



Liver Retractor for Single Incision Laparoscopic Surgery

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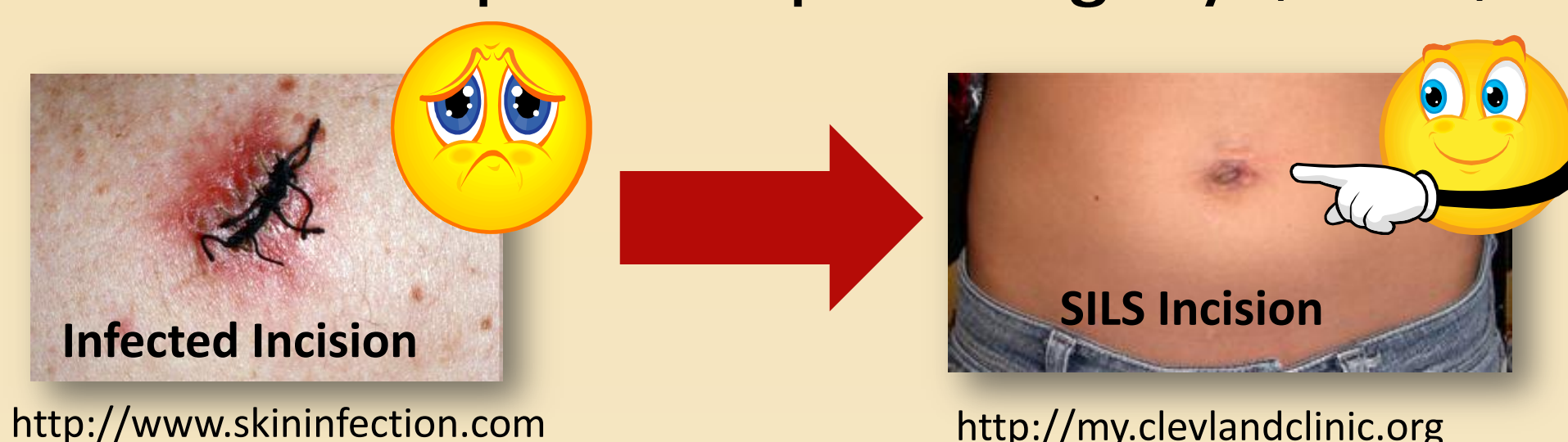
Abstract

A deployable liver retractor was developed to allow Single Incision Laparoscopic Nissen Fundoplications to be performed. The shape of this device was validated in a pig lab. Subsequently, an adequate hinge design was developed to allow for the insertion of this device through a laparoscopic port.

Problem Definition

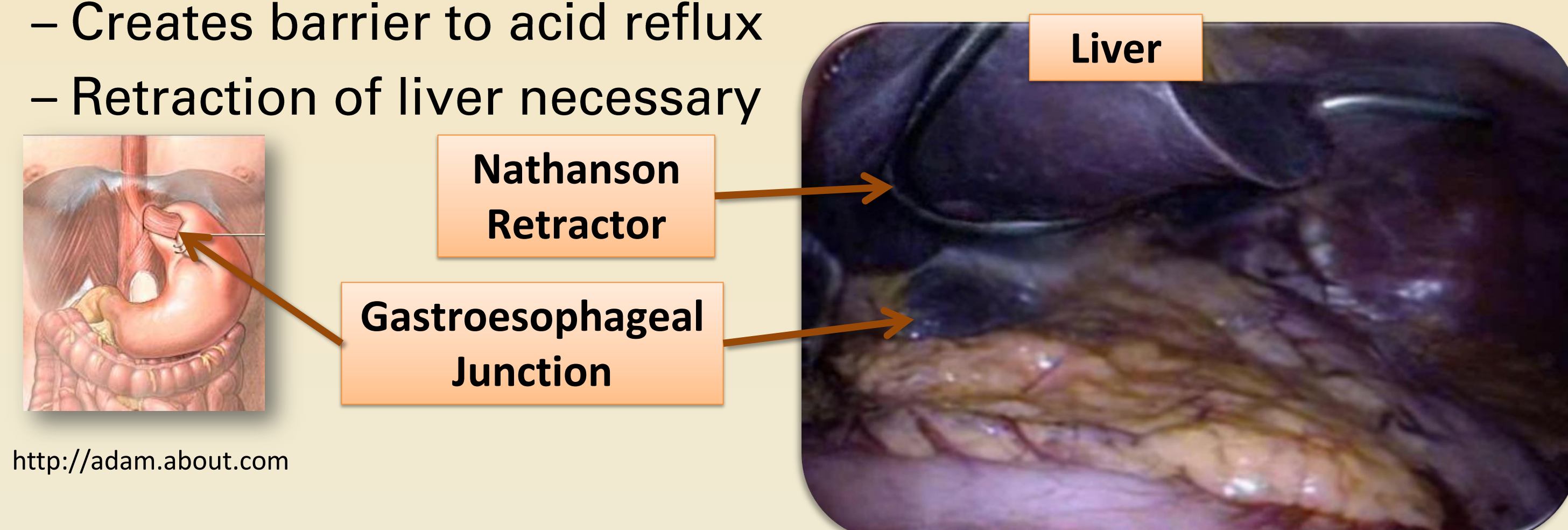
Motivation: Single Incision Laparoscopic Surgery (SILS)

