




# SILS & NOTES

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# Overview

- 
- Introduction to SILS
  - Nomenclature and ideology of SILS
  - SILS experience at Imperial
  - Introduction to NOTES
  - Potential benefit of the technique
  - Current systems/tools/devices and limitations
  - Requirements for future tools and overview of some specialised operating platforms including current research at Imperial

# Single Access Surgery

## Port Access:

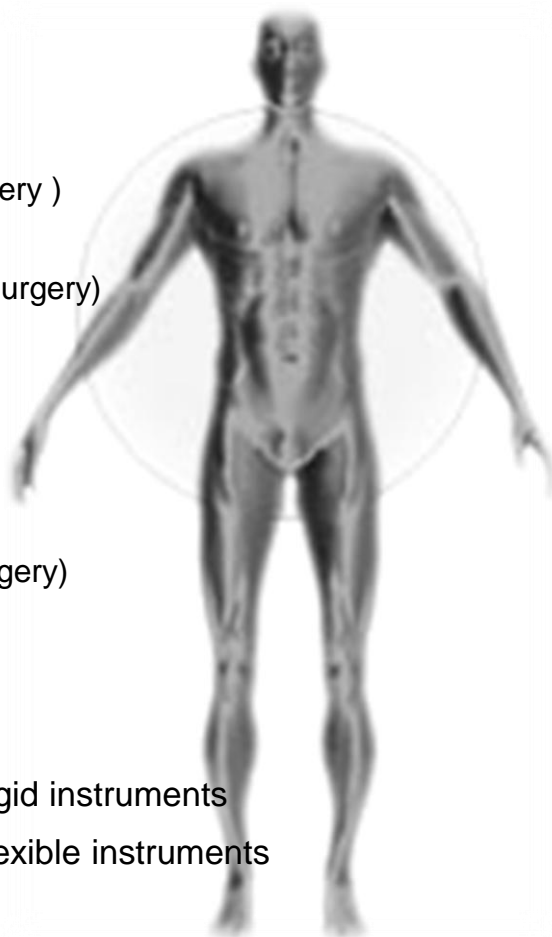
- SPA / SPLS  
(Single Port access)
- TUES  
(Transumbilical endoscopic surgery )
- NOTUS  
(Natural Orifice Transumbilical Surgery)

## Incisional Access:

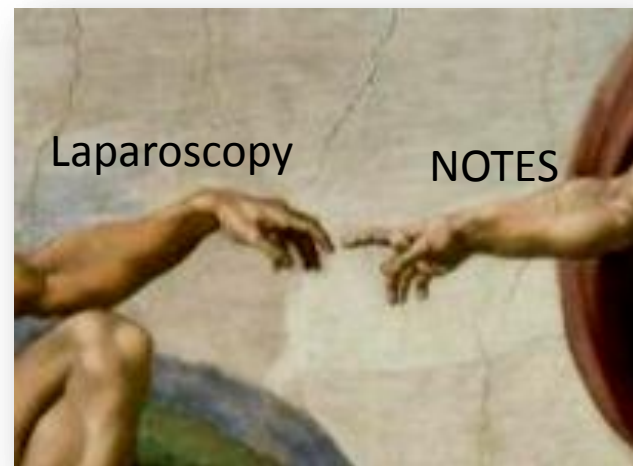
- SILS  
(Single incision laparoscopic surgery)

## NOTES Access:

- Transvaginal Surgery using rigid instruments
- Transluminal Surgery using flexible instruments



Has been described as **e-NOTES**  
(Embryonic-NOTES)





# Nomenclature

- **SILS**                      **Single incision laparoscopic surgery**
- LESS                      Laparoendoscopic single-site surgery
- SAS                      Single-access site laparoscopic surgery
- SSA                      Single-site access laparoscopic surgery
- OPUS One-port umbilical surgery
- **SPA**                      **Single Port Access surgery**
- U-LESS                      Transumbilical laparoendoscopic single-site surgery
- TUES                      Transumbilical Endoscopic surgery
- TULA                      Transumbilical laparoscopic assisted surgery
- NOTUS                      Natural orifice transumbilical surgery
- e-NOTES                      Embryonic natural orifice transluminal endoscopic surgery
- **NOTES**                      **Natural Orifice Transluminal Endoscopic surgery**
- **FAS**                      **Flexible Access Surgery**



# Single Incision Laparoscopic Surgery

Open Surgery  
1 large incision



Laparoscopy  
3 to 5 small incisions



LESS Surgery  
1 small incision



Reduction of invasiveness through progress in surgery.



# Old Concept - revived ideas!

- Matsuda T et al. Smaller ports result in shorter convalescence after laparoscopic varicocelectomy. J.Urol 1995; 152:1175-1177
- Esposito C. One-trocar appendectomy in paediatric surgery. Surg Endosc 1998; 12:177-178.
- Piskun G. Transumbilical laparoscopic cholecystectomy utilizes no incisions outside the umbilicus. J Laparoendosc Adv Surg Tech A 1999; 9:361-364.
- Cheah WK. Randomised trial of endoscopic versus laparoscopic cholecystectomy. Br J Surg 2001; 88:45-47.
- Kagaya T. Laparoscopic cholecystectomy with two ports using the "Twin-Port" system. J Hepatobiliary Pancreat Surg 2001; 8:76-80.
- Pappalepore N. Transumbilical laparoscopic-assisted appendectomy (TULAA): a safe and useful alternative for uncomplicated appendicitis. Eur J Pediatr Surg 2002; 12:383-386.
- Cuesta MA. The "invisible cholecystectomy": A transumbilical laparoscopic operation without a scar. Surg Endosc 2007
- Zhu JF. Scarless endoscopic surgery: NOTES or TUES. Surg Endosc 2007; 21:1898-1899.

# The single-incision approach



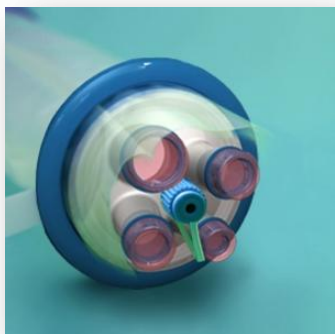
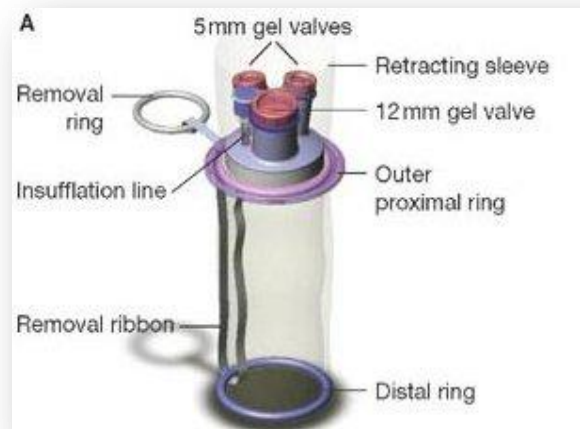


■ Omniport™ (Advanced surgical concepts)

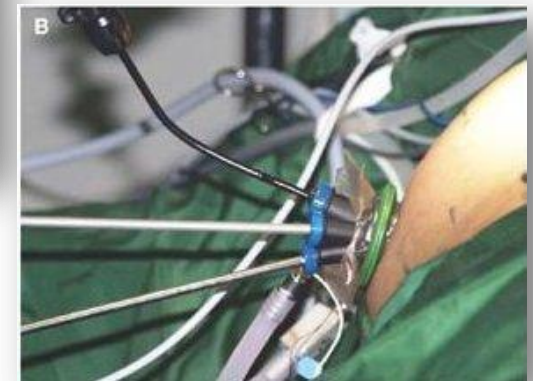




- Triport™ (Advanced surgical concepts (ASC))



- Quadport™ (ASC)



# Single access instruments

## Problems with SPA:

- ⌘ Clutter of hands externally.
- ⌘ Inadequate Triangulation.



## Overcome through:

- Using instruments of differing lengths
- Using Innovative controllably flexible instruments



## Single access Instruments

- **Real Hand™** - High Dexterity Grasper for Single Port Surgery (Novare Surgical Systems)



- **Autonomy™ Laparo-angle™**  
(Cambridge Endo (US))

- 5mm instruments
- Distal Tip bends up, down or sideways when manoeuvring the handle appropriately.
- Axial rotation using wheel.

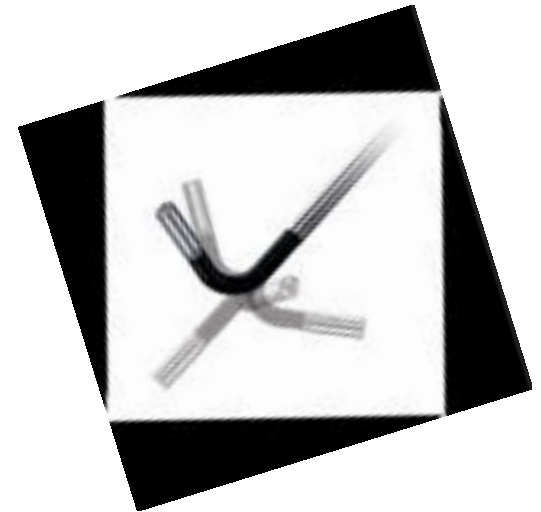


# Olympus VISERA

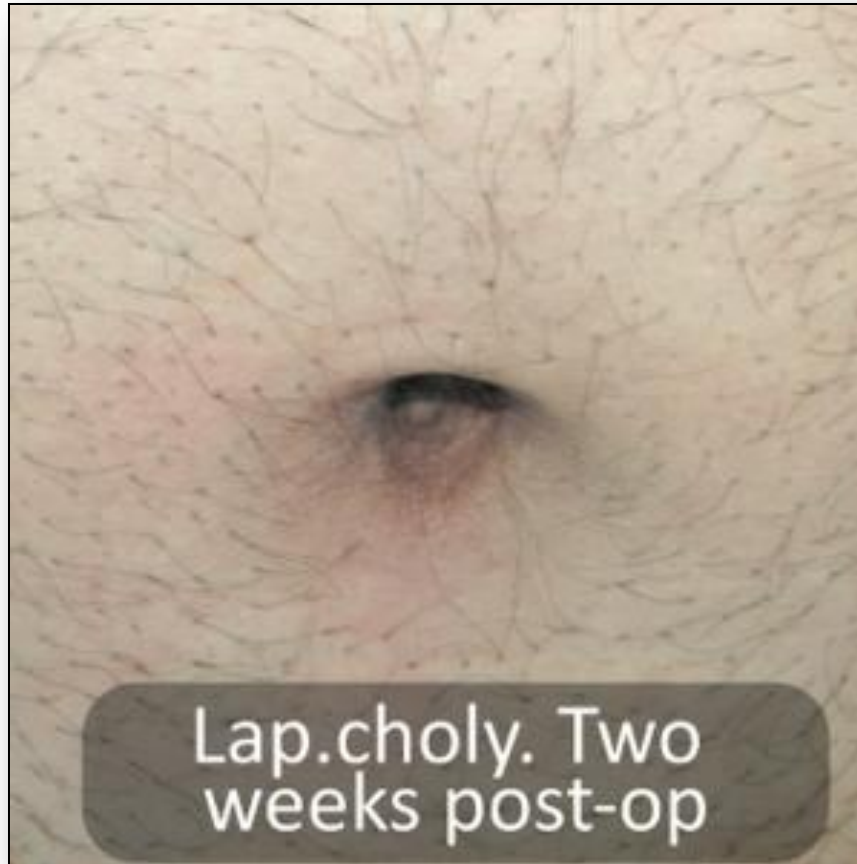
## *Laparo-Thoracico-Visoscope LTF Type VP Camera*



- The VISERA laparoscopic video camera is 5mm in diameter.
- The device is capable of angling 100 degrees in four directions.



