

Robotic Bone Drilling Assessment

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Background and Motivation

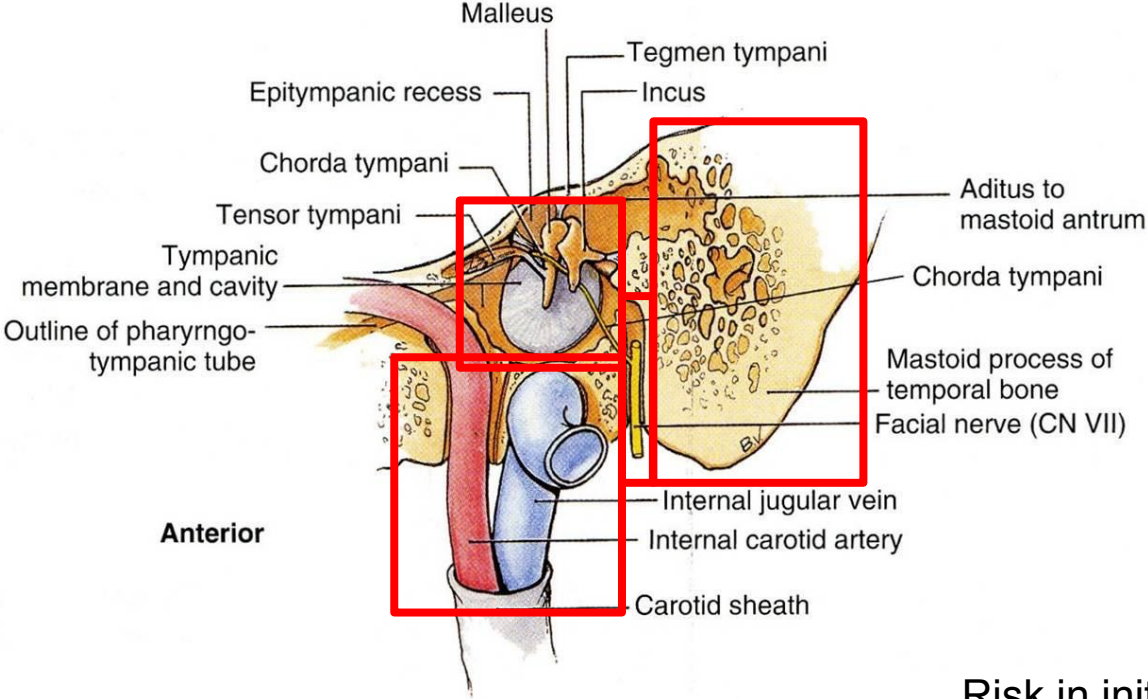


(Video from Department of Otolaryngology and Neurosurgery at George Washington University Medical Center)

Mastoidectomy: Surgery that involves the removal of a portion of the mastoid bone

- To remove diseased mastoid air cells resulting from ear infections
- To approach other structures in the ear (e.g. insertion of cochlear implants)