- Decrease number of incisions
 - Cosmetic
 - Less risk of infection
 - Patient satisfaction



Procedure: Nissen Fundoplication

- Treats gastroesophageal reflux disease
 - Creates barrier to acid reflux
 - Retraction of liver necessary



Current Method: Nathanson Retractor

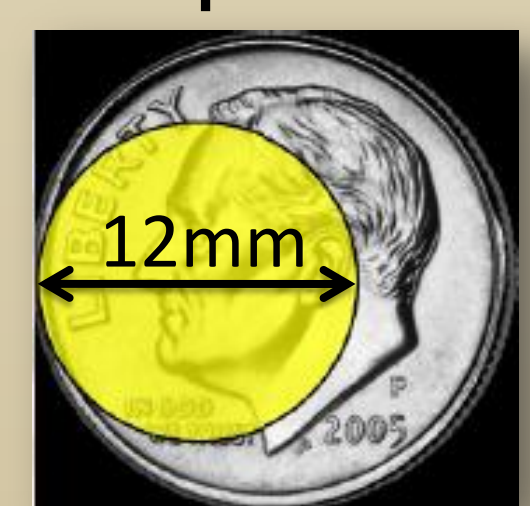
- Cannot be done as SILS: Requires an additional incision

Problem Statement:

This device is to be used for liver retraction during a SILS Nissen fundoplication. It should retract the left liver lobe of the liver to expose the gastroesophageal junction, allowing for free access to the stomach and esophagus. The device needs to be deployed and removed through a 12mm laparoscopic port.

Design Criteria

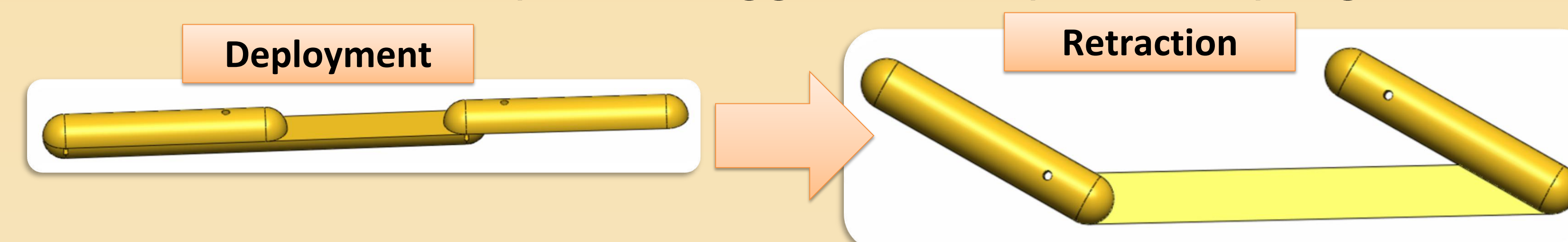
- Expose entire gastroesophageal junction
- Under 5 minute deployment
- Distribute weight of liver
- Fit through 12 mm port
- Biocompatible
- Sterilizable



