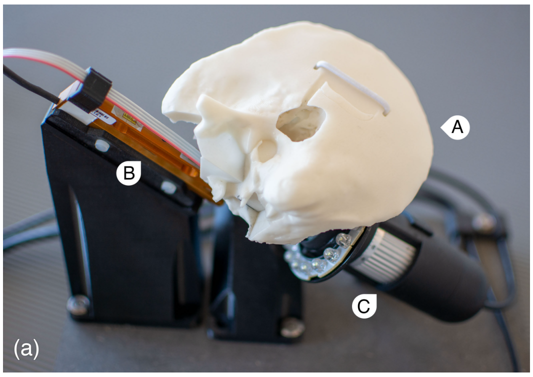
Surgical Training Models for Cochlear Implantation

May 2024

Background: During the surgical placement of a cochlear implant, even the slightest tremor creates intracochlear disturbances that dwarf physiological displacements by orders of magnitude. Extensive surgeon training is therefore crucial for successful outcomes. Unfortunately, the cochlea's location deep within the temporal bone, encapsulated in the otic capsule without any visual access, leaves the surgeon without feedback during the procedure.

We have developed advanced in-vitro models that replicate the complex anatomy and physical conditions of the human temporal bone while allowing sensory monitoring of the system. This turned out to be a valuable research platform which we have employed successfully for the testing of surgical procedures and validation of surgical instruments. In this project we now aim to refine these models to become accessible as a surgical training environment. By employing advanced signal and image processing techniques, we will develop a system that analyzes and interprets the stream of recorded sensory signals and presents real-time feedback and the detection of potentially traumatic events to the surgeon. This system will serve as a comprehensive training tool and help improve the efficiency and proficiency of surgical training, ultimately enhancing the quality of surgical care.



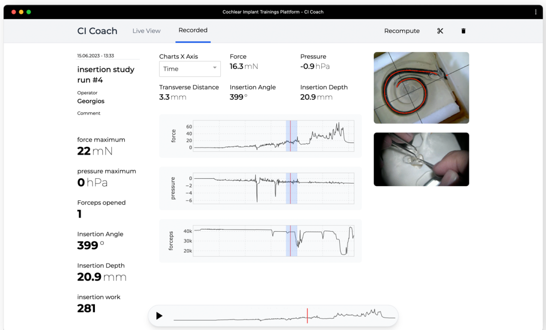


Figure 1: Left: In-vitro model of the temporal bone. Right: Graphical user interface of a performed training procedure.

Aim: Development of a system for real-time feedback and detection of potentially traumatic events during cochlear implant surgery training based on sensory data in an in-vitro model of the temporal bone.

Materials and Methods: Signal processing algorithms will be developed to analyze sensory signals recorded during the surgical training, with a focus on automatically extracting features that indicate successful procedures and detecting potential traumatic events. These algorithms will be integrated into a real-time feedback system, complemented by a user-friendly interface that presents analyzed data to the surgeon. The effectiveness of this system will be validated through a series of simulated surgeries, during which feedback from surgeons will be collected to refine the system further and ensure its practical utility in surgical training.

Nature of Thesis
- Literature review: 20%
- Signal processing: 30%
- Real-time user interface: 20%
- Experimental validation: 30%

Requirements
- Knowledge in signal processing
- Software proficiency (python)
- Interest in translational research

Our offer: The candidate will have the unique opportunity to engage in innovative clinical research as part of an interdisciplinary team of scientists, engineers, and physicians. The collaboration partners provide state-of-the-art infrastructure and equipment for the development of biomedical technologies.

Institute: Hearing Research Laboratory, ARTORG Center for Biomedical Engineering Research

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