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Case report

Prolonged intubation after robotic-assisted hysterectomy for endometrial cancer: Case reports

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1. Background

Endometrial cancer is the most common gynecologic malignancy in the United States, with an estimated 63,230 new cases in 2018 (Siegel et al., 2018). Many of these patients are diagnosed with early-stage disease and undergo surgery with hysterectomy, bilateral salpingo-oophorectomy, and when indicated, lymphadenectomy. The procedure was historically performed *via* laparotomy. However, multiple studies demonstrated that though operative times were prolonged with minimally invasive procedures, survival and recurrence rates were similar (Janda et al., 2017; Wright et al., 2016). Furthermore, there were fewer postoperative adverse events and shorter hospital stays with minimally invasive approach. These resulted in a paradigm shift from standard laparotomy to laparoscopy in the management of women with endometrial cancer.

Robotic surgery, which uses three dimensional imaging, longer and articulating instruments and allows the surgeon to operate seated, is thought to make minimally invasive surgery increasingly feasible for this population of patients. Due to the relative ease of obtaining technical proficiency, robotic surgery has further facilitated the use of minimally invasive surgical techniques in endometrial cancer. One meta-analysis of 4420 patients noted that robotic surgery resulted in lower blood loss and rates of conversion to laparotomy when compared with traditional laparoscopy. While robotic surgery resulted in higher rates of complications, the operating times, length of hospital stay, and number of lymph nodes harvested were similar (Ran et al., 2014). Another meta-analysis comparing robotic to open hysterectomy noted similar survival outcomes with shorter length of stay, lower blood loss, and lower rates of complications, readmission, and transfusion.Authors did note longer operating times and a higher incidence of vaginal cuff dehiscence with robotic hysterectomy (Park et al., 2016).

Notably, during the increased operative times required for minimally invasive surgery, patients are positioned in steep Trendelenburg with abdominal insufflation; associated complications may be serious and need to be carefully considered when undertaking these procedures. The following two cases demonstrate the rare complication of laryngeal edema requiring prolonged intubation for several days following robotic-assisted laparoscopic surgery.

2. Case 1

A 48-year-old woman was admitted for scheduled surgery for grade 1 endometrioid endometrial carcinoma found to be invading the cervical stroma on pre-operative biopsies. Past medical history was significant for class I obesity (body mass index [BMI] 34 kg/m^2), hyperlipidemia, hypertension, and pre-diabetes.Her only prior surgery was a bilateral tubal ligation. Her Mallampati score was 2, and she had been intubated without difficulty. The patient underwent a robotic-assisted radical hysterectomy, bilateral salpingo-oophorectomy, bilateral pelvic lymph node dissection, and omental biopsy.The total operative time was 11 h 28 min, including at least 10 h in steep Trendelenburg position, necessitated by small bowel prolapse into the surgical field. During this time, 5500 mL of crystalloid and 250 mL of 5% albumin were administered. Urine output was 550 mL with estimated blood loss

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Table 1
Intraoperative and postoperative performance in two cases.

	Cuff leak %		Dexamethasone (IV)		Furosemide (IV)		Fluids	
	Case 1	Case 2	Case 1	Case 2	Case1	Case 2	Case 1	Case 2
Intra-operative							Net +5100 mL (10h)*	Net +1190 mL (5 h)*
POD #0				10 mg				
POD #1	Small	0%	5 mg Q6 hrs × 4 doses	10 mg	20 mg	20 mg	LR 125 mL/h	LR 100 mL/h
POD #2	Moderate-51%	3–5%		4 mg Q6 hrs	20 mg		LR 75 mL/h	D5 1/2NS 100 mL/h
POD #3	7%	0%			20 mg		LR 25 mL/h	D5 1/2NS 60 mL/h
POD #4	25%	8%, extubated	5 mg Q6 hrs × 3 doses		20 mg		LR 75 mL/h	D5 1/2NS 60 mL/h
POD #5	40 → 70%, extubated						LR 75 mL/h	

* Hours in steep Trendrenburg position. Abbreviations: POD, postoperative day; IV, intravenous, hrs, hours; Q, every; LR, lactated ringer; and NS, normal saline.

Table 2
Proposed interventions to prevent prolonged intubation related to robotic surgery.

