Closing the Knowledge Gap in Pelvic Neuroanatomy: Assessment of a Cadaveric Training Program

Ioana Marcu (imarcu2000@gmail.com)  
Saint Louis University  https://orcid.org/0000-0002-4689-3065

Adrian Balica  
Rutgers Robert Wood Johnson Medical School

Jeffrey Gavard  
Saint Louis University

Eugen Campian  
Saint Louis University

Gustavo Fernandes  
Faculdade de Medicina do ABC

M Jonathon Solnik  
Mount Sinai Hospital

Vadim Morozov  
University of Maryland Medical Center

Nucelio Lemos  
University of Toronto

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Abstract

Background

The objective of this study is to characterize participants in a laparoscopic cadaveric neuroanatomy course and assess knowledge of pelvic neuroanatomy before and after this course.

Methods

This is a survey-based cohort study with a setting in a university educational facility. The participants are surgeons in a multiday laparoscopic cadaveric pelvic neuroanatomy course. Participants completed a precourse survey, including demographics and comfort with laparoscopic surgery. They then completed identical precourse and postcourse anatomic knowledge test. Main outcomes are scores on anatomic knowledge test precourse and postcourse.

Results

44 respondents were included: 25 completed fellowship, 15 completed residency, 2 were residents, and 2 were fellows. Participants were on average 11.09 years post training, with an average of 8.67 years from training if they completed fellowship and 18.62 years if they completed residency only. 22 of 42 respondents strongly agree or agree they are comfortable performing complex laparoscopic hysterectomies. The average precourse score was 32.18/50 points and the mean difference score (MDS, defined as mean of posttest scores minus pretest scores) was 9.80, showing significant improvement (p < 0.001). Precourse and MDS scores were not significantly different when comparing country of practice, level of training, or time since training.

Conclusion

Baseline knowledge of pelvic neuroanatomy was equal among groups when comparing fellowship status, place of training, or time since training. There was significant improvement in knowledge after training in this dissection method. This course garnered interest from surgeons with broad training backgrounds.

Background

While female pelvic anatomy is already complex in the setting of normal anatomic relationships, endometriosis, previous surgery, or neoplasms and other conditions can distort normal anatomy, making the understanding of the region more complex. Therefore, a comprehensive and thorough understanding of pelvic anatomy is crucial for successfully managing these conditions.
As our understanding of functional and surgical pelvic anatomy evolves, there has been a recent trend towards post-graduate laparoscopic training courses and mini-residencies. These courses address training of normal anatomy and also topics such as surgical complications, which cannot be routinely practiced in live patients, hysterectomies, lymph node biopsies, and dissection of neurovascular bundles.

As the role of laparoscopic surgery in residency/fellowship training continues to evolve and as the field of neuropelvology develops, ongoing study of post-graduate courses with a focus on pelvic neuroanatomy is necessary. We wish to characterize participants in a postgraduate cadaveric laparoscopic course on pelvic neuroanatomy, assess baseline anatomic knowledge and improvement as a result of this course.

**Methods**

Participants in the laparoscopic course were recruited from USA and internationally through direct communication, electronic means of advertisement and mail in brochures. Participants in this study are recruited from those participating in the course. All participants of the course are age 18 or greater, resident physicians, fellows in training, or physicians out of training. They were approached prior to the start of the course and consented for participation in a quality improvement project. The initial data was collected as a quality improvement project and IRB approval was subsequently obtained for use of the collected data as research. Inclusion criteria for the study are any participant data sets in the quality improvement project with completed pretest and posttest anatomy surveys. Exclusion criteria is that of uncompleted either pretest or posttest anatomy surveys. Given that the method of recruitment is of all those participating in this cadaveric course, there are no identifiable sources of bias in recruitment for the study that are not inherent to the course.

Female specimens with intact abdominal cavity were prepared for this course, using the ‘soft’ or Thiel’s method, which allows for insufflation and use of laparoscopic technique.

Course duration was 2 days. The course consisted of morning lectures of pelvic anatomy and narrated videos of standardized step by step dissection. This method represented a new model of pelvic dissection involving the somatic and autonomic nerves in a reproducible, step-wise fashion.

In the afternoon session, participants performed laparoscopic dissections as taught in the morning session. Self-assigned pairs worked on a same cadaver and remained paired for the entirety of the course. Course faculty were available during dissection reinforcing the steps of anatomic dissection and anatomic knowledge by answering questions and guiding the participants.

