Transplants and Grafts

Autologous Palmoplantar Dermal Cell Grafting Converts Limb Stump Skin to Palmoplantar Skin

Following an extremity amputation, the patient's leg or arm skin is surgically secured around the stump. Unlike palmoplantar skin, the thicker, hairless skin that covers the palms of hands and the soles of feet, the skin covering the stump is not designed to bear weight and is more susceptible to friction-induced irritation and sweating. Thus, prosthetic users experience issues of sweating and skin breakdown that compromise their quality of life (QOL). These problems are especially difficult for lower limb amputees.

Researchers at Johns Hopkins University (Baltimore, Maryland) have developed a novel and intuitive approach where autologous palmoplantar dermal cells are cultured and grafted to create ectopic palmoplantar skin. Fibroblasts from the dermal layer of palmoplantar skin stimulate expression of keratin 9, a protein responsible for the thickened epidermal layers in palmoplantar skin. Culturing skin stem cells with palmoplantar fibroblasts produces a population of skin cells programmed to differentiate into palmoplantar skin (*Zhu, Li, et al. 2017*; Figure 1). Initial validation of safety and feasibility of this concept was tested by injecting the cells into the buttocks of human volunteers. As a control, some skin stem cells were also cultured with fibroblasts from scalp skin, which is not expected to stimulate skin thickening, and these were injected into the volunteers' buttocks. After six months, the patches of injected cells were removed and examined. Results from the first four volunteers demonstrated formation of palmoplantar-type skin at the experimental injection site, but not at the control site. There was increased expression of keratin 9 and microscopic examination showed skin architecture with palmoplantar features (Figure 2). Results demonstrate a positive conversion of skin identity with multiple proteins and cellular features of palmoplantar skin being induced in healthy human subjects. These findings were reported in the public media on WBAL TV11 (2017).

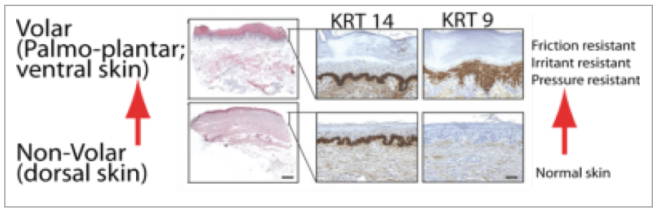

FIGURE 1: Overview of the project goal, to change non-volar dorsal skin to volar palmoplantar ventral skin. Adapted from from Rinn et al. (2008) (Figure used with permission from the authors)

As physicians rather than as engineers, the researchers did not focus on the prosthetic, but on the patient. Their innovative approach aims to strengthen the skin of the patient's stump by replacing it with palmoplantar skin through use of the patient's own skin stem cells. With encouragement from the DoD, the researchers are now planning a proposal for a multi-center clinical trial to test the efficacy of this technology to enhance the QOL in wounded Service member amputees.

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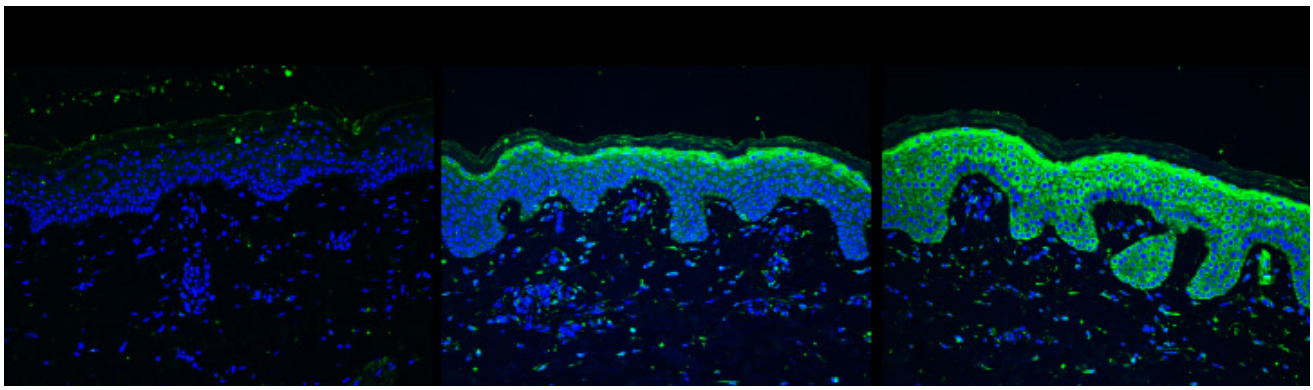

FIGURE 2: The most dramatic induction of Keratin 9 (green) occurs after volar fibroblast injection (Figure 2 from Kim et al. (2016) used with permission from the authors)

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