# Outcome





# Rationale

## Advantages

- Limited scarring – claim of no visible scarring
- Reduced tissue trauma to abdominal wall reflecting recovery times post op

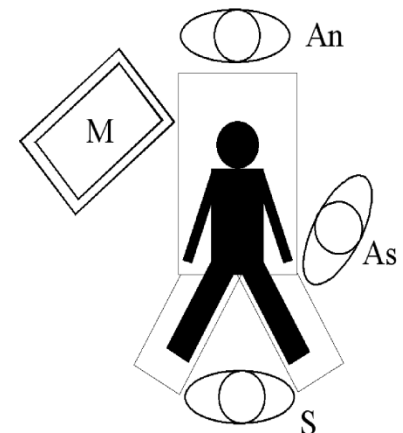
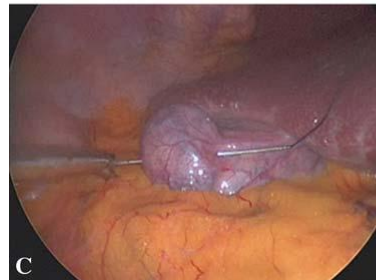
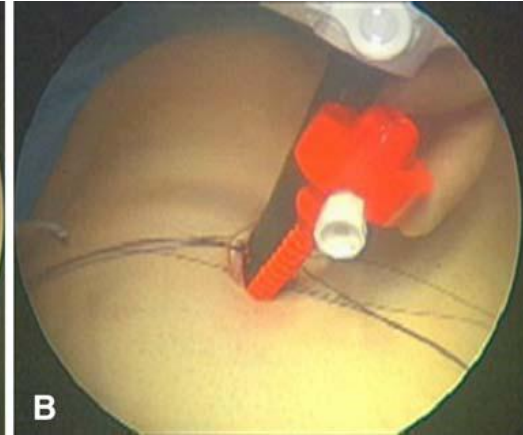
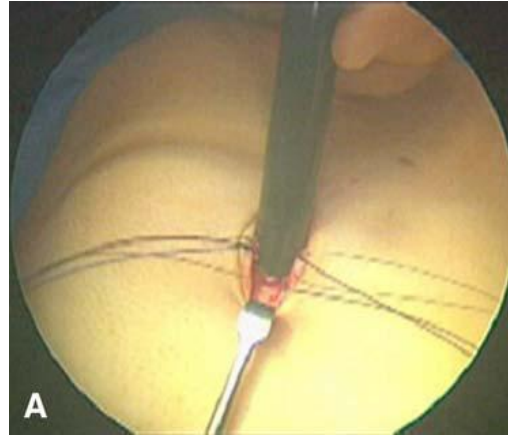
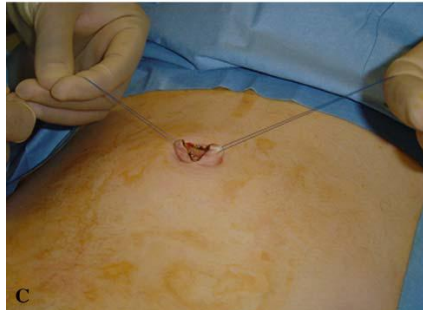
## Limitations

- Instrument clashes
- Triangulation
- Infection - distortion of the umbilical scar
- Abdominal Hernia
- Exposure – (retraction usually addressed by a second port)





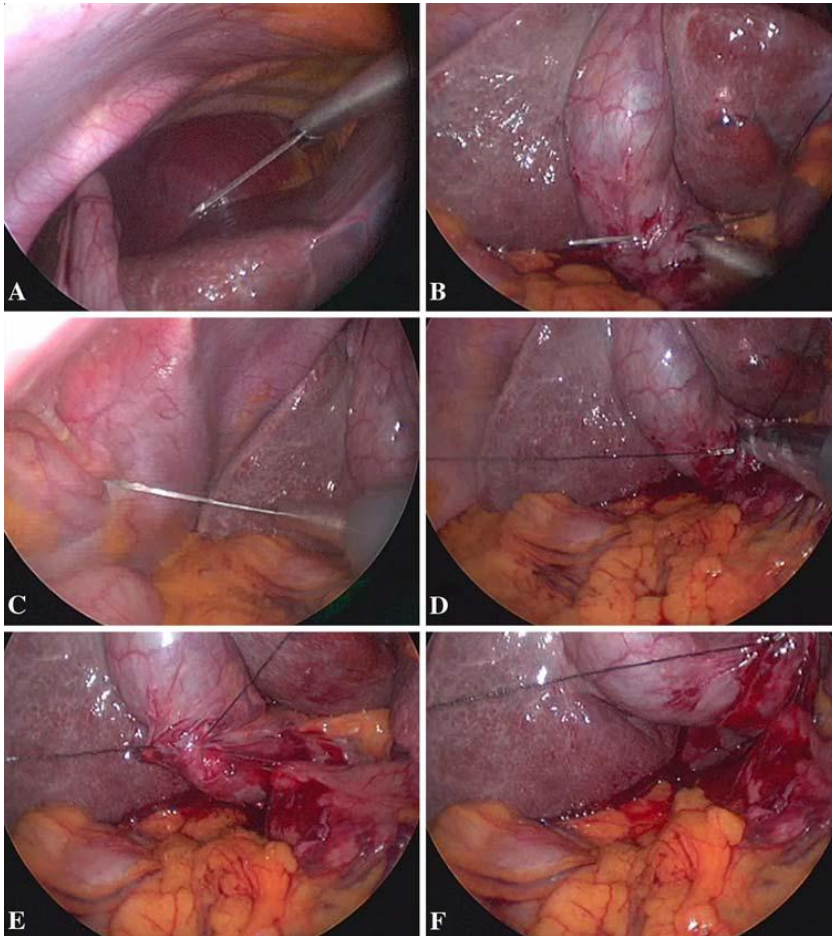
# Technique used at Imperial - Cholecystectomy



