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

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Professional Education Information

Target Audience
Educational activities are developed to meet the needs of surgical gynecologists in practice and in training, as well as, other allied healthcare professionals in the field of gynecology.

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

Aarathi Cholkeri-Singh, Chair
Joseph (Jay) L. Hudgens, Co-Chair


Course Description
This workshop provides an overview of laparoscopic suturing and knot tying techniques, which will include both intracorporeal and extracorporeal knots. The course will offer hands-on suturing simulation where experienced faculty will actively guide participants through the training steps. Various applications for different suture materials and technologies utilized in gynecologic laparoscopy will also be reviewed. The course is designed for gynecologists in practice who want to develop or improve their suturing skills for immediate application in their surgical practice.

Course Objectives
At the conclusion of this course, the participant 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 (SAME for AM and PM sessions)

8:00 Welcome, Introductions and Course Overview
A. Cholkeri-Singh
8:05 Port Placement, Needle Loading and Tissue Re-approximation
A. Cholkeri-Singh
8:20 Hands-on Training – Needle Loading and Needle Manipulation
All Faculty
9:00 Extracorporeal Knot Tying
A. Cholkeri-Singh
9:15 Hands-on Training – Extracorporeal Knot Tying
All Faculty
9:45 Questions & Answers
All Faculty
9:55 Break
10:10 Intracorporeal Knot Tying
H.C. Hur
<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Presenter/Group</th>
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<tbody>
<tr>
<td>10:25</td>
<td>Hands-on Training – Intracorporeal Knot Tying</td>
<td>All Faculty</td>
</tr>
<tr>
<td>11:05</td>
<td>Suture Selection and Technologies Used in Gynecologic Laparoscopy</td>
<td>K.C. Wang</td>
</tr>
<tr>
<td>11:20</td>
<td>Hands-on Training – Barbed Suture and Suturing Devices</td>
<td>All Faculty</td>
</tr>
<tr>
<td>11:50</td>
<td>Questions &amp; Answers</td>
<td>All Faculty</td>
</tr>
<tr>
<td>12:00</td>
<td>Course Evaluation</td>
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</tbody>
</table>
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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Viviane F. Connor
Consultant: Conceptus Incorporated
Frank D. Loffer, Executive Vice President/Medical Director, AAGL*
Linda Michels, Executive Director, AAGL*
Jonathan Solnik
Other: Lecturer - Olympus, Lecturer - Karl Storz Endoscopy-America

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Consultant: CooperSurgical, Ethicon Women’s Health & Urology, Intuitive Surgical
Other: Royalties - CooperSurgical
Linda Bradley
Grants/Research Support: Elsevier
Consultant: Bayer Healthcare Corp., Conceptus Incorporated, Ferring Pharmaceuticals
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Mark R. Hoffman*
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Speaker’s Bureau: Intuitive Surgical
Hye-Chun Hur*
Gretchen E.H. Makai
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Nash S. Moawad*
Angela M. Pratt*
Sangeeta Senapati*
Jessica A. Shepherd*
Matthew T. Siedhoff*
Karen C. Wang*

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Port Placement, Needle Loading, & Tissue Re-approximation

Jay L. Hudgens, M.D.
Center for Women’s Health
Owensboro, KY
Gratis Faculty University of Louisville
Department of Obstetrics, Gynecology, & Women’s Health

Presented by:
Aarathi Cholkeri-Singh, M.D., FACOG

Disclosures
Jay Hudgens, M.D.
Aarathi Cholkeri-Singh, M.D., FACOG
We 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

System
1. Set the Needle
2. Reapproximate
3. Knot Tying

Ipsilateral
- Ergonomics
- Assistant
- One Sided
Contralateral
- Ideal Triangulation
- Poor Ergonomics?
- No Assistant

Suprapubic
- Gravity
- Ergonomics?
- Two Sided

Needle Holders
- Straight
- Curved
  - For desired needle angles >135°
- Self-Righting
- Endo Wrist Articulating
  - Hand-held
  - Da Vinci Robot