There are no sources of funding for this study.

**Dissection steps are described below:**

One umbilical, two lateral and one suprapubic trocars are placed.
The attendant standing on the right of the specimen will start acting as surgeon and the one standing on the left as an assistant. They proceed as follows:

1. Incise the peritoneum on top of the right psoas muscle tendon and extend the incision to the promontory (Figure 1 – A, B, C);
2. Identify and lateralize the genitofemoral nerve and bluntly dissect the space between the medial border of the psoas muscle and the external iliac vessels to develop the iliolumbar and obturator spaces on the right side (Figure 1 – C, D, E);
3. Identify the obturator nerve and, just posteriorly to it, the lumbosacral trunk and the sciatic nerve (Figure 1 – E, F, G);
4. Separate the perineural fat at the sciatic notch and expose the superior and inferior gluteal nerves (Figure 1 – G, H);
5. Carry the dissection further distally and identify the endopelvic fascia, the arcus tendineus fascia pelvis and the levator ani muscles, as well as the ischial spine, the sacrospinous ligament and the pudendal nerve crossing underneath it (Figure 1 – H, I);
6. Re-focus dissection at level of the sacral promontory; dissect the presacral fascia from the pararectal peritoneum and identify the superior hypogastric plexus and the hypogastric nerves (Figure 1 – J, K);
7. Incise the presacral fascia laterally to the right hypogastric nerve and develop the presacral space down to the coccyx and laterally to the hypogastric fasciae bilaterally (Figure 1 – L, M);
8. Incise the hypogastric fascia and identify the piriformis muscle, the sacral nerve roots lying on its ventral surface and the pelvic splanchnic nerves branching out of them and running towards the inferior hypogastric plexus (Figure 1 – N, O).

At this point, the attendant standing on the left of the specimen assumes the surgeon role, giving the camera to the assistant on the right. The next steps are:

1. Incise the presacral fascia laterally to the left hypogastric nerve;
2. Incise the left hypogastric fascia and identify the piriformis muscle, the sacral nerve roots lying on its ventral surface and the pelvic splanchnic nerves branching out of them and running towards the inferior hypogastric plexus;
3. Incise the peritoneum on top of the left psoas muscle tendon;
4. Identify and lateralize the genitofemoral nerve and bluntly dissect the space between the medial border of the psoas muscle and the external iliac vessels to develop the iliolumbar and obturator spaces on the left side;
5. Identify the obturator nerve and, just posteriorly to it, the lumbosacral trunk and the sciatic nerve;
6. Separate the perineural fat at the sciatic notch and expose the superior and inferior gluteal nerves;
7. Carry the dissection further distally and identify the endopelvic fascia, the arcus tendinous fascia pelvis and the levator ani muscles, as well as the ischial spine, the sacrospinous ligament and the
pudendal nerve crossing underneath it;
8. Re-focus the dissection on the lateral aspect of the psoas muscle, incise the fascia transversalis and identify the lateral femoral cutaneous nerve and the femoral nerves;
9. Extend the dissection proximal and identify the ilioinguinal and iliohypogastric nerves.
   - The attendant standing on the right of the specimen reassumes the surgeon role and performs steps 16 and 17 on the right side.

Participants were asked to answer the following questionnaires:

Pretest, participants filled out a survey to assess demographics, level of education, prior laparoscopic training, level of comfort with laparoscopic surgery, and expectations for the course. Pretest, participants were asked to complete a multiple-choice test of anatomic knowledge (Pretest Anatomy Survey) before the first didactic lecture.

Posttest, participants filled out a multiple-choice test of anatomic knowledge identical to the pretest survey (Posttest Anatomic Survey) and a survey regarding satisfaction with the course.

Primary study objectives are to introduce a systematic method of cadaveric laparoscopic dissection of pelvic nerves and assess baseline anatomic knowledge of course participants and change in the scores after the course.

Secondary objectives are to describe course participants characteristics/demographics, expectations, comfort level with laparoscopy, and satisfaction after course as well as to perform sub-analyses that assess baseline anatomic knowledge of course participants and change in the scores after the course.

The identical pretest and posttest anatomic surveys consist of 12 images in which participants were asked to match structures on printed photograms from cadaveric laparoscopic dissections with answer choices, with 50 structures for a maximum score of 50 points.