1. Using the lowest degree of Trendelenburg positioning*
2. Regularly level the patient and discontinue abdominal insufflation throughout the case**
3. Measure strict fluid intake and output***
4. Avoid large sized endotracheal tube
5. Early conversion to laparotomy if excessive length of surgery is anticipated[a]

* 15–30° angle.
** Every 4 h for 15 min, or every 1.5–2 h for 5–7 min.
*** Recommend < 2 L for total volume intake.
[a] Recommend use of individual clinical judgment on the length of time considered excessive based on patient factors (difficulty in ventilation, facial edema, chemosis, decreasing cuff-leak, decreasing urine output, and tachycardia) and surgical factors (predicted time for completion), which should be assessed periodically.

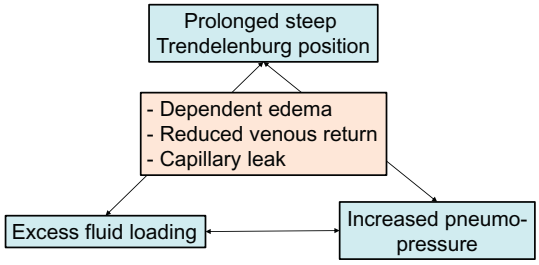

Fig. 1. Schema for dangerous triad of airway complication in robotic hysterectomy. These three factors, independently and synergistically, increase airway complications.

at 100 mL (net balance, 5100 mL positive). Due to concerns regarding increasing peak inspiratory pressures and intermittent difficulties with ventilation, para-aortic lymph node dissection was aborted.

Following the surgery, anesthesiologists suspected airway edema due to the patient's severe facial swelling. She remained intubated and was transferred to the intensive care unit. On postoperative day one, bedside laryngoscopy revealed significant vocal cord edema with mild edema of the epiglottis. No cuff leak was noted, and a chest x-ray revealed pulmonary edema. Thus, the patient was started on intravenous dexamethasone and furosemide. By postoperative day two, she was transitioned to continuous positive airway pressure (CPAP), and though following commands, still lacked a cuff leak. On postoperative day 3, otolaryngology was consulted, and repeat bedside laryngoscopy showed watery edema of the arytenoids and aryepiglottic folds with no improvement in cuff leak. She remained on CPAP until she was extubated on postoperative day five and discharged home on postoperative day seven. No lingering sequela was noted. Table 1 displays the daily postoperative management strategies used.

Final pathology showed stage II grade 1 endometrioid endometrial carcinoma invading the cervical stroma and 90% of the myometrium. Her pelvic nodes were negative for malignancy.She subsequently underwent vaginal brachytherapy and remains disease free for 1.5 years after surgery.

3. Case 2

A 40-year-old with grade 1 endometrioid endometrial carcinoma was scheduled for robotic-assisted hysterectomy.Preoperative imaging did not show evidence of metastatic disease.Her past medical history included well controlled diabetes, hypertension, subclinical hyperthyroidism, and class III obesity (BMI 44 kg/m^2). She also suffered from symptomatic cholelithiasis and a chronic draining peri-umbilical abscess for which she was referred to general surgery. Her Mallampatti score was 2, and she was intubated without difficulty using a size 8 endotracheal tube (standard 7–7.5). She underwent diagnostic laparoscopy with laparoscopic lysis of adhesions followed by a robotic-assisted hysterectomy and bilateral salpingectomy with cholecystectomy and incision and drainage of her umbilical abscess.The case duration was 7 h and 45 min with 5 h spent in steep Trendelenberg position during the hysterectomy portion of the procedure. During this period she received 1900 mL crystalloid and 500 mL 5% albumin.Her urine output was 1160 mL, and estimated blood loss was 50 mL (net balance 1190 mL positive). On completion of the surgery, no cuff leak was detected, and she was, therefore, transferred to the intensive care unit intubated with concern for laryngeal edema.

To ameliorate her airway edema, she was treated postoperatively with daily dexamethasone and fluid restriction. Despite assessment of weaning parameters multiple times per day, no air leak was noted, and she remained awake and alert on CPAP until she was extubated on postoperative day 4. Table 1 notes postoperative cuff leak measurements and fluid management strategies. She did well post-extubation and was discharged home on postoperative day 6. No lingering sequela was noted.

