Needle-free Injection of Hyaluronic Acid for Skin Remodeling via Modulation of Vimentin in a Mouse Model

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Introduction

The jet injector uses a pneumatically accelerated high-speed jet to penetrate the skin via a very small entry point in the epidermis and has demonstrated efficacy in clinical trials. However, despite its popularity its mechanisms of action are not yet fully defined and the technique has not been fully evaluated. The purpose of this study was to improve methods of jet injection using a mouse model. We investigated the mechanism of action, efficacy, and safety of the pneumatic device using injection of hyaluronic acid (HA) solution into a mouse model.

Results

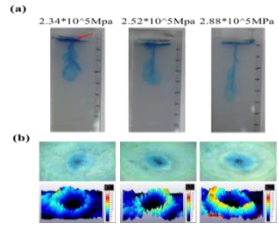

Fig. 1. Injection of skin hybrid model. (a) Typical jet penetration shapes after injection into 0.5%, 1%, 1.5% agarose gels, 20% polyacrylamide gels containing a mouse dorsal skin sample in the outer layer (Red arrow). (b) Transverse slices of the gel visualized using a folliscope confirm the presence of a hole in the mouse skin samples. VC98 images were used to assess changes in depth of the mouse skin surface.

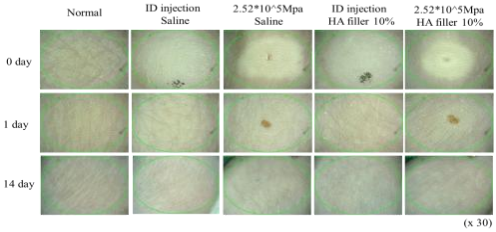

Fig. 2. *In vivo* changes in the skin surface. Effects of the INNOJECTOR™ pneumatic device on clinical and morphologic features of the injection site in hairless mice. Progression of skin surface changes for the different intervention groups was analyzed throughout a 14-day observation period. Changes in microtrauma morphology were evaluated using images taken with a folliscope (×30).

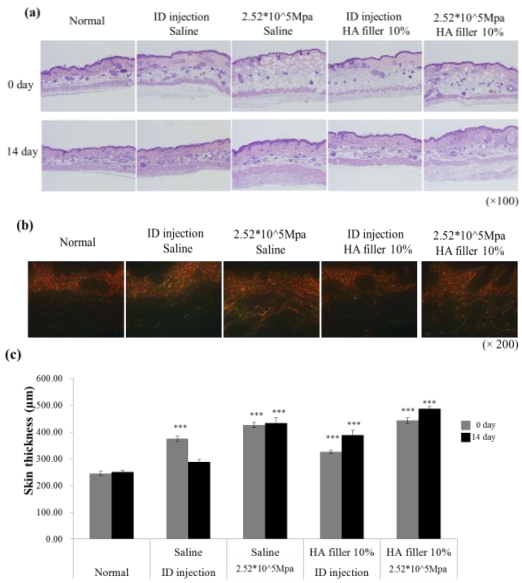

Fig. 3. Effects of pneumatic device application on skin thickness and collagen synthesis in mouse skin. Typical photographs of histology for each panel. The effect of the INNOJECTOR™ pneumatic device on mouse dorsal skin was analyzed by staining with hematoxylin-eosin (H&E) (a) and picro-sirius red (PSR) (b). (c) Dermal thickness was measured from the dermal-epidermal junction to the underlying subcutaneous tissue. Ten sections were assessed in each experimental group. The mean value was calculated and used as the final dermal thickness. Data are expressed as mean ± standard deviation (N=10). Original magnification, ×100.

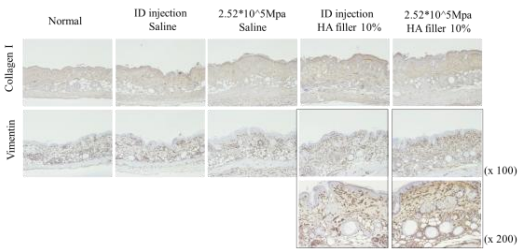

Fig. 4. Immunohistochemical identification of vimentin-positive cells in mouse skin tissue sections. Skin biopsies were taken 14 days after injection and analyzed by immunohistochemistry. The collagen type I-positive and vimentin-positive areas were stained by 3,3′-diaminobenzidine with a hematoxylin counterstain to visualize the nuclei. Original magnification, ×100, ×200.

Conclusions

- The INNOJECTOR™ increased dermal thickness and collagen synthesis in our mouse model.
- The mechanisms by which pneumatic injection using HA solution exerts its effects may involve increased dermal thickening, triggering of a wound healing process, and activation of vimentin and collagen synthesis.
- INNOJECTOR™ may induce efficient collagen remodeling with subsequent marked dermal layer thickening by targeting vimentin.