USE OF COMPUTERIZED TOMOGRAPHY TO DIAGNOSE OPERATIVE COMPLICATIONS AFTER MINIMALLY INVASIVE GYNECOLOGIC SURGERY

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ABSTRACT

Background and Objective: The indications for computerized tomography (CT) scan to evaluate complications of minimally invasive surgery have not been well established. The objective of this study was to identify patient characteristics and clinical findings that correlated with postoperative complications diagnosed on CT scan after minimally invasive hysterectomy.

Methods: A retrospective cohort study of patients who underwent laparoscopic or robotic hysterectomy, from January 2011 to December 2013, was performed to determine the incidence of surgical complications within 30 days of surgery. The study compared patients who had a CT of the abdomen/pelvis to patients who did not have a CT scan. CT findings were defined as normal or abnormal with abnormal findings categorized as infectious, gastrointestinal injury, noninfectious fluid collections, and urinary injury.

Results: Seven hundred eighty-four patients underwent minimally invasive hysterectomy. Seventy-four (9.4%) had a CT scan. Patients who had a CT scan had a lower body mass index (BMI) (p=0.03) and were of younger age (p=0.05). Preoperative conditions of chronic pain (p=0.005) and history of prior abdominal surgery (p=0.002) were statistically associated with having a CT scan. Patients with endometriosis were statistically more likely to have a CT scan when compared to other benign diagnoses (p=0.001). No malignant diagnosis was associated with having a CT scan. In the CT group, analysis of CT findings showed a correlation between fever and infectious complications (p=0.006) and hemoglobin level and noninfectious fluid collections (p=0.04).

Conclusions: Clinical findings of fever and decreased hemoglobin were associated with abnormal CT results in patients who had minimally invasive hysterectomy. Patients with BMI< 30, history of chronic abdominal

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pain, history of abdominal surgery, or a postoperative diagnosis of endometriosis were more likely to undergo a CT scan but did not have an increased incidence of an abnormal CT finding.

Keywords: hysterectomy; computerized tomography; minimally invasive surgery; abdominal surgery

INTRODUCTION

The route of hysterectomy in the United States has significantly changed in the last decade. Laparoscopic/robotic hysterectomies have increased with a decrease in the number of abdominal hysterectomies. The rate of vaginal hysterectomies has remained stable. Approximately 400-600,000 hysterectomies are performed each year in the United States [1] In 2009, minimally invasive hysterectomy represented 45% of all hysterectomies (laparoscopic 25% and robotic assisted 20%) [2, 3]. The benefits of a minimally invasive surgery to perform a hysterectomy compared to an abdominal hysterectomy are well established including reduced postoperative pain, less blood loss, lower infection rates, and quicker return to normal activities [4, 5].

The reported rates of complications associated with laparoscopic/robotic hysterectomy vary from 1% to 5.7% [6-8]. The variation in complication rates can be attributed to the complexity of the surgery and the type of complications reported. Immediate complications from the surgical procedure are injury to the bowel, urinary tract, or major vessels. Twenty-five percent of these injuries are not recognized at the time of surgery [7]. Complications of the postoperative period include incisional hernia, urinary injury, vaginal cuff dehiscence, pelvic abscess, bowel obstruction, wound seroma, and pelvic or wound hematoma. These complications can be difficult to diagnose due to variation in their presentation.

In addition to the patient's history, physical exam, and basic laboratory parameters, computerized tomography (CT) scan of the abdomen/pelvis is commonly ordered in the diagnostic evaluation of postoperative abdominal or pelvic pain or other findings suspicious for a surgical complication. There is little data in the literature to guide clinicians regarding the use of radiographic imaging after minimally invasive gynecologic surgery presenting with abnormal physical exam and laboratory findings. The objective of this study was to evaluate the correlation of patient characteristics and postoperative clinical findings with abnormalities on CT scan after minimally invasive endoscopic hysterectomy.

MATERIALS AND METHODS

This was a retrospective chart review study approved by the Institutional Review board of Carolinas HealthCare System. Inclusion criteria were all patients who had either a laparoscopic hysterectomy or robot-assisted hysterectomy by one of the four gynecologic oncology surgeons at Carolinas Medical Center, Charlotte, NC from January 2011 to December 2013 and had a CT scan within 30 days of surgery. Exclusion criteria from the study were conversion to a laparotomy, amini-laparotomy for a hand-port, or a CT scan ordered to evaluate disease status in women with a gynecologic malignancy. A variety of patient data collected included age, race, body mass index (BMI), comorbidities, indications for surgery, and history of prior abdominal surgery. Type of hysterectomy, laparoscopic or robotic, and additional procedures were recorded. Final diagnosis was categorized into benign or

malignant. For those patients undergoing CT imaging, additional information was gathered: postoperative day the CT was obtained, location of clinical evaluation prior to CT, and the number of patients hospitalized. Indications for CT scan were categorized into five groups: fever, pain, subjective complaints, abnormal physical exam findings, and abnormal labs. Details included recording highest temperature, pain score, and lab abnormalities. CT findings were reviewed for the following abnormalities: abscess, hematoma, lymphocyst, seroma, gastrointestinal (GI) injury, genitourinary (GU) injury, incisional hernia, and other abnormalities. These abnormal findings were then categorized as infectious, gastrointestinal, genitourinary, or noninfectious fluid collection.