Retractor Design

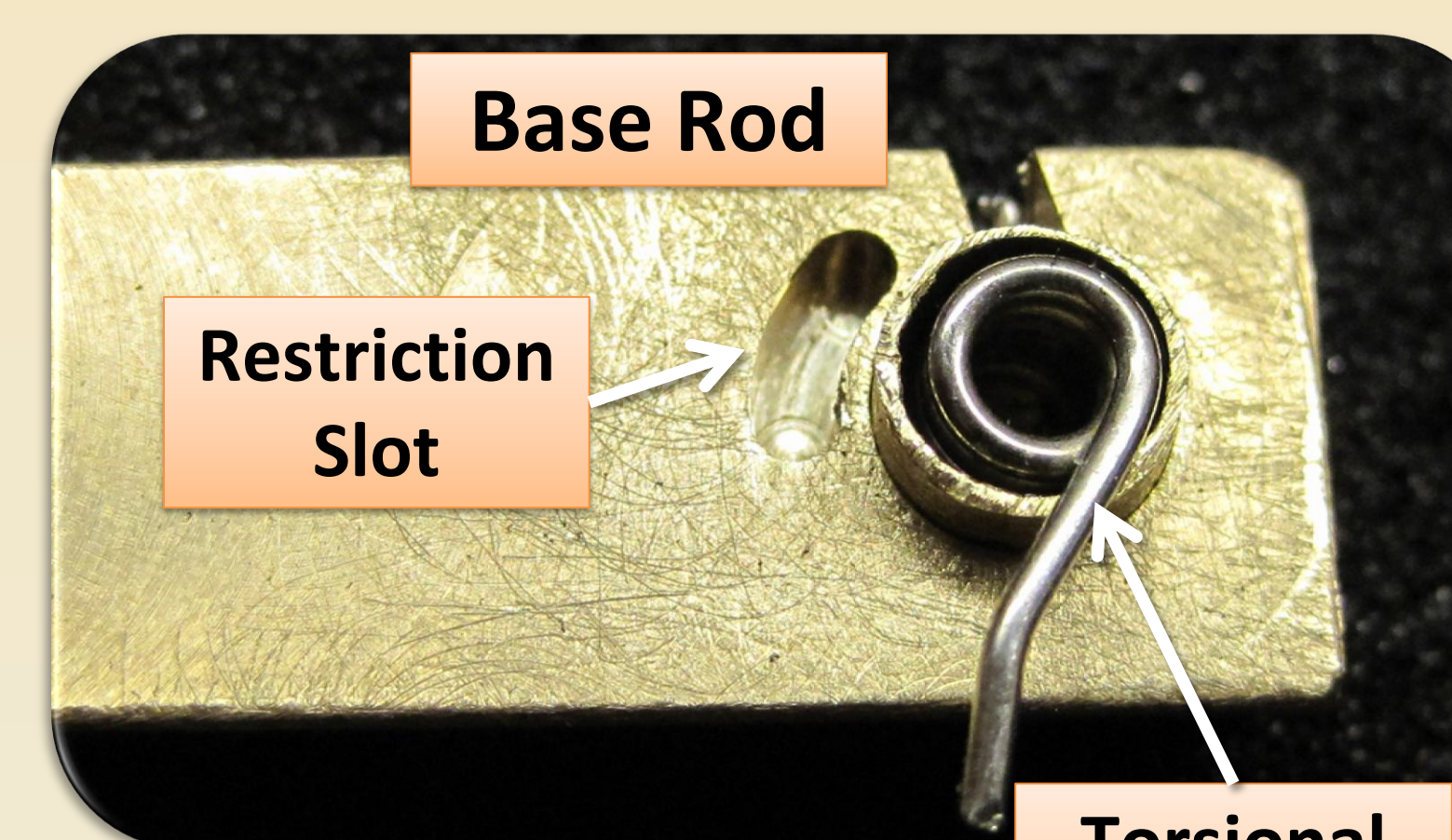
