Minimally Invasive Surgery: Past, Present, and (?) Future

OSS 2015

Nathaniel J. Soper, M.D., FACS
Chicago, IL
Disclosures

Scientific Advisory Board: Transenterix, Miret Surgical
Research Support: Karl Storz Endoscopy-America
My son, Robert, is employed by Covidien, Inc.
Outline

1. Personal reflections/history of MIS
2. Current status of laparoscopy
3. Endolumenal applications
4. NOTES
5. Other potential future applications of MIS
What is ‘Minimally Invasive’ Surgery?

- The field of surgery in which operative interventions are performed using less traumatic approaches than traditional surgical procedures
  - a.k.a. minimal access surgery
  - e.g. laparoscopic and endoscopic surgery
EROSION OF GENERAL SURGERY
BY "MINIMAL ACCESS" TECHNIQUES

Non-resective gallstone Rx
(Dissolution, ESWL, PCCL, etc)
1970-80's

Endoscopic therapy of G.I.
bleeding
1970's

Endoscopic polypectomy
1970's

Biliary stenting
1980's

ERCP/ERS
1970's

IVC filters
1980's

Endoscopic sclerotherapy
1980's

Percutaneous drainage & biopsy
1970's

Percutaneous
± endoscopic gastrostomy tubes
1980's

Angioplasty
1970's

TIPS
1990's
First Published Report of Laparoscopic Cholecystectomy

Laser Practice Report
December 1988

General Surgery

Laparoscopic laser cholecystectomy: Short hospital stay, minimal scarring
By Eddie Joe Reddick, MD, FACS
HCA Laser Training Center
West Side Hospital
Nashville, TN

The great interest in less invasive procedures for treating gallstone disease is manifested by numerous articles filling the surgical

common bile duct dilation or stones on ultrasound, no jaundice or pancreatitis, and no elevation of bilirubin or alkaline phosphatase. They also must have had no previous abdominal or pelvic surgery.

Adhesions from previous surgery makes insertion of the insufflation needle and initial trocar more dangerous and makes dissection more difficult as well. Acute inflammation around the porta hepatitis also makes dissection difficult and dangerous. Therefore, we have excluded those groups of patients. Obviously, if the patient has common duct stones, he or she will require an invasive procedure anyway, so there is no advantage to perform-
Samuel A. Wells, Jr., M.D.
Lap Chol’y: Pig Studies

Laparoscopic Cholecystectomy

Chronic Animal Studies
- 6 pigs allowed to recover
- 1 died at one week secondary to adhesive SBO
- 5 animals sacrificed at one month; performance of cholangiography, serum liver function tests and histologic examination of the liver
### Statement

**Make Checks Payable To:**
Eddie J. Reddick, M.D.
Ste. 101, 2201 Murphy Ave.
Nashville, TN 37203

**Phone**
- 615 340-6970
- 62-1254598

**Statement**
Return upper portion of statement with payment

**Patient's Name:**
Nathaniel J. Soper, M.D.
Assistant Professor of Surgery
Washington University
School of Medicine
6108 Queeny Tower, 1 Barnes Hospital Plaza
St. Louis, MO 63110

**Closing Date**

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**New Balance:**
1,000.00

**Note:** Charges and payments not appearing on this statement will appear on next month's statement.

Charges appearing on this statement are not included on any hospital bill or statement.

**Show Amount Paid Here:** $
September 21, 1989

Nathaniel Soper, M.D.
One, Barnes Hospital Plaza
St. Louis, MO 63110

Dear Dr. Soper:

I apologize for the misunderstanding that occurred concerning the charge for the preceptorship. I not only have a surgical practice, but also have a business which teaches laser surgery not only in Nashville but around the country. Therefore, I feel that my time in teaching this procedure certainly has some monetary value.

However, I would rather have your goodwill than your money so please disregard the bill that was sent to you. You can make it up to me by buying me dinner the next time I pass through St. Louis.

