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Position-Related Injury is Uncommon in Robotic Gynecologic Surgery

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Abstract

Objective—To assess the rate and risk factors for position-related injury in robotic gynecologic surgery.

Methods—A prospective database from 12/2006 to 1/2014 of all planned robotic gynecologic procedures was retrospectively reviewed for patients who experienced neurologic injury, musculoskeletal injury, or vascular compromise related to patient positioning in the operating room. Analysis was performed to determine risk-factors and incidence for position-related injury.

Results—Of the 831 patients who underwent robotic surgery during the study time period, only 7(0.8%) experienced positioning-related injury. The injuries included minor head contusions (n=3), two lower extremity neuropathies (n=2), brachial plexus injury (n=1) and one large subcutaneous ecchymosis on the left flank and thigh (n=1). There were no long term sequelae from the positioning-related injuries. The only statistically significant risk factor for positioning-related injury was prior abdominal surgery (p = 0.05). There were no significant associations between position-related injuries and operative time (P = 0.232), body mass index (P=0.847), age (p = 0.152), smoking history (P = 0.161), or medical comorbidities (P = 0.229 – 0.999).

Conclusions—The incidence of position-related injury among women undergoing robotic surgery was extremely low (0.8%). Due to the low incidence we were unable to identify modifiable risk factors for position-related injury following robotic surgery. A standardized, team-

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oriented approach may significantly decrease position-related injuries following robotic gynecologic surgery.

INTRODUCTION

Position-related injuries following gynecologic surgery are infrequent and usually resolve with conservative management. While the development of severe or permanent sequelae is rare, many position-related injuries can be prevented with proper technique and awareness (1). Position-related injuries can be musculoskeletal, neurologic, or vascular in nature (2–4). It is estimated the rate of position-related lower extremity neurologic injury is 1.5% following laparoscopic surgery in the lithotomy position. Other studies have shown that the incidence of brachial plexus injuries following gynecologic surgery to be 0.16% (5). There are very limited data evaluating the incidence of musculoskeletal and vascular injuries as these events are extremely rare (3).

To date, there are no published studies that have looked specifically at position-related injuries in robotic gynecologic surgery. When compared to laparoscopic surgery, robotic surgery is associated with increased operating time (6); a known risk factor for position-related injury (5). With the increasing use of the robotic surgical system in gynecologic surgery (da Vinci, Sunnyvale, CA), we were interested in evaluating our current positioning protocols in order to determine the incidence of position-related injuries in a gynecologic oncology population. Our aim was to evaluate the incidence and risk factors of positioning related injury in gynecologic robotic surgery as well as measures to prevent them.

POSITIONING

An experienced team consisting of nurses, operating room technicians and physicians used a standardized approach to patient positioning at our institution. Eggcrate foam is placed face down on the operating table and attached using silk tape. Two sheets are placed on the table in between where the patient's umbilicus and buttocks will rest. The patient is transferred to the operating room bed in the supine position. The patient's arms are placed on armboards at a 60 degree angle to the bed and secured using soft Velcro restraints. General endotracheal anesthesia is then induced.

The patient is moved down on the bed until the sacrum is in the middle of the bed and the lower edge of the buttocks in line with the lower break in the bed. Further care is taken to ensure that the patient's head, trunk and perineum are all on the same longitudinal axis of the bed. Yellofin stirrups (Allen Medical Systems) are then attached at the level of the patient's hips. The patient is placed in lithotomy position and her legs are transferred to the Yellofin stirrups simultaneously. Care is taken to ensure that the legs are secured firmly with the patient's heels snugly within the heel of the stirrup, and minimal pressure applied to the calf muscle and lateral tibia. The ankle and knee of the patient are then placed in alignment with the contralateral shoulder to minimize external rotation. The knee is flexed to an angle of approximately 90 degrees. The patient's position is then re-examined to ensure that the pelvis is level and the position symmetrical.

On each side, the patient's arm is tucked in a "thumbs up" position. Foam eggcrates are placed on the lateral and medial sides of the arm over the elbow and medial epicondyle. The bottom sheet is then placed over the arm and between the patient and the top sheet, tucking the arm firmly to the patient's side. Care is taken to avoid tucking IV lines along with the arm. The top sheet is then tucked over the arm, between the foam eggcrate and bottom sheet. The patient's hand is then made into a loose fist and a cylindrical piece of foam is placed in the hand. Foam eggcrate is then wrapped around the patient's fist. In patients whose large habitus prevents the arms from resting on the bed, surgical arm shields are used to provide further protection or the arms are left out at a less than a 90 degree angle on the armboards.