We analyzed the data to determine demographics and expectations for the course from the participants in the study. We analyzed the anatomic knowledge before the course and after course. We characterized participants’ expectations and analyzed how these expectations were met. Data was analyzed in SPSS. Normality was assessed using Shapiro-Wilk and differences between means were analyzed with Student T-test if data was normally distributed and Mann-Whitney U test if data was not normally distributed.

Results

Participants were included in the analysis if they filled out both pre-dissection and post-dissection anatomic surveys, irrespective of completion status of other surveys. A total of 44 participants are included in the analysis. There were 18 participants from North America included in the session, and 26 from South America. The mean age of participants is 43.4 years. Of the 44 participants, 25 completed fellowship, 15 completed residency only, 2 were current residents, and 2 were current fellows. When
pooling all data sets, participants were 11.09 years post-training, as defined by time elapsed since residency or fellowship. Participants averaged 8.67 years from training if they completed a gynecologic fellowship and 18.62 years from training if they completed residency only (Table 1).

When asked if their training program prepared them for a laparoscopic hysterectomy, 13 of 43 (30.2%) strongly agreed or agreed. Of 42 participants 35 (83.3%) strongly agree or agree that they feel comfortable performing less complicated laparoscopic surgeries such as bilateral tubal ligation. Thirty-four of 42 (81%) strongly agree or agree they feel comfortable performing complex surgeries such as hysterectomies in uncomplicated cases, while 22 of 42 (52.4%) strongly agree or agree they feel comfortable performing complex laparoscopic surgeries such as hysterectomies in complicated cases.

Of 42 participants, 27 (64.3%) responded that they had taken courses like this one in the past – 14 of 18 (77%) North Americans and 13 of 24 (54%) South Americans. When asked if similar courses impacted practice immediately after completion, 19 of 25 (76%) respondents strongly agreed and the remaining 6 of 25 (24%) agreed. No participants were neutral, disagree, or strongly disagreed. When asked if similar courses impacted long term practices, 17 of 24 (71%) who responded strongly agreed, 6 of 24 (25%) agreed, and 1 of 24 (4%) were neutral. No respondents disagreed or strongly disagreed.

The average pretest score for all participants was 32.18 ± 8.30 and mean difference score (as defined as mean of posttest scores minus pretest scores) was 9.80 ± 8.46, showing significant improvement between pre and posttest scores with a p < 0.001. Pretest score for North Americans (N = 18) was 31.00 ± 7.56 and mean difference score was 10.22 ± 6.15. Pretest score for South Americans (N = 26) was 33.00 ± 8.83 and mean difference score was 9.50 ± 9.86. The difference between mean difference scores was non-significant P = 0.77 (Table 2).

Comfort level with performing laparoscopic surgeries did not impact pre-test scores. Twenty two of 42 (52.4%) participants strongly agreed or agreed that they feel comfortable performing complex laparoscopic surgeries, such as hysterectomies. Twenty of 42 (47.6%) participants were either neutral, disagreed, or strongly disagreed when they were asked the same question. The difference between the average pretest scores of those who strongly agree or agreed with the statement (32.00 ± 7.70) and those who were neutral, disagreed, or strongly disagreed (31.85 ± 9.28) was not significantly different with a P = 0.96. There was also no significant difference between the pretest scores of participants who strongly agree or agree they feel comfortable performing less complicated laparoscopic surgeries such as bilateral tubal ligation (pretest score 31.85 ± 9.28) and those who are neutral, disagree, or strongly disagree with the statement (pretest 30.14 ± 10.70 p = 0.54) (Table 3).

Pretest score for persons who completed gynecological fellowship (N = 27) was 32.04 ± 7.03 and mean difference score was 11.18 ± 7.47. Pretest score for those who did not complete gynecological fellowship (N = 17) was 32.41 ± 10.24 and mean difference score was 7.59 ± 9.66. There was no statistical difference in the mean difference score P = 0.17 between those who completed fellowship (Table 2).
We found that having finished training (as defined as fellowship or as residency) within 5 years did not lead to significant difference in either pretest scores or difference scores. When selecting for only those who completed fellowship, or those who completed only residency, the pretest score and the difference score was not significantly different between those who had completed their respective training within 5 years or more than 5 years (Table 2).

The same analysis was carried out comparing the pretest and difference scores for those above the age of 42 and those below the age of 42, given that 42 was the median age. The analysis was performed for all participants, and they only for those who had completed fellowship and those who had completed residency only, and no statistical differences were found in these groups (Table 2).