Final pathology showed stage IA grade 1 endometrioid endometrial carcinoma invading 28% of the myometrial thickness with no lymphovascular space invasion, and she is currently disease free for 7 months and undergoing surveillance.

4. Discussion

Robotic surgery has become popular in endometrial cancer surgery because it facilitates the performance of complicated procedures in confined spaces using a minimally invasive approach (Yu et al., 2013). Due to long and articulating instruments which augment surgical maneuvering, it is also popular for endometrial cancer surgery in obese patients (Blake et al., 2016). Other touted benefits of robotic surgery include reduced blood loss and shorter length of stays, which may offset the increased operating cost of a robotic procedure (Chhabra et al., 2016; Herling et al., 2016).

Like laparoscopy, robotic surgery requires abdominal insufflation

and steep Trendelenburg positioning. However, unlike laparoscopy, robotic surgery does not allow for easy manipulation of patient positioning. In the cases presented here, the complications of these requirements resulted in longer and more costly hospitalizations than if they had been performed open.

Robotic surgery presents a unique set of anesthesia challenges.Physiologic changes as a result of abdominal insufflation and positioning include increased systemic vascular resistance and heart rate as well as decreased venous return and splanchnic blood flow (Hsu et al., 2013). Intracerebral, intraocular, and peak airway pressures all increase. Rising peak airway pressures increase the risk of barotrauma and pneumothorax and make ventilation challenging (Hirvonen et al., 1995; Mclarney and Rose, 2011). Reported complications of Trendelenberg positioning in a recent systematic review include airway edema to be 0.7–26% with prolonged intubation and reintubation rates being 3.5% and 0.7%, respectively(Maerz et al., 2017). In our experience, particularly Case 1, the robotic system had recently been introduced to our facility, and the anesthesiology and surgery teams were, therefore, less experienced with this technique. Thus, when the robotic system is newly introduced to practice, experienced and skilled teams from both specialties are mandatory. Moreover, close communications between surgeons and anesthesiologists before and during surgery is highly recommended to assess the patient condition.

In one series of 133 patients, delayed extubation was seen in seven (5.3%) patients; however, this was measured on the order of hours rather than days (Badawy et al., 2011). In a series of 1500 robotic prostatectomies, one (0.1%) patient required intubation until postoperative day one due to laryngeal edema but was then successfully extubated (Danic et al., 2007). No prior study reported intubation beyond few days postoperatively (longest, postoperative day 2), highlighting our cases as some of the most serious on record (Maerz et al., 2017). BMI and medical comorbidities have not correlated with complication rates for robotic surgery in endometrial cancer; however, there are increasing trends of higher complication rates with large BMI (< 30 *versus* > 50, 17 *versus* 26%) and multiple medical comorbidities (< 3 *versus* ≥ 3, 16–18% *versus* 28%). Thus, preoperative assessments of these factors are recommended when robotic surgery is discussed with patient (Backes et al., 2015).

Our patients experienced laryngeal edema likely due to prolonged Trendelenburg positioning.However, these cases stand out from prior literature due to the extreme duration of airway edema. These cases were discussed in a departmental quality improvement conference resulting in the implementation of several practice improvement strategies (Table 2), including leveling of the patient at regular intervals throughout the case, using the lowest degree of Trendelenburg possible, and conversion to an open procedure if a lengthy case is anticipated. Additionally, we have developed a strategy of restricted intraoperative fluid management. We acknowledge that pausing the case to undock, reposition the patient and desufflate the abdomen increases total operative times; however, this should be balanced against the adverse effects of prolonged Trendelenburg. Avoiding a large endotracheal tube is also recommended based on Case 2.

In conclusion, recognition of the following dangerous triad related to robotic hysterectomy is the key to prevent airway edema (Fig. 1): *(i)* dependent edema due to prolonged steep Trendrenburg positioning, *(ii)* reduced venous return due to abdominal insufflation, and *(iii)* capillary leak due to fluid overload. Because these factors are modifiable using a preventative strategy (Table 2), proactive intervention to reduce the risk of prolonged intubation is recommended.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

Conceptualization, M.A.C., K.M.; data curation, all; formal analysis, K.M.; funding acquisition, K.M.; methodology, K.M.; writing original draft, M.A.C.; editing and reviewing, all authors.

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