Laparoscopic Suturing: Practical Tips for Needle Management, Knot Tying and Suture Use (Simulation Lab)

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Professional Education Information

Target Audience
This educational activity is developed to meet the needs of residents, fellows and new minimally invasive specialists in the field of gynecology.

Accreditation
AAGL is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

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This workshop provides integrated lectures and hands-on simulation exercises to review techniques of basic laparoscopic suturing and knot tying for tissue reapproximation relevant to gynecologic surgeons. Along with needle management, intracorporeal and extracorporeal knot tying techniques, the various applications of different suture materials and alternative suturing technologies utilized in gynecologic laparoscopy will also be reviewed. Clinical applications will be discussed to allow the participant to transition the information learned in this course to their practice.

The hands-on suturing simulation will utilize pelvic trainers adaptable to any port configuration on the abdomen facilitating transition from the trainer to the operating room. Experienced faculty will actively guide and mentor participants through the key steps of developed training exercises suitable to their practice needs.

The course is designed for gynecologists in practice who want to develop or improve their suturing skills for immediate application in their surgical practice.

**Learning Objectives:** At the conclusion of this activity, the clinician will be able to: 1) Manipulate and load a needle laparoscopically for tissue reapproximation; 2) perform extracorporeal knots; 3) perform intracorporeal knots; 4) outline the advantages, disadvantages, and clinical applications for extracorporeal versus intracorporeal knots; 5) distinguish advantages and disadvantages of various suture materials, including barbed suture; and 6) distinguish advantages and disadvantages of suturing technologies used in laparoscopy.

### Course Outline

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:30</td>
<td>Welcome, Introductions and Course Overview</td>
<td>A. Cholkeri-Singh</td>
</tr>
<tr>
<td>1:35</td>
<td>Port Placement, Needle Loading and Tissue Reapproximation</td>
<td>J.L. Hudgens</td>
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<tr>
<td>1:50</td>
<td>Hands-on Training – Needle Loading and Needle Manipulation</td>
<td>All Faculty</td>
</tr>
<tr>
<td>Time</td>
<td>Session</td>
<td>Instructor</td>
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<tr>
<td>2:30</td>
<td>Extracorporeal Knot Tying</td>
<td>A. Cholkeri-Singh</td>
</tr>
<tr>
<td>2:45</td>
<td>Hands-on Training – Extracorporeal Knot Tying</td>
<td>All Faculty</td>
</tr>
<tr>
<td>3:15</td>
<td>Questions &amp; Answers</td>
<td>All Faculty</td>
</tr>
<tr>
<td>3:25</td>
<td>Break</td>
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</tr>
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<td>3:40</td>
<td>Intracorporeal Knot Tying</td>
<td>H.C. Hur</td>
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<tr>
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<td>Hands-on Training – Intracorporeal Knot Tying</td>
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<tr>
<td>4:35</td>
<td>Suture Selection and Technologies Used in Gynecologic Laparoscopy</td>
<td>K. Huang</td>
</tr>
<tr>
<td>4:50</td>
<td>Hands-on Training – Barbed Suture and Suturing Devices</td>
<td>All Faculty</td>
</tr>
<tr>
<td>5:20</td>
<td>Questions &amp; Answers</td>
<td>All Faculty</td>
</tr>
<tr>
<td>5:30</td>
<td>Course Evaluation/Adjourn</td>
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PLANNER DISCLOSURE
The following members of AAGL have been involved in the educational planning of this workshop and have no conflict of interest to disclose (in alphabetical order by last name).
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Consultant: Emmi
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Asterisk (*) denotes no financial relationships to disclose.
Port Placement, Needle Loading, & Tissue Re-approximation

Objectives
1. Present the different port placements used in laparoscopic suturing
2. Present a system for setting the needle
3. Discuss strategies for tissue re-approximation

Disclosure
- Grants/Research Support: Karl Storz
- Consultant: Terumo, CVS

Port Placement Video

Port Placement Video 2

Ipsilateral
- Ergonomics
- Assistant
- One Sided
Contralateral

- Ideal Triangulation
- Poor Ergonomics?
- No Assistant

Suprapubic

- Gravity
- Ergonomics?
- Two Sided

System

1. Set the Needle
2. Re-approximate
3. Knot Tying

System

- Set (perpendicular)
- Parallel (tissue)
- Rotate (key)
- Reset

Needle Entry

- Direct-trocar
- Backloaded
- Abdominal Wall

- 5mm......Backload
- 8mm......SH-1
- 10mm.....CT-2 & CT-1
- 12mm......CT
Setting the Needle