Foam eggcrates are then placed across the patient's chest at the nipple line and a soft surgical restraint is then placed firmly across the foam eggcrate. Silk tape is then placed firmly across the surgical restraints attaching at opposite sides on the bed. Anesthesia then covers the patient's eyes and places protective plastic around the patients face and neck. After careful inspection of positioning, the patient is prepped and draped for surgery. An example is shown in Figure 1.

METHODS

Following approval from the Institutional Review Board, a prospective database of all planned robotic surgical procedures performed in the Department of Gynecologic Oncology and Reproductive Medicine was maintained. For this study we reviewed all robotic cases performed from 12/2006 to 1/2014. A total of 831 patient charts were reviewed for neuropathy, vasculopathy, or musculoskeletal injuries reported during hospital stay after gynecologic robotic surgery. Operating room incident reports were also reviewed to identify injuries that may have occurred. Position-related injuries were defined as injuries that were not present prior to surgery and presented within the first two weeks after surgery. Of these, all injuries that were clearly documented as physical or electrical intraoperative trauma in the operative note were excluded. Neuropathies were defined as symptoms of parathesia, dysesthesia, or weakness in the distribution of an upper or lower extremity nerve. Vasculopathies were defined as hematomas, ecchymoses, or compartment syndrome in the upper or lower extremity not present prior to surgery. Musculoskeletal injury was defined as ligamentous, tendinous, bony, or muscular injury of the upper or lower extremity. Race was classified as "Caucasian" versus "other" for the logistic regression analysis.

Based on current data regarding position-related lower extremity injury we estimated the frequency of neuropathy to be 1.5%, therefore a sample size of 600 patients would be necessary to estimate the true frequency of position-related injury, with a margin of error $\pm$ 1% with a 95% confidence interval. We used descriptive statistics to summarize the demographic and clinical characteristics of patients. We used Fisher's exact test to compare the distribution of characteristics between patients with and without a position-related injury for those categorical variables with more than 2 levels and for categorical variables with only 2 levels and at least 1 cell with a value of 0. For categorical variables with only 2 levels and no cells with a value of 0 we used exact logistic regression methods to model the logit of the probability of a position-related injury as a function of the variable of interest and

reported the p-value from this model, along with the odds ratio (OR) and its 95% confidence interval.

For continuous variables we used the Wilcoxon rank sum test to compare medians between those patients with and without a position-related injury. There were too few events to conduct a multivariate analysis. All statistical analyses were performed using SAS 9.3 for Windows (Copyright © 2002–2010 by SAS Institute Inc., Cary, NC) and StatXact-7© for Windows (Copyright © 2005, 1989–2005, Cytel Software Corporation, Cambridge, Massachusetts).

RESULTS

Table 1 summarizes the analyses of the association of various clinical and demographic factors stratified by patients with and without a position-related injury. Median age, BMI (Body Mass Index), estimated blood loss (EBL) and operating times for patients who experienced position related injury were 40 years of age, 31.8 kg/m², 50 mL, and 276 minutes, respectively. In patients who did not experience position-related injury median age, BMI, EBL, and operating times were 54 years of age, 31.4 kg/m², 50 mL, and 198 minutes respectively. Seven of 831 patients had a positional injury for an overall rate of position-related injury of 0.8% (95% CI 0.3% – 1.7%). Patients with past abdominal surgery appear to be more at risk of a positional injury than patients without past abdominal surgery (7 of 7 patients with position-related injury, p=0.05). There was no difference in position-related injury by pre-operative diagnosis, procedure performed, race, smoking history, or medical comorbidity including diabetes, hypertension, asthma, or coronary artery disease.

The number and frequency of position-related injury is summarized in Table 2. Two patients experienced lower extremity neuropathy. One patient had difficulty with adduction of her right leg that resolved prior to her two week postoperative visit. The other patient with a lower extremity neuropathy experienced motor and sensory deficits from a left femoral and obturator nerve strain, requiring 3 months of physical therapy before resolution of symptoms. One patient experienced upper extremity weakness from brachial plexus strain that did not require intervention and was improved at her 2 week postoperative follow up visit. Three of the patients with injuries sustained minor head contusions without immediate or long-term complications other than minor swelling and pain. All of these head contusions were located on the posterior part of the head. One patient had a large subcutaneous ecchymosis on the right flank extending from mid chest to the mid-thigh that resolved without intervention. The type of surgical procedure performed, the type of injury, and the necessary intervention are shown in Table 3.