Straight Needle Holder

Curved Needle Holder

Self-Righting Needle Holder
Endowrist Needle Holder

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

System

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

Tie Knot

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

- \[ A = 2\text{cm from Swedge} \]
- \[ B = 1/3 \text{ from Point} \]
- \[ C = 1/3 \text{ from Swedge} \]
Setting the Needle

A-B-C

Left Hand  Right Hand

Right Hand Motion

Novice  Expert

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

System

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

Tie Knot

What is the most important factor in reproducible tissue re-approximation?

A. Port placement.
B. Understanding the relationship between the tissue, camera, and ports.
C. Use of mechanical suturing device to improve efficiency and accuracy.
D. The type of suture and needle used.
E. Not applicable to my practice.

References


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

"... 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

Disclosures

- I have no financial relationships to disclose.
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)

Type of knot

**Intracorporeal**

- Coefficient of friction equally distributed between suture ends
- Each end of suture enters and leaves knot in opposite direction

**Extracorporeal**

- 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

  - 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>Type</th>
<th>Conventional (%)</th>
<th>Laparoscopic (%)</th>
<th>Sliding knot (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-0</td>
<td>40</td>
<td>56</td>
<td>60</td>
</tr>
<tr>
<td>5-0 X</td>
<td>50</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>6-0</td>
<td>50</td>
<td>44</td>
<td>0</td>
</tr>
<tr>
<td>6-0 X</td>
<td>36</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>7-0</td>
<td>36</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>7-0 X</td>
<td>50</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>8-0</td>
<td>50</td>
<td>44</td>
<td>20</td>
</tr>
<tr>
<td>8-0 X</td>
<td>40</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>9-0</td>
<td>50</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>9-0 X</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10-0</td>
<td>50</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>10-0 X</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

S = Sliding Knot
x or o indicates number of flat square knots
X = throw in opposite direction from previous
# = throw in same direction as 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

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
  - Intracorporeal flat-square

Figure 1: Comparison of flat square knots of extracorporeal vs. intracorporeal single suture. The flat square knot has a lower score than the standard square knot. The bar on the right indicates the number of throws.
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/Sacrocer- vicopexy
  - 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

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

Question

A 34-year-old woman who desires pregnancy has had 18 months without conception. She has been found to have a right hydrosalpinx and is opting to undergo laparoscopic tubaplasty for treatment. Upon insertion of the uterine manipulator, the uterine fundus is perforated and actively bleeding.

What is the best step in maintaining hemostasis at the site of the uterine perforation?
A. Desiccate the area
B. Place surgical hemostatic agent
C. Place an interrupted suture
D. No treatment necessary
E. Not applicable to my area of practice

Correct Answer: C
Intracorporeal Knot Tying

Hye-Chun Hur, MD
Beth Israel Deaconess Medical Center
Director, Minimally Invasive Gynecologic Surgery
Assistant Professor, Harvard Medical School

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

Indications
General:
- any indication for extracorporeal knot tying can be applied to intracorporeal knot tying
- vaginal cuff closure
- laparoscopic myomectomy
- oophoropexy
- suturing for retraction (e.g. ovary, bowel, uterus)

Specific:
- more delicate suturing, tying knots off tension
- bowel repair
- bladder repair
- peritoneal closures (e.g. sacrocolpopexy)

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)

Disclosures
I have no financial relationships to disclose.
Breakdown of Steps
1. Select appropriate trocar size for needle delivery.
2. Cut suture in advance.
   • Interrupted suture \( \rightarrow \) 6 inches
   • Figure of eight suture \( \rightarrow \) 8 inches
   • Continuous running suture \( \rightarrow \) 12 inches
3. Place suture.
4. Throw 4-6 square knots (opposite direction).
   • Vicryl \( \rightarrow \) 4 throws
   • PDS \( \rightarrow \) 6 throws
5. Cut suture, remove needle under direct visualization.