Sincerely,

Eddie J. Reddick, M.D., FACS
Effect of Lap Chol’y

Barnes Hospital

Cholecystectomies per year

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Northwestern Medicine
L.B.J. Cholecystectomy Scar
World’s First Laparoscopic Nephrectomy, June 1990
Laparoscopic Cholecystectomy

The New ‘Gold Standard’?

Nathaniel J. Soper, MD; Paul T. Stockmann, MD; Deanna L. Dunnegan, RN; Stanley W. Ashley, MD

- Laparoscopic cholecystectomy has rapidly been adopted by surgeons, but concerns remain about its safety, the management of common bile duct stones, and the means of appropriate training. Of 647 patients referred for cholecystectomy, preoperative endoscopic retrograde cholangiography was performed in 49 (7.6%), with 27 patients (4%) undergoing sphincterotomy and stone extraction. Traditional cholecystectomy was performed in 29 patients (4.5%). Laparoscopic cholecystectomy was attempted in 618 patients and completed successfully in 600 (97.1%). Surgical trainees functioned as the primary surgeon in 70% of cases. Technical complications occurred in three patients (0.5%), including one patient with a common bile duct laceration (0.2%). Major complications occurred in 10 patients (1.6%), with no perioperative mortality. Mean postoperative hospital stay was 1 day, with return to work or full activity a mean of 8 days after surgery. Two cases of retained common bile duct stones (0.3%) were identified. We now regard laparoscopic cholecystectomy as the “gold standard” therapy for management of symptomatic cholelithiasis.

(Arch Surg. 1992;127:917-923)

ous “hands-on” courses and a number of reports attesting to the safety of the procedure in large series of patients.\(^8\)\(^-\)\(^15\) Nevertheless, there are unanswered questions concerning laparoscopic cholecystectomy. Despite the low morbidity reported by early proponents of the procedure, it is feared that the rate of complications among patients whose surgeons are less experienced in performing the procedure is higher than that with open cholecystectomy.\(^13\)\(^-\)\(^15\) Another unresolved issue is the appropriate method of training for laparoscopic surgery. It is feared that surgical residents will not learn these techniques adequately in their training programs. Finally, the issues of whether to obtain intraoperative cholangiograms on a routine or selective basis and the appropriate techniques to manage common bile duct stones in the era of laparoscopic cholecystectomy remain to be settled. The aim of the present study was to review the early experience with laparoscopic cholecystectomy at our teaching institution, specifically assessing the role of residents, rates of morbidity and mortality, and the means by which common bile duct stones have been managed.

**Patients and Methods**
The Kindest Cuts of All

Palm-size video cameras, miniaturized scissors and staplers, and minute incisions are starting to take the ouch out of surgery

By J. MADELEINE NASH

Like a kid intent on a Nintendo game, Dr. David Sugarbaker looks not at the patient lying senseless on the operating table but at the TV positioned by her side. “I think we’re right on target,” he exults. Displayed on the screen is a larger-than-life section of the woman’s years,” exclaims Dr. William Schuessler, a urological surgeon from San Antonio. The instrument sparking such enthusiasm is variously known as a laparoscope (when used in the abdomen), an arthroscope (when applied to the joints), a thoracoscope (when the chest is involved) and an angioscope (when the target lies inside blood vessel walls). But apart from differ-

Reddick, a retired Nashville surgeon credited with popularizing the technique, “we were committing assault and battery on our patients. It wasn’t what we did to their insides, but what we did in order to get there that was the problem.” Now, instead of an 8-cm to 15-cm slash down their abdomens, patients wake up with four small incisions that not only heal more quickly
A Tiny TV Camera Is Fast Transforming Gallbladder Surgery

The Keyhole Technique Uses Tiny Incision, May Work For Other Operations Too

Doctors Scramble to Learn It

By Ron Winslow
Staff Reporter of The Wall Street Journal
Laparoscopic Training
Oct., 1990
"Aha! There's the ol' gall bladder... Dang it, Lois! Would you knock off all this squirmin' around business?"
The L.C. Learning Curve

