Simulation Lab:
Practical Applications for Tissue Re-approximation, Knot Tying and Suturing Technologies

PROGRAM CHAIRS
Joseph (Jay) L. Hudgens, MD & Fariba Mohtashami, MD

Hasan Abdessamad, MD
Biba Nijjar, MD
Arleen H. Song, MD

Aarathi Cholkeri-Singh, MD
Laurence Orbuch, MD
Michael L. Sprague, MD

Thomas G. Lang, MD
Lisa M. Roberts, MD
John A. Thiel, MD

AAGL acknowledges that it has received support in part by educational grants and equipment (in-kind) from the following companies:
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Advancing Minimally Invasive Gynecology Worldwide
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SUTR-600
Simulation Lab: Practical Applications for Tissue Re-approximation, Knot Tying and Suturing Technologies

Joseph (Jay) L. Hudgens, Chair
Fariba Mohtashami, Co-Chair


This course will provide an introduction to basic and advanced laparoscopic suturing techniques in a dry lab setting and is designed for participants wanting to expand their laparoscopic suturing skills. This course will present a variety of techniques for needle loading and tissue re-approximation from different port configurations in laparoscopic box trainers. Techniques and clinical applications for extra-corporeal, intra-corporeal knot tying, and running suturing techniques relevant to vaginal cuff closure, myomectomy, and cystotomy repair will be presented. In addition, various applications of different suture materials and alternative suturing devices and technologies utilized in gynecologic laparoscopy will be reviewed. This course will aim to present the material in a systematic fashion with concrete and focused objectives throughout the session. Faculty will provide an interactive environment to meet the needs of the individual, critical to effective learning. This course is designed for the practical gynecologist to help determine which suturing techniques will work best in his or her surgical practice. This course is designed to help improve suturing skills for immediate clinical application.

Learning Objectives: At the conclusion of this course, the clinician will be able to: 1) Explain how to overcome the obstacles to laparoscopic suturing and knot tying in relation to depth perception and port placement; 2) reproduce efficient techniques for laparoscopic tissue re-approximation, suture management, and running closures; 3) Recognize and perform efficient intra-corporeal and extra-corporeal knot tying, the common mistakes encountered, and how to correct them; and 4) compare and distinguish potential benefits of suturing technologies and devices used in laparoscopy.

Course Outline

7:00 Welcome, Introductions and Course Overview J.L. Hudgens
7:05 Fundamentals of Needle Loading, Tissue Re-approximation, and Suture Management J.L. Hudgens
7:25 LAB I: Simulated Running Cuff Closure – Demonstrating Efficient Needle Loading, Tissue Re-approximation, and Suture Management during a Simulated Running Closure
8:20 Techniques for Intra-Corporeal Knot Tying: Clinical Applications, Common Mistakes, and How to Correct Them F. Mohtashami
8:40 LAB II: Intra-Corporeal Knot Tying – Identifying Critical Elements for Intra-Corporeal Knot Tying, Common Mistakes That Are Encountered, and How to Correct Them
9:40 Extra-Corporeal Knot Tying, Suture Selection, Barbed Suture, Suturing Technologies, and Clinical Applications A. Cholkeri-Singh
10:00 LAB III: Extra-Corporeal Knot Tying – Identifying Critical Elements for Extra-Corporeal Knot Tying, Common Mistakes That Are Encountered, and How to Correct Them; Comparing and Distinguishing Potential Benefits of Suturing Technologies and Devices Used in Laparoscopy

10:50 Questions & Answers

11:00 Adjourn
SUTR-601
Simulation Lab: Practical Applications for Tissue Re-approximation, Knot Tying and Suturing Technologies

Fariba Mohtashami, Chair
Joseph (Jay) L. Hudgens, Co-Chair


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Course Outline

12:30 Welcome, Introductions and Course Overview
F. Mohtashami

12:35 Fundamentals of Needle Loading, Tissue Re-approximation, and Suture Management
J.L. Hudgens

12:55 LAB I: Simulated Running Cuff Closure – Demonstrating Efficient Needle Loading, Tissue Re-approximation, and Suture Management during a Simulated Running Closure

1:50 Techniques for Intra-Corporeal Knot Tying: Clinical Applications, Common Mistakes, and How to Correct Them
F. Mohtashami

2:10 LAB II: Intra-Corporeal Knot Tying – Identifying Critical Elements for Intra-Corporeal Knot Tying, Common Mistakes That Are Encountered, and How to Correct Them

3:10 Extra-Corporeal Knot Tying, Suture Selection, Barbed Suture, Suturing Technologies, and Clinical Applications
A. Cholkeri-Singh