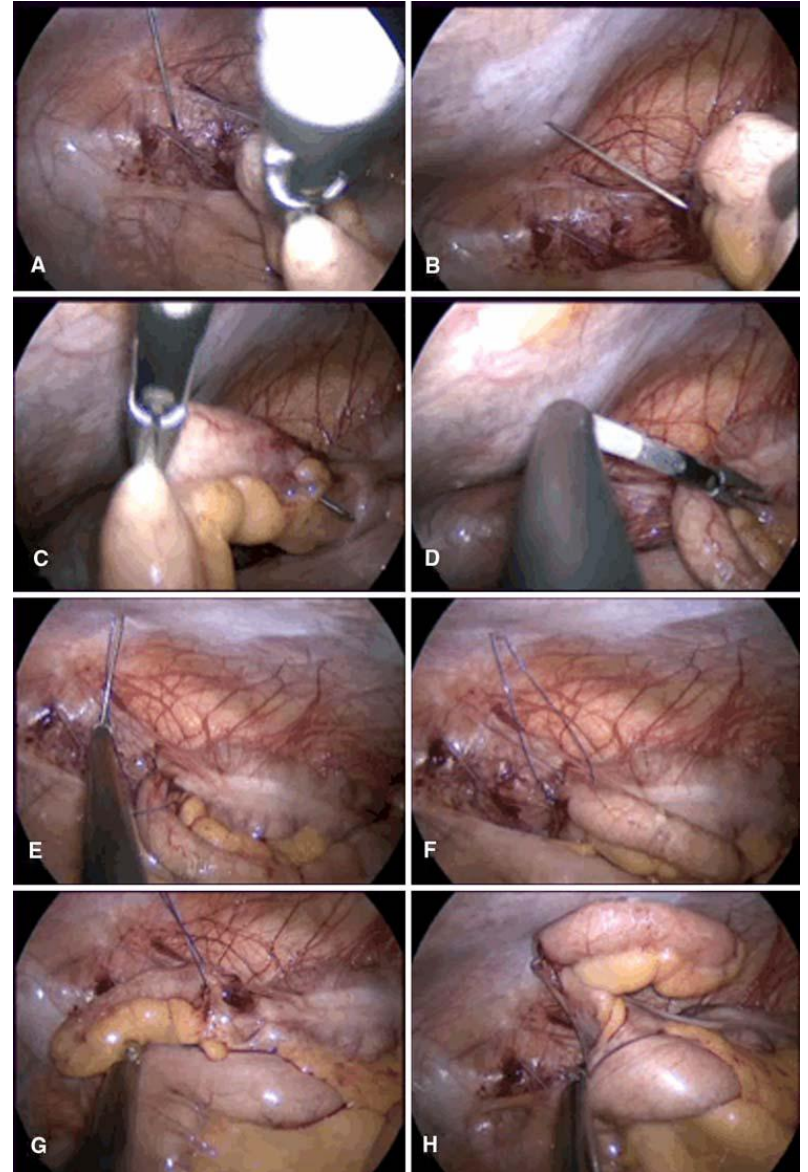




# Technique used at Imperial - Cholecystectomy



# SILS Appendicectomy

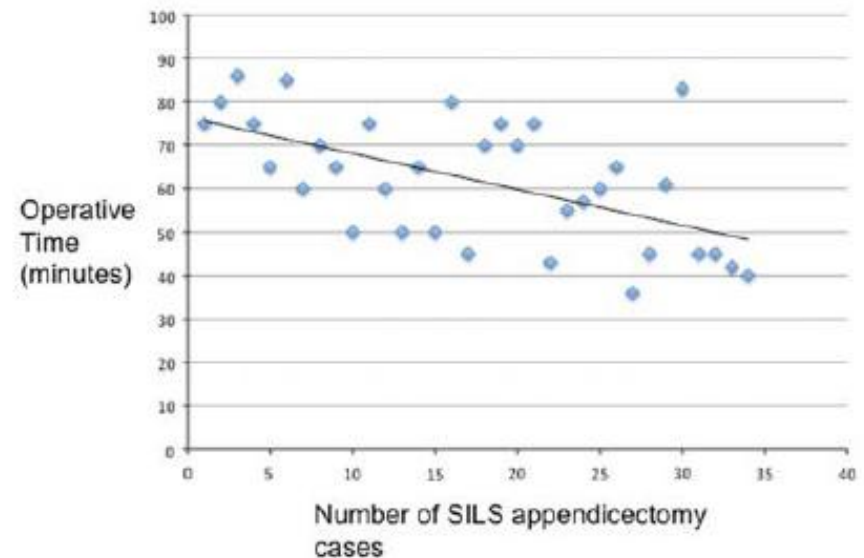


# SILS Appendicectomy at Imperial

**Table 1** Patient data

	Conventional laparoscopic appendicectomy	SILS appendicectomy
No.	33	40
Male:female ratio	15:17	18:22
Age (year)	29.85 ± 14.93	31.65 ± 15.36
Palpable mass	0	2
Primary surgeon		
Attending	8	34
Resident	25	6
Operative time (min)	70.2 ± 21.23*	60.0 ± 15.56*
Postoperative length of stay (days)	2.36 ± 2.62**	1.36 ± 0.95**

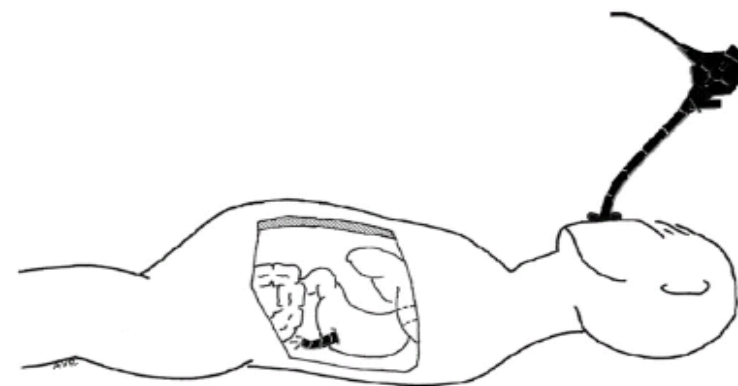
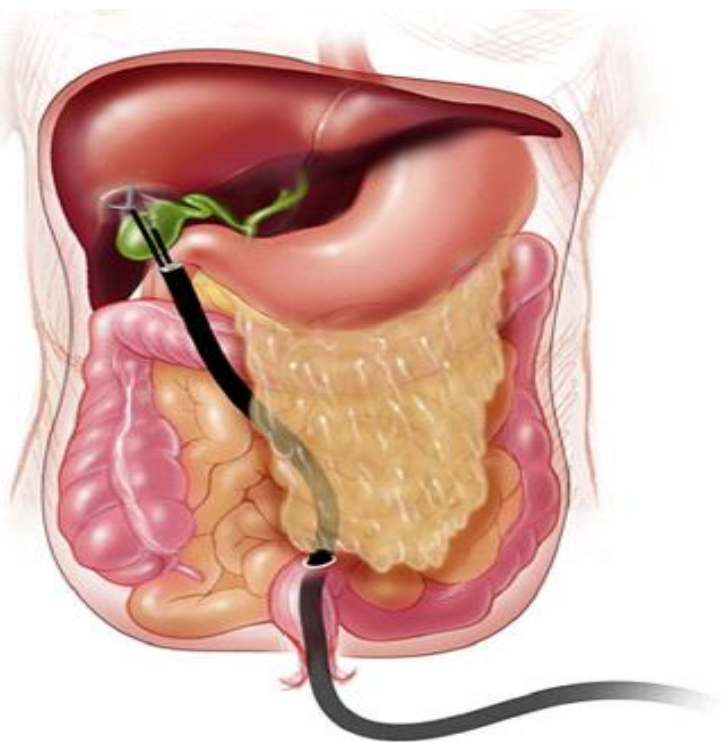
\*  $p < 0.05$ , \*\*  $p = 0.07$





# Natural Orifice Transluminal Endoscopic Surgery

“The next greatest surgical  
evolution” - CBS News, 18<sup>th</sup> September  
2007



## *Natural Orifice Transluminal Endoscopic Surgery.*

1. Passage of flexible endoscope through a natural orifice.
2. Endoscope passed to a point within the lumen closest to operating site.
3. Breach in the lumen.
4. Endoscope enters the anatomical cavity.
5. Navigates to operative site.
6. Dissection undertaken with tools transferred down the endoscope.
7. Once complete endoscope and specimen is removed.
8. Breach in lumen is closed.



Courtesy of IRCAD





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**Surgery Without Scars?**  
 "Natural Orifice" Surgery Called "Next Greatest Surgical Evolution"

Sep 19, 2007 Comments

E-MAIL STORY PRINT STORY SPHERE SHARE TEXT SIZE: A A A



"Natural orifice transluminal endoscopic surgery" eliminates big incisions -- and surgical scars -- and speeds recovery after surgery. (CBS)

Answer lips™ enabled *What's this?* (WebMD) French doctors who report removing a woman's gallbladder through her vagina say such "no-soar surgery" may be the wave of the future.

At least two U.S. women -- one at New York Presbyterian Hospital and another at the University of California San Diego Medical Center -- have undergone similar surgeries.

Doctors who advocate the technique call it "natural orifice transluminal endoscopic surgery" or NOTES. "Natural orifice" here means the vagina, the anus, or the mouth. "Transluminal" means surgeons insert surgical tools (endoscopic tools) through the body's natural openings. And the "surgery" part means doctors still have to cut through to the inside of the body and to operate on diseased organs.

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The idea is to eliminate big incisions -- and surgical scars -- and to speed recovery after surgery.

Jacques Marescaux, M.D., and colleagues at Louis Pasteur University in Strasbourg, France, appear to have been the first to perform NOTES surgery without backup from the laparoscopic instruments used for conventional minimally invasive surgery.

"With its invisible mending and tremendous potential for improving patient care and well-being, NOTES might represent the next greatest surgical evolution," Marescaux and colleagues suggest.

News » **Health & Behavior** ■ Medical Resources ■ Health Information ■ Your Health: Kim Painter

**'Natural orifice' surgery has tongues wagging**

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Enlarge By Craig Mitchell/Dyer for USA TODAY

Lynn Masterson had her gallbladder removed through her mouth, a promising technique for patients who can't tolerate an abdominal incision.

**By Rita Rubin, USA TODAY**

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 What's this?

Lynn Masterson hurt in a most unusual place after gallbladder surgery June 16.

"I had actually had more pain and decreased mobility with my tongue," says Masterson, 47, a radio station traffic reporter.

That's because her surgeon pulled her gallbladder out through her mouth.

She was Lee Swanstrom's third through-the-mouth patient. Swanstrom, of the Oregon Clinic, performs the operation at Portland's Legacy Good Samaritan Hospital.

Friends and family were shocked to learn the route Masterson's gallbladder took from her body. A co-worker joked that he had wondered why her breath smelled funny after surgery.

**FIND MORE STORIES IN: Gastroenterology | Lee Swanstrom**

The thought of having the gallbladder extracted through the mouth or, in women, the vagina, is enough to send some patients fleeing. But by eliminating an external incision, proponents say, the approach promises to reduce pain and speed recovery.

**■ MOST UNUSUAL SURGERY**

Surgeon Lee Swanstrom of the Oregon Clinic removed Lynn Masterson's gallbladder through her mouth. Here's how:

1. Swanstrom snaked an endoscope through Masterson's esophagus and into her stomach.
2. Swanstrom inserted a tiny knife through the scope and cut a quarter-inch to three-eighths-inch hole in her stomach. He then passed a tiny balloon through the scope and inflated it when it got to the end, stretching the hole.<sup>1</sup>
3. Swanstrom dissected Masterson's gallbladder and pulled it back through her stomach and out her esophagus. (At 4 or 5 inches long, it was too large to bring through the scope and out of her mouth in one piece.)
4. Swanstrom closed the hole in Masterson's stomach with sutures.

<sup>1</sup> For Masterson and others in his first group of patients, Swanstrom also made two tiny incisions in her abdomen through which he could monitor what was going on. The goal, though, is surgery with no abdominal incisions.

Source: USA TODAY research

**SURGERY: It's a kinder cut for patients**

"It seems a little strange to have organs coming out natural orifices," acknowledges Columbia University surgeon Marc Bessler, who has recently taken out two women's gallbladders through the vagina. Those areas "have God-given purposes, and God never intended organs to come out of them." (Except, of course, he adds, the placenta after a baby is born.)

Five patients turned him down before a 66-year-old agreed to let him remove her gallbladder through her vagina, Bessler says.

Masterson, of Hillsboro, Ore., had been Swanstrom's patient a decade earlier for esophageal surgery. She says she didn't hesitate when he asked whether she'd like to participate in his study of "natural orifice transluminal endoscopic surgery," or NOTES.

Swanstrom snaked a narrow tube called a flexible endoscope down Masterson's esophagus and into her stomach. Working with tiny tools inserted through the tube, he cut a hole in her stomach, about a quarter-inch wide, to reach her gallbladder.

"Over time, flexible endoscopy has gotten more aggressive or surgical-like," Swanstrom says, noting that doctors remove large colon polyps through a scope inserted in the rectum. "It just made sense to take that one final little jump and go across the wall of the GI tract."



## Surgeons Remove Gallbladder Through Patient's Vagina

Friday, September 14, 2007

**FOX NEWS**

[E-MAIL STORY](#) | [PRINTER FRIENDLY VERSION](#)

**Surgeons at the University of California, San Diego Medical Center successfully removed a patient's gallbladder through her vagina.**

The procedure was the first clinical trial surgery in the Southwest to evaluate the safety and effectiveness of performing abdominal procedures through the body's natural openings.