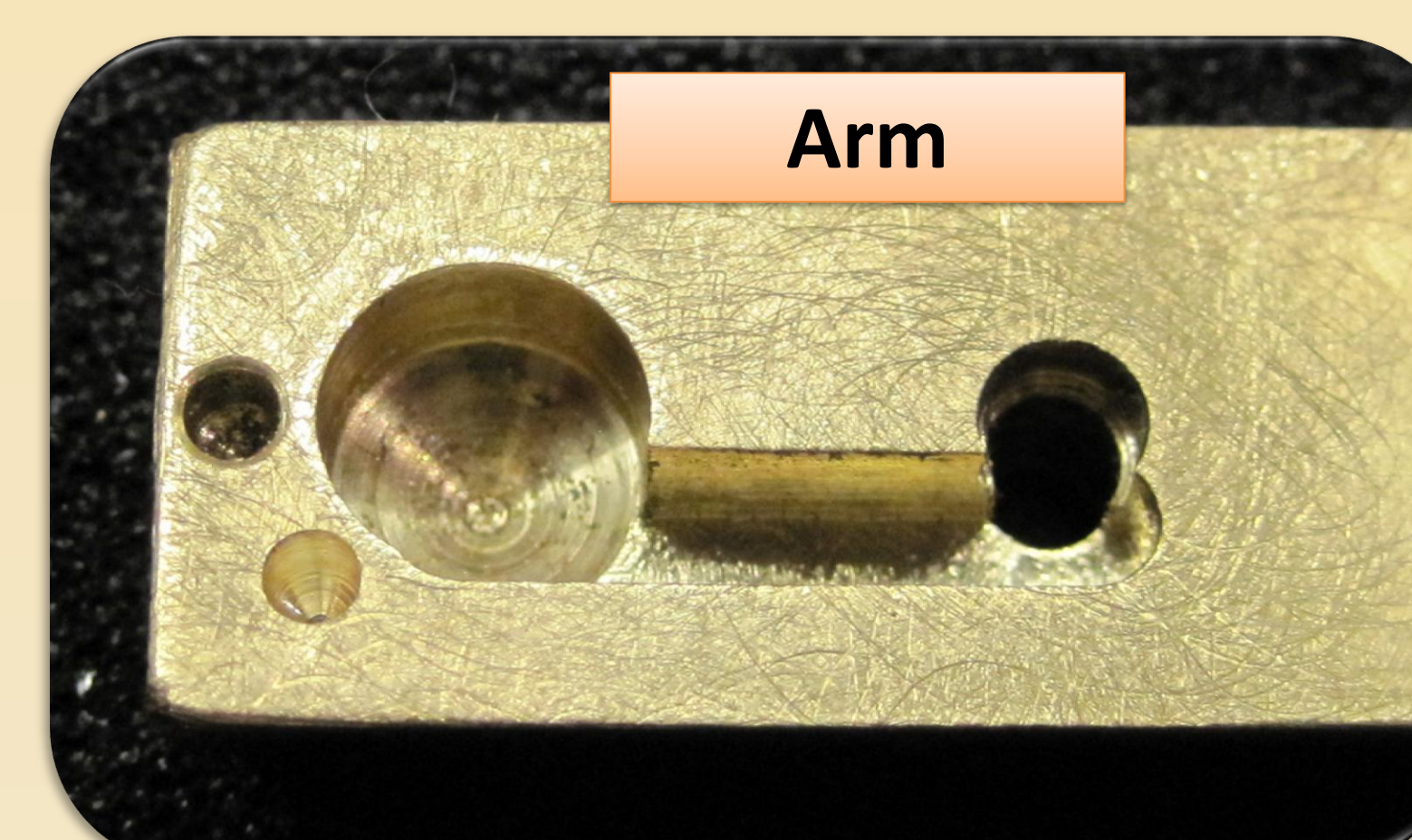
Previous Work

