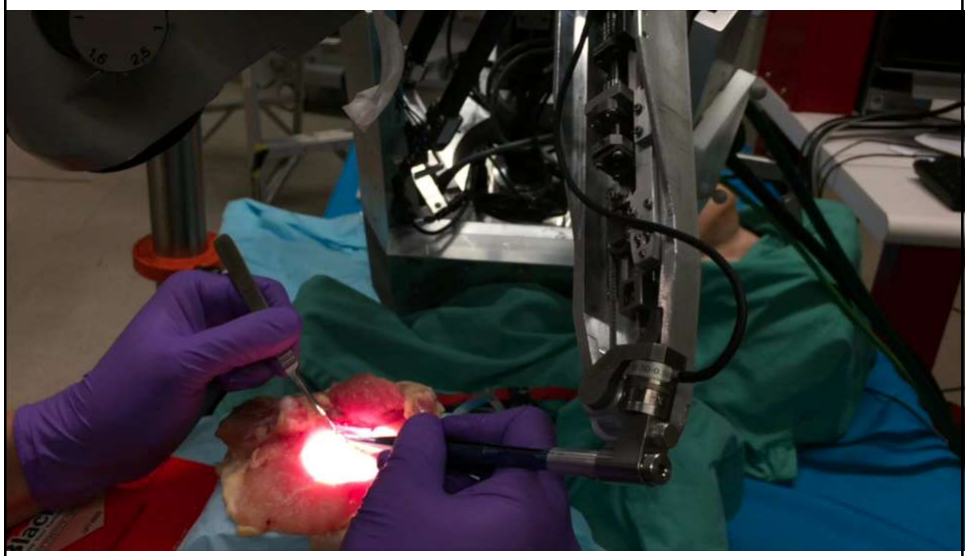
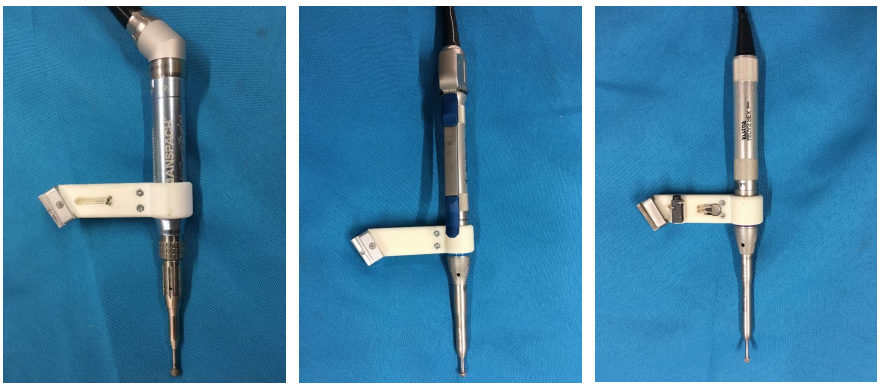
Surgical Instrument for Robotic Open Microsurgery

- **Goal:** Work closely with clinical collaborator to develop novel surgical instruments for robotic vein suturing.
- **What Students Will Do:**
  - Discuss requirements with clinical collaborator
  - Evaluate previous design from last year's CIS 2 project
  - Design solution
  - Fabricate solution
  - Test solution in simple model
  - Iterate design until satisfactory
  - Test in phantom
- **Deliverables:**
  - Completed instrument
  - Design Documentation
- **Size group:** 2
- **Skills:**
  - CAD/CAM
  - Design experience
- **Mentors:** Yunus Sevimli, Dr. Russ Taylor, Dr. Chris Razavi



Surgical Drill Holder with Force Feedback

- **Goal:** The goal is to integrate a "smart" surgical drill into the Galen System. Currently we can mount commercial surgical drills onto the Galen's end effector, allowing the user to have more precision when operating the drill through a cooperative control scheme. This, however, eliminates the natural haptic feedback available when using the drill by hand. This project requires bringing together the benefits of a robot-operated drill while maintaining freehand haptic feedback.
- **What Students Will Do:**
  - Learn about the use of surgical drills in different surgical cases
  - Design a way to integrate a force sensor in or around the drill
  - Fabricate the product
  - Test on phantoms
- **Deliverables:**
  - Completed design
  - Design documentation
- **Size group:** 2
- **Skills:**
  - CAD/CAM
  - Electromechanical design experience
- **Mentors:** Yunus Sevimli, Paul Wilkening, Dr. Russ Taylor, Dr. Matt Stewart