The UCSD Medical Center procedure involved removing the gallbladder through the patient's vagina without traditional incisions through the skin. One small incision through the naval was needed to help guide the surgeon.

The procedure, called Natural Orifice Translumenal Endoscopic Surgery (NOTES), involves passing surgical instruments and a tiny camera through a natural orifice, such as the mouth or the vagina, to the desired organ.

By avoiding major incisions through the skin, muscle, and nerves of the abdomen, patients may experience a quicker recovery with less pain and scarring while reducing the risk of post operative hernias, according to a new release.

Drs. Santiago Horgan and Mark A. Talamini, chairman of the Department of Surgery at UC San Diego Medical Center performed the surgery on a 42-year-old San Diego resident. Her gallbladder was removed through the vagina during a 1.5-hour procedure.

ADVERTISEMENTS

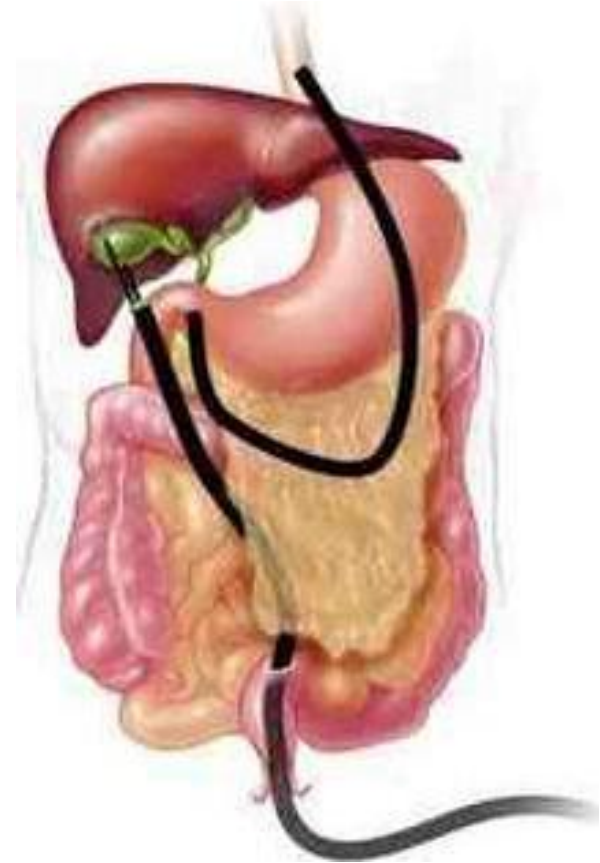
A total of four patients will be recruited for the clinical trial. One more female patient will have her gallbladder removed through the vagina and two patients will have the organ extraction performed through the mouth.





## Benefits of NOTES

- No scars
- No wound infection
- Less pain
- No hernias
- No internal adhesions
- Surgery under less than general anaesthesia





# Endoluminal/NOTES History

1957 1970 1980 1998 2000 2003 2004 2005 2006 2007



Flexible Fiberscope invented

Apollo Group Formed

Dr. Kalloo publishes 1<sup>st</sup> X-Gastric  
Peritonoscopy

Contemporary Endoscope

Dr Seifert first documents NOTES  
– Pancreatic Necrosectomy

Advanced Endoscopic Procedures

1<sup>st</sup> NOSCART Meeting

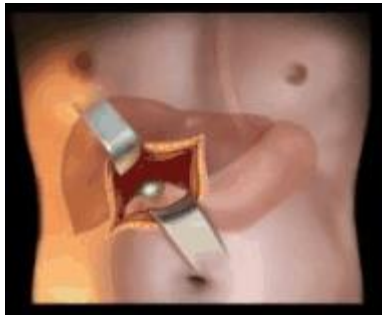
Multiple US IRB's approved for NOTES

Drs. Rau and Reddy present on  
first X-Oral Appendectomy

USGI Press Release on 1<sup>st</sup> X-  
Vaginal Cholecystectomy

## Evolution of abdominal surgery

- Open Cholecystectomy: 1867
- Laparoscopic Cholecystectomy: 1987
- Transgastric Cholecystectomy: 2007





# Potential applications

## ■ Bariatric Surgery

- Sleeve Gastrectomy.

## ■ General Surgery

- Cholecystectomy.
- Appendicectomy.
- Peritoneoscopy and biopsy during Whipples.
- PEG retrieval.

## ■ Colorectal

- Colectomy Right and Left
- Ventral wall mesh hernia repair. (1)

## ■ Urology

- Nephrectomy via retroperitoneal exposure

## ■ Other procedures

- Diaphragmatic pacing wire placement.

# Clinical Applications – July 2008

Author	Year	NOTES/hybrid	No. of patients	Orifice	Operation
Bessl					
Brand					
Forgi					
Dolz					
Zorro					
Mare					
Decar					
Rao e					
Palan					
Bernl					
Rao e					
Pearl					
Gettn					
Haze					
Rao e					
Steel					
Rao e					
Lacy					
Mark					

The screenshot shows a Windows Internet Explorer browser window displaying a PubMed search for 'natural orifice'. The search results are sorted by 'Recently Added' and show 779 results. The first two results are highlighted:

- [Stent placement provides safe esophageal closure in thoracic NOTES\(TM\) procedures.](#)  
Turner BG, Cizginer S, Kim MC, Mino-Kenudson M, Ducharme RW, Surti VC, Sylla P, Brugge WR, Rattner DW, Gee DW.  
Surg Endosc. 2010 Sep 4. [Epub ahead of print]  
PMID: 20820811 [PubMed - as supplied by publisher]
- [Current status of natural orifice trans-endoscopic surgery \(NOTES\) and laparoendoscopic single site surgery \(LESS\) in urologic surgery.](#)  
Sanchez-Salas RE, Barret E, Watson J, Stakhovskiy O, Cathelineau X, Rozet F, Galiano M, Rane A, Desai MM, Sotelo R, Vallancien G.  
Int Braz J Urol. 2010 July-August;36(4):385-400.  
PMID: 20815945 [PubMed - as supplied by publisher]

**NOTES** natural orifice transluminal endoscopic surgery, **Hybrid** hybrid NOTES procedure, **TV** transvaginal, **TG** transgastric, **Tves** transvesical



# 2010 – Multiple NOTES registries

Ann Surg. 2010 Aug;252(2):263-70.

## **The German registry for natural orifice transluminal endoscopic surgery: report of the first 551 patients.**

Lehmann KS, Ritz JP, Wibmer A, Gellert K, Zornig C, Burghardt J, Büsing M, Runkel N, Kohlhaw K, Albrecht R, Kirchner TG, Arit G, Mall JW, Butters M, Bulian DR, Bretschneider J, Holmer C, Buhr HJ.

Department of Surgery, Charité University Hospital-Campus Benjamin Franklin, Berlin, Germany. kai.lehmann@charite.de

### **Abstract**

**OBJECTIVE:** To analyze patient outcome in the first 14 months of the German natural orifice transluminal endoscopic surgery (NOTES) registry (GNR).

**SUMMARY BACKGROUND DATA:** NOTES is a new surgical concept, which permits scarless intra-abdominal operations through natural orifices, such as the mouth, vagina, rectum, or urethra. The GNR was established as a nationwide outcome database to allow the monitoring and safe introduction of this technique in Germany.

**METHODS:** The GNR was designed as a voluntary database with online access. All surgeons in Germany who performed NOTES procedures were requested to participate in the registry. The GNR recorded demographical and therapy data as well as data on the postoperative course.

**RESULTS:** A total of 572 target organs were operated in 551 patients. Cholecystectomies accounted for 85.3% of all NOTES procedures. All procedures were performed in female patients using transvaginal hybrid technique. Complications occurred in 3.1% of all patients, conversions to laparoscopy or open surgery in 4.9%. In cholecystectomies, institutional case volume, obesity, and age had substantial effect on conversion rate, operation length, and length of hospital stay, but no effect on complications.

**CONCLUSIONS:** Despite the fact that NOTES has just recently been introduced, the technique has already gained considerable clinical application. Transvaginal hybrid NOTES cholecystectomy is a practicable and safe alternative to laparoscopic resection even in obese or older patients.

# Level I/II evidence

Gastrointest Endosc. 2010 Sep 16. [Epub ahead of print]

## Randomized, blinded comparison of transgastric, transcolonic, and laparoscopic peritoneoscopy for the detection of peritoneal metastases in a human cadaver model.

Voermans RP, Henegouwen MI, Cuba ED, Broek FJ, van Acker G, Timmer R, Fockens P.

Department of Gastroenterology and Hepatology (R.P.V., E.d.C., F.J.C.v.d.B., P.F.), Department of Surgery (R.P.V., M.I.v.B.H., G.v.A.), Academic Medical Center, University of Amsterdam, Department of Gastroenterology and Hepatology (R.T.), St. Antonius Hospital, Amsterdam, The Netherlands.

### Abstract

**BACKGROUND:** Natural orifice transluminal endoscopic surgery peritoneoscopy may be able to replace laparoscopic peritoneoscopy (LAP) for staging of GI malignancies if it is proven to be equally accurate and safe.

**OBJECTIVE:** To compare transgastric peritoneoscopy (TGP) and transcolonic peritoneoscopy (TCP) to LAP, pairwise, in a randomized, blinded (to location and number of beads) human cadaver model with simulated peritoneal metastases.

**DESIGN:** Metastases were simulated by 2.5-mm, color-coded beads, which were placed into the peritoneal cavity via an open approach. In previous porcine experiments, LAP resulted in a yield of 95%. By using a noninferiority design with a margin of equivalence of 15%, we needed a sample size of 34 beads for 80% power. Randomization was performed for number and location of beads. Eighteen experiments were performed on 6 fresh-frozen human cadavers.

**SETTING:** Experimental surgical laboratory.

**INTERVENTION:** LAP, TGP, and TCP were performed in randomized order by one of two surgeons/endoscopists blinded for location and number of beads.

**MAIN OUTCOME MEASUREMENTS:** Number of beads detected and touched.

**RESULTS:** LAP found and touched 33 beads (yield 97%), TGP 26 beads (76%; difference in yield vs LAP was -20.5 [95% CI, -26.3 to -9.27]), and TCP 29 beads (85%; difference in yield vs LAP was -11.8 [95% CI, -14.6 to 4.98]). Beads that were missed were mostly located at the inferior liver surface: TGP missed 6 of 9 of these beads (67%), TCP 4 of 9 (44%).

