Microsurgical Forceps

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Galen Robotics

Introduction

- We designed and fabricated new microforceps to be used with the Galen surgical robot.
- This included creating and prototyping multiple designs prior to our final design.
- While it is fairly easy to adapt already existing tools for use with the Galen, these may not make the best use out of the surgical platform.

The Problem

- When modifying already existing forceps for use with the Galen, the user ends up holding the tool below the robot attachment point.
- This leads to the surgeon running into workspace limits.
- It also results less fine control, as small changes in angle at the tool tip would necessitate large movements of the robot arm

The Solution

- Design new microvascular forceps that allows them to be held by the surgeon above the robot attachment point.
- We took apart existing forceps and cannibalized the jaws and inner sliding rod mechanism.
- We studied existing forceps and evaluated designs for applicability in our situation.
- We created, prototyped, and tested five different gripper and actuator designs before settling on a final, improved design.
- The latest design is now being fabricated out of a stainless steel and bronze composite metal.

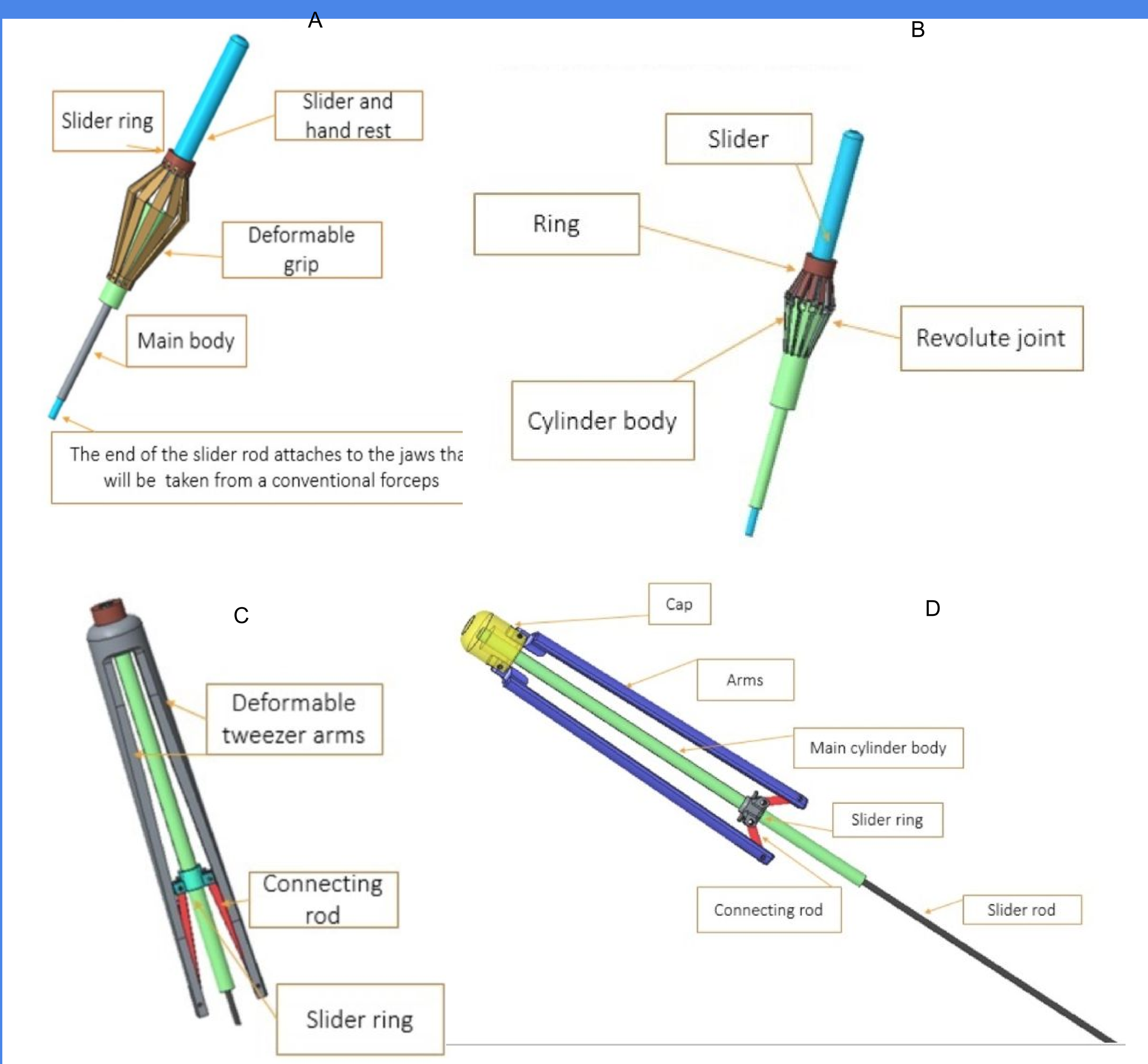

Figure 1. Previous design iterations

S.No	Minimum tool Requirements
1.	Held by surgeon above the robot attachment point
2.	Rotation about own axis
3.	Symmetric / cylindrical profile
4.	Held with either dominant non-dominant hand
5.	Normally-open configuration
S.No	**Additional requirements**
1.	Sterilizable (stainless steel)
2.	Design for Manufacture and Assembly

Table 1. Requirements for a microsurgical forceps

Outcomes and Results

- The plastic prototype of the new tool is easy to actuate and use.
- The new instrument integrates with the Galen and is able to be controlled while attached to the robot.
- Apparent workspace is increased, as the shorter shaft below the robot means small angle changes at the tool tip require less movement of the robot arm.

