

Robotic Mastoidectomy

Andrei Danilchenko, BS, Jenna L Toennies, MS, Ramya Balachandran, PhD
Stephan Baron, PhD, Benjamin Munske, BS, Robert J Webster III, PhD
Robert F Labadie, MD, PhD

Hypothesis: Using image-guided surgical techniques, we propose that an industrial robot can be programmed to safely, effectively, and efficiently perform a mastoidectomy.

Background: While a mature field with surgical applications in urologic, cardiothoracic and head and neck oncologic surgery, robots have yet to be clinically utilized in otologic surgery despite significant advantages including reliability and precise-repeatability.

Methods: We designed a robotic system that incorporates custom software to an industrial robot Mitsubishi RV-3S (Mitsubishi Electric & Electronics USA, Inc., Cypress, CA) to allow complex path implementation. The software controls the movements of the robot based on real-time feedback from commercially-available Spectra optical tracking system (NDI, Waterloo, Ontario) via the reference markers. We custom-built an end effector to hold a surgical drill. The desired path of the drill was contoured on clinically-applicable temporal bone CT scan using planning software and then exported to the robotic system. Bone-implanted fiducial markers were used to provide registration between CT and physical space.

Results: On 3 phantoms, we drilled the mastoid cavity before moving on to implementation on cadaveric skulls. 5mm fluted ball bits were used for drilling. Drilling was subjectively accurate without violation of any major landmarks (i.e. tegemen, external auditory canal, sigmoid sinus). Video of the robotic drilling will be presented.

Conclusions: To the best of our knowledge, this is the first time that a robot has been used to perform a mastoidectomy. While significant hurdles remain to translate this to clinical use, we have shown that it is feasible.

Acknowledgement: Funded by NIH/NIBIB-R21EB006044-01A1

IRB Approval: N/A

Define Professional Practice Gap: Knowledge about robots

Educational Need: Knowledge about robots

Knowledge

Learning Objective: Feasibility of performing robotic mastoidectomy

Desired Result: Robot performing mastoidectomy

Medical Knowledge