**LIMITATIONS:** Cadaver model.

**CONCLUSION:** In this prospective, blinded, comparative trial in a human cadaver model, TCP was comparable to LAP in detecting simulated metastases. TGP was inferior to LAP. Future development should focus on improved visualization of the inferior surface of the liver.



# Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR)™

[www.noscar.org](http://www.noscar.org)

Joint committee by the American Society for Gastrointestinal Endoscopy (ASGE) and the Society for American Gastrointestinal Endoscopic Surgeons (SAGES) was setup to review NOTES.

## **Challenges for NOTES as highlighted by NOSCAR group revolved around:**

- Safe access and closure to the peritoneal cavity with prevention of infection.
- Development of NOTES specific designed equipment including instruments capable of suturing.
- Developing NOTES to ensure a safe and reliable technique.
- Highlight untoward physiological events.
- Determine appropriate training opportunities.



# Evolutionary **NOT** Revolutionary

Professor Hunter – Chairman of Surgery, Oregon Health and Science University in Portland

Quote from the Archives of Surgery,

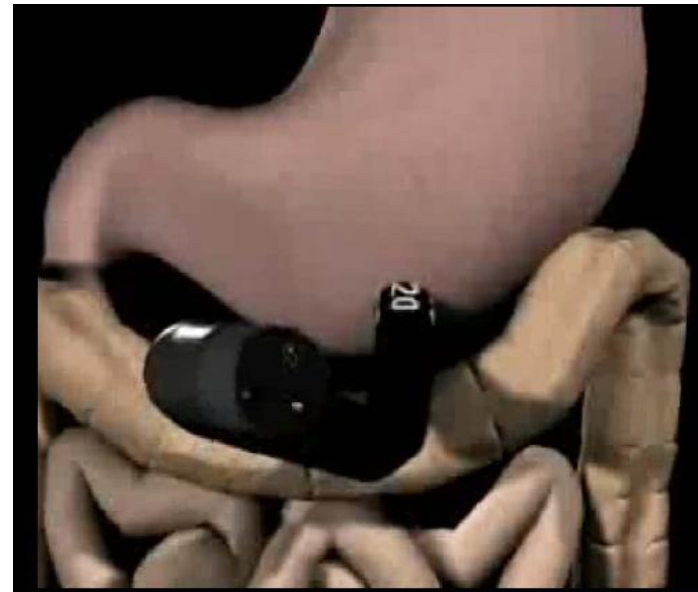
*"The benefits of NOTES are not earthshaking and the risks are real," "Marescaux and colleagues. You have (again) put man on the moon. Now we need to figure out if there is any reason to populate this new plane."*

*"There is a lot of great opportunity here," he says. "I don't see NOTES as revolutionary. It might be incrementally better for some things. It is evolution rather than revolution at this point."*



## Access to peritoneal cavity

- Transgastric
- Transcolonic
- Transvaginal
- Transvesical

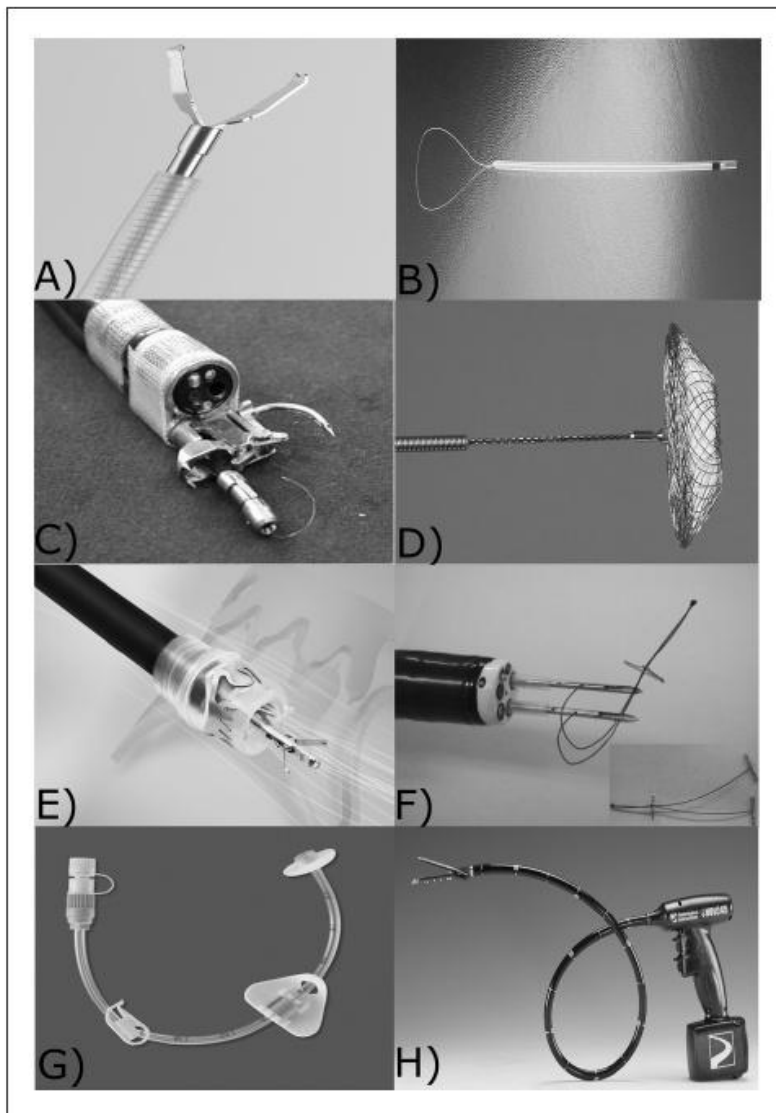


**Transgastric approach**



# Opening techniques

- Transgastric
  - As for PEG site placement.
- Transvaginal
  - Gynaecologist to be present. Needle inserted into anterior OS.
  - Saline infused fills PoD pushing bowel away from vagina.
  - Access with needle knife and dilatation.
- Transrectal
  - Access using TEMS, offers a stable platform from which to insert scope and also easy closure maintained.



**Figure I.** (A) Endoscopic clip. (B) Endoloop. (C) Eagle claw. (D) Cardiac septal occluder. (E) Over-the-scope clips. (F) T-tags. (G) PEG tube. (H) Flexible stapler


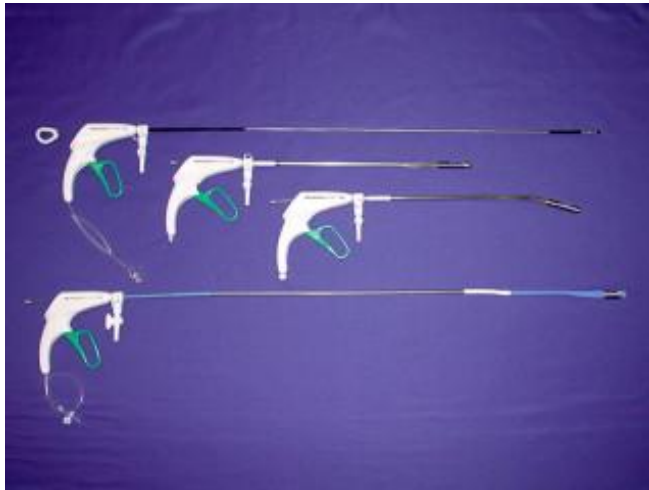
- Examples of gastrotomy closure modalities
  - Over 20 different modalities described in the literature

# Complexity Assessment of Gastrotomy Closure Devices


Name of Device	Complexity Assessment Categories			
	Approach to Target	Stabilizing the Target	Firing of Device	Reversibility of Closure
Endoscopic clips	+	-	+	+
Endoloops	+	-	+	+
Eagle Claw VII	+	-	+	+
Cardiac septal occluder	-	-	+	-
PEG tube	+	-	-	-
Over-the-scope clip	+	+	+	-
T-tags	+	-	+	-
LSI prototype	+	+	+	+
Tissue plicating device	+	+	+	-
Endoscopic stapler	-	+	+	-

Abbreviations: +, favorable; -, unfavorable.

# Closure techniques



BRIGHAM AND WOMEN'S HOSPITAL  
HARVARD MEDICAL SCHOOL



---

Evaluation of a Novel Access and Closure Device  
for NOTES Applications:

**A Transcolonic Survival Study in the Porcine Model**

Marvin Ryou MD; Derek Fong, MD; Reina Pai, MD;  
Jude Sauer, MD; and Christopher C. Thompson, MD





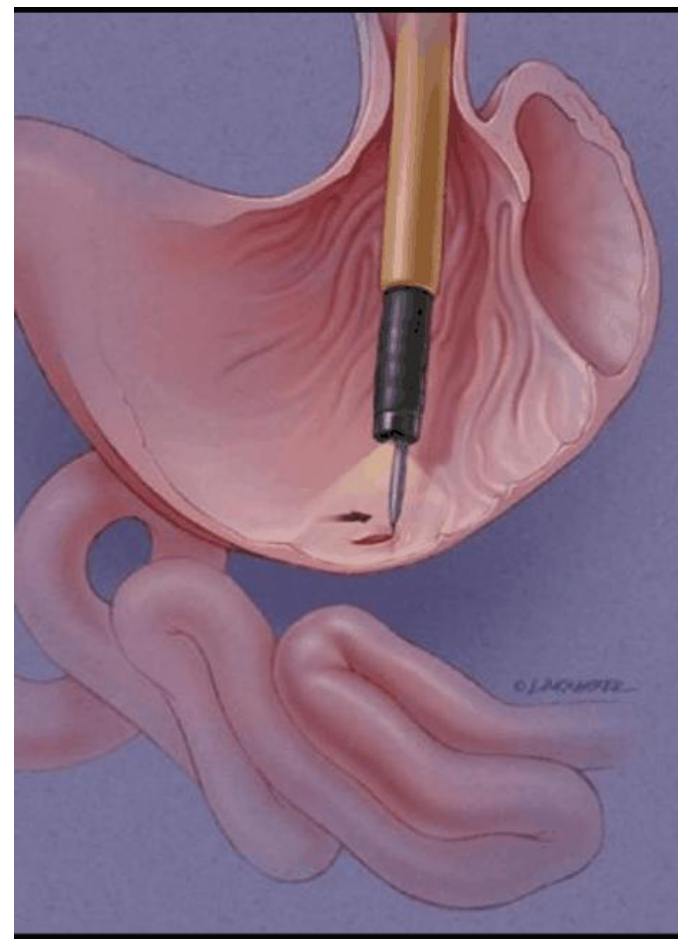
# Standardized Protocol for Evaluation of Gastrotomy Closure Techniques

