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Project Title: Reassembly of full-thickness skin from micro skin columns

Year awarded: 2016

What do you hope to learn through this research? The ultimate goal of this research project is to confer the benefits of full-thickness skin grafting while eliminating most of the associated donor site morbidities. Our approach will be to take small columns of full-thickness skin, with each donor wound so small that it can close spontaneously without scarring, then reassemble the skin columns in the proper epidermal-dermal orientation, and bind the columns together in biocompatible matrices to form full-thickness skin constructs which can then be used for wound grafting.

What can you tell us about the progress made in this area since you first began your research? Using the swine skin wound model, we have confirmed that small, full-thickness columns of skin can be harvested without causing long-term scarring, and that these columns can be spread randomly (*i.e.* not maintaining the orientation of normal skin) into a wound to accelerate re-epithelialization. However, after repairing the wounds this way, the dermis still shows abnormal, scar-like features. We hypothesized that the quality of dermal wound healing can be enhanced by maintaining the epidermal-dermal polarity when engrafting the skin columns, and this WHF funding will be used to test this hypothesis.

How can this research help patients, clinicians and/or scientists? Autologous split-thickness skin grafting is the current gold standard for repairing large wounds, however split-thickness grafts cause many side effects at the donor sites, and they are also missing many important components that are located in the deeper parts of the skin. This research project could lead to new technologies for skin grafting that would confer the benefits of full-thickness skin grafting, while minimizing the donor site side effects.

Has your work thus far yielded any surprises? At the onset of this project, we expected that managing/guiding the physiologic responses to the harvesting and engrafting of small columns of skin would be the more challenging aspects, while the engineering effort involved in building the tools for harvesting and manipulating these columns would be (we thought) relatively simple. But as the project progressed we found out that these engineering challenges were much greater than anticipated, as there are not a lot of existing tools designed for working with tissue at the “mesoscale” range of hundreds of micrometers. My WHF project is part of our effort to develop practical tools to solve this problem.

How did this award help your career? This award will allow me to pursue a line of research that is fairly high risk, but potentially with substantial rewards. It also comes at an important point of my career, as I begin to transition into an independent investigator. Most of all I hope that this award would provide an avenue for me personally, and our laboratory in general, to become more closely integrated with the wound healing community and learn from more seasoned practitioners and investigators in the field, especially since we have only become involved in wound healing research relatively recently.

How did you get interested in wound healing and this area in particular? The invention of fractional laser ablation by my mentor, Dr. Rox Anderson, showed us that large volumes of full-thickness skin (up to 40% in the face) can be removed, in the form of thousands to millions of very small wounds, with very little donor site morbidity and no long-term scarring. We became interested in seeing whether, instead of burning all that tissue away with a laser, these small pieces of skin tissue could be collected and utilized. Wound healing seemed to be a natural application. We were also motivated by our collaborators at the Department of Defense, who identified improved wound healing technologies as a pressing need.

Tell us about some of the outcomes of your research you are most proud of and what it means for patients, clinicians and/or scientists. While the “random” application of the columns into wound beds does not completely restore the dermis (at least in the swine model), there was enough improvement in healing outcomes that the technology was licensed to a startup company for commercialization a little over a year ago. The company has made rapid progress in device development as well as conducting first-in-human studies, with promising results. I am very excited at the prospect of this technology being developed into a practical tool for clinical use.

What are your future plans for your work in wound healing? I am very motivated to develop practical technologies to enable the restoration of deep skin wounds back to the state of unwounded, normal skin, or at least get as close as possible. In addition to this WHF-funded project, I am pursuing joint projects with collaborators with expertise in stem cells and biomaterials, to investigate potential synergistic effects by combining them with skin columns.

Who do you consider your mentors and your close associates in this project? How did you start working with them? Dr. Rox Anderson has been my mentor since I joined his lab in 2009 as a postdoctoral fellow. He conceived of the original idea of harvesting and engrafting very small pieces of skin tissue to minimize donor site morbidity, and has provided invaluable guidance both on the technical execution of this project and on the commercialization process. In addition to Dr. Anderson and my colleagues in his research group, I’ve also learned a great deal about skin tissue engineering and wound healing from our collaborator Dr. Cathy Rasmussen (Stratatech Corp). Last but certainly not the least, I learned many of the research techniques involved in this project, as well as much of my general approach to science, under the tutelage of my thesis advisor, Dr. Rakesh Jain.

Tell us about your life away from the lab and/or clinic? I enjoy spending time with my wife and our two small children. I’m also a freelance illustrator, avid volleyball player, and very out of practice violinist.