Probability of Injury

Experience (Number of Procedures Performed)

Diagnosis and Management of Biliary Complications of Laparoscopic Cholecystectomy

Nathaniel J. Soper, MD, M. Wayne Flye, MD, L. Michael Brunt, MD, Paul T. Stockmann, MD, Gregorio A. Sicard, MD, Daniel Picus, MD, Steven A. Edmundowicz, MD, Giuseppe Aliperti, MD, St. Louis, Missouri
2 more deaths from video surgery

By Robert Whitaker

The death toll of patients injured while having their gallbladders removed with laparoscopes has risen to six in New York, and at least 122 other people have been injured because of surgeons’ errors, according to the state Health Department.

That represents two deaths and eight injuries added to the state’s list of botched laparoscopic cholecystectomy operations since Feb. 1, when The Times Union first reported on a rash of complications associated with this procedure. The operation has become popular in the last two years.

Also may strongly suggest that surgeons who have one complication during their first 100 procedures get further training or.proctoring from a more experienced surgeon, and after a second complication, ‘go back to school,’ period,” said Dr. Harvey Bernard of the state Health Department.

Department officials are taking

"I felt I was dying. I was so sick and in such agony I was screaming at the nurses"

— Patricia Bryant

"Albany (N.Y.) Times Union, 3/22/92"

"I am frustrated by the process. The incident reporting isn’t just supposed to be a surveillance system. It’s supposed to be a design..."

According to spokeswoman Jeanie Cross, starting in February 19, HANYS conducted seminars and drew up written recommendations for credentialing surgeons.

"It is a little surprising to find out that all of sudden the Health Department is doing it, too,” she said.

If done properly, removing the
“….raised doubts about the adequacy of surgery’s self-regulated system for introducing new laparoscopic procedures.”
“Those who cannot remember the past are condemned to repeat it”

-George Santayana
Laparoscopic Surgery
“What a Long, Strange Trip It’s Been”

- Laparoscopic cholecystectomy:
  - Widespread adoption 1990-92
  - Prospective, randomized trials 1992 to the present
- Other laparoscopic procedures: ‘Cowboy’ advances, 1990 on
Laparoscopic Procedures Accepted

- Cholecystectomy
- Antireflux Surgery
- Adrenalectomy
- Splenectomy
- Nephrectomy
- Ventral Hernia Repair

- Heller Myotomy
- Donor Nephrectomy
- Gastric Bypass
- Colectomy
- Appendectomy*
- Inguinal Hernia Repair*
Laparoscopic Procedures
Early and/or Limited Application

– CBD Exploration
– Gastrectomy
– Liver resection
– Hepatic tumor ablation
Laparoscopic Procedures

New(er) Operations

– Esophagectomy
– Esophageal Lengthening Procedures
– Rectal resection
– Pancreatic resection
“Surgical Robotics” as currently practiced = computer interface between surgeon and patient
Computer-assisted ("Robotic") Surgery

- Intuitive (DaVinci)
  - FDA approved for Gen Surg
  - Monopoly on market
  - Immersive 3-D, "wrist" articulation
  - Bulky, large ports
  - $$$ (>2.5M USD purchase + FTE + disposables)
From T. Ponsky
Potential Advantages of Robotics in Surgery

- Improved dexterity
  - Tremor elimination
  - Motion scaling
  - ‘True’ motion of instruments
  - Articulation

- Better visualization
  - Surgeon directed optics
  - Stable visual field
  - 3-D vs 2-D visualization

- Enhanced ergonomics for the surgeon
- Telesurgery applications
Current Disadvantages to use of Robotics

- **Absence** of haptic ("tactile") feedback
- **Expense**
  - Initial equipment expense
  - Per case disposables
  - Upkeep, personnel
- **Complex, bulky equipment/few end effectors**
- **Steep learning curve**
- **Training and safety concerns**
- **Relative lack of General Surgical applications**
Robotic Abdominal Surgery