DISCUSSION

The incidence of position-related injury in our patient population was extremely low and consistent with the literature reported for other surgical approaches. Due to the low incidence, we were unable to identify modifiable risk factors for position-related injury during robotic surgery. Prior studies in gynecologic laparoscopy have identified increased operating time as a risk factor for position-related neurologic injury. Other than a history of

abdominal surgery, we were unable to identify risk factors for position-related injury in gynecologic robotic surgery that are traditionally associated with gynecologic laparoscopy. A previous study by Warner *et al.* reported a significant increase in the incidence of lower extremity neuropathy following laparoscopic surgeries requiring the patient to be placed in the lithotomy position for greater than two hours (7). In our study, all patients who experienced position-related injuries had procedures that lasted more than 2 hours (median operative time 276). Although lysis of adhesions was only documented for two of seven patients who experienced position-related injury, adhesive disease may have been a contributing factor to the increased operative time. A significant number of patients, however, underwent lengthy surgeries without evidence of injury. Median operative time for patients who did not experience a position-related injury was 198 minutes.

In our analysis we found that BMI, medical comorbidities, surgical procedure, operative time, estimated blood loss and age were not independent risk factors for position-related injury. Other than operative time, our findings replicate data regarding position-related injury following traditional laparoscopy (4,5,8,9). We attempted to not only evaluate the risk factors and incidence of position-related injury but type of injury as well. The majority of position-related injuries in our study were scalp trauma or ecchymosis, which has not been previously reported in the literature (10). This may have occurred during transport from the surgical bed to the stretcher or may be due to prolonged time in the Trendelenburg position resulting in ecchymosis from vascular stasis. Our rate of upper extremity neuropathy was consistent with previous studies evaluating upper extremity neuropathy following gynecologic laparoscopic surgery (11). Finally, the frequency of lower-extremity neuropathy was significantly less than the incidence shown in prior studies evaluating lower-extremity neuropathy following laparoscopic gynecologic surgery (4,5). Furthermore, the patient who experienced obturator neuropathy may have been a result of the lymph node dissection and not from positioning, although this would be difficult to prove. Backes *et al.* reported morbidity and outcomes following robotic surgery for endometrial cancer staging and found a 1.0% rate of lower-extremity postoperative neurologic injury (5/471 cases). Similarly, they reported two obturator nerve injuries that may have been due to retroperitoneal lymph node dissection and not patient positioning (12).

Standardized protocols have been shown to decrease medical errors, iatrogenic injury and improve patient outcomes across a broad range of medical specialties (13–15). All of the patients in our study were cared for by an experienced team of nurses, operating room technicians and physicians who used a standardized approach to patient positioning. Within the limits of our analysis, we believe the infrequent occurrence of position-related injury may have been positively influenced by a standardized protocol taught to all providers and emphasized by team members.

Both a strength and a weakness of our study was the low rate of position-related injury following surgery. Overall, our rate of position-related injury was 0.8%. We based our sample size estimate on an expected rate of lower extremity neuropathy following gynecologic laparoscopy surgery of 1.5% (4). Although the number of patients evaluated in our study exceeded our calculated sample size, a larger number of patients may be needed to determine if other statistically significant risk factors for injury exist. Other limitations of

our study include postoperative injury misclassification and failure to report or document postoperative injuries. A prospective collection of positioning-injuries could potentially be more accurate in identifying all patients affected.

A low rate of position-related injury in robotic gynecologic surgery is important in regards to patient counseling. When compared to position-related injuries following vaginal, abdominal, or laparoscopic hysterectomies (5,16); robotic hysterectomy does not increase risk of injury. When counseling patients on the various surgical modalities; risk of position-related injury should not impact a surgeon's decision to determine the most appropriate approach to hysterectomy.

With the increasing number of robotic hysterectomies performed in the United States each year (17), more hospitals and physicians will be implementing or learning robotic surgical platforms to meet the increasing demand. Our results support the development of a team-oriented, standardized approach to patient positioning for both hospitals and care teams. This will likely result in a low incidence of position-related injuries for these women.