- Angles set to 45° and 135° degrees for optimal load distribution and retraction
- Suture attachment points staggered to improve torque generation



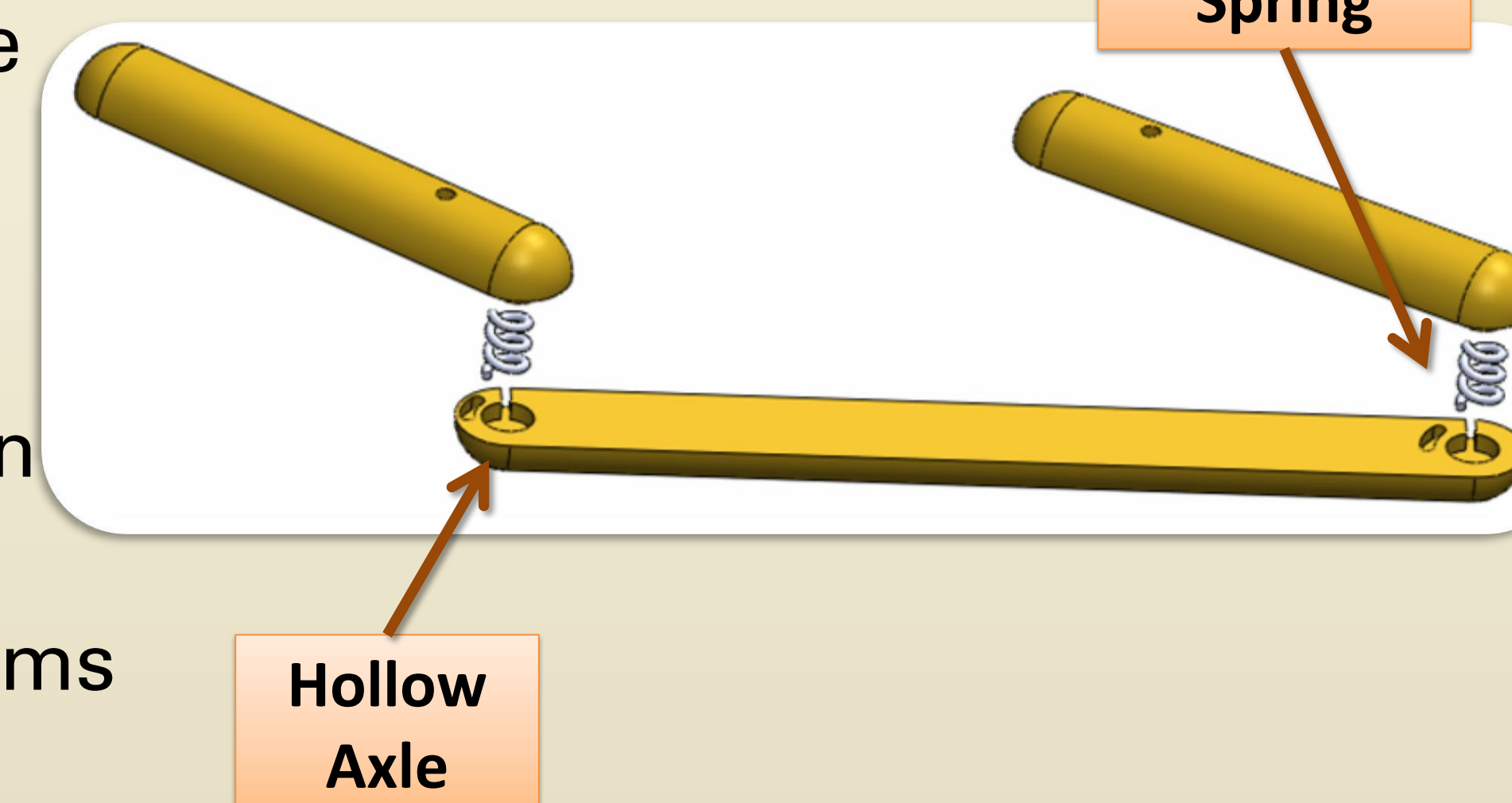
Modifications

- Torsional spring loaded hinge
 - Allows rotation of arms between retraction and deployment positions
- Peg – slot stopping mechanism
 - Peg slides in slot track when arms rotated
 - Maintains arms in 45° and 135° retraction positions