Satisfaction was high for this course. 31 of 44 (70%) were very satisfied, 12 of 44 (27%) were satisfied and only 1 of 44 (2%) was very dissatisfied. When asked to rate how integral the following components of the course were, on a scale from 1 to 5, with 1 being most integral and 5 being least integral, participants gave the cadaveric component a rating of 1.14, followed by the video rating of 1.32, and the lecture component 1.57.

Participants were also asked to rate perceived improvements as a result of this course, on a scale from 1 to 5 with 1 being strongly agreed with 5 being strongly disagree. An average rating of 1.29 was given by 44 participants when they were asked if they believed this course improved knowledge of pelvic neuroanatomy. An average rating of 1.63, 1.79, and 1.79 were given when participants were asked if this course improved knowledge of pelvic vasculature, musculature, and knowledge of the ureter anatomy respectively. An average rating of 1.86 was given when participants were asked if they believed this course improved laparoscopic dissection method and 2.05 when asked if the course improved surgical skills (Table 4).

Nineteen of 44 (43.2%) participants strongly agree and 21 of 44 (47.7%) agree that this course will change the way the practice laparoscopic surgery. Twenty three of 44 (52.3%) participants strongly agree and 19 (43.2%) agree that they would take a similar course in the future. Sixteen of 44 (36.4%) strongly agree and 20 (45.5%) agree that they would take the same course again.

**Conclusion**

Since the 1990s, the development of video-laparoscopy, MRI, and surgical instrumentation and techniques have truly revolutionized knowledge of pelvic anatomy. This has allowed for the development of new procedures, understanding of previously uncomprehended conditions and improvement of outcomes virtually all pelvic procedures.

Neuropelveology is one illustrative example of these advances in knowledge. It is an emerging field\(^9,10\), opened by the advances of laparoscopic technique and instrumentation, which allowed for the development of the Laparoscopic Neuronavigation (LANN) technique. This technique revolutionized our
knowledge of pelvic neuroanatomy and the pathology of pelvic nerves, and initiated the movement of nerve-sparing procedures in radical pelvic surgery\textsuperscript{11–16}.

These fast advances in medical knowledge, however, have created a knowledge gap. Given the newness of the field, Neuropelveology has not been taught as part of most medical school or residency education. Moreover it is an area of knowledge that does not lend itself to typical residency anatomic education in departments without neuropelveologists.

Most surgical anatomic teaching during residency is ‘hands on’ in the operating room or based on visual media of anatomy\textsuperscript{1}. Cadaveric dissection training has been shown to improve laparoscopic surgical skills and improve anatomic knowledge at both the resident and fellow training level\textsuperscript{8,17–20}.

Our primary objective was to assess the baseline pelvic neuroanatomy knowledge of surgeons attending our laparoscopic neuroanatomy course, as well as assess the impact of our teaching method on their anatomical knowledge. The objective of this course was to teach pelvic neuroanatomy. While only specialized neuropelveologists perform laparoscopic nerve dissection on live patients for therapeutic reasons, this knowledge can be applied by pelvic surgeons for nerve preservation when performing radical procedures and result in improved quality of life for patients\textsuperscript{9}.

Baseline anatomic knowledge has been assessed after training in other studies; after a surgically-intensive fellowship such as gynecologic oncology, there was inadequate knowledge of anatomic structures\textsuperscript{8}. Resident physicians lose a considerable amount of basic anatomic knowledge while transitioning from student to clinician\textsuperscript{21,22}. In our group, there was statically significant improvement in the pelvic neuroanatomic knowledge after the course.

There seems to be no significant difference in the pretest scores or in the difference scores when subcategories of participants are compared. This may be due to a similar baseline knowledge among self-selected participants, the context of a non-validated questionnaire or due to the lack of power to identify such differences.

The fact that reported surgical comfort level did not correlate with improved baseline knowledge or improvement may reflect lack of power, lack of self-awareness of surgical skills or, most likely, the fact that pelvic neuroanatomy was not a topic when these surgeons were taught the complex procedures they perform.