Physiological	Histology	Imaging	Endpoints
Perioperative morbidity	Examination of ex vivo specimen	Fluoroscopic evaluation (leak/no leak)	Subjective characteristics of closure modality
Perioperative complications		Endoscopic findings (macroscopic)	Time taken to complete closure (seconds)
Necropsy and laparotomy			Assessment on complexity scale/4 (if a device)
Air and water leak pressure (mm Hg)			



# Operative Challenges

- Optimal site for peritoneal access
- Organ retraction
- Control of major bleeding
- Tissue approximation



# NOTES – current limitations & conventional equipment

- Access / Closure
- Infection – risk of sepsis
- Physiological effects
- Equipment - Instruments & Tools
  - ☒ Stable platform
  - ☒ Navigation
  - ☒ Orientation
  - ☒ Visualisation





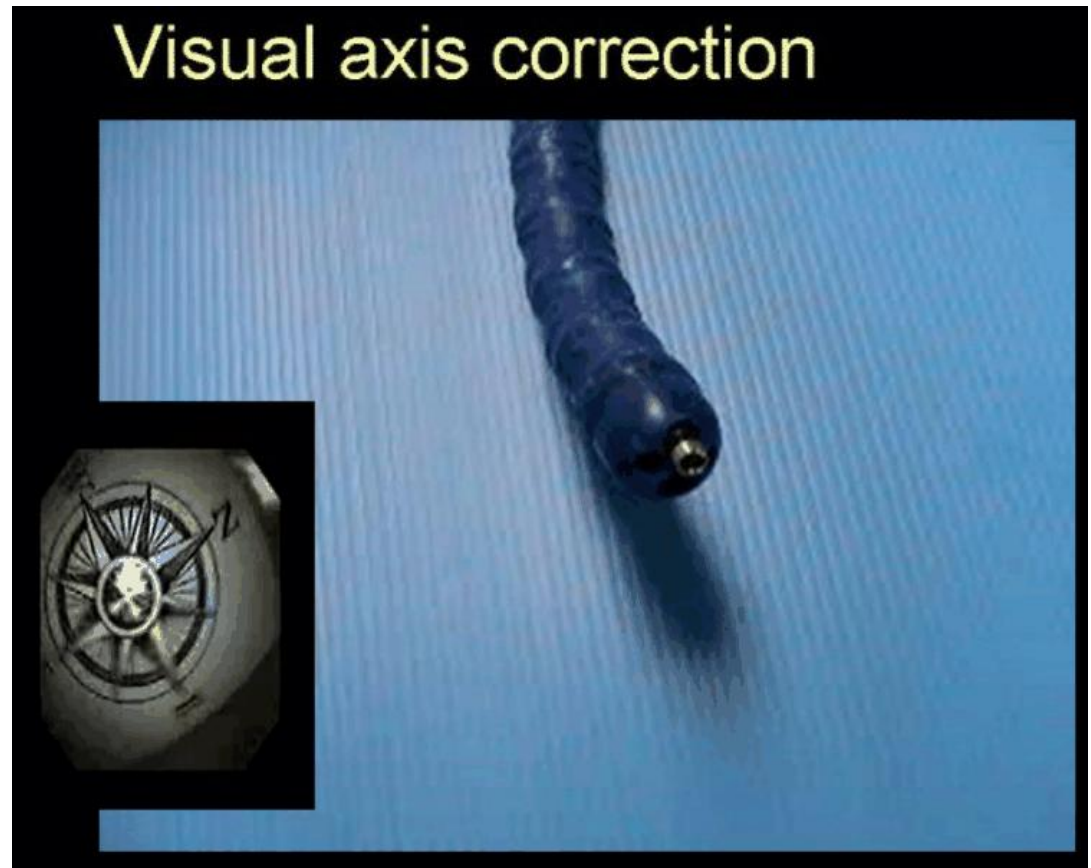
## Current platform challenges

- Scope instability – counter forces
- Floppy instruments
- Visual orientation (visual axis correction)
- Small and few instrument channels (“one handed” surgeon)
- Lack of controlled insufflation
- Inadequate tissue approximators



## Visualization

- Insufficient light
- Limited field of view
- Non-variable horizon



**Correcting internal scope visually (instrument not corrected) can be distracting.**



# Navigation and Orientation

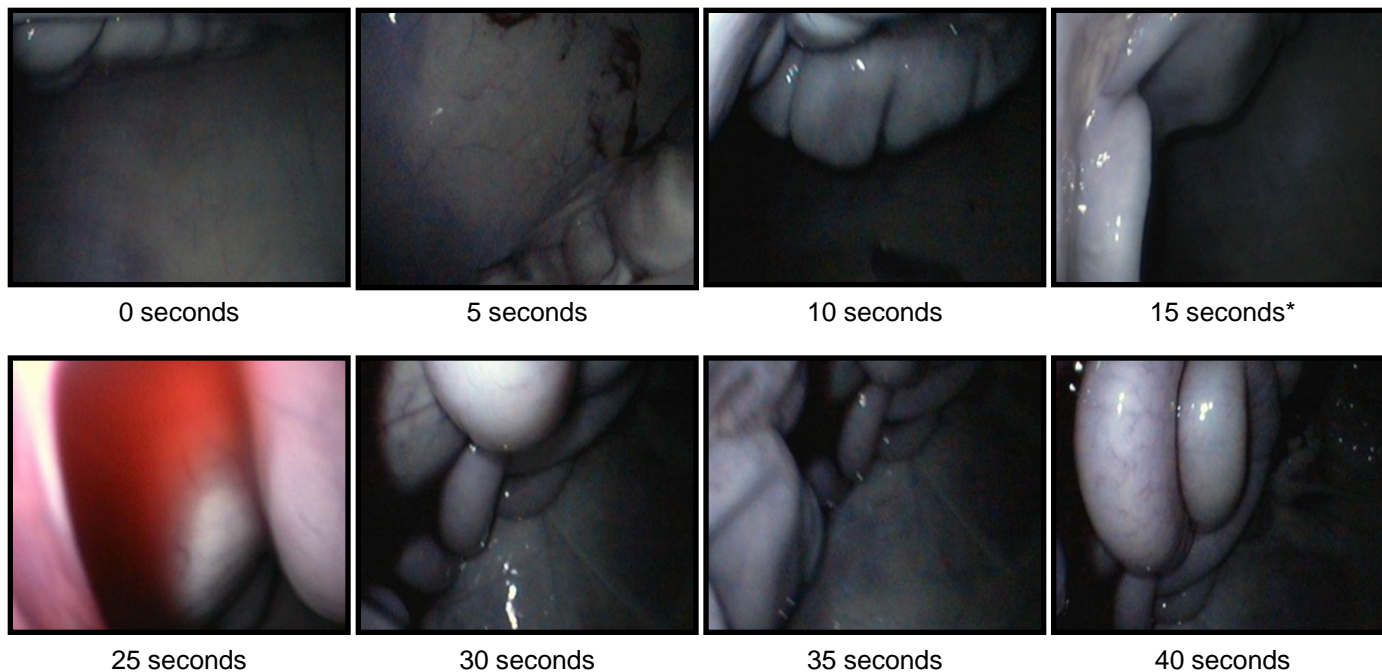
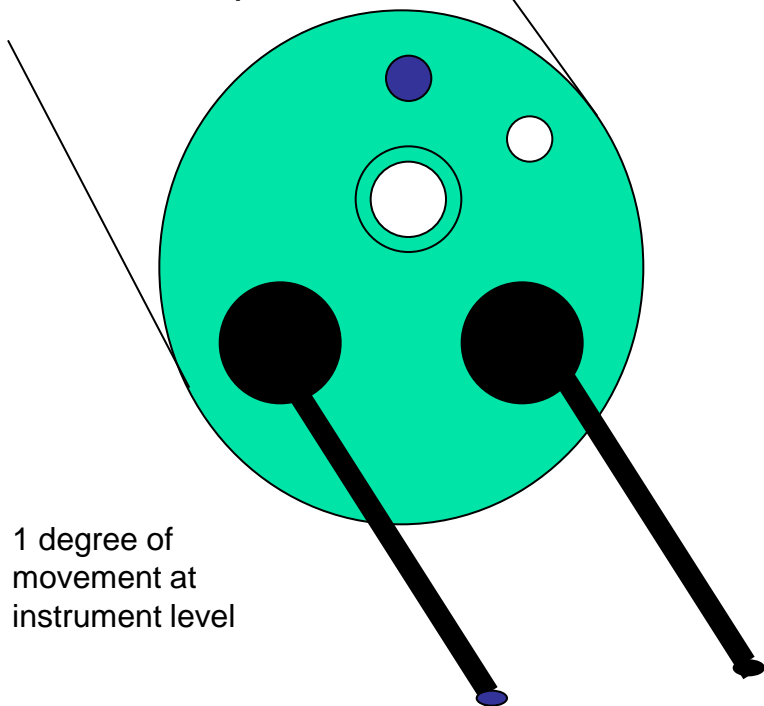


Fig 1. Images from a sequence of NOTES footage on a porcine model demonstrating the disorientation that can occur during exploration of the peritoneal cavity using a flexible endoscope.

# Conventional equipment - instrumentation

Front view of  
endoscope



1 degree of  
movement at  
instrument level

Triangulation  
required to operate  
safely





1. Challenge to manipulate tissue without constraints using flexible instruments through flexible endoscopes.

2. Surgical Instruments - Externally controlled, long length and large number of assistants required to use.

3. Triangulation - insufficient retraction to place tension on the tissues for accurate dissection.



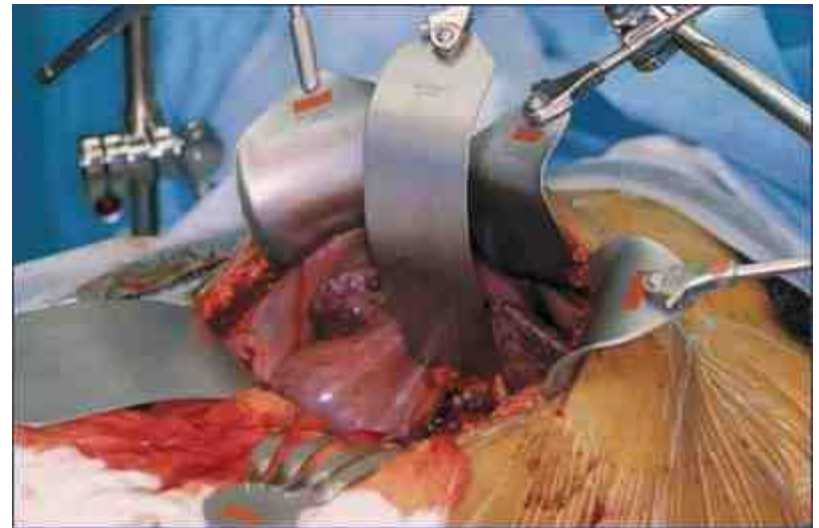
Fig: Demonstrating difficulty in manipulating tissues using current instrument design.



