Paving the Way from Reconstructive Surgery to Regenerative Surgery
By Naichen Cheng
Department of Surgery, National Taiwan University Hospital

Plastic surgeons treat many complex wounds that require soft tissue reconstruction, such as diabetic foot ulcers, postoperative breast reconstruction, severe infection or major trauma reconstruction. Traditionally, structural defects rely on replacement with autologous tissue or allogeneic materials. Although certain success has been achieved, the final outcome was still not ideal in many cases. In recent years, the development of regenerative medicine has provided a new possibility of treatment. The essential part of regenerative medicine is tissue engineering, defined as the "application of engineering and life science principles and methods, the development of biological substitutes, in order to restore, maintain, or improve the function of biological tissue." It was my great honor to receive the International Scholar Award of 2016 from the American College of Surgeons. With the support and recommendation of ACS, I also had the privilege to visit Stanford University and University of Chicago before going to Washington DC for the ACS Clinical Congress. The trip was focused on understanding the impact of regenerative medicine may have on the practice of plastic surgeons in the future, particularly in the field of wound healing and breast reconstruction.

As my first stop, I visited Dr. Geoffrey Gurtner at Stanford University. Dr. Gurtner has conducted many important studies in wound healing research, focusing on understanding how tissue regeneration and fibrosis pathways interact during wound healing following skin injury. I had a chance to discuss with each member in his lab and attended the lab meeting. The laboratory is equipped with state-of-the-art instruments for a variety of wound healing studies, and the research topics covered biomedical engineering, molecular biology, cytology, animal assays, drug release, genetic engineering, and tissue rejection reactions. I learned from Dr. Gurtner about conducting high-quality research while keeping busy clinical work through appropriate time management, delegation and seeking collaboration opportunities. Since I also did quite some research on regenerative medicine for wound healing, Dr. Gurtner invited me to give a speech at the Grand Rounds of Plastic Surgery. I had a nice discussion with some senior doctors in the audience after the presentation, including Professor Michael Longaker, who also specializes in wound healing research.

I also visited Dr. Gurtner’ clinic at the Wound Care Center of Stanford
University. Besides plastic surgeons, the center also hires physicians specializing in metabolic diseases, cardiovascular surgery, rehabilitation and infectious disease. The center is also equipped with two hyperbaric oxygen chambers, along with other facilities that provide medical care for various wounds. Dr. Gurtner conducted several clinical trials aiming to promote the application of regenerative medicine principles in the treatment of chronic wounds, such as the use of amniotic membrane products with live cells to enhance the healing of chronic wounds. With the increase of elderly population globally, the incidence of diabetic ulcers, bed sores, lower extremity arterial ulcers is expected to rise in the future, imposing a great challenge to the medical care and social supportive systems. Therefore, a wound care center equipped with hyperbaric oxygen therapy and other cutting-edge wound care facilities is necessary to provide a full range of treatment in patients with chronic wounds.

Then I visited Professor David Song at the University of Chicago. Dr. Song is an internationally recognized expert in breast reconstruction surgery and is the immediate past President of the American Society of Plastic Surgeons. The incidence of breast cancer continues to rise in many countries, and the demand for breast reconstruction also increased. For women, the breast is an important gender symbol, and breast reconstruction can significantly reduce the psychological trauma of patients after mastectomy. Breast reconstruction is now a mature technique with multiple choices, including prosthesis and autologous tissue transfer. Although using artificial implant is still the most common form of breast reconstruction, autologous tissue reconstruction has generally been considered to yield better aesthetic results. Dr. Song specializes in several methods of autologous breast reconstruction, including deep inferior epigastric perforator flap (DIEP), superior gluteal artery perforator flap (SGAP), superficial inferior epigastric artery flap Epigastric artery flap (SIEA) and thoracodorsal artery perforator flap (TAP). I had the privilege to observe Dr. Song performing some of these surgeries and learned quite some surgical techniques. Moreover, Dr. Song has conducted several clinical trials related to chest wall reconstruction, breast tumor resection, and breast reconstruction. During my visit, I also participated in some clinical teaching activities, such as journal reading club, and I had a chance to interact with residents, fellows and the faculty regarding debated issues in wound care and breast reconstruction.

