SCIENTIFIC PAPER JSLS

Needs Assessment for Electrosurgery Training of Residents and Faculty in Obstetrics and Gynecology

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ABSTRACT

Background and Objectives: Effective application of electrosurgical techniques requires knowledge of energy sources and electric circuits to produce desired tissue effects. A lack of electrosurgery knowledge may negatively affect patient outcomes and safety. Our objective was to survey obstetrics-gynecology trainees and faculty to assess their basic knowledge of electrosurgery concepts as a needs assessment for formal electrosurgery training.

Methods: We performed an observational study with a sample of convenience at 2 academic hospitals (Beth Israel Deaconess Medical Center and Mount Auburn Hospital). Grand rounds dedicated to electrosurgery teaching were conducted at each department of obstetrics and gynecology, where a short electrosurgery multiple-choice examination was administered to attendees.

Results: The face validity of the test content was obtained from a gynecologic electrosurgery specialist. Forty-four individuals completed the examination. Test scores were analyzed by level of training to investigate whether scores positively correlated with more advanced career stages. The median test score was 45.5% among all participants (interquartile range, 36.4%–54.5%). Senior residents scored the highest (median score, 54.5%), followed by attendings (median score, 45.5%), junior residents and fellows (median score in both groups, 36.4%), and medical students (median score, 27.3%).

Conclusion: Although surgeons have used electrosurgery for nearly a century, it remains poorly understood by most obstetrician-gynecologists. Senior residents, attendings, junior residents, and medical students all show a general deficiency in electrosurgery comprehension. This study suggests that there is a need for formal electrosurgery training. A standardized electrosurgery curriculum with a workshop component demonstrating clinically useful concepts essential for safe surgical practice is advised.

Key Words: Electrosurgery, Surgical curriculum, Surgical teaching.

INTRODUCTION

Electrosurgery is used by all surgical disciplines and has played an increasingly important role in the advancement of surgical techniques and minimally invasive surgery. Most surgeons, including obstetrician-gynecologists, operate with electrosurgical devices regularly when performing abdominal, vaginal, laparoscopic, and hysteroscopic procedures. Both monopolar and bipolar instruments are widely used in electrosurgery, among which the radiofrequency (RF) knife a monopolar handheld device often informally referred to as the "Bovie," is the most broadly used device. Effective use of electrosurgical tools requires knowledge of energy sources and concepts of electric circuits to produce the desired clinical effect while minimizing patient risk. The current generated by electrosurgical generators can pose great risk to patients if improperly used. Although there has been a rapid increase in the numbers of new electrosurgical devices and technologies, the underlying principles of electricity and circuits are the same. A basic knowledge and competence in the fundamentals of electrosurgery are essential for the practice of safe and effective surgery.

In 2004 Mayooran et al[1] published a study that suggested that there is a lack of basic electrosurgery knowledge among obstetrician-gynecologists. Almost 10 years later, the lack of electrosurgery teaching and basic understand-

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DOI: 10.4293/JSLS.2014.00293

ing appears to be an ongoing problem.[2] This deficit may directly affect patient safety and the quality of health care delivery. The increasing use of electrosurgical devices in surgical procedures highlights the importance of electrosurgery education to all surgeons, especially residents in training.

Historically, procedural training in medical education was performed at the bedside, where "see one, do one, teach one" became the adage. The new procedural training paradigm incorporates competency-based knowledge and clinical skills, and it includes a focus on patient safety through simulation teaching in a medically safe simulated environment.[3] Although much of the research in surgical education focuses on procedural skills and simulation, cognitive skill remains a major component of surgical performance. In fact, it has been estimated that a surgical procedure is 25% technical skill and 75% cognitive skill.[4,5] Beyond a reserve of knowledge, cognitive skill includes clinical decision making and judgment.[5] The Accreditation Council for Graduate Medical Education includes knowledge as 1 of the 6 main components of surgical competency (knowledge, patient care, interpersonal and communication skills, professionalism, practice-based learning, and system-based practice).[6] Safe and effective electrosurgery training requires training in all of these domains.