**A-B-C**

- **A** = 2 cm from Swedge
- **B** = 1/3 from Point
- **C** = 1/3 from Swedge

**Setting Video 1**
Setting Video 3

Setting the Needle

A-B-C

Left Hand
Right Hand

Right Hand Motion

Novice
Expert

Hiemstra et al JMG 2011 vol. 38, pgs 494-499

Ipsilateral Relationship

Contra-lateral Relationship
Supra-pubic Relationships

Clinical Video 1

Clinical video 2

System

- Set (perpendicular)
- Parallel (tissue)
- Rotate (key)
- Reset

References


Extracorporeal Knot Tying
Aarathi Cholkeri-Singh, M.D., FACOG
Clinical Assistant Professor of Obstetrics and Gynecology at UIC
Associate Director of Minimally Invasive Gynecologic Surgery
Director of Gynecologic Surgical Education at ALGH

Objectives
- Review principles of knot security
- Overview of applications of Extracorporeal Knots
- Understand Extracorporeal Knot tying technique
- Extracorporeal knot troubleshooting
- Video demonstrations of extracorporeal knot use in gynecologic surgery

Principles of Knot Security
1. Type of Suture
2. Type of Knot
3. Surgical Technique
4. Length of cut end

GOAL = tissue is approximated and secured

Suture Material
- Natural vs. Synthetic
  - Natural i.e. Chromic
    - Tissue fluids alter ability to hold knot
  - Synthetic
    - Multifilament
      - Lie flat more readily secondary to less memory
    - Monofilament
      - Less tissue inflammation
      - Slippage and weaken from surgical instruments
- Friction is greater for braided multifilament than monofilament suture

Disclosures
- Consultant: Ethicon Endo-Surgery, Karl Storz

"... an unreliable suture knot can spoil the outcomes of an otherwise beautifully performed surgical procedure."
- unknown author

Role of extracorporeal knots in laparoscopic surgery. www.laparoscopyhospital.com

Suture Length

- Single-use suture, minimum length of suture should be 27 inches (70 cm) – standard length
- Multiple-use or purse-string suture, recommend length of suture to be minimum 48 inches (122 cm)

Laparoscopic Knots

- Amortegui et al, Surg Endosc 2002
  - 1 surgeon, 7 types of knots
  - 140 knots conventional vs. 140 knots laparoscopic
  - 2-0 braided polyester
  - 4-6 throws
  - Knots measured for breaks using tensiometer and knot slips >3mm

Type of knot

**Intracorporeal**
- Sliding knot
  - Coefficient of friction not equally distributed between suture ends
  - Each end of suture enters and leaves knot in opposite direction

**Extracorporeal**
- Sliding knot
  - Coefficient of friction not equally distributed between suture ends
  - Each end of suture enters and leaves knot in same direction
  - One axial strand is held under tension as the other ties around it

Laparoscopic Knots

<table>
<thead>
<tr>
<th>Knot Type</th>
<th>Sliding (1)</th>
<th>Conventional (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracorporeal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extracorporeal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each knot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Sliding Knot
  - 1 or # indicates number of flat square knots
  - S throw in opposite direction from previous
  - X throw in same direction as previous
  - # change of axial strand and next throw turns in same direction as previous
  - S change of axial strand and next throw turns in opposite direction from previous

Laparoscopic Knots

- Goldenberg et al, JSLS 2009
  - 3 surgeons, 100 knots, 2-0 silk, 4 throws measured for knot slips and breaks using tensiometer

Extracorporeal square knots vs.
Intracorporeal slip-square vs.
Intracorporeal flat-square

These configurations had superior tensile strength to others tested in laparoscopic group (p<0.05)
No significant difference between these 3 configurations
Robot-assisted Laparoscopic Knots

• Larger variability in the strength of the knots made using the robot, which corresponded to higher percentage of unraveling knots

Table 1: Mean ultimate load (in Newtons) and knot failure mode for each laparoscopic and robotic combination

<table>
<thead>
<tr>
<th>Knot</th>
<th>Ultimate Load (Newton)</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>25.8 ± 3.4</td>
<td>Tensile</td>
</tr>
<tr>
<td>Robotic</td>
<td>20.8 ± 3.4</td>
<td>Tensile</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Extracorporeal Knots

• Decrease operative time
• Easy to perform
• Quicker to tie than intracorporeal knots
• Tensile strength comparable to intracorporeal knots

Applications

• General GYN
  - Ovarian reconstruction
  - Vaginal cuff closure
  - Cervical stump closure
  - Myomectomy
  - In lieu of additional port and grasper
• Repairs
  - Bladder
  - Bowel
• Uterine Perforation

Useful for any interrupted or purse-string suturing

Surgical Technique of Extracorporeal Knots

1. Interrupted or purse-string stitch placed in tissue
2. Both ends of suture outside of laparoscopic port
3. Knot formed outside of abdominal cavity
4. Laparoscopic knot pusher mounted adjacent to knot
5. Tension placed on both ends of suture as laparoscopic knot pusher cinches down and secures each knot to tissue
6. Release knot pusher from suture
7. Repeat throws (steps 2-6)