Future Work

- The stainless steel and bronze composite metal prototype will arrive and be assembled in a week.
- Olivia will be conducting a user study using this instrument to quantify the benefits of using the Galen robot in microvascular anastomosis.

Lessons Learned

- Establish requirements of final product very clearly right from the beginning
- It is okay and sometimes even preferred for the initial design and final product to be very different!
- Order parts and book training well ahead of time
- Engineering and medical mentors may not agree with each other

Credits

- Radhika created the CAD models of the designs. Design creation, manufacturing, and assembly were all shared.

Support by and Acknowledgements

- Core NSF CISST/ERC; Galen Robotics
- Thank you to Dr. Russell Taylor for being an incredible mentor!

S.No	Feature
1.	Cylindrical/Semi-cylindrical shape
2.	Milled for friction
3.	The length of the handle from where it is gripped to the top end must be around 10 cm
4.	5-10 mm diameter of handle
5.	40-100 gm opening/closing force
6.	3:1 - 6:1 mechanical advantage
7.	Grip span no more than 3 inch when fully open
8.	Grip span no less than 1 inch when fully closed
9.	Handle does not rest inside of palm

Table 2. Characteristics of good microsurgical instruments

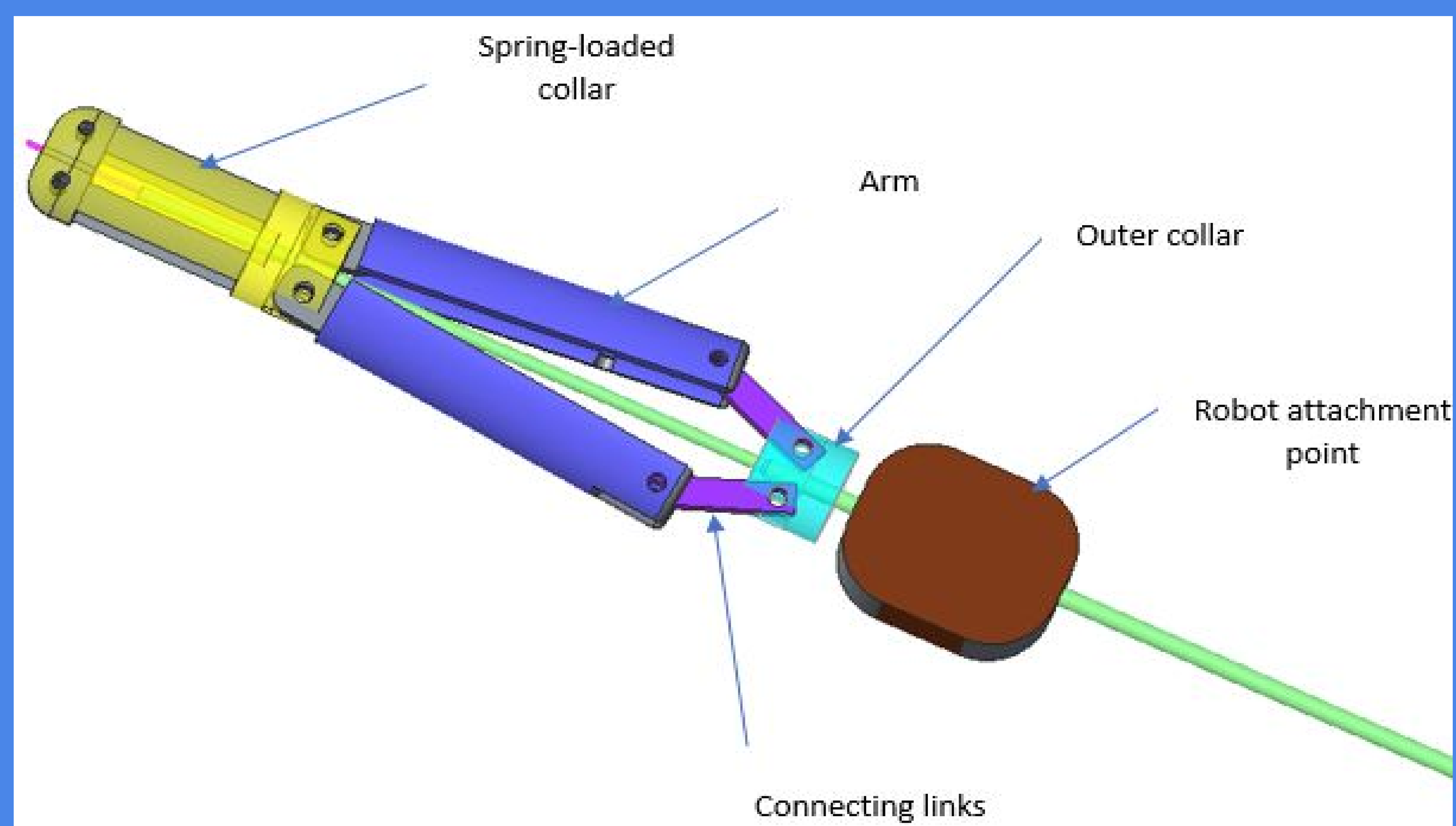

Figure 2. Latest design iterations