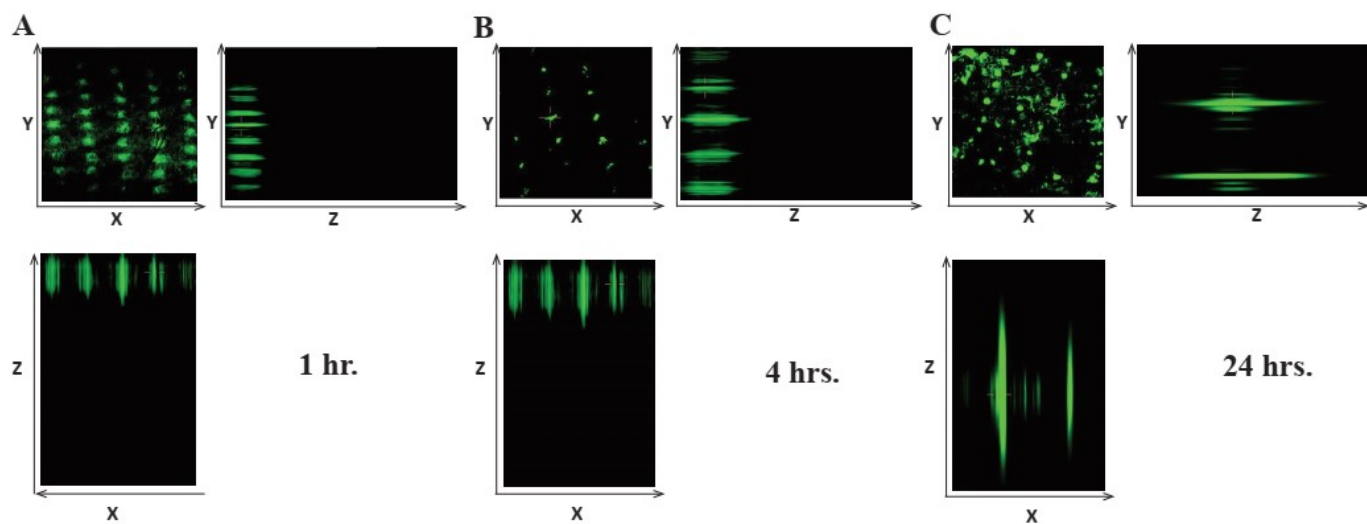


Fig. S3. Illustration of the fluorescent emission of the FITC-DMNPs through skin layers, showing the depth of IgM diffusion in the ZY and XZ axes: (A) After an hour of applying the patch, (B) After 4 hours of applying the patch, and (C) After 24 hours of applying the patch.