ECS 193AB Winter/Spring2017

Remote monitoring application/device after microvascular free tissue transfer

***Note a Mechanical Engineering team has already matched to the project. A CS team is needed. The client has met with the ME team once.

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Clinical Problem

12% of (19 million) women in the United States will be diagnosed with breast cancer in their lifetime, and many of these patients will require mastectomy, most choosing to have reconstruction. The current gold standard of reconstruction is free tissue transfer from the abdomen, a complex and technically difficult procedure with high risks. With an expected increase in mastectomies, anticipated increase in gender reassignment/confirmation surgery and the evolution of tissue engineering, (requiring microsurgical implantation of engineered organs and tissues), microsurgical reconstructions and constructions are likely to only increase in number in the upcoming decades.

Microsurgical reconstruction involves removing tissue from one part of the body and transplanting it to another. In order to successfully accomplish this transfer, the blood supply of the removed tissue must be connected to the blood supply at the recipient site. The vessels being connected in microsurgical reconstruction are very small, often ranging in size from 1-3 mm in diameter. The most dreaded complication of microsurgery is flap failure or loss, which most often is the consequence of venous or arterial thrombosis, or formation of a blood clot. However, arterial or venous thrombosis is not necessarily synonymous with tissue death, however, as salvage is possible with prompt return to the operating room. Current literature has identified the most controllable factor increasing salvage is time required to return to the operating room once thrombosis is suspected. This places a large emphasis on postoperative monitoring, and significant time, energy and financial investment has been applied towards developing technology that detects clotting as early as possible. Due to the technical aspects of many free flaps, not just those used for breast reconstruction, the microsurgeon many times must rely on adjunct technologies alone to monitor the health of the free flap.

As a result, the surgeon must rely on either his or her own examination and/or adjunctive measures and staff to promptly identify flap compromise. In the 21st century there are available technologies that should allow us to examine the patient remotely, and remote examination has been successfully employed by our colleagues in Neurology. To date, unsuccessful attempts have been made to demonstrate meaningful use of remote monitoring by our colleagues in reconstructive surgery.

Translational Importance/Opportunity:

Using singular or multiple adjuncts requires audiovisual monitoring at the bedside, and observation of this monitoring should theoretically be possible remotely. Tissue Oximetry is a flap monitoring technology that has successfully set up an application that allows the reconstructive surgeon to monitor oxygen concentration measurements of tissue via a cellphone. Studies have also previously examined the usefulness of remote photographic monitoring of non-buried free tissue transfer but did not demonstrate significant improvement in flap salvage. Finally, the implantable Doppler probe has become the most used adjunct to the clinical examination among reconstructive surgeons, yet remote monitoring of the implantable Doppler probe has yet to be developed. Theoretically this should be simple as the monitoring signal is audio only, and the availability of cellular networks and/or wireless internet is nearly ubiquitous among recovery and intensive care units in developed nations.

Desired Outcome:

We propose that a device and application be developed with the goal of remotely monitoring the audio signal from the implantable Doppler probe. The reconstructive surgeon should subsequently be able to monitor the bedside Doppler signal at any time, remotely. We anticipate this be performed in two phases:

First Phase (BME): Device development of microphone and transmitter that would allow the surgeon to remotely monitor the bedside audio signal (from the already existing device) to the surgeon's cellphone.

Second Phase (CS): Application development that would allow for simple interface and interaction with the device, including the ability to store signals to allow for signal comparison (hour to hour, with storage for a minimum of 72 hours) and signal quality to allow research regarding changes in signal quality prior to clotting.

Success in this endeavor would be of immense value to the reconstructive surgeon, not only because of flap salvage but also due to time saved by eliminating unnecessary return trips to the hospital for flap examination, significantly improving quality of life for the reconstructive surgeon. An application of such magnitude would require investigation after development, and we are prepared to launch and/or assist in the investigation of the usefulness of such an application at our and other institutions.