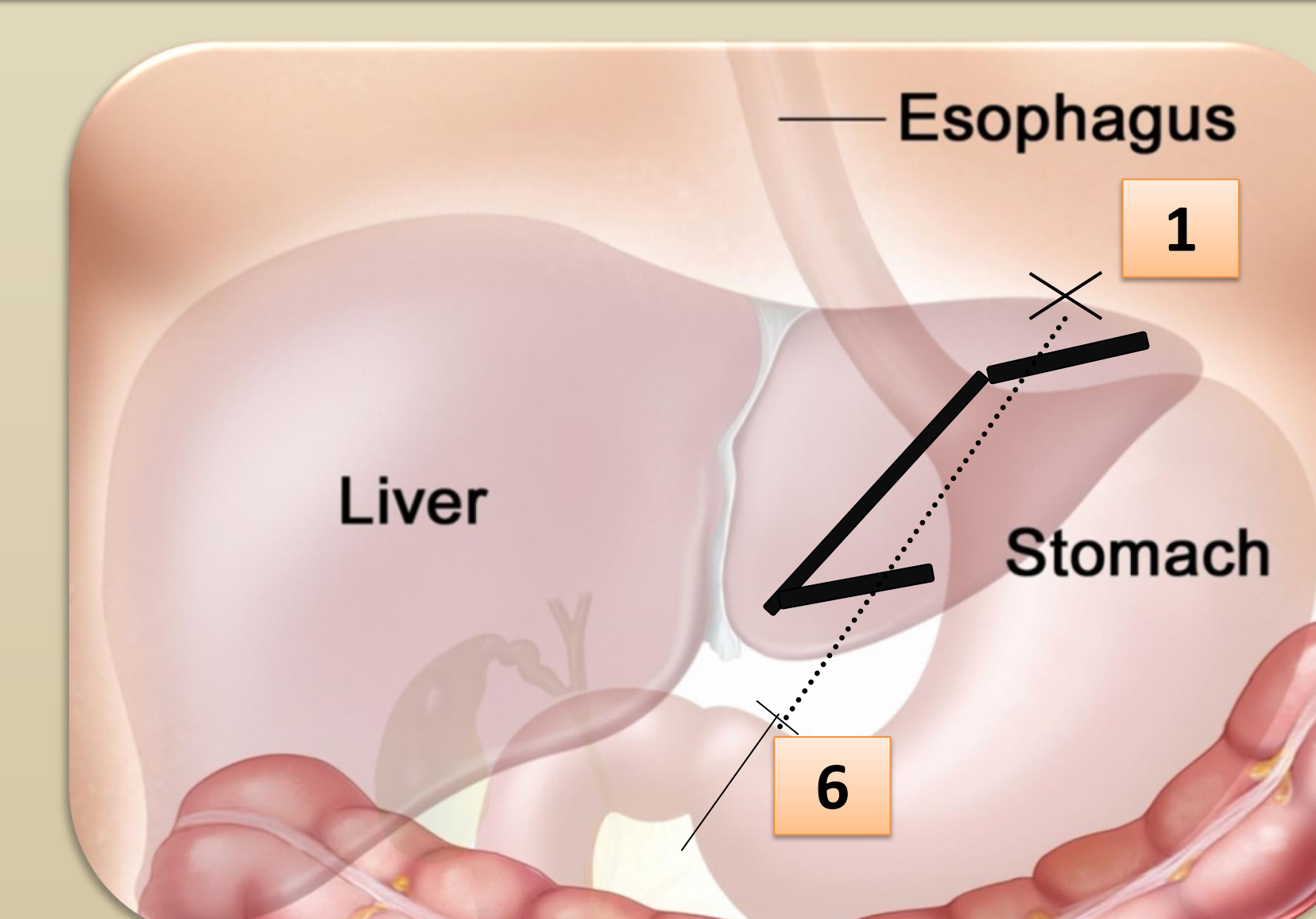
Current Design

- Hollow cylinder axle
 - Torsional spring inside connecting arm to base
 - Transfers liver force to the cylinder
- Deployment
 - Straight arms
 - Torsional spring in tension
- Retraction
 - Tension release rotates arms
 - Spring relaxed