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LAB III: Extra-Corporeal Knot Tying – Identifying Critical Elements for Extra-Corporeal Knot Tying, Common Mistakes That Are Encountered, and How to Correct Them; Comparing and Distinguishing Potential Benefits of Suturing Technologies and Devices Used in Laparoscopy

4:20 Questions & Answers All Faculty

4:30 Adjourn
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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Hasan Abdessamad*
Aarathi Cholkeri-Singh
Consultant: Bayer Healthcare Corp., Ethicon Endo-Surgery, Karl Storz
Joseph (Jay) L. Hudgens*
Howard Jones*
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Arleen H. Song*
Michael L. Sprague  
Consultant: Covidien  
John A. Thiel  
Grants/Research: Bayer Healthcare Corp., Channel Medical, Conceptus Incorporated, Halt Medical, Hologic, Minerva Surgical  

Asterisk (*) denotes no financial relationships to disclose.
Fundamentals of Needle Loading, Tissue Re-approximation, and Suture Management

Jay L. Hudgens, M.D., F.A.C.O.G.
Assistant Professor
University of Mississippi Medical Center
Director of Minimally Invasive Gynecology
Wiser Women’s Hospital
Jackson, MS

Disclosure

I have no financial relationships to disclose.

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 and suture management

System

1. Set the needle
2. Reapproximate
3. Knot tying

Geometry

Geometry = The Study of Relationships

- Anatomy
- Laparoscope
- Instruments
- Needle
Geometry

Parallel = Miss
Perpendicular = Hit

Port Placement 1

Port Placement 2

Ipsilateral

• Ergonomics
• Assistant
• One Sided

Contralateral

• Ideal Triangulation
• Poor Ergonomics?
• No Assistant

Suprapubic

• Gravity
• Ergonomics?
• Two Sided
1. Set the Needle
2. Re-approximate
3. Knot Tying

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

Tie Knot

Needle Entry
• Direct-trocar
• Back loaded
• Abdominal Wall

• 5mm......Backload
• 8mm......SH-1
• 10mm.....CT-2 & CT-1
• 12mm.....CT

Setting the Needle

A-B-C
A-C

Beginner
Advanced

"A" = 2cm from Swedge
"B" = 1/3 from Point
"C" = 1/3 from Swedge
Expert Needle Loading

Right Hand Motion

Novice

Expert

Hiemstra et al JMG 2011 vol. 18, pgs 494-499

System

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

Ipsilateral Relationship

Mechanics Produce

Mechanics Produce
Supra-pubic Relationship

Extra Corporeal Cuff Closure

Re-approximation Video 1

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

Tie Knot

Suture Management
1. Pulley
2. Walk the Line
3. Hand over Hand
Rules for Suture Management

• 1. Never let go with both hands
• 2. Grasp the suture perpendicular
• 3. Walk the Line
• 4. Use a Pulley

References


Techniques for Intra-Corporeal Knot Tying: Clinical Applications, Common Mistakes, and How to Correct Them

Fariba Mohtashami, MD, FRCSC
Clinical Assistant Professor
University of British Columbia
Vancouver, Canada

Objectives

➢ Identify the indications for intracorporeal knot tying

➢ Explain the ergonomics and rationale for reproducible intracorporeal knot tying

➢ Apply skills learned to avoid common mistakes in intracorporeal knot tying

Indications

➢ Any indication for laparoscopic suturing and knot tying

➢ Tying knot with minimal tension
  - Bladder repair
  - Bowel repair
  - Closing peritoneum

➢ The initial and final knot for continuous suturing

➢ When extracorporeal knot tying fails
  - Suture breaks off
  - Knot pusher unavailable

Intracorporeal knot tying

➢ Requires great manual dexterity

➢ Rate-limiting step in many procedures

➢ Must be mastered by every laparoscopic surgeon

➢ Anyone can learn it in the dry lab!

Technique for Intracorporeal knot tying

➢ Ease

➢ Rapidity of execution

➢ Reproducibility

➢ Tightness of the knot

Disclosures

➢ I have no financial relationships to disclose.
Steps
1. Choose the trocar for needle delivery
   - 10mm trocar: Direct entry
   - 5mm trocar: Backload
2. Cut the suture in advance
   - Interrupted: 6 inches (15cm)
   - Figure of eight: 8 inches (20cm)
   - Continuous running: 12 inches (30cm)
3. Place suture
4. Throw 4-6 square knots in opposite direction
5. Cut suture and remove needle under direct visualization
**Common mistakes Video2**

**Common mistakes Video3**

**Tips**
- **Use your tips!**
  - Work at tip of your instruments
  - Grasp the tip of your short tail, No bowtie!
- Leave the tail short (2-3 cm)
- Make a good loop. No loop, No knot!

