**Understanding the Limitations of Minimally Invasive Ear Surgery to Aid Future Innovation to Increase its Adoption**

**Background:** Transcanal endoscopic ear surgery (TEES) is a new and growing field that allows surgeons to perform common ear surgeries such as ear drum reconstruction, skin growth removal and hearing bone repair through a natural body opening, the ear canal [1]. Alternatively, traditional microscope-guided surgery is very invasive and requires a large skin incision behind the ear. By comparison, the endoscopic approach allows for better visualization, more effective growth removal and the preservation of the hearing bones. TEES reduces the length of hospital stay, overall procedure cost and significantly improves cosmesis, which is very important to patients [1]. However, with all of these benefits, a survey of 80 Canadian otologists (ear surgeons) reported the adoption rate of TEES as less than 10% [2]. 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. Nevertheless, the literature has not yet reported specific reasons for this low adoption and limited guidance regarding how to improve TEES.

**Objectives and Hypothesis:** The objective of this study is to investigate otologists’ preferences concerning the adoption of TEES, with a focus on the limitations of existing tools. Since instruments are not optimized for TEES, I **hypothesize** that a needs analysis survey, and a surgical time-flow analysis of expert otologists, will identify the one-handed surgical technique, that is required while using the endoscope, as a current limitation of TEES. I aim to identify existing instrument limitations to motivate the endoscopic ear surgery community to fabricate and test new tools to improve the adoption of TEES worldwide. This project aligns with CIHR’s mandate as TEES is a surgical technique being used internationally and the objective of the project is to encourage greater use of the technique, to facilitate safer and more effective middle ear surgery in Canada [1].

***Aim 1 (September – May):*** 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, using the SickKids RedCap research platform. The qualitative results will be analyzed statistically to develop a second survey with more specific questions to identify distinct criteria that define the needs of TEES.

***Aim 2 (September – May):*** A time-flow analysis study which involves recording the duration of surgical steps for common TEES procedures will be conducted by observing surgeons at SickKids. This data will quantify the efficiency of current tools, propose functionalities that future instruments should have, and determine steps where intervention is required to ease the surgery.

***Aim 3 (November – January):*** A task-space analysis study which involves recording the tip motions of existing TEES instruments. The measurements will be collected while an otologist performs simulated ear surgery maneuvers inside of a 3D-printed ear canal model. The data will be recorded using a micro-scale electromagnetic sensor that will map how the tools move while an expert completes a procedure. The 3D ear-canal model was developed from a CT scan of a typical patient who is a candidate for TEES surgery. This will function as a guide to aid the design of future instruments.

**Significance:** Endoscopic ear surgeons continually design instruments to better facilitate TEES, and yet the technique’s adoption rate remains low among otologists internationally. Aims 1-3 combine to study surgeon perceptions, actual operating room efficiency for existing procedures and finally the actual motions current non-optimal instruments undergo when performing TEES surgery. These studies will identify limitations of existing instrumentation at different levels, and can provide criteria for the development of novel, safe and efficient TEES tools. The results will be analyzed using descriptive statistics and disseminated through peer-reviewed otolaryngology journals. Further, an initial functional prototype instrument platform, based on new experimental instruments currently being designed for endoscopic neurosurgery, was designed and tested by the supervisor and student to facilitate ear drum reconstruction surgery. This platform will be used as a base to develop tool designs in response the results of this research. Thus, this project represents a valuable collaboration that will be applicable to other minimally invasive surgeries such as neuro, sinus, nasal, spinal and arthroscopic surgery.