Current applications

• Esophageal myotomy/esophagectomy
• Gastric bypass in superobese
• Biliary and pancreatic reconstructive procedures
• Rectal resections
• Vascular bypasses
• Tubal reanastomosis
• Gyn-Onc resections*
• Radical prostatectomy**
• Partial nephrectomy
Clinical Experience With Robotic General Surgery

- Case series of computer-assisted surgery for laparoscopic Heller myotomy, fundoplication, cholecystectomy, donor nephrectomy, adrenalectomy, esophagectomy, etc.
- No evidence of improved outcomes
- Trans-continental laparoscopic cholecystectomy--Jacques Marescaux, M.D. in NYC, patient in Strasbourg, France
- Telesurgery to remote areas of Canada (M. Anvari)
Current Value of Robotic Surgery

Value = \frac{Quality}{Cost} \uparrow \uparrow = \text{unjustifiable for most general surgery applications}
Robotics in General Surgery

Conclusions

- We are witnessing the infancy of this field; currently few documented advantages for GI surgical applications
- Numerous technical and financial impediments limit widespread application
- The potential advantages of robotic surgery compel further evaluation and application of computer-assisted technology in the O.R.
- Mini-robots may play a role in the future
(From R. Clayman)
Surgery ‘On the Cusp’

- Procedures via natural orifices
- Reduced port laparoscopy
- Other image-guided therapies
Endolumenal Procedures

Antireflux Therapies:
• FDA Approved
  – Stretta--submucosal RF heating—Bankrupt
  – Bard--sutured gastroplasty—Doesn’t work
  – Enteryx--intramuscular injection of biopolymer—Withdrawn
  – NDO Plicator--full-thickness plication of GEJ
• Minimal clinical use—Bankrupt
  – Esophyx—trial at NU
EsophyX® Transoral Incisionless Fundoplication (TIF)

- Endolumenal fundoplication
- Restores angle of His, creates full-thickness valve with polypropylene fasteners
- Phase II clinical trial in Europe
- Released by FDA 9/07
- Limited experience in U.S.—sham-controlled trial in progress
TIF—Esophyx Device

Controls
Tissue Invaginator
Tissue Mold
Chassis with depth markings
Stylet / Fastener
Helical Retractor

Thursday, October 27, 11

Northwestern Medicine
Esophyx Fasteners After Application
Endoluminal Fundoplication (ELF)

Pre-ELF  Post-ELF

4 week Post-ELF

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Endolumenal Therapy (cont)

**Upper GI**
- Mucosal resections—now, full-thickness
- Ablative techniques for Barrett’s**
- Endolumenal bariatric applications
- Endoscopic stapling/suturing

**Trans-rectal**
- TEM
- Endoscopic stapling
Natural Orifice Translumenal Endoscopic Surgery (NOTES)
Abdominal Surgery

Open surgery
('big surgeons make big incisions')

Laparoscopic Surgery

Percutaneous ablations
(Interventional radiology)

Natural Orifice Translumenal Endoscopic Surgery (NOTES)
“He took out my appendix and I don’t even have a scar.”
The NOTES Concept

- Enter body through natural orifice (mouth, anus, vagina, etc.) with endoscope
- Exit mucosa of viscera
- Perform extra-lumenal procedure
- Pull back into viscus and close visceral wall securely
- Remove scope from orifice
Trans-gastric NOTES


— Gastrointest Endosc 60(1): 114-7
Trans-vaginal Cholecystectomy

Tsin 2003 – “Culdolaparoscopy….can be used for exploration and operation in the abdominal cavity…. (and) feasibility of a cholecystectomy.”

Why NOTES?

- Less invasive (?)
  - Less pain
  - Less tissue trauma
- Outpatient procedures—disruptive technology (?)
- Cosmesis
- Anticipated public demand for “incisionless” surgery
Possible Procedures--???