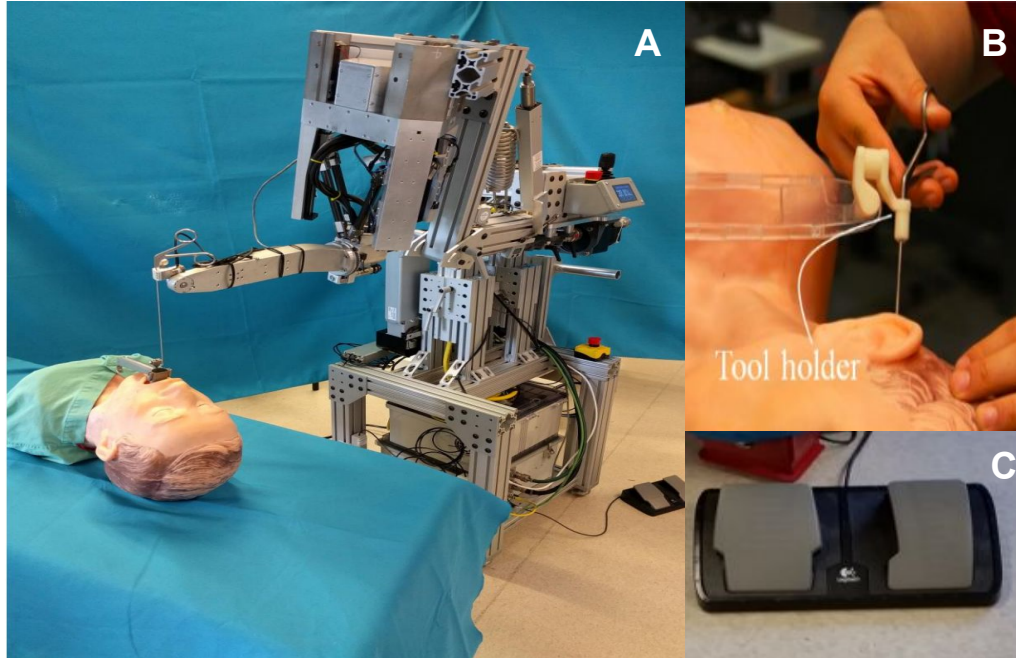
Background and Motivation



(Image from StudyBlue flashcards)

Risk in initial surgery: 1~3%
Risk in revision surgery: 4~10%

Background and Motivation



A) Galen Robot

B) Cooperative control of tools

C) Foot pedal to modulate control gains

Image (a) from Joseph Peine's presentation: Integration of Galen for Otology Applications

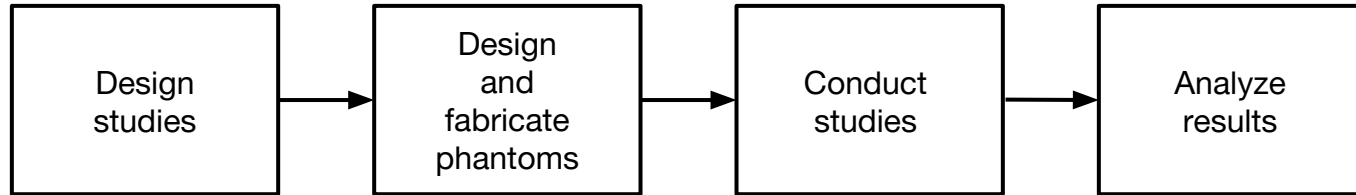
Images (b)(c) from Kevin Old's dissertation: Robotic Assistant Systems for Otolaryngology-Head and Neck Surgery

Goal

Design and conduct experiments to evaluate the performance of the Galen System in the bone drilling procedure

- Safety
- Effectiveness
- Speed

Technical Approach



Three groups of subjects will be tested:

- Laymen (no prior surgical experience)
- Surgeons in training
- Senior surgeons

Three levels of robotic assistance per group:

- No assistance
- Hand tremor elimination
- Hand tremor elimination and virtual fixtures

Deliverables

- Minimum Deliverable
 - Safety Assessment
- Expected Deliverable
 - Effectiveness Assessment
- Maximum Deliverable
 - Speed Assessment

All assessments will be written reports.

Dependencies

- Access to 3D printer to build phantoms
- Access to Galen System/surgical drills/mock OR + robot software
- Recruitment of volunteers for study (laymen, surgeons in training, and senior surgeons)
- Scheduling of mock operations
- Computer vision packages

Management Plan

Shain	Yifan
Design studies	
Monitor studies	
Design and fabricate phantoms	Analyze results
Weekly meetings	

Reading List

Dillon, Neal P., Ramya Balachandran, J. Michael Fitzpatrick, Michael A. Siebold, Robert F. Labadie, George B. Wanna, Thomas J. Withrow, and Robert J. Webster. "A Compact, Bone-Attached Robot for Mastoidectomy." *Journal of Medical Devices* 9.3 (2015): 031003. Web.

Hofer, M., R. Grunert, E. Dittrich, E. Müller, M. Mockel, K. Koulechov, M. Strauss, W. Korb, T. Schulz, A. Dietz, T. Luth, and G. Strauss. "Surgery on the lateral skull base with the navigated controlled drill employed for a mastoidectomy (pre clinical evaluation)." *Medicine Meets Virtual Reality*

Olds, Kevin. *Robotic Assistant Systems for Otolaryngology-Head and Neck Surgery*. Thesis. Thesis / Dissertation ETD, n.d. N.p.: n.p., n.d. Print.

Strauss, Gero, Kirill Koulechov, Mathias Hofer, Elmar Dittrich, Ronny Grunert, Hendrick Moeckel, Eva Müller, Werner Korb, Christos Trantakis, Thomas Schulz, Juergen Meixensberger, Andreas Dietz, and Tim Lueth. "The Navigation-Controlled Drill in Temporal Bone Surgery: A Feasibility Study." *The Laryngoscope* 117.3 (2007): 434-41. Web.