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: Leave free end (tail) short
4. Throw 4-6 square knots (opposite direction)
   TIP: Keep heel of needle in-line with needle grasper
   TIP: Pull ends so the free end stays short
5. Cut suture and remove needle under direct visualization

Important Tips
- Leave free end (tail) short
- Keep heel of needle in-line with needle grasper
- Pull ends so the free end stays short

Figure of Eight Suture

Take Home Points
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
• Pull ends so the free end stays short
Conclusion

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

Laparoscopic suturing and intracorporeal knot tying is a skill that anyone can learn and master in the dry lab setting.

Questions?
Alternative Suture and Technologies used in Gynecologic Laparoscopy

Karen C. Wang, MD
Associate Director MIGS, Fellowship Director
Brigham and Women’s Hospital
Instructor, Harvard Medical School
AAGL November 6, 2012

Objectives

- Introduce alternative suture material and devices utilized in gynecologic laparoscopic surgery
- Demonstrate utility of these alternatives to facilitate laparoscopic suturing

Solution?

- Barbed suture
- Automated suturing devices

Laparoscopic suturing

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

Barbed Suture

- Quill™
  - FDA approved 2004
  - Initially used by Plastics
- V Loc™
  - FDA approved 2009

Disclosures

- I have no financial relationships to disclose.
**Quill™**
- Angiotech
- Bidirectional
- Helical pattern
- Anchors every 1mm

**V Loc™ 90 and 180**
- Covidien
- Unidirectional barbed suture
- 20 barbs/cm
- Spiral configuration of barbs

**V Loc™ 90 and 180**
- V Loc™ 90
  - Similar to Monocryl
- V Loc™ 180
  - Similar to PDS, Maxon
- Suture lengths: 6, 9, 12, and 18 inches
- Suture size: 3-0, 2-0

**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

**Advantages of Barbed Suture**
Barbed suture associated with significantly shorter suturing times for laparoscopic myomectomy compared to traditional sutures.

**V-Loc™ vs continuous suture in lsc myomectomy**
- N = 19
- Solitary intramural fibroids 3-5 cm

<table>
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<tr>
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<th>V-loc 90</th>
<th>Conventional</th>
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<tr>
<td>EBL</td>
<td>113.7 ± 74.1 ml</td>
<td>168.6 ± 75.1 ml</td>
<td>0.0076</td>
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<tr>
<td>Operative time (total)</td>
<td>51 ± 16.1 min</td>
<td>58 ± 17.8 min</td>
<td>0.0616</td>
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<tr>
<td>Suturing time</td>
<td>9.9 ± 4.3 min</td>
<td>15.8 ± 4.7 min</td>
<td>0.0004</td>
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Alessandri et al. 2010 JMIG
Einarsson et al. 2011. JMIG
Angioli et al. 2012. IJGO
Advantages of Barbed Suture

- Does barbed suture reduce the risk of vaginal cuff dehiscence?
  - Retrospective study N = 387, Jan 2007 - Jan 2010
  - 149 Barbed suture vs. 229 with Vicryl or Endostitch
  - Mean time dehiscence 45 days
  - Two layer closure 0-PDO Quill 14 x 14 cm

<table>
<thead>
<tr>
<th>No. Dehiscence</th>
<th>Length of follow-up (days)</th>
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<tr>
<td>Quill (149)</td>
<td>0</td>
</tr>
<tr>
<td>Vicryl or Endostitch or Monofilament suture</td>
<td>10 (4.2%)</td>
</tr>
</tbody>
</table>

Siedler et al. 2011. JMIG

Downside of Barbed Suture

- Does barbed suture increase the risk of adhesion formation?
  - Unidirectional barbed suture
    - 13 canine enterotomy model
    - No significant difference in adhesion scores at 21 days
  - Bidirectional barbed suture
    - 23 non-pregnant ewes
    - Necropsy at 3 months
    - 12 horns (52.2%) with barbed suture-adhesions
    - 10 horns (43.5%) with Vicryl closure-adhesions