We have identified knowledge of electrosurgery as a potential deficit in formal teaching in the obstetrics-gynecology (Ob-Gyn) resident curriculum. In this study we aim (1) to assess the knowledge of electrosurgical principles among obstetrician-gynecologists as a needs assessment for formal electrosurgery training and (2) to explore additional ways to teach electrosurgery more effectively. We hypothesize that obstetrician-gynecologists continue to lack an understanding of basic electrosurgical principles and that traditional didactic lectures may be insufficient for electrosurgical training.

MATERIALS AND METHODS

An electrosurgery test consisting of 11 multiple-choice questions on electrosurgical concepts was constructed. The test was designed by 2 minimally invasive surgery fellowship–trained gynecologists, both graduates of the Association of Professors of Gynecology and Obstetrics (APGO) Electrosurgery Scholars Program.[7] The test was developed to assess knowledge of key concepts of electrosurgery including definitions of a circuit, function of the dispersive electrode (often informally referred to as the grounding pad), tissue effects, and surgical risks (eg, capacitance coupling), in addition to clinical applications in gynecologic surgery. The principles addressed in the electrosurgery test mirrored the objectives included in the APGO Electrosurgery Scholars Program syllabus:

- circuit characteristics, monopolar and bipolar circuits
- role of the dispersive electrode (also known as the grounding pad)
- tissue effects with electrosurgery
- clinical applications
- risk of injury associated with electrosurgery

Each question was paired to an objective. Questions were included to test the first two levels of Miller's pyramid: knows (ie, fact gathering) and knows how (ie, interpretation/application).[8,9] Four of the electrosurgery test questions can be described as recall of basic knowledge, whereas the remaining 7 questions illustrate clinical scenarios to assess higher cognitive skills used for patient management and surgical planning.

A pilot electrosurgery test was initially administered to obstetrics and gynecology residents at Beth Israel Deaconess Medical Center (BIDMC) and Johns Hopkins University, as well as to scholars of the 2012 APGO Electrosurgery Scholars Program. The pilot test results from BIDMC have been reported previously.[10] From this pilot test, a revised version of the electrosurgery test was developed for use in this study. To address process validity, scoring of the pilot test was reviewed and changes were made to improve the test and to simplify the scoring method. Questions that previously contained more than one correct answer and required learners to supply multiple answers were modified to have a single correct answer. For the revised test, credit is given for each correct answer and each question is weighted equally (% Score = Total number correct/Total number of questions × 100).

To ensure accuracy and face validity for test content, both the pilot electrosurgery test and the revised electrosurgery test were reviewed by an electrosurgery expert who is an advanced minimally invasive gynecologic surgeon with a degree in electrical engineering. The reviewer was not involved in the test design. The revised electrosurgery test was also distributed to 4 minimally invasive gynecologic surgery experts at various institutions to assess how experts performed on it.

The final version of the electrosurgery test was administered during grand rounds dedicated to electrosurgical teaching, conducted at BIDMC and Mount Auburn Hospital. The grand rounds were open to the entire Department of Obstetrics and Gynecology, including attendings, fellows, residents, and medical students. Postgraduate year (PGY) 1 and PGY 2 residents were designated as junior residents, whereas PGY 3 and PGY 4 residents were grouped as senior residents. We conducted an electrosurgery workshop to follow a didactic lecture dedicated to electrosurgical teaching to demonstrate the principles of electrosurgery to the audience.

All statistical tests were performed with SAS software, version 9.3 (SAS Institute, Cary, North Carolina). All tests were two sided, and $P < .05$ was considered statistically significant. Data are presented as median and interquartile range (IQR) or proportion. Comparisons were made by use of the χ^2 or Fisher exact test for categorical variables and the Wilcoxon signed rank test for continuous variables. Test scores were analyzed by level of training, categorized as medical student, junior resident, senior resident, fellow, or attending.

RESULTS

Forty-three individuals completed the pilot test (17 BIDMC residents, 10 Johns Hopkins residents, and 16 APGO electrosurgery scholars) and 44 completed the revised examination (32 from BIDMC and 12 from Mount Auburn Hospital). Because the grand rounds are voluntary and participants come and go, we were unable to accurately assess the overall attendance and test response rate. The demographic breakdown of respondents is shown in **Table 1**. Most respondents were attendings (40.9%) and residents (27.2%), with a small percentage of medical students (11.4%) and fellows (6.8%) represented in the group. The respondents largely comprised women (84.1%), reflecting the predominance of female providers in the Ob-Gyn departments. The professional breakdown of respondents by specialty is shown in **Table 1**.