Deployment Procedure

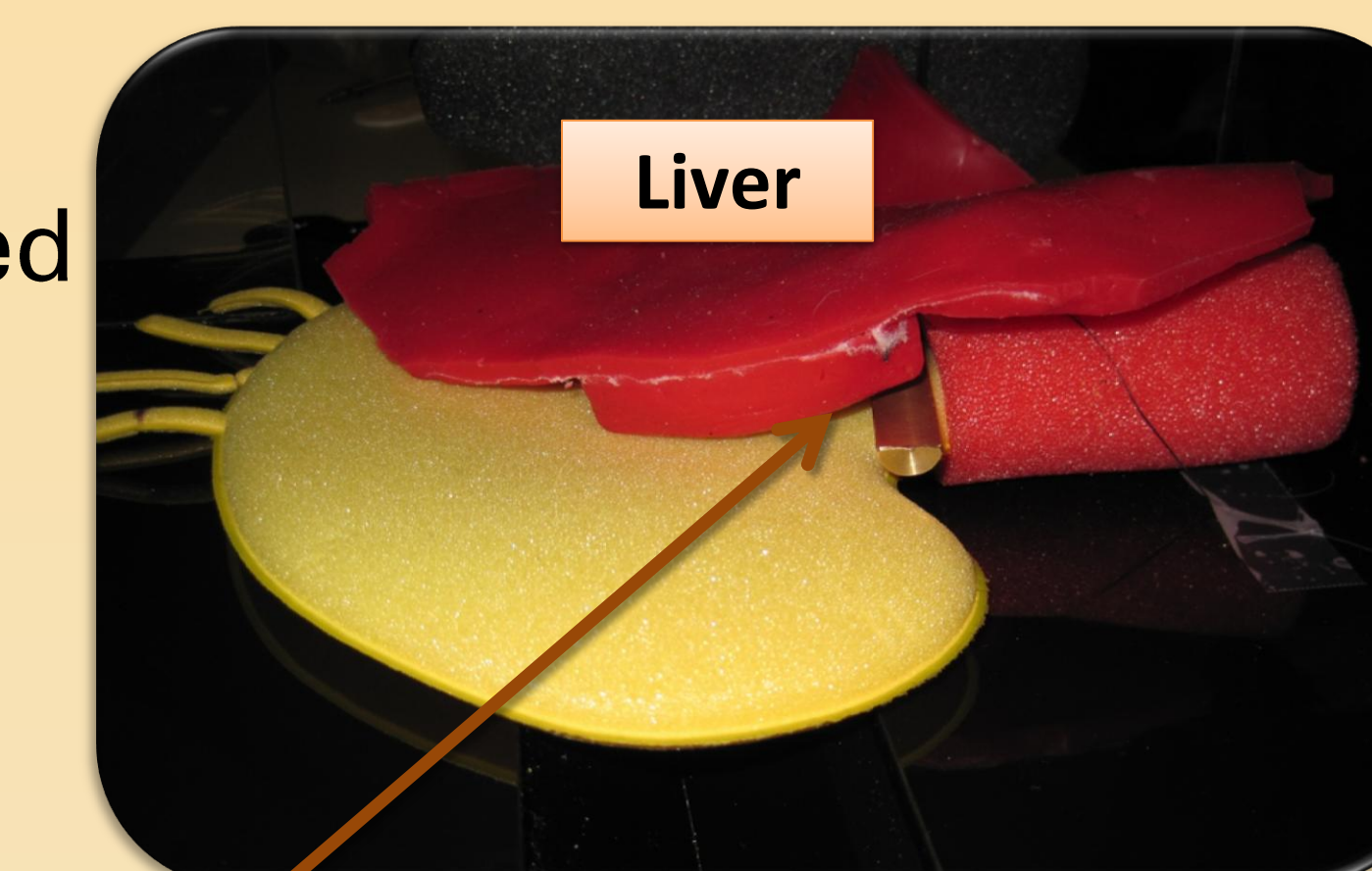
1. Attach suture to left crus
2. Thread suture through retractor
3. Insert retractor
4. Deploy retractor
5. Move retractor under liver
6. Pass suture out abdominal wall
7. Apply tension to retract liver



