Development Of An Atraumatic Flexible Soft Robotic Surgical Retractor

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Background

1. Surgical retractors are paramount for enchancing visibility and improving exposure of operator fields.[1]
2. Clinical gap: Majority of existing surgical retractors are not flexible and the amount of force applied by the retractors is difficult to control. Latrogenic tissue trauma can then result from inappropriate tissue retraction.

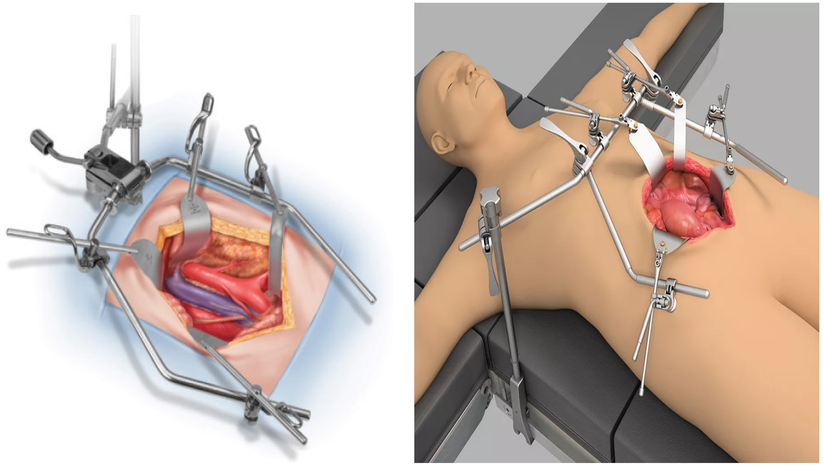


Figure 1: Retractors used in abdominal surgery[2,3]

Objective

We therefore aim to design an atraumatic flexible robotic surgical retractor to reduce the likelihood of tissue trauma during retraction.

The technology



Figure 2: Schematics of the retractor (left) and the retractor without air (middle) and pneumatically actuated with air (right)

1. Soft robotic retractors can conform to the shape of the tissue upon encountering resistance.
2. Novelty: Our soft flexible robotic retractor utilizes a metallic endoskeleton to grant variable resistance properties to the retractor.
3. Pneumatically actuated and self-retaining, freeing up hands of surgeons and assistants.
4. Fabrication: 3D printed using a flexible material.

Methodology

We performed multiple ex-vivo experiments using balloons to simulate intraabdominal organs within a 3D-printed abdominal model. Retractors were moulded into desired positions. Average force and bending angle of the actuator were measured.

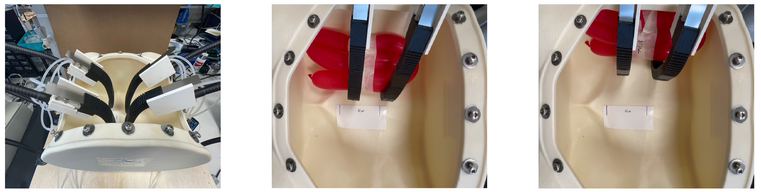
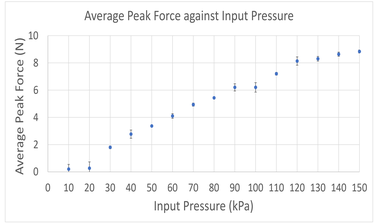


Figure 3: The actuator tested in a simulated abdomen (left) with balloons unactuated (middle) and pneumatically actuated (right)

Results and Discussion



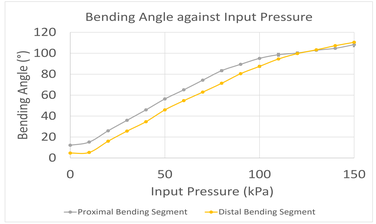


Figure 4: Average force (left) and the bending angle (right) of the actuator

1. Force: Soft flexible retractors can exert forces up to 10N, which translates to approximately retraction of a maximum of 1kg of soft tissue.
2. Bending: The maximum bending angle is 110° distally and 108° proximally

Future Directions

1. Further enhancements to design of retractor to reduce bulkiness of anchoring mechanism and number of pneumatic tubes.
2. Perform animal trials to evaluate effective of robotic retractor as compared to traditional surgical retractors.
   a) Primary endpoint: Retaining position of intraabdominal organs without slippage.
   b) Secondary endpoints: evaluation of tissue trauma via histological examination

Conclusion

We believe that our soft flexible robotic retractor will enable surgeons to perform surgery without worry of iatrogenic tissue trauma, with the additional benefit of freeing up assistants' hands for more crucial tasks.

References

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