**The Development of New Instrumentation to Facilitate Endoscopic Ear Surgery**

**Background:** Transcanal endoscopic ear surgery (TEES) is a new and growing field that allows surgeons to perform common procedures such as ear drum reconstruction, skin growth removal and hearing bone repair through a natural body opening, the ear canal [1] [2] [13]. 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. As well, TEES has significantly improved cosmesis which is very important to patients [13]. However, with all of these benefits, a survey of 80 Canadian otologists reported the adoption rate of TEES as less than 10% [3]. To date, the literature has not yet reported specific reasons for this low adoption and there is little knowledge regarding how to improve its use.

**Objectives and Hypothesis:** To increase the use of TEES, the following will be investigated: a) the reasons surgeons have not adopted TEES and b) the limitations of existing tools. This data will be used to develop criteria against which new instrumentation can be designed and tested. 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. To elaborate, existing otologic instruments are developed for two-handed microscope-guided surgery and are not optimized for TEES, making one-handed operation challenging. I aim to identify existing instrument limitations and to fabricate and test new instruments to improve the adoption of TEES. 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 [2].

**Experimental Approach and Methods/Procedures:** The following aims integrate both the Biomedical Engineering and Clinical Research pillars of CIHR. *Aim 1:*A needs assessment survey, sent to \_\_ 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 otolaryngologists’ feedback on TEES. A separate time-flow analysis, recording the duration of surgical steps for TEES procedures conducted by surgeons at the Hospital for Sick Children, will quantify the efficiency of current TEES tools. The results will be analyzed using descriptive statistics and disseminated through peer-reviewed otolaryngology journals to provide criteria for the development of novel, safe and efficient TEES instruments. *Aim 2:*An initial, functional prototype instrument platform 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 to the needs assessment. For example, to ease control of bleeding and to access hard to reach places in the middle ear. The instruments will be designed to optimize the functionality, maneuverability and ease-of-use of one-handed tools within the ear canal alongside an endoscope. *Aim 3:* Validation testing will be conducted to compare existing tools with the new prototypes. A mock operating room will be used by experienced TEES surgeons to test the tools on 3D printed ear models, followed by cadavers. The surgeons will perform ear drum reconstruction and dissect hidden recesses behind the ear drum. Qualitative feedback and the time required to successfully complete these procedures will be recorded, analyzed and compared to the data collected on standard tools in *Aim 2*. *Aim 4:*The instrument feedback will be used to optimize the tool design for use on actual patients.

**Significance:** The instrumentation will be developed based on new experimental instruments currently being designed for endoscopic neurosurgery. Thus, this project represents a valuable collaboration that will be applicable to other minimally invasive surgeries in bony cavities such as sinus, nasal, spinal and arthroscopic surgery [4]-[6]. This technology will positively impact the healthcare system because TEES has already been demonstrated to reduce patient morbidity rates and length of hospital stay [4]. Additionally, endoscopic ear surgery has been shown to reduce rates of residual skin growth after surgery as the endoscope allows greater visualization in the previously hidden recesses within the middle ear [7].

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There are TEES surgeons who develop their own tools and have sold thyem for TEES but still there is not a very big adoption of TEES theredfore, conducting the needs analysis and time flow will help set the criteraia/requiremetnts against which surgoens could target more of an audience

Significance section: future work of the project is to develop the tools

There is a team of surgeons who believe in TEES and this is part of the team effort of IWGEES to increase adopition of TEES worldwide

We ;have created this modular platform that cvan be sused to cater the current prototype to satisfy the needs assessment and workspace criteria