Among all test takers at the Ob-Gyn grand rounds, the median test score was 45.5% (**Table 2**). Although the test scores had a wide range, from 18.2% to 100%, the IQR spanned from 36.4% to 54.5%. When we analyzed the test scores by level of training, senior residents scored the highest (median, 54.5%; IQR, 45.5%–63.6%), followed by attendings (median, 45.5%; IQR, 36.4%–63.6%), junior residents and fellows (median in both groups, 36.4%; IQR, 36.4%–54.5%), and medical students, who had the lowest scores (median, 27.3%; IQR, 27.3%–54.5%). The differences in median test scores by level of training were not statistically significant ($P = .36$). In addition, there was no significant difference in correct response rates for individual questions by level of training (**Tables 3 and 4**). All 4 minimally invasive surgery experts each scored 73% on the electrosurgery test.

Table 1.
Demographic Characteristics of Electrosurgery Test Takers (N = 44)

	n (%)
Age [mean (range)] (y)	32.0 (28.0–49.0)
Gender	
Male	4 (9.1)
Female	37 (84.1)
Missing	3 (6.8)
Career stage	
Medical student	5 (11.4)
Junior resident	6 (13.6)
Senior resident	6 (13.6)
Fellow	3 (6.8)
Attending	18 (40.9)
Other/missing	2 (4.5)
Missing	4 (9.1)
Profession	
Generalist academic	8 (18.2)
Generalist private	6 (13.6)
Gynecologic oncology	2 (4.5)
REI[a]	2 (4.5)
Urogynecology	3 (6.8)
MFM[a]	1 (2.3)
Other/missing	5 (11.4)
NA[a]	17 (38.6)

Data are presented as number (percent) unless otherwise indicated. Residents and medical students were not applicable given their stage of training.

[a]MFM = Maternal Fetal Medicine; NA = not applicable; REI = Reproductive Endocrinology Infertility.

The questions on the physics equation for power and methods for achieving hemostasis during a LEEP (Loop Electrical Excision Procedure) yielded the greatest percentage of correct responses (both with a 90.9% correct response rate) (**Tables 3 and 4**). The questions about the definition of electric circuits, how to achieve surgical tissue effects, and the risk of capacitive coupling had the lowest scores, ranging from only 11.4% to 20.5% correct response rates. The questions reflecting knowledge on clinical applications such as managing patients with jew-

Table 2.
Comparison of Electrosurgery Test Scores by Level of Training

Training Level	Score [Median (IQR)] (%)[a]
All (N = 44)	45.5 (36.4–54.5)
Medical student (n = 5)	27.3 (27.3–54.5)
Junior resident (n = 6)	36.4 (36.4–54.5)
Senior resident (n = 6)	54.5 (45.4–63.6)
Fellow (n = 3)	36.4 (36.4–54.5)
Attending (n = 18)	45.5 (36.4–63.6)
Other/missing (n = 6)	40.9 (36.4–45.5)

[a] $P = .36$ for comparison of different training levels.

The "other/missing" category comprised the following: 1 respondent was a PA student, 1 respondent was a nurse midwife, 1 respondent wrote "other," 1 respondent left the question blank but later checked off generalist private practice, and 2 respondents did not answer the question regarding either current career stage or profession.

elry (34.1% correct response rate) or implants (38.6% correct response rate) were also answered incorrectly by most participants.

DISCUSSION

Electrosurgery has been used in the operating room for nearly a century but remains poorly understood by most gynecologic surgeons and obstetricians. We identified concepts of electrosurgery as a potential deficit in resident knowledge and developed a test to assess current knowledge of electrosurgical principles and its clinical applications in gynecologic surgery. The electrosurgery test was designed and applied as a needs assessment for formal electrosurgery training. The target population was residents, clinical fellows, and faculty in obstetrics and gynecology.

