Development of a versatile three-dimensional skin model using silica nano-nonwoven fabrics

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In this study, epidermal and epidermal-dermal skin models were constructed using silica nano-nonwoven fabrics. To construct the epidermal skin model, epidermal keratinocyte line, HaCaT cells, or primary normal human epidermal keratinocytes (NHEK) were seeded onto silica nano-nonwoven fabrics placed in cell culture inserts and cultured at the air-liquid interface for two weeks in keratinocyte differentiation medium. In order to construct the epidermal-dermal skin model, fibroblast cell line, NIH3T3 cells, or primary normal human dermal fibroblasts (NHDF) were seeded and cultured for five days in silica nano-nonwoven fabrics prior to seeding of keratinocytes. Constructed models were evaluated by microscopic observation after hematoxylin and eosin staining, trans-epithelial electrical resistance (TEER) measurement and quantification of various epidermal/dermal-related gene expressions using real-time PCR. The thickness of epidermis of the models constructed with silica nano-nonwoven fabrics was thicker than that constructed in cell culture inserts. The expression of genes such as \( hTGM1 \) and \( hLOR \) in epidermal models constructed on silica nano-nonwoven fabrics were much higher than those of cell culture inserts. This means that silica nano-nonwoven fabrics may mimic the basal lamina structure and increase the functions of keratinocytes. In the construction of epidermal-dermal skin models, similar positive effect of silica nano-nonwoven fabrics were observed. Finally, the prepared three-dimensional epidermal and epidermal-dermal skin models were evaluated by a method similar to the OECD TG skin corrosiveness test. The three-dimensional skin models met the evaluation criteria of the skin corrosiveness test. These results suggested the usefulness of the silica nano-nonwoven fabrics-based three-dimensional skin models.