We identified a trend, although not statistically significant, where those who completed fellowship had higher pre to post-test difference score compared to those who did not complete fellowship. Their pretest scores were nearly identical, which indicates similar neuroanatomy knowledge despite the longer training, meaning pelvic neuroanatomy was not a priority subject or not approached at all during their fellowships. On the other hand, the trend of greater improvement in those who completed fellowship may be due to fellowship-trained participants having more training and/or exposure to complex procedures and are, therefore, more prepared to assimilate complex information. This is also an indicator that the lack of
difference between groups was not due to a false negative result of an underpowered study, but due to the absence of pelvic neuroanatomy on pelvic surgery training curriculums. This not only reflects the previously mentioned knowledge gap, but reinforces the importance of these cadaver courses.

Concurring with other studies assessing satisfaction after laparoscopic courses \(^7\), this course had high satisfaction, with 43 of 44 participants being either very satisfied or satisfied with the course and with the cadaveric component being considered the most integral part.

Participants reported the highest score of subjective improvement in pelvic neuroanatomy 1.29 (score from 1–5), followed by scores of 1.63, 1.79, and 1.79 for pelvic vasculature, pelvic muscles knowledge, and knowledge of the ureter respectively. While this course focuses on neuroanatomy, this in in the context of other anatomic landmarks. Participants also reported expectation of improvement in surgical skills and dissection method of 2.05 and 1.86, respectively. Participants expected that improved anatomic knowledge will translate in greater surgical skill.

Reflecting similar results in other studies, participants believe that this course will change their practice \(^6,19,23,24\). Our participants also overwhelmingly agreed similar past courses impacted both their short term and longer-term practice patterns. 95% of participants strongly agreed or agreed that they would participate in a similar course in the future and that 81% would participate in the same course in the future.

Limitations of this study include that the anatomy test is not validated. However, there is no validated testing tool for pelvic neuroanatomy. Another aspect of the anatomy test to consider is the questions before and after are identical. Furthermore, all survey-based questionnaires suffer from the same weakness of recall bias. Over half of the participants do not speak English as a primary language.

Given that participants in this study come from a diverse geographic background and at different levels of education, we believe that this study is generalizable to a broad cross section of gynecologic surgeons, especially as most gynecologic surgeons do not have significant background in pelvic neuroanatomy.

In conclusion, laparoscopic pelvic neuroanatomy is an unfamiliar subject to both intermediate and advanced gynecologic surgeons. However, it can be effectively taught through a standardized and reproducible dissection protocol. The development and reproduction of such courses is essential for closing the knowledge gap in this area that is so important for reducing perioperative complications and improving the quality of life of patients undergoing pelvic surgery.

**Abbreviations**

MDS: mean difference score, defined as mean of posttest scores minus pretest scores

**Declarations**
Ethics Approval and Consent to Participate: St. Louis University IRB number: 29284 4/23/2018, with last approval 11/2019. IRB approval was obtained in order to perform data analysis to draw generalizable conclusions previously collected as part of a QI Project. The data set was a deidentified RedCap database and original surveys were also destroyed. As such, consent was not obtained at the time of data collection. The data that was collected for the QI project was anonymous and deidentified. The QI project was approved with an HHS determination form.

Consent for publication: Not applicable. This manuscript does not contain an individual’s personal data in any form. All authors have given consent for publication.

Availability of date and materials:
All original data and master lists have been destroyed in the appropriate manner. Data sets exist in deidentified form in a RedCap database. Datasets used are available from the corresponding authors on reasonable request.

Competing interests’ statement:
Ioana Marcu MD has no disclosures and no conflicts of interest.
Adrian Balica MD has no disclosures and no conflicts of interest.
Leme Fernandes MD has no disclosures and no conflicts of interest.
Jeffrey Gavard PhD has no disclosures and no conflicts of interest.
Dr. Solnik has the following disclosures: he is a consultant for medtronic, he is on the advisory board of allergan, and he is on the advisory board for Abbvie.

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Authors’ Contribution:
All authors have read and approved the manuscript.