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Highlights

- Incidence of position-related injury among women undergoing robotic gynecologic surgery was extremely low (0.8%).
- Prior abdominal surgery was the only identified risk factor for position-related injury.
- A standardized approach may significantly decrease position-related injuries following robotic gynecologic surgery.

Figure 1.

Table 1
Comparison of patient demographic, clinical and surgery-related factors between patients with and without position-related injuries

	Position-Related Injury				
	No	Yes	P Value	OR	95% CI
Age			0.152	---	---
N	769	7			
Median	54.2	40.0			
Range	9.1–83.0	18.4–72.1			
Body Mass Index (kg/m ²)			0.847	--	---
N	802	7			
Median	31.4	31.8			
Range	13.9–70.8	19.4–43.2			
Estimate Blood Loss (mL)			0.151		
N	795	7			
Median	50	50			
Range	0–1800	25–75			
Surgery Time (minutes)			0.232		
N	547	5			
Median	198	276			
Range	72–492	132–342			
	<div>NoYes</div>				
	N	%	N	%	
Race					0.999 1.39 0.23–14.7
Asian	40	4.9	0	0.0	
African American	67	8.1	1	14.3	
Hispanic	162	19.7	1	14.3	
Caucasian	529	64.2	5	71.4	
Other / Unknown	26	3.2	0	0.0	
Diagnosis			0.910	---	---

	Position-Related Injury				P Value	OR	95% CI
	No	Yes					
Cervical Cancer/Dysplasia	159	19.3	2	28.6			
Adnexal Mass	137	16.6	1	14.3			
BRCA 1/2	8	1.0	0	0.0			
Endometrial Cancer/Hyperplasia	458	55.6	4	57.1			
Other	36	4.4	0	0.0			
Unknown	26	3.2	0	0.0			
Smoking History					0.161	3.83	0.64–26.3
No	591	71.7	3	42.9			
Yes	206	25.0	4	57.1			
Unknown	27	3.3	0	0.0			
Diabetes History					0.229	3.47	0.50–20.7
No	656	79.6	4	57.1			
Yes	142	7.2	3	42.9			
Unknown	26	3.2	0	0.0			
Prior Abdominal Surgery					0.05	---	---
No	299	36.3	0	0			
Yes	500	60.7	7	100			
Unknown	25	3.0	0	0			

/ P-value and odds ratio (OR) for “Caucasian” vs. “Other”.

Table 2

Overall Positioning Injury Rates

	N	%	P Value	95% CI
Overall	7	0.85	---	0.34–1.73
Lower Extremity Neuropathy¹	2	0.24	0.006	0.03 – 0.87
Upper Extremity Neuropathy²	1	0.12	0.999	0.00–0.67
Contusion/Ecchymosis	4	0.48	---	0.13–1.23

¹ Rate of positioning-related lower extremity neuropathy in patients who underwent robotic gynecologic compared to the rate of position-related lower extremity neuropathy of 1.5 % (15 out of 991 cases) in patients who underwent laparoscopic gynecologic surgery (Warner *et al.* October 2000).

² Rate of positioning-related upper extremity neuropathy in patients who underwent robotic gynecologic compared to the rate of position-related upper extremity neuropathy of 0.16% (5 out of 3200 cases) in patients who underwent laparoscopic gynecologic surgery (Romanowski *et al.* 1992).

Table 3**Position Related Injuries and Consequences**

Year	Surgical Procedure Performed¹	Positioning Injury	Intervention Required
2008	LSO, Staging	Mild head contusion	None
2010	PLND, CKC, ECC	Difficulty adducting right leg	Unknown
2011	Hyst, BSO, Staging, LOA, cystoscopy	Headache with mild head contusion	None
2011	Hyst, BSO, Staging, LOA	Large subcutaneous ecchymosis over left flank and thigh	None
2013	Hyst, BSO, pelvic sentinel lymph node mapping and right PLND	Motor and sensory weakness from left femoral and obturator nerve strain	Physical therapy for 3 months
2013	Radical trachelectomy, bilateral PLND	Mild head contusion	None
2013	Hyst, BSO, pelvic sentinel lymph node mapping, Staging	Upper extremity weakness	None

¹ Hyst (hysterectomy), BSO (bilateral salpingo-oophorectomy), LSO (left salpingo-oophorectomy), Staging (pelvic and periaortic lymph node dissection), PLND (pelvic lymph node dissection), CKC (cold knife cone), LOA (lysis of adhesions), ECC (endocervical curettage)