Laparoscopic Knot Pushers
Suture Tail
- Cutting tail of knot too short compromises knot integrity as it can easily unravel
Troubleshooting

- Suture too short
- Needle through 5 mm port
- Suture twisting
- Open knot pusher released early

Short Suture

Needle Back-loading

Untwisting Suture

Replacing Knot Pusher
Replacing Knot Pusher

Laparoscopic Babcock

Applications of Extracorporeal Knots

Vaginal Cuff Repair

Uterosacral Suspension

Ovarian Reconstruction
Oophoropexy

References
1. Role of extracorporeal knots in laparoscopic surgery. www.laparoscopyhospital.com
2. Sanz LE. Selecting the best suture material. Contemp Ob/Gyn. 2003;57(7-8).
**Intracorporeal Knot Tying**

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Beth Israel Deaconess Medical Center  
Assistant Professor, Harvard Medical School

**Disclosures**

- **Other:** Author: UpToDate  
- **Other:** Received travel expenses to discuss residency robotic training curriculum: Intuitive Surgical

**Objectives**

- Indications for intracorporeal knot tying  
- Basic equipment  
- Technique  
  - breakdown of steps  
  - helpful tips  
  - video demo

**Indications**

<table>
<thead>
<tr>
<th>General:</th>
<th>Specific:</th>
</tr>
</thead>
<tbody>
<tr>
<td>any indication for extracorporeal knot tying can be applied to intracorporeal knot tying</td>
<td>more delicate suturing, tying knots off tension</td>
</tr>
<tr>
<td>vaginal cuff closure</td>
<td>bowel repair</td>
</tr>
<tr>
<td>laparoscopic myomectomy</td>
<td>bladder repair</td>
</tr>
<tr>
<td>oophoropexy</td>
<td>peritoneal closures (e.g. sacrocolpopexy)</td>
</tr>
<tr>
<td>suturing for retraction (e.g. ovary, bowel, uterus)</td>
<td>continuous suture</td>
</tr>
</tbody>
</table>

**Equipment**

- Laparoscopic Needle Driver (curved, locking)  
- Laparoscopic Needle Grasper (straight)  
- Laparoscopic Scissors  
- Suture, cut 6-8 inches (interrupted vs figure of eight sutures)  
- 10 mm trocar (direct delivery of needle)  
- 5 mm trocar (back load needle)
Breakdown of Steps

1. Select appropriate trocar size for needle delivery.
2. Cut suture in advance.
   - Interrupted suture → 6 inches
   - Figure of eight suture → 8 inches
   - Continuous running suture → 12 inches
3. Place suture.
4. Throw 4-6 square knots (opposite direction).
   - Vicryl → 4 throws
   - PDS → 6 throws
5. Cut suture, remove needle under direct visualization.

Replicate an instrument tie.

Tips: Intracorporeal Knot Tying

1. Select appropriate trocar size for needle delivery
2. Cut suture in advance (6-8 inches)
3. Place suture (use locking needle driver)
   - TIP #1: Leave free end (tail) short
4. Throw 4-6 square knots (opposite direction)
   - TIP #2: Keep heel of needle in-line with needle grasper
   - TIP #3: Don’t drift from surgical field when suturing
   - TIP #4: Pull ends so the free end stays short
5. Cut suture and remove needle under direct visualization

Important Tips

- TIP #2: Keep heel of needle in-line with needle grasper
- TIP #3: Don’t drift from surgical field when suturing
- TIP #4: Pull ends so the free end stays short

Common Mistakes to Avoid

- TIP #2: Keep heel of needle in-line with needle grasper
- TIP #3: Don’t drift from surgical field when suturing
- TIP #4: Pull ends so the free end stays short
Laparoscopic suturing and intracorporeal knot tying is a skill that anyone can learn and master in the dry lab setting.

Important Tips
- Think ahead
  - select appropriate trocar size (10 vs 5mm)
  - cut suture in advance (6-8 inches)
- Suturing & Intracorporeal Knot Tying
  - Leave free end (tail) short
  - Keep heel of needle in-line with needle grasper
  - Don’t drift from surgical field when suturing
  - Pull ends so the free end stays short

Figure of Eight Suture

Continuous Running Suture

Take Home Points

Conclusion

If you can do an instrument tie, you can do intracorporeal knot tying.
Suture Selection and Technologies Used in Gynecologic Laparoscopy

Kathy Huang, M.D.
Director of Gynecologic Robotic Surgery
Assistant Professor
New York University Langone Medical Center

Disclosure

Other: Proctor: Intuitive Surgical

Objectives

• Demonstrate proper suturing technique for both Bi-directional and Uni-directional Barbed Sutures
• Demonstrate proper technique for Endo-Stitch
• Describe the advantages as well as the disadvantages of utilizing barbed suture/suturing devices