JG: Data analysis and interpretation, statistical analysis, manuscript preparation
ACB: conception and design of study, responsible course faculty, manuscript preparation, participant recruitment
ECC: Conception and design of study, responsible course faculty, participant recruitment
GLF: Conception and design of study, responsible course faculty
MJS: Conception and design of study, responsible course faculty
VM: Conception and design of study, responsible course faculty

NL: Conception and design of study, responsible course faculty, manuscript preparation

IM: Conception and design, data collection, data analysis and interpretation, statistical analysis, manuscript preparation, participant recruitment

These data have not been published and the manuscript is not under review at any other journal. These data have been presented at the American Association of Gynecologic Laparoscopists Global Congress of Minimally Invasive Gynecology 2018 Nov 11-15 in Las Vegas, Nevada

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Authors’ Information:

Ioana Marcu MD1, Adrian Balica MD2, Jeffrey Gavard PhD1, Eugen C. Campian MD PhD1, Gustavo Leme Fernandes3, M Jonathon Solnik4, Vadim Morozov MD5, Nucelio Lemos MD6

From the following institutions’ Departments of Obstetrics and Gynecology: 1Saint Louis University School of Medicine, Saint Louis, MO, United States; 2Rutgers Robert Wood Johnson Medical School, New Brunswick, NJ, United States; 3Faculdade de Medicina do ABC, Santo André, São Paulo, Brazil; 4Mount Sinai Hospital, Toronto, ON, Canada; 5University of Maryland, Baltimore, Maryland, United States; 6University of Toronto, Toronto, ON, Canada

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Emails for authors

Jeffrey Gavard: jeffrey.gavard@health.slu.edu

Adrian C Balica: balicaac@rutgers.edu

Eugen C Campian: ecristian.campian@health.slu.edu

Gustavo Leme Fernandes: gustavo.fernandes@increasing.com.br

M Jonathon Solnik: jonathon.solnik@sinahealthsystem.ca

Vadim Morozov: morozovfamily13@gmail.com

Nucelio Lemos: nucelio@gmail.com
Corresponding author:

Ioana Marcu:

Saint Louis University School of Medicine, Saint Louis, MO, United States
imarcu2000@gmail.com

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Tables

Table 1 Characteristics of Course Participants
|                          | Number | Age (years) | Time since training (years) |
|--------------------------|--------|-------------|-----------------------------|
| All                      | 44     | 43.42 (10.17) | 11.09 (10.04) |
| Completed Residency only | 15     | 48.21 (10.16) | 18.62 (11.24) |
| Completed Fellowship     | 25     | 42.76 (8.57)  | 8.67 (8.68)   |
| Current Residents        | 2      | 42.61 (10.05) | 10.35 (8.68)  |
| Current Fellows          | 2      | 44.00 (11.19) | 13.70 (11.93) |

Age presented as Mean (Standard Deviation). Years from training represented as Mean, Median (Standard Deviation).

* Age unknown for one participant

**Data known for 14 of 15 possible participants'
Table 2 Precourse and Mean Deviation Scores on Anatomic Survey
|                          | Precourse score | Postcourse score | Mean Deviation Score | P-Value                        |
|--------------------------|-----------------|------------------|----------------------|--------------------------------|
| All (N=44)               | 32.18 (8.30)    | 41.98 (6.32)     | 9.80 (8.46)          | <0.001 between precourse and postcourse score* |
| North American (N=18)    | 31.00 (7.56)    | 41.22 (6.54)     | 10.22 (6.15)         | < 0.001                        |
| South American (N=26)    | 33.00 (8.83)    | 42.50 (6.23)     | 9.50 (9.86)          | < 0.001                        |
|                          |                 |                  |                      | P-value 0.44 for pretest scores, 0.77 for MDS |
| Fellowship trained (N= 25)* | 32.32 (7.16)    | 43.40 (5.42)     | 11.08 (7.15)         | <0.001                         |
| Residency completed only (N=15)* | 31.07 (10.08)  | 38.93 (6.76)     | 7.87 (10.08)         | <0.01                          |
|                          |                 |                  |                      | P-value 0.65 for pretest scores, 0.25 for MDS |
| < 5 years since training (N=12)** | 32.50 (8.69)    | 43.25 (6.74)     | 10.75 (8.51)         | <0.001                         |
| > 5 years since training (N=25)** | 30.84 (8.37)    | 41.00 (5.99)     | 10.16 (8.19)         | <0.001                         |
|                          |                 |                  |                      | P-value 0.58 for pretest scores, 0.84 for MDS |
| < 5 years since training, completed fellowship (N=11) *** | 33.09 (8.86)    | 44.00 (6.53)     | 10.91 (8.91)         | <0.01                          |
| > 5 years since training, completed fellowship (N=13) *** | 31.00 (5.34)    | 43.08 (4.73)     | 12.08 (4.97)         | <0.001                         |
|                          |                 |                  |                      | P-value 0.48 for pretest scores, 0.70 for MDS |
| < 5 years since training, completed residency only (N=1) **** | 26.00           | 35.00            | 9.00                 | –                              |
| Category                                                                 | Mean (Standard deviation) | Mean (Standard deviation) | Mean (Standard deviation) | P-value |
|--------------------------------------------------------------------------|---------------------------|---------------------------|---------------------------|---------|
| > 5 years since training, completed residency only (N=12) ****          | 30.67 (11.03)             | 38.75 (6.58)              | 8.08 (10.51)              | <0.05   |
| P-value 0.69 for pretest scores, 0.94 for MDS                           |                           |                           |                           |         |
| Age <43 years (N= 23)^                                                  | 32.39 (7.61)              | 42.43 (6.87)              | 10.04 (7.92)              | <0.001  |
| Age >43 years (N= 20)^                                                  | 32.05 (9.41)              | 41.20 (5.77)              | 9.15 (9.29)               | <0.001  |
| P-value 0.90 for pretest scores, 0.74 for MDS                           |                           |                           |                           |         |
| Age <43 years, completed fellowship (N=13)                              | 31.92 (7.72)              | 43.62 (6.37)              | 11.69 (7.74)              | <0.001  |
| Age >43 years, completed fellowship (N=12)                              | 32.75 (6.82)              | 43.17 (4.45)              | 10.42 (6.72)              | <0.001  |
| P-value 0.78 for pretest scores, 0.67 for MDS                           |                           |                           |                           |         |
| Age <43 years, completed residency only (N=6) ^^                         | 31.33 (7.31)              | 38.50 (7.34)              | 7.17 (6.94)               | 0.05    |
| Age >43 year, completed residency only (N=8) ^^                         | 31.00 (12.84)             | 38.25 (6.54)              | 7.25 (12.50)              | 0.15    |
| P-value 0.95 for pretest scores, 0.99 for MDS                           |                           |                           |                           |         |