Fig: IRCAD - highlights the number of assistants required to undertake a procedure using current instrument design.

# Large organ Retraction

- Required method involves being able to adjust retraction position and strength with ease.
- Current NOTES methods include:
  - Suturing to abdominal wall
  - T-tags
  - Magnets





# T-fasteners for Retraction

NOTES# 4

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## Magnets for ureter retraction



**The use of magnets for both enhancing dissection and presenting the dissection planes.**





### Limitations:

Requires a removing hand from endoscope to continually adjust position of magnet.

Clip magnets unreliable as slip or damage tissues.

## Applications and tools : “endo-suturing”

### ■ Endoluminal surgery

- Valvuloplasty <sup>a</sup>
- Devices attachment <sup>a</sup>
- Fistula closure <sup>a</sup>
- Gastric reduction <sup>a</sup>
- Bleeding ulcer <sup>b</sup>
- Perforation closure <sup>b</sup>
- Full-thickness biopsy <sup>b</sup>

### ■ Transgastric surgery

- Gastric wound closure <sup>b</sup>
- Gastrojejunostomy <sup>b</sup>
- Ventral hernia repair <sup>b</sup>
- Salpingectomy <sup>b</sup>

... ..

*(<sup>a</sup> Clinical applied already, <sup>b</sup> Animal study)*

## Limitations of suturing device

- Dependent on suction
- Unable to oversee scarred tissue
- Side-operating method
- Difficult at particular place
- Limited view of the action

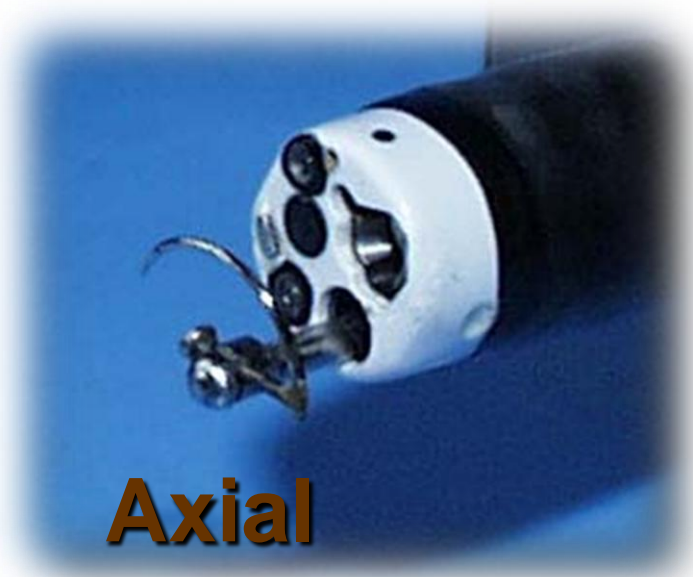


Early  
prototypes

**Plane**



**Axial**



**Plane**



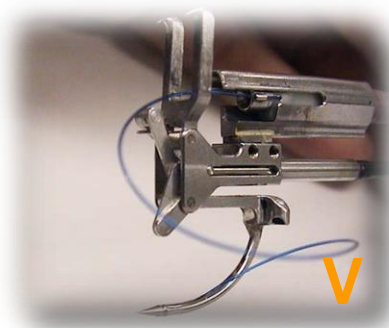
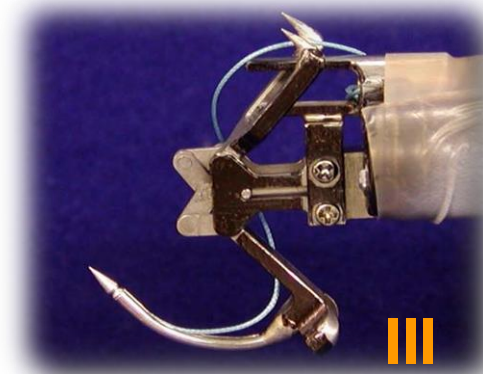
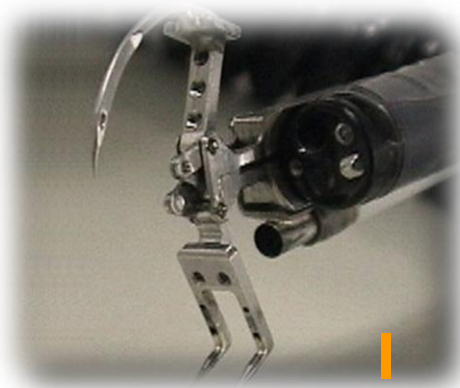