We initially assessed the knowledge of basic electrosurgery concepts among obstetrics and gynecology residents and participants in the APGO Electrosurgery Scholars Program with a pilot test; we then extended the testing to other members of the Department of Obstetrics and Gynecology, including faculty. The results from our electrosurgery testing suggest that there is a general deficit in electrosurgery knowledge among obstetrics and gynecology faculty, fellows, and medical students. Although senior residents and attendings show a trend of having a greater knowledge base than junior residents and medical students, the overall low test scores for all groups suggest that there is a general deficiency in electrosurgery knowledge, supporting the need for formal training. Interestingly, participants scored highest on questions testing basic recall, in particular the question on the physics equation for current and voltage; in contrast, a substantial percentage of clinically relevant questions were answered incorrectly, including common issues such as how to manage patients with jewelry or metal implants undergoing surgery with an electrosurgical instrument.

Our findings suggest that there is a deficit in electrosurgery knowledge among obstetrics and gynecology faculty and trainees, with a need for more formal electrosurgery training and curricula. Our initial goal was to establish more formal electrosurgery training for our obstetrics and gynecology residents; however, the results of our study suggest that both faculty and trainees may benefit from electrosurgery teaching. Our study supports the need for a formal intervention to enhance electrosurgery training of all members of the obstetrics and gynecology department.

Although basic principles of electrosurgery are taught in the operating room and during resident didactic lectures, electrosurgical training is not part of the formal resident curriculum at our institution. Residents are often expected to learn and apply these principles in the operating room during live procedures under the supervision of their faculty. With a lack of knowledge among faculty, the deficiency in electrosurgery training is likely to perpetuate and may directly affect patient safety and the quality of health care delivery. The Society of American Gastrointestinal and Endoscopic Surgeons has recognized the deficit in knowledge of energy sources among surgeons and established the Fundamental Use of Surgical Energy (FUSE) program that addresses a broad spectrum of energy sources including electrosurgery, ultrasonic energy, and microwave energy and may serve as a valuable resource for all surgical disciplines.[11] This may serve as a valuable resource for surgical training programs seeking additional surgical teaching on various energy sources.

We are developing an electrosurgery test for Ob-Gyn residents that we hope to validate for use in our surgical curriculum in the near future. To explore additional ways to teach electrosurgery more effectively, our updated electrosurgery curriculum includes a simulation workshop that is coupled with the didactic lecture, allowing the learner to see the electrosurgical principles demonstrated in a laboratory setting. A study by Davis

Table 3.
Breakdown of Correct Responses by Test Question and Level of Training

Question	All (N = 44)	Medical Student (n = 5)	Junior Resident (n = 6)	Senior Resident (n = 6)	Fellow (n = 3)	Attending (n = 18)	Other/ Missing (n = 6)	*P* Value
Power setting	40 (90.9)	4 (80.0)	6 (100.0)	6 (100.0)	3 (100.0)	16 (88.9)	5 (83.3)	.77
Circuit	5 (11.4)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (16.7)	2 (33.3)	.46
Electrosurgical risks	29 (65.9)	3 (60.0)	4 (66.7)	5 (83.3)	3 (100.0)	13 (72.2)	1 (16.7)	.12
Dispersive electrode	30 (83.3)	2 (40.0)	3 (50.0)	5 (83.3)	2 (66.7)	13 (72.2)	5 (83.3)	.58
Desiccation effect	30 (68.2)	2 (40.0)	4 (66.7)	4 (66.7)	1 (33.3)	15 (83.3)	4 (66.7)	.33
LEEP[a] tip	40 (90.9)	4 (80.0)	4 (66.7)	6 (100.0)	3 (100.0)	17 (94.4)	6 (100.0)	.21
Hysteroscopy cutting	7 (15.9)	0 (0.0)	1 (16.7)	2 (33.3)	0 (0.0)	4 (22.2)	0 (0.0)	.65
Cutting effect	9 (20.5)	1 (20.0)	0 (0.0)	2 (33.3)	0 (0.0)	5 (27.8)	1 (16.7)	.73
Jewelry	15 (34.1)	2 (40.0)	1 (16.7)	1 (16.7)	1 (33.3)	9 (50.0)	1 (16.7)	.53
Metal implant	17 (38.6)	2 (40.0)	3 (50.0)	3 (50.0)	1 (33.3)	5 (27.8)	3 (50.0)	.85
Capacitive coupling	7 (15.9)	0 (0.0)	2 (33.3)	4 (66.7)	0 (0.0)	1 (5.6)	0 (0.0)	.01

Data are presented as number (percent).
[a]LEEP = LOOP ELECTRICAL EXCISION PROCEDURE.

