Simulation Lab: Laparoscopic Suturing:
Practical Applications for Tissue Re-approximation,
Intra-corporeal and Extracorporeal Knot Tying,
Barbed Suture, and Suturing Technologies

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3-Dmed, Aesculap, Applied Medical, CooperSurgical, Ethicon US, LLC, Medtronic, Karl Storz Endoscopy-America, Inc.
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.

The AAGL designates this live activity for a maximum of 3.75 AMA PRA Category 1 Credit(s)™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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SUTR-601
Simulation Lab: Laparoscopic Suturing: Practical Applications for Tissue Re-approximation, Intra-corporeal and Extracorporeal Knot Tying, Barbed Suture, and Suturing Technologies
Joseph (Jay) L. Hudgens, Chair


This course provides 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, vaginal vault suspension, and cystotomy repair will be presented. In addition, applications of different suture materials including barbed suture will be reviewed. The participant will also have the opportunity to work with suturing devices utilized in gynecologic laparoscopy. The aim of this course is to present the material in a simple, systematic, and reproducible fashion. Faculty will provide an interactive environment to meet the needs of the individual, critical to effective learning.

**Learning Objectives:** *At the conclusion of this course, the clinician will be able to: 1) Reproduce efficient techniques for laparoscopic tissue re-approximation, suture management, and running closures; 2) perform efficient intra-corporeal and extra-corporeal knot tying, identify the common mistakes that are encountered, and how to correct them; and 3) compare and distinguish potential benefits of barbed suturing technologies and devices used in laparoscopy and review the clinical applications for vaginal cuff closure, myomectomy, vaginal vault suspension, and cystotomy repair.*

**Course Outline**

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SUTR-602
Simulation Lab: Laparoscopic Suturing: Practical Applications for Tissue Re-approximation, Intra-corporeal and Extracorporeal Knot Tying, Barbed Suture, and Suturing Technologies

Fariba Mohtashami, 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: Tissue Re-approximation, Suture Management, and Simulated Running Cuff Closure

1:45 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

3:00 Extra-Corporeal Knot Tying, Suture Selection, Barbed Suture, Suturing Technologies and Clinical Applications
S.S. Singh

3:20 LAB III: Extra-Corporeal Knot Tying, Suturing Devices and Technologies

4:15 Clinical Applications: Questions, Answers, and Course Evaluations
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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Amber Bradshaw
Erica Dun*
Frank D. Loffer, Medical Director, AAGL*
Linda Michels, Executive Director, AAGL*
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Arleen H. Song*
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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. Re-approximate
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

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

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

Beginner
Advanced
Expert Needle Loading

Right Hand Motion

Novice

Expert

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
• Learn technical skills to tie intracorporeal knots
• Understand the common mistakes and how to avoid them

Indications for intracorporeal knot tying

• 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

• Is an advanced skill
• Requires great manual dexterity
• Has a steep learning curve
• Rate-limiting step in many procedures
• Must be mastered by every laparoscopic surgeon
• Anyone can learn it in the dry lab!

Steps for Intracorporeal knot tying

• Choose the trocar for needle delivery
  - 10 mm trocar: Direct entry
  - 5 mm trocar: Backload
• Cut the suture in advance
  - Interrupted: 6 inches (15 cm)
  - Figure of eight: 8 inches (20 cm)
  - Continuous running: 12 inches (30 cm)
• Place suture
• Throw square knots: 4 throws in opposite directions for Vicryl
• Cut suture and remove needle under direct visualization

Consultant: Ethicon Endo-Surgery
Technique for Intracorporeal knot tying

- Ease
- Rapidity of execution
- Reproducibility
- Tightness of the knot

If you can do an instrument tie, you can do intracorporeal knot tying!