Miller et al. 2012 J Invest Surg

- "His" pareunia
  - Limited data
  - 117 TLH, 82 completed questionnaires
  - 5 reported persistent dyspareunia (6.8%) at 6 months post-op
  - 6 reported "his"pareunia (8.2%)

Einarsson et al. 2010 JSLS

Downside of Barbed Suture

- Case report
  - Bowel obstruction after TLH
  - 0-PDO 14 x 14 cm Quill with Lapra Ty
  - Presented POD #30
  - On laparoscopy - tail of left end of barbed suture (4cm) found as cause of point of volvulus

Donnellan et al. 2011, JMIG

Quill™ Suturing Video: Myomectomy Closure

V-Loc™ Suturing Video: Vaginal Cuff Closure
Automated Suture Devices

- RD 180™ and TK®
  - LSI Solutions
  - Single use
  - First used for heart valve surgery
  - Vaginal cuff closure

- Endostitch™
  - Covidien
  - Single use
  - Vaginal cuff closure

- “Running Device”
  - 5 or 10 mm

- “Titanium Knot”
  - Trims suture
  - Secures suture
  - Permanent clips

Endostitch™

- 10 mm
- Shuttle needle
- Option articulating tip

- Intracorporeal knot tying 18 cm
- Extracorporeal knot tying 120 cm

Endostitch™ Video

- Comparative study of pyeloplasties and bladder neck suspension
  - Automated intracorporeal suturing versus conventional suturing

<table>
<thead>
<tr>
<th></th>
<th>Endostitch</th>
<th>Conventional</th>
<th>P</th>
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<tbody>
<tr>
<td>Stitch placement</td>
<td>43 ± 27 sec</td>
<td>151 ± 24 sec</td>
<td>&lt;0.0001</td>
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<tr>
<td>Knot tying</td>
<td>74 ± 50 sec</td>
<td>197 ± 70 sec</td>
<td>&lt;0.0001</td>
</tr>
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</table>

Adams et al. 1995. Urology

Endostitch™ Video
Endostitch™ with Barbed Suture

- 0, 2-0, 3-0 V-Loc
- 10, 15, 20 cm lengths

Suture Comparison

<table>
<thead>
<tr>
<th>Suture Name, Size</th>
<th>Type</th>
<th>Absorption Rate</th>
<th>Tensile Strength</th>
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<tbody>
<tr>
<td>Quill Polydioxanone Monofilament</td>
<td>Complete by 180 days</td>
<td>80% at 14 days, 60% at 28 days</td>
<td></td>
</tr>
<tr>
<td>V Loc VLoc™ 0 VLoc™ 180 Monofilament</td>
<td>Complete 60-110 days, Complete by 180 days</td>
<td>65% at 21 days</td>
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<tr>
<td>RD 180 Strongsorb 2-0 Monofilament</td>
<td>Complete 60-110 days, Complete &lt; 110 days</td>
<td>77% at 21 days</td>
<td></td>
</tr>
<tr>
<td>Endostitch Polysorb 3-0 Multifilament</td>
<td>Complete 56-70 days</td>
<td>30% at 21 days</td>
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Cost $$$

<table>
<thead>
<tr>
<th>Suture</th>
<th>Price</th>
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<tr>
<td>Quill</td>
<td>$20-60</td>
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<tr>
<td>V-Loc</td>
<td>$30-33</td>
</tr>
<tr>
<td>RD 180 + TK</td>
<td>$175 each</td>
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<tr>
<td>Endostitch</td>
<td>$140-150</td>
</tr>
<tr>
<td>Suture Suture</td>
<td>$57</td>
</tr>
</tbody>
</table>

References

- Donnellan NM and Mansuria SM. Small bowel obstruction resulting from laparoscopic vaginal cuff closure with a barbed suture. JMIG 2011;18(4):528-530.
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.