In a chat with Dr. Song, he acknowledged the value of autologous fat transplantation for breast reconstruction and believed that adipose tissue-related technologies and products represent an important adjunct in breast reconstruction.
Autologous fat grafts have been used for more than 100 years in plastic and reconstruction surgery. The early development of autologous fat transplantation is associated with a high incidence of complication, such as infection, fat resorption, fat necrosis, and calcification. With the improvement of liposuction technique with refined procedures of purification, separation, and injection, autologous fat transplantation has become a reliable cosmetic and reconstructive surgical technique. The most common application is treating the facial defects caused by trauma or subcutaneous fat atrophy. Since excessive adipose tissue can be frequently found in abdomen or other parts of the body, we usually can harvest enough fat for transfer with minimal donor site morbidity. Consequently, its application in the treatment of breast defects flourished in the recent years. In particular, recent studies have shown that adipose tissue contains a large amount of mesenchymal stem cells, which is a valuable cell source for regenerative medicine or tissue engineering. Cell-assisted lipotransfer, as described by Professor Takaro Yoshimura from Japan, depicted a procedure that separates adipose-derived stem cells (ASCs) from adipose tissue and mixes them with fat to increase the concentration of ASCs within fat, thus increasing the survival and regeneration of the transplanted fat. However, the machine that can separate adipose stem cells from fat extracts has not yet been approved in the United States and is therefore not available in the majority of hospitals, including the University of Chicago.

As the final highlight of my visit, I went to Washington DC to attend the Clinical Congress of the American College of Surgeons. Since my residency, I have met several surgeons with a title of the honorary Fellow of American College of Surgeons (FACS), so I was really excited to get a chance to actually attend the ACS Clinical Congress. I was amazed by the scale of the conference and the variety of the sessions provided for the educational purposes. I appreciated that ACS allowed me to attend a few scientific sessions for free on a first-come, first-served basis. Dr. Maurice Nahabedian, a Professor of Plastic Surgery at Georgetown University delivered a comprehensive review on breast reconstruction in the session “Atypical Breast Lesions: Defining and Managing This High Risk Population”. After the session, I also discussed with Dr. Nahabedian about his surgical technique of complete coverage of prosthesis with artificial dermis in implant-based reconstruction. Another session “Wound Care: Mentoring the Mentors” was also very helpful for me. The speakers covered a wide range of wound care issue, including infection control, negative pressure wound therapy, nutrition support, and the choice of dressings.

Thanks to the arrangement of the International Relations Committee of ACS,
international guest scholars from various countries got a chance to know each other in several occasions, such as the welcome reception and luncheon. We were also invited to the stage of the opening ceremony and the Annual Meeting of the International Relations Committee. I appreciated the prospect of ACS to extend its impact beyond the United States and to promote communication among the surgical communities around the world. I think it is not only beneficial for ACS, but also the surgeons worldwide. In the session for the scholar’s presentation, I was impressed by the diversity of the background of the scholars, ranging from basic research, clinical medicine, to surgical education and humanitarian aid. I also gave a speech entitled "Paving the Way from Reconstructive Surgery to Regenerative Surgery". The concept of promoting tissue regeneration with bioactive scaffolds or cell therapy has caught much attention in the field of plastic and reconstructive surgery. However, transplanting isolated adipose-derived stem cells into injured tissue often results in early cell death with limited therapeutic effects. Our study explored the use of cell sheet technology, which can exhibit excellent biological properties, resulting in promoting wound healing and tissue regeneration.

While visiting the medical centers of Stanford University and University of Chicago, the quality of its excellent medical service was impressive. The operation rooms were full of all kinds of advanced equipment and expensive devices. For example, feather sutures, which were used only for endoscopic or cosmetic surgeries in Taiwan, were used to do general skin closure. In the outpatient clinic, plenty time was allowed for the doctors to communicate with patients and their caregivers. However, the good quality relies on the high medical expenses in the United States, rendering medical insurances not affordable for the poor. These complex health care issues are also under debate in many countries all over the world. For example, my research topic of applying adult stem cells in regenerative medicine and tissue repair will be a very expensive treatment modality. Striking a balance between developing cutting-edge medical technologies and making them affordable for most people will be a challenge. Finally, I would like to thank the American College of Surgeons again for the award and the precious opportunity to visit the clinical congress. In the future, I believe the research done in the laboratory will eventually lead us to achieve the clinical application of regenerative medicine in wound healing and breast reconstruction.
Pictures

1. Dr. Cheng with Dr. Geoffrey Gurtner in Stanford University

2. Dr. Cheng delivered a speech in Stanford University, hosted by Dr. Geoffrey Gurtner
3. Dr. Cheng with Dr. David Song in University of Chicago

4. Dr. Cheng received the award of International Guest Scholar in the ACS Clinical Congress