Instrument tie

- Video

Intracorporeal tie

- Video
  - Fixed port sites
  - Long instruments
  - Fulcrum effect
  - Impaired tactile feedback
  - Lack of 3-dimensional view

Technique for Intracorporeal knot tying

- Leave a short tail (2-3 cm)
- Make a good loop
- Supinate left hand
- Align suture parallel to right instrument
- Wrap the suture around the needle driver
- Grasp the tip of the short tail
- Pull hands to the opposite direction
- Move left hand over the knot

Expert Knot

- Video
Smiley Knot

- Video

Vaginal Cuff

- Video

Bowel Repair

- Video

Common mistakes

- Cut the suture in advance

Common mistakes

- Video

- Align suture parallel to needle driver

Common mistake: Bow tie

- Video

- Leave tail short, grasp the tip
Common mistake: Drifting

• Video

• Stay over the short tail

Tips for Success

• Video

• Leave a short tail
• Make a good loop...
  No loop, no knot!
• Do not drift
• Supinate left hand
• Align suture parallel to right instrument
• Work at tip of instruments
• Make small circles to wrap the suture
• Do not leave left hand behind
• Grasp the tip of short tail

REFERENCES

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

Quiz Video

• Video

What was the mistake?

1. Suture not cut in advance
2. Inadequate loop
3. Suture not parallel to the right instrument
4. Drifted left hand
5. Long tail

✓ Long tail

Questions?

Practice makes PERFECT
Extra-corporeal Knot Tying, Suture Selection, Barbed Sutures and Technologies and Clinical Applications

Sony Sukhbir Singh MD, FRCSC, FACOG
Associate Professor
Vice Chair Gynecology
Department of Ob/Gyn
The Ottawa Hospital/University of Ottawa

Objectives
Review the differences between intra- and extra-corporeal knot tying
Review the scenarios where extracorporeal knots may be utilized
Understand the relevant equipment and set up
Demonstrate and practice knot techniques

Why Extracorporeal Knots?
• Ease of execution
  ◦ Removes the need for triangulation and fine movements for intra-corporeal suturing
  ◦ Reproducible
  ◦ Quicker in less experienced hands
• Comparable tensile strength to intracorporeal knots

Why not?
◦ May “rip” through delicate structures during tying (i.e. bowel/bladder/vessels
◦ Some use larger ports to accommodate this type of suturing
◦ Techniques require training and practice

Techniques
• Loop Ligatures
  • Pretied
  • Self-Tied
• Intracorporeal tying
• Extracorporeal tying
• Automated systems

Extracorporeal Knots

Knots created by removing both ends of the suture outside the laparoscopic ports

Form knot outside of the abdominal cavity

Use of a knot pusher to cinch and secure each throw


Extracorporeal Knots

Knots

- square
- Flat
- surgeons
- Sliding
- Roeder


Variations on Slip Knots


Kottman R et al. JSLS 2012 16: 280-282 (Indianapolis, Ind.)

Variations on Slip Knots


Kottman R et al. JSLS 2012 16: 280-282 (Indianapolis, Ind.)

“Black Box” Warning

Higher “forces” applied during laparoscopic surgery on tissue

EXTRACORPOREAL forces > INTRACORPOREAL

Risk of tearing, ripping and resulting risks

Robotics provides even less “haptic” feedback than “straight stick”


When to use Extracorporeal Knots

Vaginal Vault Closure

Sacrococcygeus – medial longitudinal ligament is secure against the sacrum

Paravaginal Repairs/Burch Procedure

Laparoscopic cervical cerclage (securing the knot around the cervix)

Securing a well isolated pedicle (i.e. uterines, IP)

Kottman R et al. JSLS 2012 16: 280-282 (Indianapolis, Ind.)
When to be cautious... Extracorporeal Knots

- Bowel repair
- Blood vessel repair
- Ureteric repair

Which Knot?