**Tips**
- **Use your curves!**
  - Curved instruments facilitate tying.
  - Allow scooping through concave needle curves.
- Stay in the surgical field, don’t drift!
- Move both hands together to grasp distal end of short tail. Don’t leave the left hand behind!

**Motor Learning Theory**

**Why master manual dexterity in the dry lab?**
- The skills are transferable to the real OR
- Human brain capacity is limited
- Things can go wrong in the OR
K.I.S.S.

References
- Charles H. Koh. Laparoscopic Suturing in the Vertical Zone. Endo Press 2008: Tuttlingen, Germany

Evaluation Question Video

What was the mistake?
- Wrong angle between suture and right instrument
- Inadequate loop
- Drifted left hand
- Long tail
- Short suture

Good surgeons are made not born!

Thank you!
Disclosures

- Consultant: Bayer Healthcare Corp., Ethicon Endo-Surgery, Karl Storz

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
- Discuss laparoscopic suturing alternatives

“... an unreliable suture knot can spoil the outcomes of an otherwise beautifully performed surgical procedure.”

- unknown author

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
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

Laparoscopic Knots

<table>
<thead>
<tr>
<th>Number</th>
<th>Conventional (%)</th>
<th>Laparoscopic (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S:5-0-6</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>100%</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>3-0-5:5</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>100%</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>100%</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>100%</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

- Sliding knot
- Indicates number of flat square knots
- Indicates number of throw in opposite direction from previous
- Change of axial strand and next throw turns in same direction as previous
- Change of axial strand and next throw turns in opposite direction from previous

Robot-assisted Laparoscopic Knots

- Larger variability in the strength of the knots made using the robot, which corresponded to higher percentage of unraveling knots
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
- UroGyn
  - Sacrocolpopexy/Sacro-rectovaginal repair
  - Paravaginal defect repair
  - Burch
  - McCall's Culdoplasty
- REI
  - Cuff tuboplasty
  - Tubal Reanastomosis

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


Extracorporeal Knot

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

Extracorporeal Knot Video

Closed Knot pusher

Extracorporeal Knot Tips

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

Needle Back-loading

Needle Back-loading

Untwisting Suture

Replacing Knot Pusher

Replacing Knot Pusher


Alternate Strategies for Laparoscopic Suturing

- Technically challenging
- Diminished tactile feedback
- Lack of depth perception
- Tremor amplification
- Limited instrument mobility

Solution?

- Barbed suture
- Automated suturing devices

Barbed Suture

- Initially used by Plastics
- FDA Approved products
  - V Loc™
  - Covidien
  - STRATAFIX™
  - Ethicon

V Loc™ Cuff Closure

STRATAFIX™ Spiral Device with Bidirectional Design: Portfolio Summary

- 16 codes (Similar to Monocryl)
  - Bidirectional length: 14-72 cm
  - Sizes: 4-0 to 2-0
- 30 codes (Similar to PDS)
  - Bidirectional length: 18-72 cm
  - Sizes: 5-0 to 1
- 2 codes (Similar to Prolene)
  - Bidirectional length: 28 & 48 cm
  - Sizes: 0 to 1

Sizes reflect tensile strength.
V-Loc™ vs continuous suture in lsc myomectomy

- N = 19
- Solitary intramural fibroids 3-5 cm

<table>
<thead>
<tr>
<th></th>
<th>V-loc 90</th>
<th>Conventional P</th>
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<tbody>
<tr>
<td>EBL</td>
<td>113.7 ± 74.1 ml</td>
<td>168.6 ± 75.1 ml</td>
</tr>
<tr>
<td>Operative time (total)</td>
<td>51 ± 18.1 min</td>
<td>58 ± 17.8 min</td>
</tr>
<tr>
<td>Suturing time</td>
<td>9.9 ± 4.3 min</td>
<td>15.8 ± 4.7 min</td>
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Barbed vs Standard Braided Suture

- N = 63
- Laparoscopic Cuff Closure
- Outcomes:
  - Operative Times (p < 0.0001)
    - Attendings 7.1 min
    - Residents/Fellows 12.8 min
  - Rates of dyspareunia, “His”pareunia and sexual function were similar for both groups at 3 months postop


Advantages of Barbed Suture

- No knot tying required
- Equally distributed tension throughout suture
- Enables continuous suturing without backsliding
- Provides hemostatic closure of myometrium during myomectomy
References

1. Role of extracorporeal knots in laparoscopic surgery. [www.laparoscopyhospital.com]
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

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.

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 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.