JOURNAL OF
Surgical Simulation

Journal of Surgical Simulation (2017) **4**, 44–47
DOI: https://doi.org/10.1102/2051-7726.2017.0009

ORIGINAL ARTICLE

The validity of a surgical model simulating loss of vessel control in an abdominal hysterectomy

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Date accepted for publication: 19 October 2017

Abstract

Background: Resident surgical training in open gynecologic surgery is steadily decreasing with the advent of minimally invasive surgery. The role of this study was to evaluate the content and face validity of a low-fidelity surgical model simulating loss of uterine artery control in an abdominal hysterectomy. **Methods**: A low-fidelity surgical model was created to simulate ligation of the uterine artery during an abdominal hysterectomy. The model was designed to "bleed" at the time of ligation, requiring the gynecology resident to secure the pedicle. Interns and chief residents from a single institution were timed from the start of the simulated bleeding to when they regained control of the pedicle. The times of each year group were then compared using a t test. All residents who completed the simulation participated in a post-simulation survey. **Results**: In the post-simulation survey, 100% of the 15 residents who had previously performed an abdominal hysterectomy believed the model was a "somewhat" or "very close representation" of a real hysterectomy. The mean times for the first and fourth year residents were 43 and 27 seconds, respectively. This difference between years was statistically significant ($P = 0.05$). **Conclusion**: The speed with which the simulated bleeding vessels were ligated improved significantly between first and fourth year residents as surgical experience increased. This study demonstrates the content and face validity of this surgical model. Therefore, this model could be used to objectively evaluate ability to secure a bleeding uterine artery pedicle and aid in resident training.

Keywords: *hysterectomy; gynecology; abdominal surgery; simulation*

Introduction

Surgical models are increasingly being incorporated into surgical education. Simulations are valuable to surgical education due to their ability to train muscle memory through repetitive motion, the freedom they offer to make errors without patient harm, and the possibility of isolating critical physical and mental steps of a surgical procedure. The potential for their use in graduate medical education is significant as national governing bodies and simulation-based training curricula mature.[1] Particularly in the field of gynecology, where surgical numbers are drifting away from open procedures, proficiency in open techniques is likely to suffer.

An increasing deficiency in abdominal hysterectomies (TAH) at time of graduation has emerged over the past 20 years within obstetrics and gynecology resident training. The average resident in the United States in 2005 graduated having performed 85 TAHs. By 2015, that number had fallen to 45.[2] As a result, fewer residents have encountered and successfully dealt with complications during an abdominal hysterectomy before independent practice (Fig. 1). In addition, education on acute hemorrhage control is largely unavailable in resident education; however brief learning from education modules can provide effective learning methods for resident education.[3]

Surgical simulation provides the potential to bridge the gap and aid resident proficiency in TAHs. Hong et al.[4] demonstrated the ability of a low-fidelity TAH model to supplement previous surgical experience and improve surgical skills and knowledge. The usefulness of surgical models in resident education is largely dependent on the model's validity and efficacy in teaching the clinical skills being simulated. Face validity, how well a simulator appears to mimic the clinical skill or scenario depicted, and content validity, how closely the skills used within the simulation relate to those used in similar scenarios in reality, are 2 measures of surgical model validity.[5] This article presents a low-fidelity surgical model simulating loss of uterine artery vessel control in an abdominal hysterectomy as an educational tool for obstetrics and gynecology residents. In addition, we specifically evaluate the face and content validity of this surgical model to demonstrate its potential as an educational tool.

Methods

A low-fidelity surgical model was created using a uterus fabricated by 3D printing techniques. Latex rubber tubing was used to model the uterine arteries on the sides of the printed uterus. This study was approved by our Institutional Review Board with special consideration for inclusion of a resident physician population, and all participants were asked to give informed consent. Residents were recruited from a single institution. A total of 18 residents were included in the study, including 5 interns, 4 second years, 5 third years, and 4 chief residents. The researcher performed a teaching session on the proper technique to ligate the uterine artery during an abdominal hysterectomy on the right side of the model. Each participant was then instructed to independently ligate the uterine artery on the left side. A stopcock was released by the instructor, which caused the uterine artery pedicle to bleed once the participant cut the clamped uterine artery pedicle. The participant was then required to independently regain control of the pedicle without instruction (Fig. 2).

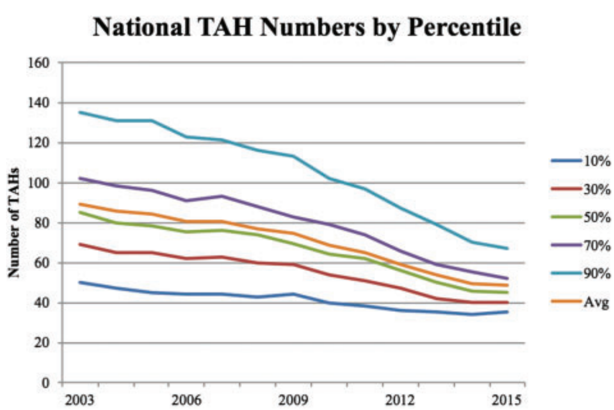

Figure 1. Number of TAHs nationally by percentile at time of residency graduation.[2]

The simulation was timed from the start of the simulated bleeding until the resident regained control of the pedicle and stopped the bleeding. Times were then compared using Student's t test. Five interns (1st year) and 4 chief (4th year) residents from a single institution were included in this analysis. A P value of <0.05 was used to signify significance.