Bi-directional barbed suture

• Bi-directional barbed suture was introduced in January 2007 and uni-directional barbed suture was approved shortly after
• Barbed suture: EASE OF USE
  • eliminates knot tying
  • achieves hemostasis without the use of locking and figure of eight
  • decreases operative time

Bi-directional Barbed Suture

- 63 patients were randomized to Quill or Vicryl
- operative time for cuff closure
- sexual function questionnaire - preop and 3 months postop


Outcome

- 10.4 vs 9.6 minutes, p=0.51
- Cuff healing - similar
- No difference in rates of dyspareunia, partner dyspareunia
- Sexual function: similar
- Statistical power of 80% to detect of difference of 5 min
- Cuff closure time: attendings faster than residents/fellows
  - 7.1 vs 12.8 minutes, p<0.0001

Unidirectional Barbed Suture

- V-Loc 90 (4-0 to 2-0)
- V-Loc 180 (4-0 to 0)

Prospective Study

- Women with single intramural myoma
- V-Loc vs classic continuous suture with intracorporeal knots
- Mean operative time was shorter in V-Loc; 51 vs 58 min
  - suturing time: 9.9 vs 15.8, p=0.0004
  - decreased blood loss, p=0.0076
  - decreased drop in hemoglobin, p=0.0176


Retrospective analysis: 138 consecutive laparoscopic myomectomies by a single surgeon over a 3 year period

- 31 Vicryl and 107 bidirectional barbed
- Barbed suture group:
  - decreased operative time: 118 vs 162 min, p<0.05
  - reduced duration of hospital stay: 0.58 vs 0.97, p<0.05
  - No differences: perioperative complications, EBL, or # of myomas removed during surgery


V-Loc

- Retrospective Study from Feb 2008 to August 2012
- 202 TLH: Vloc = 63 and PDS =139
- Postop fever: higher in Vloc group
- similar operative time, blood loss and hospital stay

Endo Stitch

- 10mm disposable suturing device
- Allows for placement of multiple suture types during laparoscopic surgery and simplifies knot tying
- SILS Stitch:
  - added advantage of articulation up to 75 degrees and rotation up to 360 degrees

References

CULTURAL AND LINGUISTIC COMPETENCY

Governor Arnold Schwarzenegger signed into law AB 1195 (eff. 7/1/06) requiring local CME providers, such as the AAGL, to assist in enhancing the cultural and linguistic competency of California’s physicians (researchers and doctors without patient contact are exempt). This mandate follows the federal Civil Rights Act of 1964, Executive Order 13166 (2000) and the Dymally-Alatorre Bilingual Services Act (1973), all of which recognize, as confirmed by the US Census Bureau, that substantial numbers of patients possess limited English proficiency (LEP).

California Business & Professions Code §2190.1(c)(3) requires a review and explanation of the laws identified above so as to fulfill AAGL’s obligations pursuant to California law. Additional guidance is provided by the Institute for Medical Quality at [http://www.imq.org](http://www.imq.org).

Title VI of the Civil Rights Act of 1964 prohibits recipients of federal financial assistance from discriminating against or otherwise excluding individuals on the basis of race, color, or national origin in any of their activities. In 1974, the US Supreme Court recognized LEP individuals as potential victims of national origin discrimination. In all situations, federal agencies are required to assess the number or proportion of LEP individuals in the eligible service population, the frequency with which they come into contact with the program, the importance of the services, and the resources available to the recipient, including the mix of oral and written language services. Additional details may be found in the Department of Justice Policy Guidance Document: Enforcement of Title VI of the Civil Rights Act of 1964 [http://www.usdoj.gov/crt/cor/pubs.htm](http://www.usdoj.gov/crt/cor/pubs.htm).

Executive Order 13166, “Improving Access to Services for Persons with Limited English Proficiency”, signed by the President on August 11, 2000 [http://www.usdoj.gov/crt/cor/13166.htm](http://www.usdoj.gov/crt/cor/13166.htm) was the genesis of the Guidance Document mentioned above. The Executive Order requires all federal agencies, including those which provide federal financial assistance, to examine the services they provide, identify any need for services to LEP individuals, and develop and implement a system to provide those services so LEP persons can have meaningful access.

Dymally-Alatorre Bilingual Services Act (California Government Code §7290 et seq.) requires every California state agency which either provides information to, or has contact with, the public to provide bilingual interpreters as well as translated materials explaining those services whenever the local agency serves LEP members of a group whose numbers exceed 5% of the general population.

~

If you add staff to assist with LEP patients, confirm their translation skills, not just their language skills. A 2007 Northern California study from Sutter Health confirmed that being bilingual does not guarantee competence as a medical interpreter. [http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2078538](http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2078538).