All scores represented as Mean (Standard deviation)

N varies due to number of respondents for each category.

* 4 participants were active residents or fellows

** Years since training is not applicable to 2 current residents and 2 current fellows and was unknown for 3 participants.

*** Years since training was unknown for 1 participant

**** Years since training was unknown for 2 participants

^ Age unknown for 1 participant.

^^ Age unknown for 1 participant.
| Table 3 Surgical Comfort Level and Pretest scores |
|-------------------------------------------------|
| N total= 42                                      |
| Pretest score for those who                      |
| Strongly Agree or Agree                          |
| Pretest score for those who are                  |
| Neutral, Disagree, or Strongly Disagree          |
| N value                                          |
| p value                                          |
| "I feel comfortable performing less complicated laparoscopic surgeries such as bilateral tubal ligation" |
| 32.29 (7.98)                                    |
| N = 35                                          |
| 30.14 (10.70)                                   |
| N = 7                                           |
| p=0.54                                          |
| "I feel comfortable performing complex laparoscopic surgeries such as hysterectomies in uncomplicated cases" |
| 31.82 (8.40)                                    |
| N = 34                                          |
| 32.38 (8.83)                                    |
| N = 8                                           |
| p=0.87                                          |
| "I feel comfortable performing complex laparoscopic surgeries such as hysterectomies in complicated cases" |
| 32.00 (7.70)                                    |
| N = 22                                          |
| 31.85 (9.28)                                    |
| N = 20                                          |
| p=0.96                                          |

Participants were provided the statements in column 1 prior to starting the course. They were asked to answer on a 5 point scale from strongly agree (1) to strongly disagree (5). Those who answered strongly agree or agree were grouped together. Those who answered neutral, disagree, or strongly disagree grouped together. Pretest scores of the groups are compared. All scores represented as Mean (Standard deviation). Data presented as Pretest score (Standard Deviation) with N= number of respondents out of 44.

