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Development of wearable sensor device using biodegradable microneedle patch

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The microneedle-mediated transdermal delivery system has been developed to provide minimal invasive self-administration method. Droplet-born air blowing (DAB) method has great advantages in stability with precise dose control because DAB provide quick manufacturing process with ambient temperature. Also, microneedle (MN) array is stamped on the skin, and interstitial fluid (ISF) is obtained. MNs are designed to collect dermal interstitial fluid containing biomarkers without the risk or pain needed for collecting blood. This study suggests the novel dissolving microneedle fabrication method, droplet-born air blowing (DAB), which provide gentle temperature and fast manufacturing process with precise dose control. Microneedle fabricated by DAB method. Briefly, biodegradable polymer such as HA (hyaluronic acid) were dissolved in water with active ingredients. The mixture was dropped to a patch, and each droplet is shaped to the microneedle. The loaded amount of active ingredients was analyzed by ELISA or HPLC/UV system. Skin permeability of microneedle was confirmed by OCT (optical coherence tomography) and delivered amount into the skin was analyzed using Franz diffusion cell (Logan, FDC-6T). We optimized the DAB process parameters and scaled up without applying any heat. Various ingredients were loaded within microneedles approximately 100% compared to theoretical values independent of microneedle length. In vitro and ex vivo studies using Franz diffusion cell showed excellent delivery efficiency compared to topical solution. In vivo OCT images clearly showed that whole length of microneedles could penetrate into human skin. DAB technology suggests a way to solve the problems of conventional molding method to fabricate dissolving microneedle. Based on the method, we have successfully developed mass production system to manufacture microneedle-arrayed patch. We loaded lots of active ingredients with precise dose control, and confirmed the delivery efficiency of labile ingredients within microneedles. Also, we can access to biomarkers in dermis and future medical diagnostic and monitoring applications.

Recent Publications:

1. J D Kim, M Kim, H Yang, K Lee and H Jung (2013) Droplet-born air blowing: novel dissolving microneedle fabrication. Journal of Controlled Release 170(3):430-436.
2. S P Sullivan, D G Koutsonanos, M P Martin, J W Lee, V Zarnitsyn, S O Choi, N Murthy, R W Compans, I Skountzou and M R Prausnitz (2010) Dissolving polymer microneedle patches for influenza vaccination. Nature Medicine 16:915–920
3. Kolluru C, Williams M, Chae J and Prausnitz M R (2019) Recruitment and collection of dermal interstitial fluid using a microneedle patch. Advanced Healthcare Materials 1801262.
4. Kim H K, Lee S H, Lee B Y, Kim S J, Sung C Y, Jang N K and Lee S (2018) A comparative study of dissolving hyaluronic acid microneedles with trehalose and poly (vinyl pyrrolidone) for efficient peptide drug delivery. Biomaterials Science 6(10):2566-70.
5. Kim J H, Shin J U, Kim S H, Noh J Y, Kim H R, Lee J and Kim H K (2018) Successful transdermal allergen delivery and allergen-specific immunotherapy using biodegradable microneedle patches. Biomaterials 150:38-48.

Biography

Eunjin An received her bachelor's degree in Department of Chemistry. Also, she received her Master´s degree in Department of Pharmacy from Duksung Women's University, Republic of Korea. Her research interests are biomaterial polymer materials and devices for effective drug delivery systems. And now her studying microneedle patch for transdermal drug delivery system and wearable device at Raphas Co. Ltd. Raphas Co., Ltd. is engaged in the research and development of cosmetics, medical devices and pharmaceuticals.

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