- Staging for cancer or pain
- Appendectomy
- Bowel resection
- Bariatrics
- GYN procedures
- Adhesiolysis
- Diaphragm pacing
- Cholecystectomy***
- Per-oral endoscopic myotomy (POEM)***
Natural Orifice Access Routes

- Trans-nasal
- Trans-aural
- Trans-oral**
  - Trans-esophageal
- Trans-gastric (TG)
- Trans-vaginal (TV)**
- Trans-vesical
- Trans-anal*
NOTES Cholecystectomy

- Trans-gastric (TG)
  - Gastrotomy/closure
  - Retroflexed view
  - Remove GB/stones via esophagus
  - All ‘hybrid’ (lap-assisted) procedures to date
- Trans-vaginal (TV)
  - Vaginotomy/closure
  - Direct (in-line) view
  - Can use rigid and/or flexible instruments
  - Limited experience as true NOTES procedures
  - Only applicable to women
NU Hybrid NOTES™ Cholecystectomies: TG (4) vs TV (9)

- Operative time, 323 vs. 140 min*
- Access closure time, 63 vs 7 min*
- Length of stay, 52 vs 9 hrs*
- Pain pills, 4.5 vs. 0.3
- Complications, 1 vs 0
Standard LC vs. T-V Hybrid Chol’y

- 7 matched patients in each group, collected prospectively
- 4-port LC vs. T-V chol’y using single 5 mm umbilical port and flexible instruments
- OR time 68 vs. 162 min (p<0.05); 6/7 in each group outpatient; no major complications
- VAS pain and narcotic use significantly less during first 24 hr. in T-V group

• Teitelbaum et al, Surg Endosc, in press
Mean VAS Pain Score (0-10)

Time Point

PACU Arrival, 30 min, 1 hr, 2 hrs, POD #1, POD #4, POD #7, POD #14

* : p < .05

LC
TVC

Northwestern Medicine
NOTES Results

- Largely unknown
- NOSCAR registry not widely used
- Many small published series, primary transvaginal
- Transgastric operations double or triple OR time; transvaginal procedures ~1.5 X
- Complications reported: gastrostomy bleeding, peritonitis, esophageal perforation, injury to bladder and rectum, inability to extract GB through esophagus*
  - 36% GBs unable to be pulled through standard overtube (Auyang, et al, Surg Endosc 2011)
- Most centers have stopped trials
They took out your gallbladder...how?

‘Natural orifice’ surgery has tongues wagging

Story by Rita Rubin, USA TODAY
Surgeons taking out
gall bladders via mouth

Albert Pagliuca talks with Dr. Eric Hungness, who performed the operation with two other doctors. | THOMAS DELANY JR., SUN-TIMES

BY JIM RITTER
Northwestern Memorial Hospital surgeons used an unusual new technique to remove Albert Pagliuca’s gall bladder. They pulled it out through his mouth.

Surgeons inserted thin surgical instruments down Pagliuca’s throat to his stomach, then cut through the stomach wall to reach his gall bladder.

Pagliuca, 44, went home the next day.

He said he felt some abdominal discomfort, “but nothing like I thought it would be.” After two days, he stopped taking pain pills.

Northwestern is among several hospitals pioneering surgery through the mouth, vagina or anus to reach the gall bladder and perhaps other internal organs.

The goal is to eliminate incisions and scars, reduce pain and speed recovery.

Pagliuca is among the 750,000 Americans who have gall bladders removed each year because of gallstones. The organ is shaped like a pear, but smaller.

Surgeons typically use minimally invasive laparoscopic techniques to remove gall bladders. While these techniques are less painful than traditional open surgery, they still cut through abdominal muscles and leave several small scars.

Using the natural-opening technique, Northwestern surgeons reached Pagliuca’s abdominal cavity by cutting a one-inch hole in his stomach wall.

Doctors hope this surgery will hurt less because the stomach has few pain nerves. But if surgeons don’t properly close the hole, stomach juices could leak out, causing a life-threatening inflammation.

“We’re all acutely aware of the potential downsides of these operations,” said Dr. Nathaniel Soper, who performed Pagliuca’s operation along with Dr. Eric Hungness and Dr. John Martin.