Testing

Size & Shape

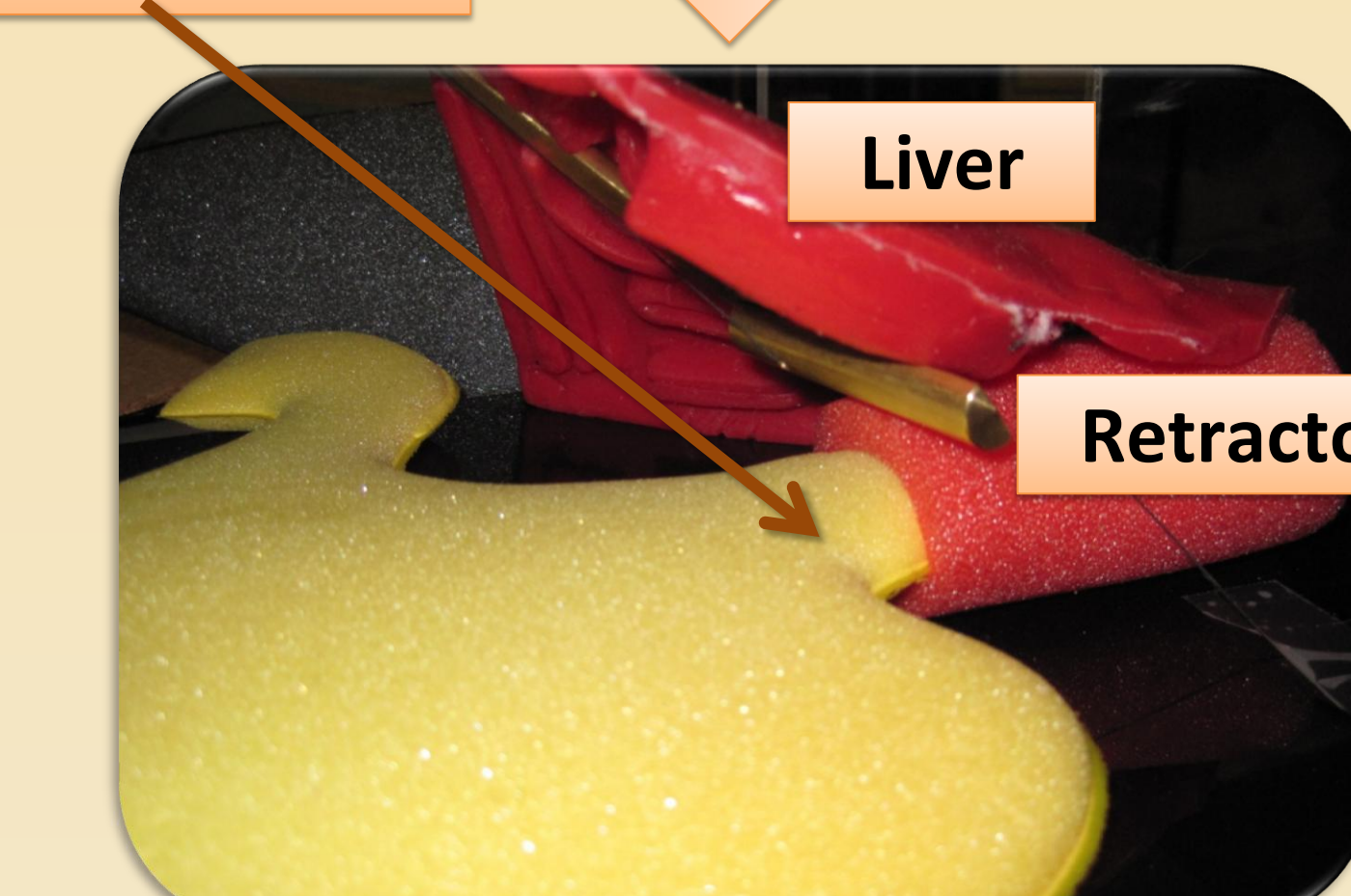
Retractor successfully inserted and retrieved through actual 12mm SILS port



Retraction

- Mock organs selected
 - Stomach (yellow)
 - Esophagus (red)
 - Liver (red, floppy)
- Sutures were attached
- Force applied lifted floppy liver, exposing the gastroesophageal junction

Gastroesophageal Junction



Future Work

- Create biocompatible version of device
 - Single-use versus multiple-use
 - Select material for device
- Quantify field of view provided by device
- Improve maneuverability with laparoscopic tools
- Develop suture attachment protocol
 - Pre-attach suture to retractor for internal deployment
- Address liver variability concerns

References

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