Harry Barberian Scholarship Application

March 3, 2017

Criteria:

* Originality of the research question and its importance
* Feasibility – do you have the skills and resources to carry out the study?
* Impact – long –term or short-term potential for application?

Applicant’s name: Arushri Swarup

Supervisor: Dr. Adrian James

Location of Laboratory or Institution: Hospital for Sick Children Toronto

Project Title:

Description: - in lay terms describe (500 words)

**Background:**

* Explain TEES and this is how it’s different from microscopic

Transcanal endoscopic ear surgery (TEES) is a new and growing field that allows surgeons to perform common ear surgeries such as ear drum reconstruction, cholesteatoma (skin growth) removal and hearing bone repair through a natural body opening, the ear canal [1]. The objective of this project is to evaluate and develop innovative surgical instruments for the new and growing technique of transcanal endoscopic ear surgery (TEES). TEES is performed by feeding an endoscope and an instrument through the ear canal to visualize the surgical field and perform the surgery without a skin incision [1] [2]. As with traditional, invasive surgery, minimally invasive TEES allows the surgeon to perform common procedures, such as ear drum reconstruction, tumor removal and bone repair, while reducing the length of hospital stay, overall procedure cost and scarring [1] [3]. Despite these benefits, the adoption rate of TEES is low and one possible explanation is that existing instruments are developed for two-handed microscope-guided surgery and are not optimized for one-handed TEES, making the surgery challenging [4]. This project proposes the design of **novel instruments** to facilitate TEES and allow more surgeries to be completed minimally invasively which **benefits the patient and hospital.**

**Project Objective:** This project aims to understand the limitations of current TEES tools to develop design criteria to fabricate new, better surgical instruments to facilitate and increase the use of TEES.

**Methodology:** The following methodology will be employed to successfully complete this project. First, a survey will be sent out to ask expert ear surgeons around the world to rate the importance of various tool functionalities. Next, a time flow study will record the duration of steps of TEES, performed by experienced ear surgeons at The Hospital for Sick Children in Toronto (SickKids). The results of these two studies aim to determine the desired functions of new tools and current inefficiencies of TEES. This will be used to develop design criteria for new tools. A Research Ethics Board (REB) application has been submitted to SickKids to conduct these studies. Next, by using the resources available at the CIGITI lab at SickKids, a virtual model of TEES will be created. The model will include 3D renders of patient ear canal anatomy, an endoscope and an instrument. 3D ear-canal models are rendered from CT scans of patients who are candidates for TEES surgery. This will develop a platform to design tool prototypes that can fit inside specific patient anatomy and perform the intended function efficiently. Tool prototypes will be tested in cadaver models by surgeons to obtain feedback to optimize the prototype so it can be further developed to be used by surgeons in patients during TEES. Thus this project will present the unique method of developing patient-specific tools, advancing the capabilities of minimally invasive tools.

***Aim 1 (months 1-9):*** A needs assessment survey, sent to 100 otologists internationally, will follow a two-round Delphi method to identify trends and limitations for surgeon adoption of TEES. The questionnaire has been developed based on local otologists’ feedback on TEES. The questionnaire’s resulting qualitative scores will be analyzed using non-parametric tests and ANOVA to develop a second survey with more specific questions to identify distinct criteria that define the limitations of instruments and needs of surgeons using TEES.

***Aim 2 (months 1-9):*** A time-flow analysis study will record the duration of surgical steps for common TEES procedures. It will be conducted by observing a total of 50 surgeries performed by five surgeons at The Hospital for Sick Children, Toronto. This data will quantify the efficiency of current tools, and determine steps where innovation in instrument design is required to ease the surgery.

***Aim 3 (months 3-5):*** A task-space analysis study will record the tip motions of existing TEES instruments. The measurements will be collected at the CIGITI lab, at The Hospital for Sick Children, while an experienced otologist simulates safe ear surgery maneuvers inside of 3D-printed ear canal models. The data will be recorded using a micro-scale electromagnetic sensor that will map how the tools move. The 3D ear-canal models are being developed from CT scans of patients who are candidates for TEES surgery. This study will help quantify the interaction between the geometry of instruments, anatomy of the patient and the ergonomics of the surgeon. This will provide a platform for developing novel instrumentation with improved functionality within the constraints of the ear canal.

Use a virtual and printed model to develop instruments

**Feasibility and Impact:** SickKids is the institution where the surgeon supervisor and graduate student are working on this project. SickKids remains one of the very few centres in North America where a surgeon completes the majority of middle ear procedures using TEES. As well, the CIGITI lab at SickKids has successfully manufactured medical-grade tools for endoscopic neurosurgery and has developed brain surgery virtual models. Thus, SickKids and the University of Toronto provide the resources and skills to advance the technology available to facilitate TEES and **inspire future innovation of minimally invasive tools**, aiming to increase the use of minimally invasive surgery and **send patients home sooner and safer.**

CIGITI has done surveys and has close collaboration with surgeons. Projects that have made surgical simulation models and surgical tools have undergone testing and surveys to evaluate their efficacy and so the lab will provide the appropriate resources to make the model and conduct/analyze the survey results as per scientific protocol.

Detailed Budget