Extracorporeal square knots & intracorporeal square knots
STRONGER than intracorporeal slip-square knots

Equipment Essentials – Extra Corporeal

- Knot Manipulators
- Needle Holders
- Length of Suture
- Type of Suture

Principles of Extracorporeal Knot

- Suture preparation
- Knot transfer (knot manipulator)
- Knot tightening

Suture

Composition
- permanent vs absorbable
- braided vs monofilament
- barbed vs standard

1. Eliminates need for “tailing”
2. No requirement to tie distal end

Suture

Composition
- permanent vs absorbable
- braided vs monofilament
- barbed vs standard

Caliber
- large 1-0 to 2-0 (extracorporeal or extracorporeal)
- fine 3-0 to 7-0 (intracorporeal)

Length
- 90 - 120 cm (extracorporeal)
- 6-15 cm (intracorporeal)
Suturing Equipment & Supplies

**Needles**

- **Shape**
  - straight
  - ski
  - curved

- **Diameter**

Slide courtesy of Dr. M. Moore

**Endostitch Anatomy**

- **Endostitch: Intracorporeal Suturing**

- **Endostitch: Intracorporeal Suturing**

**Suture Assist Devices**

- **LAPRA TY® Clip (Ethicon)**
  - Secures ends of single stranded absorbable suture

- **Pre-tied Loops**
  - Endoloop Ligature (Ethicon)
  - Surgilie Ligating Loop (Covidien)
  - Various materials

**History of the Barbed Suture**

- **1956**: DR. J.H. Alcamo granted patent for first Unidirectional barbed suture
- **2004**: FDA approves Quill Medical Bidirectional barbed PDS suture
- **2009**: FDA approves V-Loc 180 by Covidien, first unidirectional
  - Ethicon markets unidirectional and bidirectional barbed suture

Quill delayed absorbable: tensile strength is 80% at 4 weeks and 40% at 6 weeks (absorbed at 6 mos)

Greenberg JA. *Rev Obstet Gynecol* 2010
"Barbed Sutures"

UNI-DIRECTIONAL

- Eliminated need for double needle
- Required 2 needles (one at either end)

BI-DIRECTIONAL

- Introduced 2007
- Introduction of a loop to secure suture at start

- Overall reduction in operative time
- RCT (Einarsson): similar outcomes to traditional suture (slightly faster)


Options

V-Loc™ Caudex, North Haven, CT

65% tensile strength at 3 weeks, absorbed by 6 months

STRATAFIX™ by Ethicon

- Unidirectional Design
- Bidirectional Design

- Adjustable barbed
- Loop around device

Barbed Suture at MIS Hysterectomy

- Systematic Review 2015 (Bogliolo et al)
- >11 papers (3 robotic, 2 with malignancy, 1 single port)

- Main outcomes: suturing time, bleeding, dehiscence
- No difference in minor bleeding or vaginal cuff dehiscence
- Slight difference in major bleeding favoring Barbed suture
- Suturing time is REDUCED with barbed suture


Barbed Suture Complications

- Systematic Review 2015 (Bogliolo et al)
- >11 papers (3 robotic, 2 with malignancy, 1 single port)

- 4 cases of bowel obstruction with Barbed suture used at sacral colpopexy (peritoneal closure)
- 1 case of small bowel volvulus at laparoscopic myomectomy
- 1 small bowel obstruction post TLH (barbed suture with "Lapra Ty")


Objectives

- Review the differences between intra- and extra-corporeal knot tying
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References

Greenberg JH. Rev Obstet Gynecol. 2010
Kothari R et al. JSLS 2012;16:280-183 ( Jablapur, India)

Hands On Demo

1. Extra-corporeal knot tying (simple) – VIDEO
2. Complex slip knots (Roeder/Weston) – Preceptor Guided Teaching
3. Trial of Barbed Sutures or other available technology

Great Resources

Thanks to Krisztina Bajzak and Jenn Mercer of Memorial University, Newfoundland.

YOUTUBE LINK to the VIDEO:

https://youtu.be/fm6Z_Nmltpc
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.