Mechanism of Skin Improvement in Radiation Wounds Following Fat Grafting: The Fate of Adipose-derived Stem Cells and Role of Stromal Vascular Fraction

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**PURPOSE:** Consequences of radiation include thickened, fibrotic and inelastic skin. Fat grafting helps alleviate this damage by decreasing epidermal thickness, increasing vascularization, and decreasing fibrosis. The exact mechanism is not understood and carries many hypotheses including the effects of adipose-derived stem cells (ADSCs) within fat. The first aim of this study was to determine which components of fat cause benefits seen with postradiation fat grafting with the hypothesis that pure ADSC group would have the greatest difference in epidermal thickness. The second aim was to determine the mechanism by which these skin changes are mediated with the hypothesis that human ADSCs can differentiate into epithelial stem cells to regenerate the skin.

**METHODS:** The dorsal skin of nude mice was directly radiated. Four weeks postradiation, injections were performed under the radiated skin with either human lipoaspirate, stromal vascular fraction, or pure ADSCs. The pure ADSCs were confirmed as p63− with flow cytometry before injection. The mice were euthanized at 2 and 4 weeks postinjection. Epidermal thickness was measured to determine treatment effect. Immunohistochemistry was performed using an antibody specific for human epithelial stem cell marker p63 and imaged using confocal microscopy. Nuclei positive for DAPI or p63 were quantified using ImageJ.

**RESULTS:** At 2 weeks, all experimental groups that were injected with human cells (ADSC, SVF, and lipoaspirate) had statistically thinner epidermis compared to the radiation-only control group without statistical differences between experimental groups. At 4 weeks, lipoaspirate and SVF groups remained statistically thinner than control groups with no statistical difference between the two. At 4 weeks, the epidermal thickness of the ADSC group was not statistically different than controls. There was a significant decrease in epidermal thickness from week 2 to week 4 in the lipoaspirate, SVF, and matrigel-only groups. Immunohistochemistry showed the presence of p63+ human cells in all experimental groups and absence in control groups. At 2 weeks, there is a statistically higher percent of p63+ cells in the ADSC and SVF groups compared to all other groups. From week 2 to week 4, there was a significant increase in the percent of p63+ cells present in the lipoaspirate group. At week 4, all experimental groups had a statistically higher percentage of p63+ cells than control groups without statistical differences between the experimental groups.

**CONCLUSIONS:** These findings suggest that improvements seen in radiated skin after fat grafting are due to presence of transferred ADSCs. ADSCs are likely not the only factor necessary to mediate the changes and the other components present within the SVF and lipoaspirate are likely important because these 2 groups maintained significantly thinner epidermis at 4 weeks, whereas the pure ADSC group did not. The ADSCs seem to convert into epithelial stem cells as evidenced by the presence of p63+ human cells within the epidermis of the experimental
groups and absence in control groups. The increase in percentage of p63+ cells from week 2 to week 4 suggests that these stem cells are continuing to divide and regenerate the skin.

Improving Quality of Life Through a Rehabilitation Program for Patients With Burned Hand

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**BACKGROUND:** Burn injuries, including hands, are one of the most devastating injuries. Hand burns do not often play a major role in the mortality. But, they represent a huge problem that may eventually lead to chronic disabilities, lifelong impairment, and significant functional and occupational limitations. These comorbidities can negatively affect a patient’s quality of life (QoL) besides, making reintegration into society is difficult. This study aims to investigate the effect of our designated burn rehabilitation program on improving QoL of patients with hand burns.

**METHODS:** A randomized controlled study was conducted for 12 months. It included 60 adult patients with hand burns who were randomly divided and assigned to a study and control groups. Both groups underwent basic rehabilitation. A newly designed program was implemented for the study group. Data were collected using 3 tools; bio–socio-demographic characteristics, the Burn Health Knowledge Questionnaire, and the Burn Specific Health Scale-Brief. The QoL of patients with hand burns was evaluated 3 times.

**RESULTS:** One and 3 months after implementing the burn rehabilitation program, the total mean scores for the QoL of patients in the study group improved from 31.1 ± 11.3 to 118.5 ± 21.3 and 135.4 ± 24.3, respectively (P < 0.001). In addition, the changes in QoL of the patients in the control group significantly improved from 24.8 ± 12.1 to 57.6 ± 19.1 and 87.5 ± 23.8, respectively (P < 0.001). Despite this steady improvement in the control group, the mean scores on the QoL subscales and total mean scores remained lower than those in the study group.

**CONCLUSIONS:** Based on the results obtained in the current study, the design and implementation of a burn rehabilitation program based on clinical knowledge improve the QoL of patients with burns. Therefore, this program is recommended for use early as a part of the treatment process for patients with burns.

Surgical Technique for Targeted Muscle Reinnervation at the Time of Below-Knee Amputation

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**PURPOSE:** Targeted muscle reinnervation has been shown to improve neuroma pain and prevent neuroma formation by providing sensory nerves a pathway for growth, thus avoiding formation of a symptomatic neuroma. This procedure has been studied in the lower extremities for amputees with neuroma or phantom limb pain; however, there are no descriptions of the entire surgical technique when performed with below-knee amputation (BKA) and posterior skin flap closure. We present our current surgical technique for flap design, identification of donor and recipient nerves, and nerve coaptation.

**METHODS:** The anterior BKA incision is designed 10–12 cm distal to the tibial tuberosity with transverse length 2/3 the circumference of the calf. The posterior skin flap is designed extending distally by the same distance as the anterior arc. Marks are made on the skin to approximate the locations of the commonly used recipient motor entry points (tibialis anterior, extensor digitorum longus, peroneus longus, flexor digitorum longus, and soleus). Donor nerves that are identified for coaptation include the saphenous, sural, tibial, deep and superficial peroneal. The initial dissection is made under tourniquet. The saphenous nerve is identified through the anterior incision running in the subcutaneous tissue and is dissected distally before transection. The remainder of the anterior tibial skin is removed from the crural fascia. The superficial peroneal nerve is identified distally as it emerges between the extensor digitorum longus and peroneus longus muscles, transected and dissected proximally. The anterior compartment muscles are dissected to identify the deep peroneal nerve, the motor entry point branches are preserved, and a tug test confirms its location in the midline proximally. The