Liver Retractor for Single Incision Surgery

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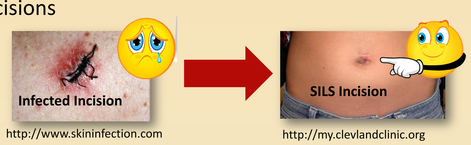
Abstract

A deployable liver retractor was developed to allow Single Incision Laparoscopic Nissen Fundoplications to be performed. After testing the prototype in a pig, the design was modified to improve the efficacy of the device. An adjustable locking hinge will also be implemented. These changes will be incorporated and the modified prototype assessed.

Problem Definition

Motivation: Single Incision Laparoscopic Surgery (SILS)

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

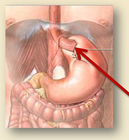


http://www.skininfection.com

http://my.clevlandclinic.org

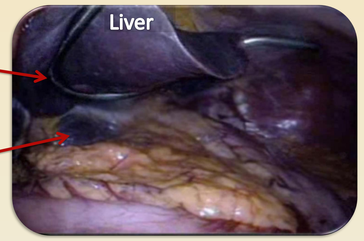
Procedure: Nissen Fundoplication

- Treats gastroesophageal reflux disease
  - Top of stomach wrapped around esophagus
  - Creates mechanical barrier to acid reflux
  - Retraction of liver necessary


http://adam.about.com

Nathanson Retractor

Gastroesophageal Junction



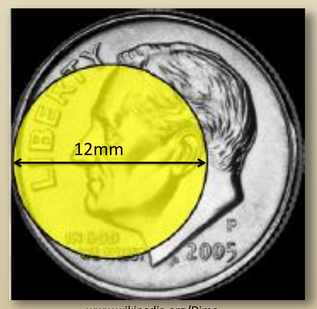
Problem Statement:

This device is to be used in SILS procedures such as Nissen fundoplication, a process that wraps a portion of the stomach around the esophagus. It should retract the left liver lobe to expose the gastroesophageal junction, allowing free access to the stomach and esophagus. It should be capable of being both safely deployed and removed through a 12mm laparoscopic port.

Design Criteria

- < 5 minute deployment
- Expose entire gastroesophageal junction
- Distribute weight of liver
- Fit through 12 mm port
- Non-toxic
- Sterilizable
- Deploy and remove safely

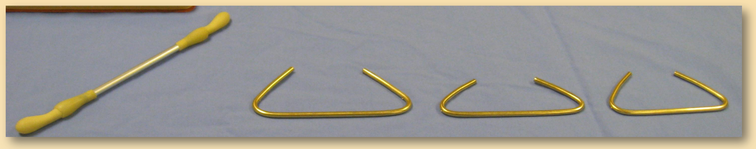

http://www.covidien.com



www.wikipedia.org/Dime

Testing Procedure

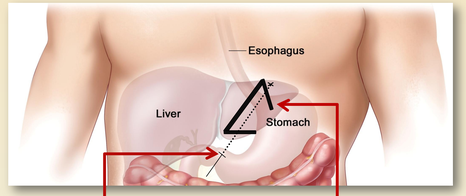
Liver Retractor Prototypes:



Prototype	Middle Section Length	Arm Angles
A: Deployment Mechanism	12.5 cm	90
B	13.7 cm	47
C	13.3 cm	38
D	12.0 cm	47

Deployment Procedure:

1. Attach suture to left crus
2. Thread suture through retractor
3. Insert retractor through 12 mm port
4. Deploy retractor arms
5. Position retractor under liver
6. Pass suture out abdominal wall
7. Apply tension to suture to retract liver
8. Clamp suture



http://www.meb.uni-bonn.de/cancer.gov

Suture Attachment Point: Left Crus

Suture Exit Point: Abdominal Wall

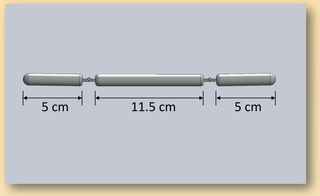
Results

- Middle Section Length
  - 13.7 cm retractor too long
  - Can adjust abdominal wall suture attachment point for varying lengths
- Arm Angles
  - 47 on abdominal side, >90 on crus side
  - Left lobe of liver extends beyond left crus
- Suture Attachment Points
  - Arms rotated downwards with sutures attached at each joint
  - With sutures attached further up arms
    - Retraction force improved
    - Torque remained sub-optimal

Modified Design

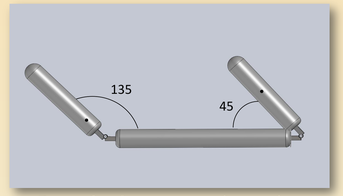
Changes Made:

- Middle section set to 11.5 cm
  - Longer than 10 cm Red Rubber Robinson
  - Short enough to fit inside abdominal cavity



Pre-deployment orientation

- Angles set to 45 and 135 degrees
  - Optimizes retraction
- Staggered suture attachment points on device
  - Due to location of left crus
  - Improved torque generation



Post-deployment orientation
(Dots = suture attachment points)

Future Work

- Refine/test deployment mechanism
- Develop suture attachment protocol
  - Pre-attach suture to retractor for internal deployment
- Finalize device length
- Implement adjustable locking hinge for adjustable angles
- Evaluate modified design

References

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