Table 4 Subjective Improvements After This Course
|                                | Average of 1-5 Scores | 1= Strongly agree | 2= Agree | 3= Neutral | 4= Disagree | 5= Strongly Disagree |
|--------------------------------|-----------------------|-------------------|----------|------------|-------------|----------------------|
| Improved my surgical skills   | 2.05 (0.95)           | 13                | 21       | 6          | 3           | 1                    |
| N=44                           |                       |                   |          |            |             |                      |
| Improved my laparoscopic       | 1.89 (0.91)           | 17                | 18       | 7          | 1           | 1                    |
| dissection method              | N= 44                 |                   |          |            |             |                      |
| Improved my knowledge of       | 1.29 (0.69)           | 34                | 9        | 0          | 0           | 1                    |
| neuroanatomy                   | N=44                  |                   |          |            |             |                      |
| Improved my knowledge of       | 1.63 (0.85)           | 23                | 17       | 2          | 1           | 1                    |
| pelvic vasculature             | N=44                  |                   |          |            |             |                      |
| Improved my knowledge of       | 1.75 (0.75)           | 19                | 20       | 3          | 1           | 1                    |
| pelvic musculature             | N=44                  |                   |          |            |             |                      |
| Improved my knowledge of pelvic ureter | 1.80 (0.89) | 19                | 18       | 5          | 1           | 1                    |
| N=44                           |                       |                   |          |            |             |                      |

Participants were provided the statement “This course... improved my surgical skills,” and as on for all of the statement in column one. They were asked to answer on a 5 point scale from strongly agree (1) to strongly disagree (5). All scores in column 2 represented as Mean (Standard deviation), N= number of respondents out of 44.

**Figures**
Figure 1

Dissection and Anatomic Structures. A. LCIV: Left common Iliac Vein EIV: External Iliac Vein PM: Psoas Muscle Solid Line: Sacral Promontory Dashed Line: incision B. LCIV: Left Common Iliac Vein Solid Line: Sacral Promontory C. EIV: External Iliac Vein Arrow GNF: Genitofemoral Nerve PM: Psoas Muscle D. Opening Obturator Fossa PM: Psoas Muscle Arrow GNF: Genitofemoral Nerve EIV: External Iliac Vein E. Within Obturator Fossa Arrow ON: Obturator Nerve Arrow LST to Green Shaded Area: Lumbosacral Trunk Arrow GNF: Genitofemoral Nerve PM: Psoas Muscle F. Arrow ON: Obturator Nerve L4, L5: Lumbar Nerve Roots LST: Lumbosacral Trunk Arrow GNF: Genitofemoral Nerve PM: Psoas Muscle G. IIV: Internal Iliac Vein SGV: Superior Gluteal Vein SVA: Superior Gluteal Artery L4, L5: Lumbar Nerve Roots LST: Lumbosacral Trunk SPF: Sciatic Perineural Fat White Shaded Arrow Head: Ischial Spine Dotted line: Sciatic Notch GFN: Genitofemoral Nerve PM: Psoas Muscle H. IIV: Internal Iliac Vein IIA: Internal Iliac Artery PV: Pudendal Vein PA: Pudendal Artery PN: Pudendal Nerve ICM: Iliococcygeus Muscle Red Shaded Area CM: Coccygeus Muscle White Shaded Area: Ischial Spine Asterix: Sacrospinous ligament ATFP: Arcus Tendineus Fascia Pelvis Blue Shaded Area: Endopelvic fascia OIM: Obturator internus muscle SN: Sciatic Nerve Dotted Line: Sciatic Notch I. ICM: Iliococcygeus Muscle White Shaded Area: Ischial Spine Asterix on Area Outlined with White Line: Sacrospinous Ligament PfM: Piriformis Muscle ATFP: Arcus Tendineus Fascia Pelvis Blue Shaded Area: Endopelvic fascia SN: Sciatic Nerve Dotted Line: Sciatic Notch J. Solid Line: Sacral Promontory Green Shaded Area SPH: Superior Hypogastric Plexus LCIIV: Left Common Iliac Artery RCIA: Right Common Iliac Artery K. SHP: Superior Hypogastric plexus LHN: Left Hypogastric Nerve RHN: Right Hypogastric Nerve Blue shaded area PSF: Presacral Fascia L. SHP: Superior hypogastric plexus RHN: Right Hypogastric Nerve LCIV: Left Common Iliac Vein RCIA: Right Common Iliac Artery U: Ureter M. Overview of Presacral Space N. Green Shaded Area IHP: Inferior Hypogastric Plexus Green Shaded Area PSN: Pelvic Splanchnic Nerve S2, S3, S4: Sacral Nerve Roots O. IHP: Inferior Hypogastric Plexus MRV: Middle Rectal Vein IIV: Internal Iliac Vein PSN: Pelvic Splanchnic Nerve S2, S3, S4: Sacral Nerve Roots