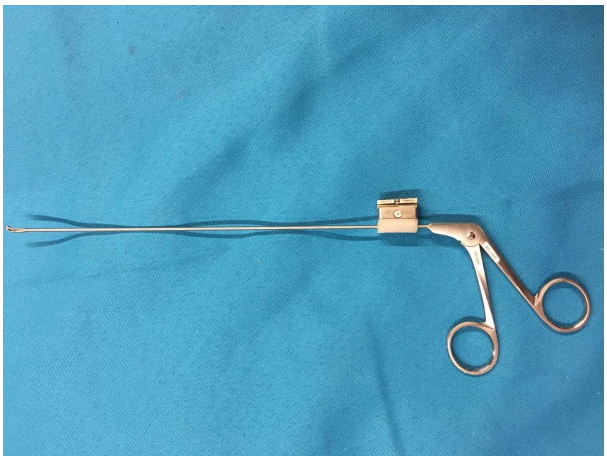
"dumb" drills

Robotic Bone Drilling Assessment

- **Goal:** We can mount commercial surgical drills onto the Galen's end effector, which is expected to increase the precision of the drill cuts. The goal of this study is to quantifiably verify this assertion by designing and conducting studies. An example study could include measuring the depth of each drill pass, maintaining a minimum distance from critical structures, and comparing the evenness of drill passes. An optional component involves developing a virtual fixture for drilling, and comparing it to the results of manual and robot-assisted tests.
- **What Students Will Do:**
  - Observe surgical cases
  - Design studies
  - Design and fabricate phantoms
  - Conduct studies
  - Analyze results
  - Design and program a drilling virtual fixture (robot software component)
- **Deliverables:**
  - Study protocol
  - Phantoms
  - Study results and analysis
- **Size group:** 2 (hardware only) or 3 (with robot software component)
- **Skills:**
  - Imaging Analysis
  - CAD/CAM
  - MATLAB or Python
  - C++ (robot software component)
- **Mentors:** Paul Wilkening, Yunus Sevimli, Dr. Russ Taylor, Dr. Matt Stewart
- **Note:** This could be the start of a good MS or PhD qualifying project

Force Sensing Laryngeal Tool

- **Goal:** The goal is to integrate a "smart" laryngeal tool capable of sensing tool-to-tissue forces into the Galen System. Laryngeal surgery requires grasping the vocal cords with a very long tool that is used for retraction while a cyst is removed. The goal of this project is to place strain sensors on the shaft of the tool, calibrate it, and incorporate the force feedback into the Galen control.
- **What Students Will Do:**
  - Place strain sensors on tool and calibrate it
  - Provide adaptive feedback control (force scaling) and force limiting behaviors
  - Test on phantoms
  - Conduct user study comparing freehand vs robot vs robot+force
- **Deliverables:**
  - Completed design
  - Design documentation
  - Study results
- **Size group:** 2
- **Skills:**
  - Simple mechanical fabrication skills + electrical interfacing skills
  - Programming (C++)
- **Mentors:** Dr. Russ Taylor, Dr. Lee Akst, Yunus Sevimli, Paul Wilkening



"dumb" laryngeal gripper

Robotic Soft Tissue Manipulation Assessment

- **Goal:** The goal of this project is to design and conduct one or more studies that quantifiably assess robotically-assisted soft tissue manipulation. The cases chosen can be from otolaryngology, neurosurgery or general open microsurgery. Examples include nodule dissection, anastomosis, tissue incision or retraction. **Note:** There may be several such projects, using different applications. An optional component involves developing a virtual fixture for the chosen application, and comparing it to the results of manual and robot-assisted tests.
- **What Students Will Do:**
  - Observe and analyze surgical cases
  - Design studies
  - Design and make phantoms and/or custom tools (optional)
  - Conduct studies
  - Analyze results
  - Design and program virtual fixture (robot software component)
- **Deliverables:**
  - Study protocol
  - Phantoms and/or tools (optional)
  - Study results and analysis
- **Size group:** 2 or 3 (with robot software component)
- **Skills:**
  - Computer vision
  - CAD/CAM
  - MATLAB or Python
  - C++ (robot software component)
- **Mentors:** Paul Wilkening, Yunus Sevimli, Dr. Russ Taylor, Dr. Matt Stewart, Dr. Lee Akst, Dr. Chris Razavi
- **Note:** This could be the start of a good MS or PhD qualifying project