**EAGLE CLAW<sup>®</sup>**



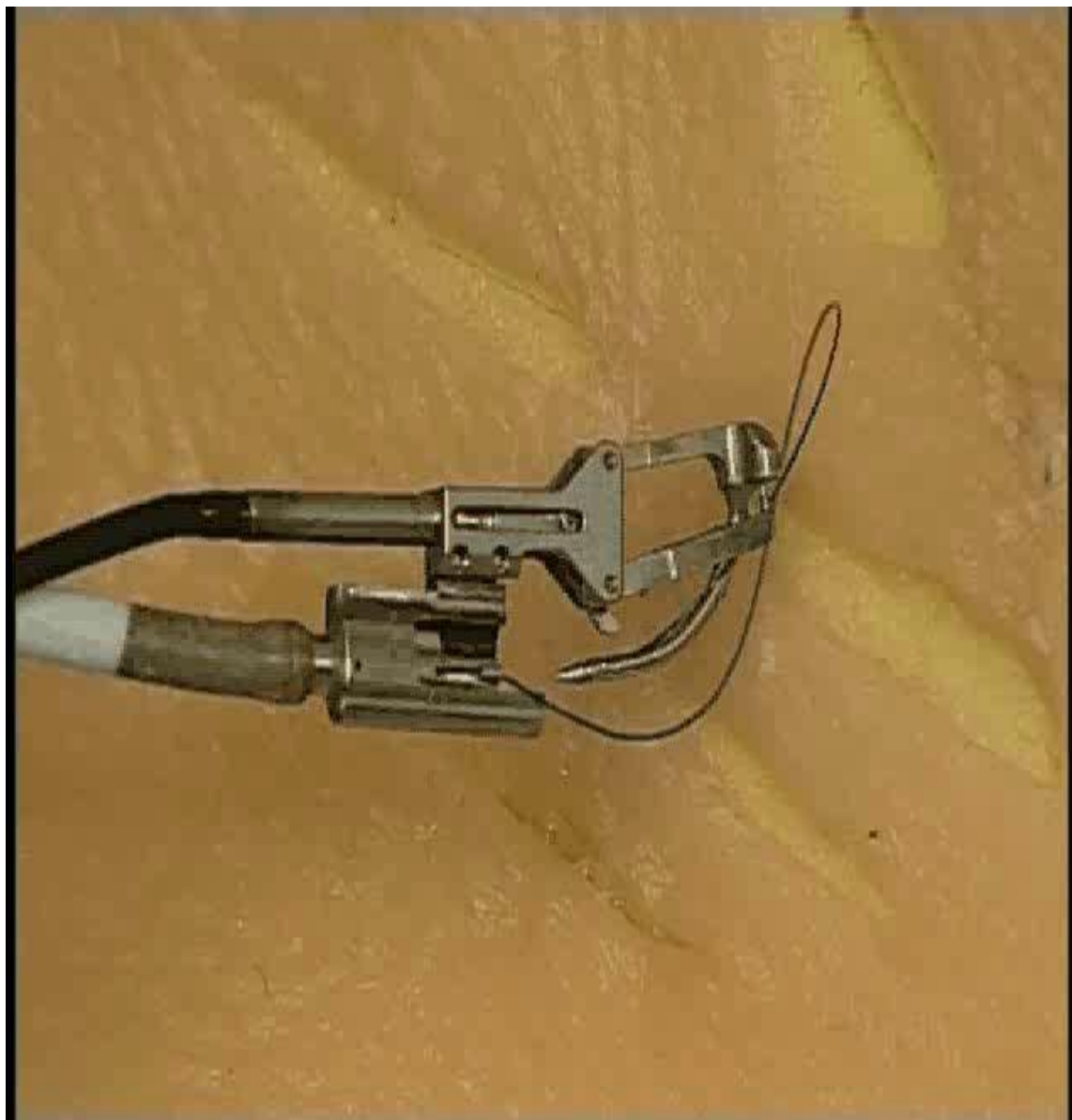


## Eagle Claw



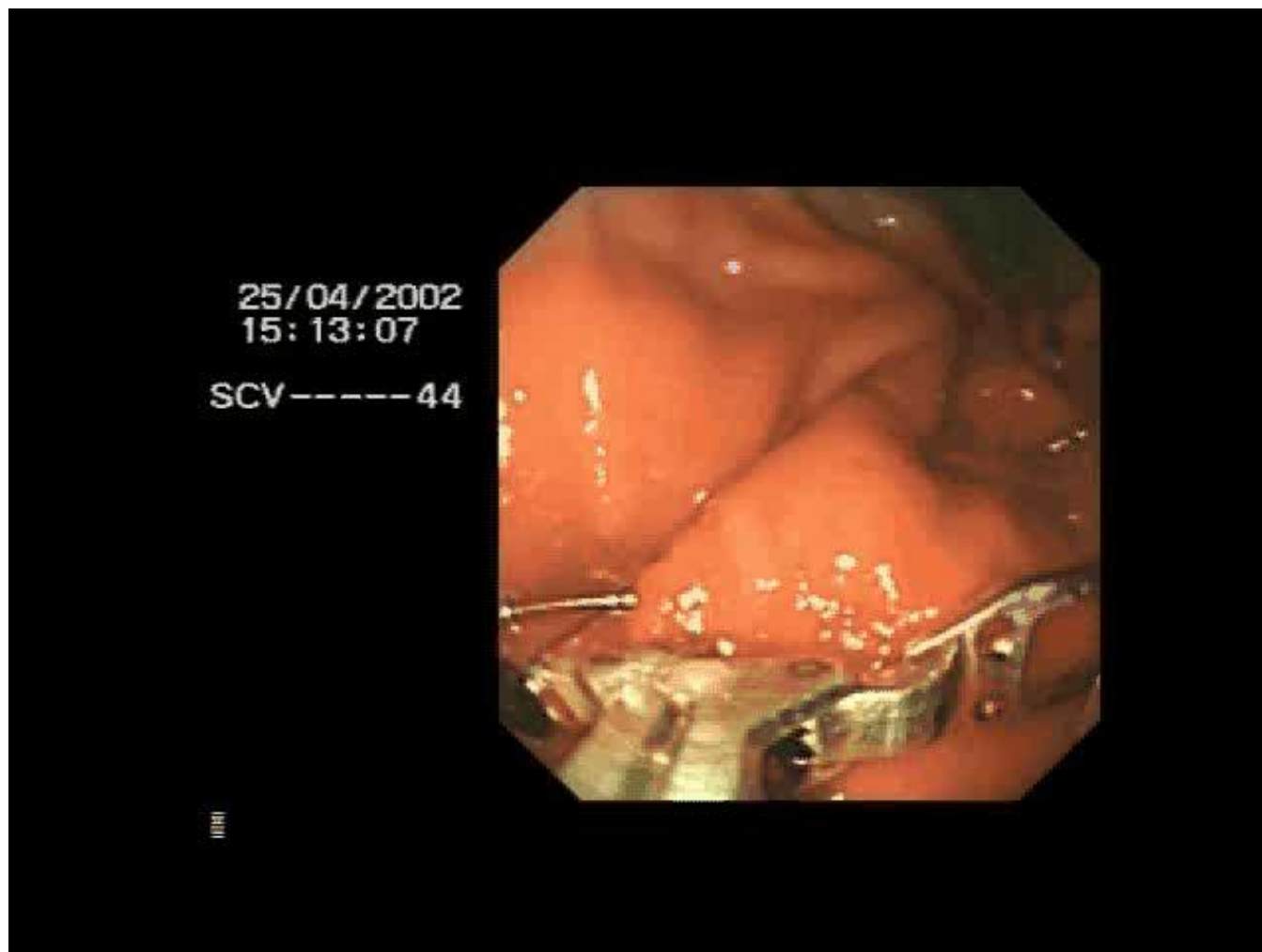


# Eagle Claw V





## Eagle Claw II





## Requirements for a NOTES specific Endoscope

- Navigate to the operative target safely and accurately in the correct visual orientation.
- Flexible to access otherwise inaccessible areas but with the ability to be made rigid on demand and maintain its shape.
- Superior optics that can offer depth perception and offer visualization of structures, front and back, without disorientation
- A more ergonomic control mechanism freeing up hands.
  - Reducing the number of assistants required to perform a procedure.



## Requirements for successful N.O.T.E.S instruments

- Rigid platform from which to extend the instruments.
- Rigid articulating instrument arms.
- Ability to place the tissue under tension for safe and reliable dissection.

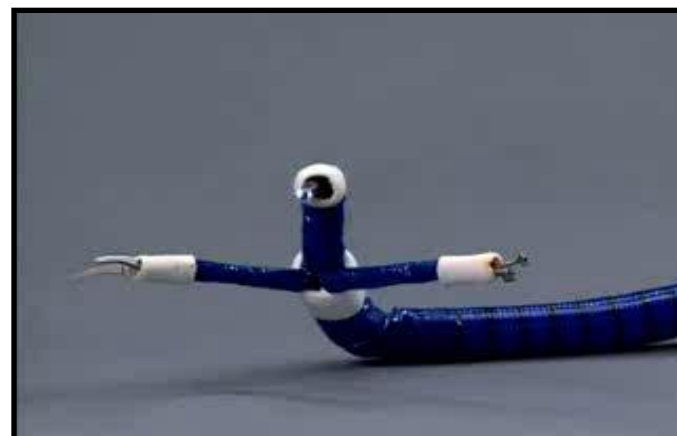
## First Endoscopic NOTES tools

NOTES endoscope. Three channelled scope with three independently controlled paediatric diameter endoscopes.



# What is currently available? Endoscopes and Overtubes

Olympus "R"  
scope







## USGI - Shapelock overtube

- Flexible endoscope able to manoeuvre to operative target.
- External sheath which can lock on demand leaving endoscope rigid.
- Instruments can be deployed from secure base.



# What is currently available?

## USGI Endosurg Operating System

Provides a stable operating platform and possibility of off-axis visualisation

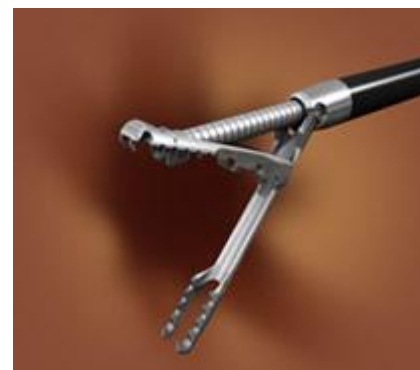
Allows the use of multiple, instruments for two-handed operation

Enables suturing for tissue apposition and wound closure

Flexible instrument still has to reach target

Platform will lose position once shapelock is released

Only 2 DoF at instrument tip



# The "Giodora" Boston Scientific Direct Drive

## A Direct Drive Endoscopic System for Endoluminal and NOTES Applications



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Derek Fong<sup>1</sup>, Reina Pai<sup>1</sup>, Paul Smith<sup>3</sup>, Barry Weitzner<sup>3</sup>

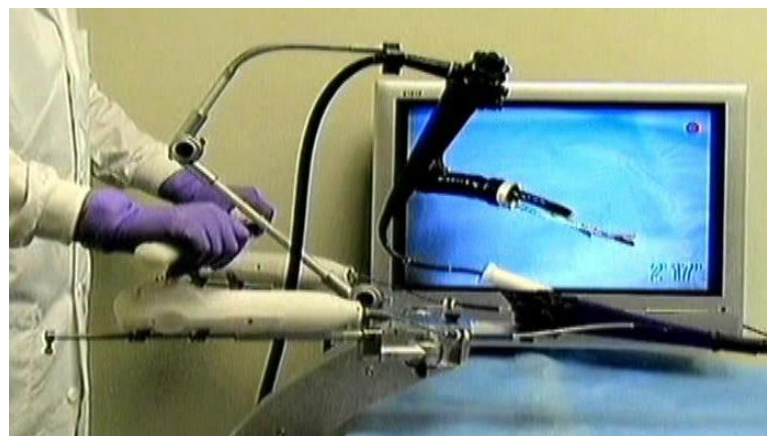
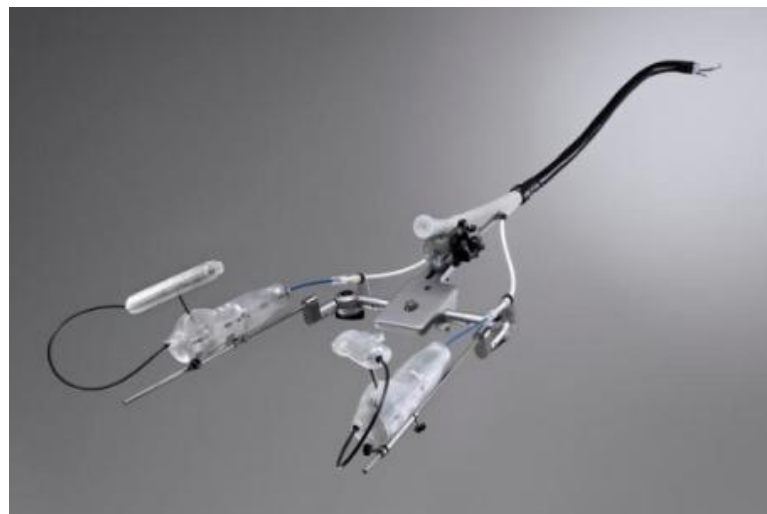
1. Brigham and Women's Hospital, Harvard Medical School
2. Dartmouth Hitchcock Medical Center
3. Boston Scientific



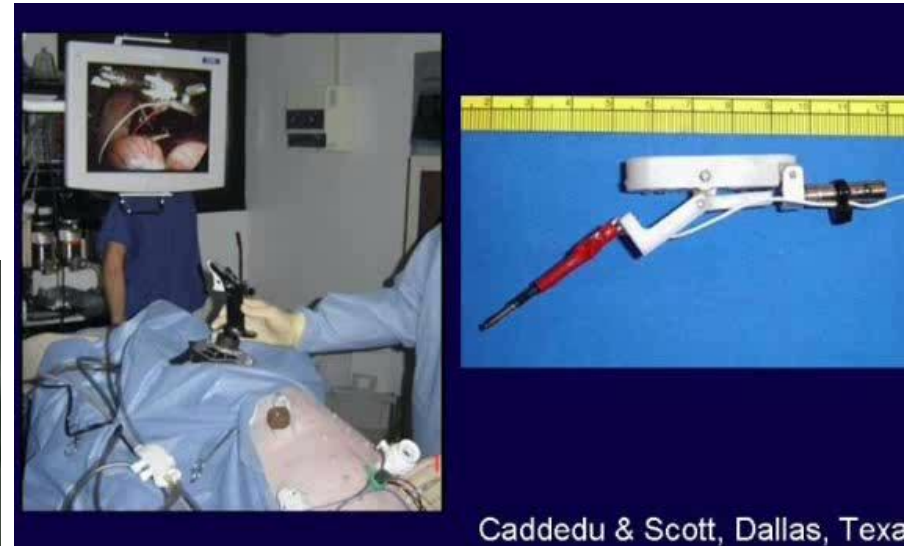
# What is currently available?

## Boston Scientific Direct Drive

- Control mechanism similar to laparoscopic paradigm
- Rigid overtube improves stability
- Orientation controlled with inner endoscope
- Not fully operable with 1 person
- Navigation to target tissue suboptimal
- Triangulation of instruments still poor



# Robotic Implementation



Caddedu & Scott, Dallas, Texas

Miniature – magnet controlled robotic instruments.





# Robotic implementation

## Computer Assisted Robotic Endosurgery

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Dartmouth Medical School  
Hanover, NH



# Conclusion

- NOTES is here to stay!
- Future applications uncertain
- Likely to complement certain procedures in minimally invasive surgery
- Improvement in tools and instrumentation a certainty



100 years of living science

100

