# Identification Marking of Laparoscopic Instruments for Video Recording

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## ABSTRACT

A side effect of quality teaching methods, are students who perform the concepts they've learned at a high level. A higher surgery success rate generally correlates with physicians who are better trained. Laparoscopic surgeries require the use of a camera to serve as the surgeon's eyes, and recording of the surgery is often used to evaluate a resident's performance. Our client is requesting that we design an accessory-marking device to the 5 mm diameter laparoscopic instrument, so that when a teaching physician and resident are operating simultaneously, their instruments can be distinguishable on screen both during and post-surgery.

## BACKGROUND

- Laparoscopic surgery, otherwise known as minimally invasive surgery or keyhole surgery, was first implemented on humans in 1910 by Swedish physician Hans Christian Jacobaeus [2]
- Requires 3 - 4 small incisions of 5 mm to 10 mm
- Benefits include shorter recovery time than traditional open surgery and minor scarring [2]

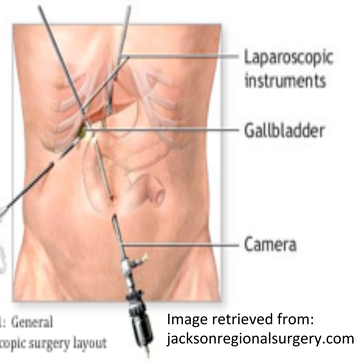


Figure 1: General laparoscopic surgery layout

Image retrieved from: jacksonregionalsurgery.com

- A 5 mm diameter trocar, otherwise known as a port, is placed through each incision and can pass an instrument with about 1 mm to spare on each side
- Commonly used for surgeries in abdominal area as shown in Figure 1
- Reduces risk of hernia development
- The laparoscopic instrument consists of a handle with a trigger like mechanism, connected to a various sized diameter shaft with lengths ranging from 28 cm to 36 cm
- A variety of tips are used as illustrated in Figure 2, some with cutting function, and others with grasping function


Figure 2: Variety of tip shapes and sizes used in laparoscopic surgeries.
Retrieved from: www.laparoscopyhospital.com/Laparoscopic_Instrument_Detail2.doc

## DESIGN CRITERIA

- Device must be sterile and made out of a biocompatible material
- If deemed reusable, must withstand sterilization processes a series of enzyme baths and steam heating up to 132° C
- Cannot deviate from pre-surgery position or interfere with any moving instrument mechanism as shown in Figure 3

Figure 3: Region of attachment for marking device.

- To be introduced into the body, the device needs to be made radiopaque so it is visible on X-Ray should it fall off in the body
- Maximum thickness of 1 mm to fit through trocar
- Material cannot absorb heat while surgeon is cauterizing

## PRELIMINARY RESEARCH

- Determined materials to be used for each design based on biocompatibility
  - Acrylonitrile Butadiene Styrene (ABS)
  - Acrylated Olefin
  - Silicone
- Explored options of making the device radiopaque – barium sulfate

Figure 4: Removal of a gallbladder involving simultaneous instrument operation

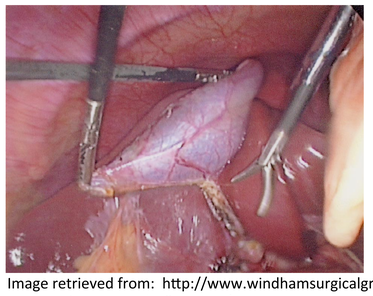

Image retrieved from: http://www.windhamsurgicalgroup.com/services_Laparoscopic_Surgery.php

## MOTIVATION

- As shown in Figure 4, it is difficult to distinguish one instrument from another while operating simultaneously in the body
- Previous attempts at marking the instruments failed
- No current solutions to problem on market

REFERENCES
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[2] "Laparoscopic Colon Surgery : Laparoscopic Colon Resection." *Comprehensive Center for Laparoscopic Surgery -- White Plains, New York*. Web. 12 Oct. 2011. http://lapsurg.org/colon.html.
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[4] "What Is Laparoscopic Surgery." *Center for Pancreatic and Biliary Diseases*. University of California, Department of Surgery. Web. 12 Oct. 2011. <http://www.surgery.usc.edu/divisions/tumor/pancreasdiseases/web%20pages/laparos copic%20surgery/WHAT%20IS%20LAP%20SURGERY.html>.
[5] "FDA Approved Plastics Materials - Order Online." *Plastic Sheet, Plastic Rod, PlasticTubing - Buy Online*. 2011. Web. 16 Oct. 2011. http://www.professionalplastics.com/FDAApprovedPlasticMaterials.

## FINAL DESIGNS

Snap Clamp

- Constructed of acrylonitrile butadiene styrene (ABS).
- Dimensions are 2.5 cm long by 0.5 mm thick with a 315° revolution
- Production cost per piece - $3.00 via rapid prototyping
- White for visible contrast and minimal distraction
- Radiopaque thread glued on inner radius
- One-time use – material loses compression force after several applications
- Disposable

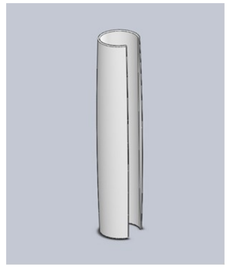

Figure 4: SolidWorks rendering of the Snap Clamp Design.

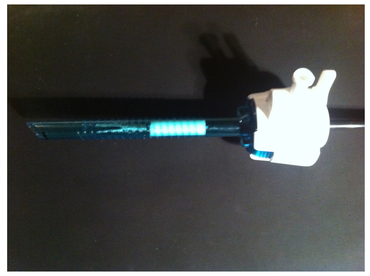

Figure 6: Snap clamp design entering trocar

Heat Shrink Wrap

- Medical grade heat shrink tubing made of acrylated olefin
- 4 cm long by 0.64 mm thick
- Shrinks in boiling water
- Proposed application for the OR staff uses hot water bath
- Minimal resistance through trocar as illustrated in Figure 8
- Radiopaque thread shrink compressed between wrap and shaft
- Colored white to ensure visibility with minimal distraction
- Requires 45 seconds in water bath and 3 minutes of drying time
- Disposable

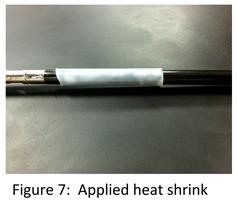

Figure 7: Applied heat shrink wrap

Figure 8: Heat shrink wrap design entering trocar

## FUTURE WORK

- Further explore injection molding options, and other materials
- Design sterile packaging for the mass produced product
- Addition of barium sulfate to ABS before molding
- Find radiopaque heat shrink tubing
- FDA validation

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