Table 4.
Examples of Test Questions

Power setting question

The power setting on the electrosurgical generator reflects

A. Current and circuit
B. Current and grounding
C. Current and hertz
D. Current and voltage

Tissue effect questions

Desiccation of tissue occurs when the activated electrode is in contact with tissue for a sufficient amount of time resulting in cell dehydration and eschar buildup. This tissue effect can be generated with

A. Cutting waveform only
C. Coagulation waveform only
C. Blended waveform only
D. Both cutting and coagulation waveforms

et al[12] suggests that didactic teaching alone does not effect a practice change among providers whereas interactive methods (eg, workshops) are more likely to change physician practices. The electrosurgery workshop was focused on clinically relevant concepts of electrosurgery essential for safe electrosurgical practice, such as concepts of circuit pathways, current density, and stray current. In our experience, a simulation workshop using inexpensive tissue models is a highly effective method to demonstrate how electrical current produces different tissue effects, and it provides a more concrete opportunity for learners to grasp the previously mentioned concepts. Although the didactic component is important, the electrosurgery workshop is often the venue where adult learners bridge the gap between their cognitive knowledge of electric circuits and the clinical impact on tissue to obtain desired surgical outcomes and avoid patient complications. Recalling adult learning theory, Confucius reminds us, "I hear and I forget. I see and I remember. I do and I understand." The adult learner assimilates content more completely if he or she is engaged in the process of discovery and exploration rather than being the passive recipient of information.[13] Our curriculum is well timed with the Accreditation Council for Graduate Medical Education milestone project that includes patient safety and cites knowledge of various forms of energy sources in expected performance.

There are several limitations of this study. First, this was a descriptive study that used a sample of convenience to explore the current knowledge base among providers, resulting in a small sample size. Given the small sample size, it is difficult to determine whether the lack of a statistically significant difference for median test scores among groups truly reflects a lack of difference in electrosurgery knowledge versus a lack of power to detect differences among groups. Second, the electrosurgery test used to survey the study participants, which was designed as an educational tool for departmental teaching at grand rounds, was not a validated test. The test did undergo a preliminary validation process in which 4 minimally invasive surgery experts tested each scored 73%, which was much higher than the median test score of the study participants (45.5%). However, further test validation is necessary to make conclusions about the validity or reliability of the electrosurgery test used for this study. We are in the process of developing and validating an electrosurgery test as part of our current electrosurgery curriculum. Third, undersampling of the content domain is possible because of the small number of test questions. For this study, our goal was to design a short test that broadly covered electrosurgery concepts for the purpose of efficiency during grand rounds. In the current process of developing an Ob-Gyn electrosurgery test and curriculum, we are attempting to balance test validity and test length. Fourth, the participants of the grand rounds represent mixed faculty, and we were unable to determine whether an even distribution of faculty was represented. Although further studies are needed to assess the extent to which surgeons lack electrosurgery knowledge, most providers would agree that there is a lack of formal electrosurgery teaching in Ob-Gyn training programs.

CONCLUSIONS

Electrosurgery has become an important component of current surgical practice. A basic understanding of general electrosurgical principles is critical for the best use of electrosurgical devices to obtain the desired surgical outcomes while optimizing patient safety. Our electrosurgery test served as a needs assessment of a formal electrosurgery curriculum. Our results suggest that there is limited knowledge of basic electrosurgery concepts among both trainees and faculty in obstetrics and gynecology, supporting the need for formal electrosurgery teaching. An electrosurgery workshop to demonstrate the concepts reviewed in a didactic lecture may be a more effective method of electrosurgery training than didactic teaching alone. Further evaluation is needed to assess the true status of electrosurgery knowledge among obstetrician-gynecologists, as well as the best methods for electrosurgery training.

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