Dermal substitutes using electrospun silk fibroin nanofiber sponge

Chan Hum Park[a,b], Ok Joo Lee[b] , Jung Min Lee[b], Hyung Woo Ju[b] and Bo Mi Moon[b]

[a]Department of Otorhinolaryngology-Head and Neck Surgery, School of Medicine, Hallym University, Chuncheon, Korea
[b]Nano-Bio Regenerative Medical Institute, Hallym University, Chuncheon, Korea

Statement of Purpose: Several auto- or alloplastic dermal substitutes have been used for full thickness skin defect. However, there is no ideal dermal substitute, which is biocompatible, adequate mechanical properties, and sufficient thickness and volume. Silk fibroin can be considered as a possible alternative material for construction of dermal substitutes because of high biocompatibility, excellent physical characteristics, and promoting tissue regeneration. Compared to other biomaterials, such as collagen and polylactic acid, SF has excellent strength, toughness, and thermal stability. Recently, nonwoven SF membranes have been fabricated by electrospinning.

Methods: We created biocompatible, highly porous, and thick silk fibroin nanofiber sponge using electrospinning. SF nanofiber sponges (thickness 2.41 mm) and Matriderm® (thickness 1 mm) were cut into 1×1.5 cm^2 to exactly transplantation sites before implantation. The two pieces of 1×1.5 cm^2 full thickness skin defect were cut off from each rat. SF nanofiber sponges and Matriderm® were implanted in the each wound and fixed with non-absorbable. And then, silicone caps with a diameter of 2.5 cm were sutured over the wound to protect the implant sites.

The animals were sacrificed at 1, 2, and 3 weeks after implantation. The electrospun SF nanofiber sponges and Matriderm were dissected from the rats, including the surrounding soft tissue. For histological evaluation, harvested tissues were fixed in 10% buffered formalin solution for 2 days. Each specimen was embedded in a paraffin block and sectioned into 5 μm-thick slides. Then, the sections were stained with Haematoxylin and Eoxin (H&E) and Masson's Ttrichome and visualized with a microscope.

Results: Collagen fibers and blood vessels were easily infiltrated into large pores of silk fibroin sponge and regenerated collagen fibers showed homogeneous pattern. Although dermal regenerative effect of silk sponge was similar to that of Matriderm, silk sponge was almost completely degraded and did not induce wound contracture unlike Matriderm.

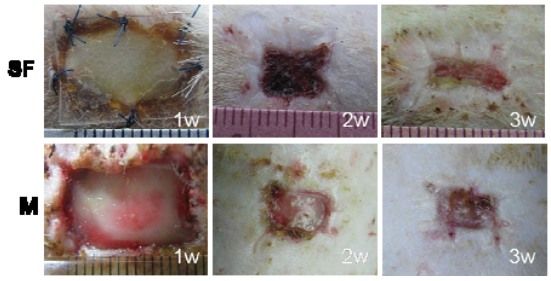

Figure 1. Gross findings of silk fibroin treated and Matriderm® treated wounds.

Conclusions: In conclusion, electrospun SF nanofiber sponges have their own unique advantages such as low price, easy preparation, biocompatible and favorable tissue regeneration and should facilitate one step grafting for full thickness skin defect without wound contracture. We suggest that the electron silk fibroin nanofiber sponge can be applied to the treatment of full thickness skin defect.

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