The participants were required to complete a pre- and post-experiment survey. They were questioned regarding previous experience with loss of uterine artery vessel control during an abdominal hysterectomy (yes or no). In the post-procedure survey, the participants were asked how well they felt the model simulated ligation of the uterine artery in a real procedure: 0 (not applicable, have never seen a TAH before), 1 (not at all), 2 (somewhat), 3 (very close representation), to 4 (could not tell the difference).

Results

In order to compare the greatest difference in surgical experience, the amount of time required to regain control of the bleeding was compared between interns and chief residents and was found to be significantly different ($P = 0.05$). The intern class took an average of 42.7 s to ligate the uterine artery with a standard deviation of 15.5 s, whereas their chief counterparts took an average of 23.7 s to ligate with a standard deviation of 6.5 s (Fig. 3).

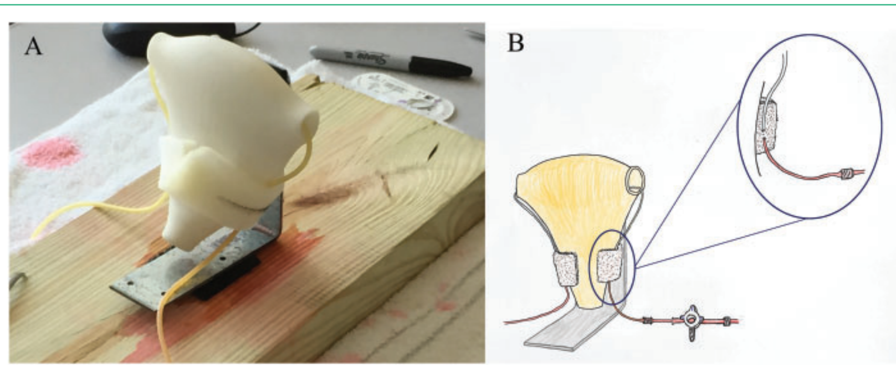

Figure 2. (A) The surgical model, (B) pictorial representation of the stopcock mechanism in the model (illustration by Dr Miriam B. Marcum).

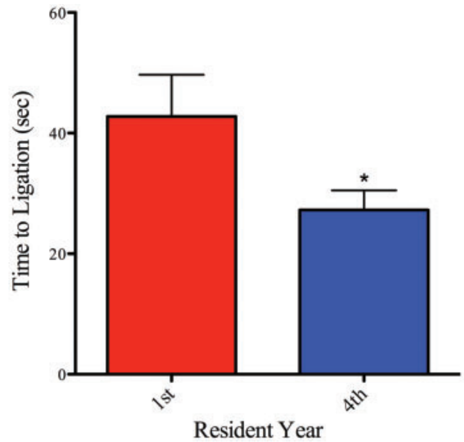

Figure 3. Time (s) to ligation of the uterine artery by resident class.

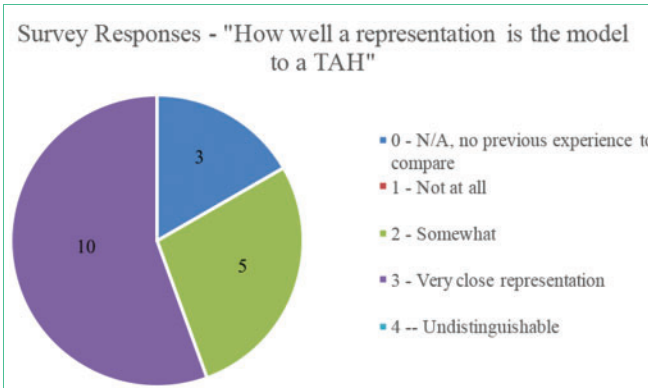

Figure 4. Survey responses when residents were asked how well the model represented a TAH.

Survey responses demonstrated that 100% of participants with previous logged TAHs felt the simulation was either a “somewhat close” or a “very close” representation of ligating a uterine artery during an abdominal hysterectomy (Fig. 4).

Discussion

Surgical models are increasingly being incorporated into surgical education curricula. Evaluation of a surgical model first requires assessment of its validity, specifically its content and face validity.

Face validity was demonstrated through subjective assessment of participants. All participants agreed that this model is a “somewhat close” or a “very close” representation of ligating a uterine artery during an abdominal hysterectomy. Content validity of the model was proven through comparison of those who have participated in TAHs (4th year residents) with those who have not (1st year residents). The time measured to control the simulated bleeding within the experimental model was significantly less in residents with more surgical experience, demonstrating the need for similar surgical skill to complete the simulation.

Limitations of the study include the small sample size overall and within each resident class. In addition, the model specifically assessed only the abdominal approach to a hysterectomy and does not necessarily apply to vaginal or laparoscopic hysterectomy techniques. This project specifically assessed the validity of the model. Future studies are aimed at examining the efficacy of the model in teaching these skills as well as variations beyond the abdominal approach.

Simulator-based training has significant potential in developing the surgical skills and knowledge base of residents. Models similar to this have been shown previously to improve junior fellows’ confidence in surgical skills and improve overall outcomes of hysterectomy.[6] Muto et al.[7] demonstrated the efficacy of an internal carotid artery model in teaching residents acute hemorrhage control in vascular surgery. This model presents residents with an uncommon complication of open surgical procedures requiring prompt intervention utilizing both surgical judgement and skill. Models such as this may be used as tools to supplement resident education where clinical cases fall short.

Conflict of interest

None declared.

Acknowledgements

We would like to thank Dr. Miriam B. Marcum for contributing her time and artwork to this project.

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