Using a different natural opening, Columbia University surgeons removed a woman’s gall bladder by entering her vagina and then cutting through the vaginal wall.

A third technique is to go through the anus and cut through the colon wall. Northwestern is testing this method on pigs and cadavers.

In a recent survey of about 250 patients at Northwestern and the Oregon Clinic, about 60 percent said they would prefer natural-opening surgery to current techniques.
POEM Results

Thousands performed in Shanghai, Yokohama, etc.

>130 performed at NM
Publications on learning curve, perioperative results, one-year outcomes
Equivalent perioperative outcomes to Heller myotomy
~4% failure rate at one year (learning curve)
~30% rate of GERD at one year
Most patients coming to our center now demand POEM

Hungness, Teitelbaum, Soper, et al, multiple publications
Hindrances to NOTES’ Expansion

- Cost/payment considerations
- Potential issues with FDA—‘off-label use of endoscopic equipment’
- Patient safety concerns
- Lack of ‘buy-in’ by patients and referring physicians
- Need for better instrumentation
It's a kinder cut for patients

Surgery offers less scarring

By Rita Rubin
USA TODAY

"No-scar" abdominal surgery is one of the hottest topics of discussion when surgeons or gastroenterologists meet these days.

Instead of entering the abdomen through an incision in the skin, doctors who perform this type of operation enter the body through one of its natural openings — usually the mouth — and then make an incision internally to reach their destination. The procedure is a cross between endoscopy and surgery.

To reach the abdomen in this way, for example, doctors must make an endoscope, or lighted tube, down the esophagus and into the stomach.

Working through the endoscope, doctors then make a small incision in the stomach so they can get to other organs in the abdominal cavity.

Proponents say this "natural orifice" approach, still in its infancy, could revolutionize surgery, the way laparoscopic or "keyhole" surgery did 20 years ago. Besides leaving no visible scar, they say, the technique promises to reduce pain and recovery time.

But they express concern that some ill-prepared doctors and hospitals might embrace the technique for marketing purposes rather than for medical reasons.

They point to the rush to perform laparoscopic surgery, which led to scores of injuries and at least seven deaths in New York alone in the early 1990s. That led the state's health department to take the unprecedented step of setting criteria for surgeons to meet before allowing them to perform the procedure unsupervised.

"It's a little bit alarming to see how many courses are cropping up" for no-scar surgery, says surgeon Lee Swanstrom of the Oregon Clinic in Portland.

Swanstrom, who in May became the first U.S. doctor to remove a patient's gallbladder through her mouth, says he has been invited to speak at eight courses in the next six months.

He says he was upset to learn that an Italian doctor and a Greek doctor who attended a course in Europe recently began operating on humans with minimal practice on animals beforehand.

So far, Swanstrom estimates, only dozens of patients worldwide have had no-scar surgery.

Three of the patients were his, all of them women whose gallbladders were removed through their mouths, while two others in New York had theirs taken out through their vaginas.

"The progress has been astonishing," says David Raitner, a Massachusetts General Hospital surgeon in Boston who has performed no-scar surgery only in pigs.

At an international conference in March 2005, Raitner says, attendees figured they were three years away from trying the approach in patients.

Still, Raitner says, "we just don't want people to go and do this on a whim."
On the Road to Transluminal Misadventure: NOTES

Frederick L. Greene, MD
Chairman, Department of General Surgery
Carolina Medical Center
Charlotte, N.C.

It is safe to say that most of the readership of General Surgery News has successfully weathered the revolutionary changes brought about by minimal-access surgery through the use of laparoscopic instrumentation in the abdomen and thoracoscopic applications in the chest. Since the mid- to late 1980s, laparoscopy has completely revamped our thoughts regarding surgical approaches and has, to a degree, limited the opportunities for “traditional” open surgery that many initially experienced and perfected in their training. The important issue throughout the laparoscopic revolution has been the introduction and application of new technologies and operations utilizing the same principles of wound care and surgical management traditionally followed for decades during the “open” era.

The same excitement that accompanied developments in laparoscopy appears evident in the recent interest and various dialogues concerning natural orifice transluminal endoscopic surgery (NOTES). The use of the flexible endoscope to accomplish certain abdominal and thoracic interventions by transgressing the walls of various organs has led to a greater awareness and understanding of the importance of flexible endoscopy in surgical practice. For this I am grateful because throughout my career I have encouraged the concept that surgeons must stay involved in surgical endoscopy, and that we must mandate adequate training of flexible gastrointestinal (GI) endoscopic procedures in our residency programs. The Residency Review Committee for Surgery and the American Board of Surgery have certainly embraced this concept and for that we should be thankful. Endoscopic evaluations of the GI tract began with surgeons, and should continue to be strongly advocated in the surgical community.

Although I should be extremely pleased that the concept of NOTES creates more opportunities for surgical use of the flexible endoscope, I am quite concerned about the apparent disregard of basic surgical principles these techniques engender. Each day in our open and laparoscopic approaches we judiciously attempt to avoid injury to the GI tract or other hollow viscera. Certainly, as surgeons, we recognize the dire consequences that even small leaks will create in our patients. It seems absolutely folly to embrace concepts in which flexible endoscopes intentionally create perforations in the GI tract in order to remove diseased organs that can be safely extirpated through transabdominal approaches using minimal incisions. Should we launch upon this concept merely to avoid an incision (no matter how small) in the abdominal wall?

Although I am pleased that the concept of NOTES has created a greater bending between the gastroenterologists and surgeons who see this as a potential “team sport,” I fear that rogue gastroenterologists will interpret the NOTES philosophy as a “green light” to unilaterally undertake transluminal cholecystectomy, appendectomy and who knows what! In the early phase of the laparoscopic era we were challenged by a group of gastroenterologists, versed in laparoscopic diagnostic techniques, who were determined to remove gallbladders. Early privileging and credentialing strategies appropriately suggested that only those who can take care of the complications created during laparoscopic procedures and who had appropriate surgical training should see NOTES, page 4.

Northwestern Medicine
Summary: NOTES 2015

- Limited clinical experience—majority ‘hybrid’
- Most centers have discontinued NOTES cholecystectomies
- Increasing interest in trans-**anal** procedures
- POEM procedure promising and may be the primary result of the NOTES investigations
Spin-offs

- Single incision laparoscopic surgery
  - SILS, SPA, OPUS, etc., etc.
  - In-line dissection; many instruments expensive; concern re: injuries occurring as a result of novel dissection and retraction techniques*

Other ‘Spin-Offs’

- Microlaparoscopy
- Advanced endolumenal techniques
- TEM, transrectal procedures
Future Prognostication

“We don’t like their sound, and guitar music is on the way out.”

• Decca Recording Co. executive, on rejecting the Beatles, 1962
MIS: What’s Ahead

- Single incision laparoscopy—coupled with robotics?
- Return of ‘needle-oscopy’
- Simulators for skill acquisition and improvement
- Computerized preoperative planning with intraoperative image registration to allow focused therapy (CT, MR, U/S, etc)
- Endoluminal procedures (bariatrics)
MIS: What’s Ahead

Advanced technology application

• Purpose-built robotic systems that are smaller and cheaper
• Use of micro-robots
• Sense-enhancement (haptics, etc.)
• Ability to overlay alternative ‘views’ over visual field (scintigraphic, infrared, etc)
• Widespread telematics applications--intraoperative consultations, etc.
MIS: What’s Ahead

No-incision surgery

• Improved endolumenal techniques
• Blurring of intraluminal/extraluminal abdominal procedures
• New training paradigms for ‘GI Interventionists’—GI surgeons clearly need to embrace flexible endoscopy!
• Further development and clinical application of NOTES
• Widespread application of “trackless” ablative procedures
“We can anticipate a day when surgery can be done without a knife or a hole”

- John Hunter, 1790
“Surgery is moving from knife, to cannula, to needle...... to nothing.”

--Ralph V. Clayman, 2000