Basic demographic information was summarized using descriptive statistics. Exact 95% confidence intervals were calculated for the percentage of patients having a CT scan and for the percentage of CT scans that were abnormal. To assess associations between CT ordered (yes/no) and other variables, Student's t-test was used for normally distributed data, the Wilcoxon rank-sum test was used for ordinal data or skewed data, the chi-squared test or Fisher's exact test was used for categorical data. Patients having a CT scan were divided into abnormal and normal scans and these groups were compared on variables using the above-referenced statistical tests. For each medical history and diagnostic variable found to be significantly associated in the univariate analysis, a multiple logistic regression was performed with CT ordered as the dependent variable, adjusting for age and BMI. Data analyses were performed using SAS® Enterprise Guide® 6.1 (SAS Institute Inc., Cary, NC), and a p-value less than 0.05 was considered statistically significant.

RESULTS

Seven hundred eighty-four (784) patients met study inclusion criteria with a mean age of 56 years old and mean BMI =31. Laparoscopic and robotic procedures were similarly distributed (53% versus 47%). A CT scan was performed on 74 patients (9.4%, 95% CI 7.5%-11.7%) in the 30-day postoperative period.

We first compared patients who had CT scan and those with no CT scan (Tables 1, 2). Patients in the CT group had a lower BMI (p=0.03) and were younger (p=0.05) than patients with no CT scan. Chronic pain was associated with having a CT scan as 10 of the 44 patients (23%) with chronic pain had a scan compared with 64 of 740 patients (9%) without chronic pain (p=0.005). Among patients having a CT scan, those with chronic pain tended to be younger than those without chronic pain [mean (SD) 46.4 (12.0) v. 54.4 (12.9)] (p=0.07). Adjusting for age and BMI in a logistic model, patients with chronic pain had significantly higher odds of receiving a CT scan compared to patients without chronic pain (OR 3.1, p=0.03). History of prior abdominal surgery was associated with having a CT scan as 55 of the 451 patients (12.2%) compared to 19 of 333 patients (5.7%) with no history of abdominal surgery (p=0.002). Adjusting for age and BMI, this association remained statistically significant (OR 2.3, p=0.002).

Table 1: Demographic and Comorbidity Variables

Variable	Group	Total	CT ordered	p-value
Race	Hispanic	24	2 (8.3%)	0.76

	White	602	57 (9.5%)	
	Black	143	15 (10.5%)	
	Other	15	0 (0%)	
Co-morbidities	chronic pain - yes	44	10 (22.7%)	0.005
	no	740	64 (8.7%)	
	pulmonary disease - yes	37	3 (8.1%)	1.0
	no	747	71 (9.5%)	
	Diabetes - yes	140	8 (5.7%)	0.10
	no	644	66 (10.3%)	
	Hypertension - yes	387	34 (8.8%)	0.54
	no	397	40 (10.1%)	
	Depression - yes	137	17 (12.4%)	0.19
	no	647	57 (8.8%)	
	tobacco use - yes	96	8 (8.3%)	0.69
	no	688	66 (9.6%)	
	history of abdominal surgery -yes	451	55 (12.2%)	0.002
	no	333	19 (5.7%)	

Data are frequencies (% of group with CT ordered)

P-values are from Fisher's exact test or chi-square test

Table 2: Surgical and Pathologic Variable Variables

Variable	**Group**	**Total**	**CT ordered**	**p-value**
Type of surgery	Laparoscopic	444	39 (8.78%)	0.47
	Robot-assisted	340	35 (10.29%)	
Adnexal surgery	Yes	719	70 (9.74%)	0.34
	No	65	4 (6.15%)	
Lymphadenectomy	Yes	335	35 (10.45%)	0.41

	No	449	39 (8.69%)	
Diagnosis	Benign	306	29 (9.48%)	0.98
	Malignant	478	45 (9.41%)	
Malignant Diagnosis	Cervical	55	7 (12.7%)	0.25
	Uterine	399	34 (8.5%)	
	Ovarian	17	3 (17.6%)	
	Other	7	1 (14.2)	
Benign Diagnosis	Fibroids	100	6 (6.0%)	0.001
	Endometriosis	38	10 (26.3%)	
	Endometrial Pathology	29	5 (17.2%)	
	Adnexal Pathology	71	4 (5.6%)	
	Other	68	4 (5.9%)	

Data are frequencies (% of group with CT ordered)

There was no difference in CT scans ordered for different malignant diagnoses (p=0.25). Analysis of patients with benign diagnoses indicated the percentage of patients having a CT scan was significantly different among subgroups (fibroids, endometriosis, benign endometrial pathology, adnexal pathology, and other (p=0.001). Notably, 10 of 38 patients (26%) with endometriosis had a CT scan compared with 19 of the 268 (7%) with other benign diagnosis. Logistic regression analysis on patients with a benign diagnosis, adjusting for age and BMI, patients with endometriosis had significantly higher odds of receiving a CT scan compared to patients with fibroids (OR 4.0, p=0.02) and patients with adnexal pathology (OR 3.8, p=0.05).

Abnormal CT scans were confirmed in 36 patients (48.6%, 95% CI 36.9%-60.6%), representing4.6% (95% CI 3.2%-6.3%) of the total study population. There was no significant difference in age, BMI, postoperative day of CT scan, race, comorbidities, laparoscopic vs. robotic surgery, adnexal surgery, lymphadenectomy, or benign versus malignant diagnosis between patients with abnormal scans and patients with a normal CT scan (Table 3). Clinical indications for CT scan included abnormal labs (72%), abnormal physical exam (70%), and fever (42%). None of these findings were associated with an abnormal CT scan. The most common clinical pathway to CT scan was through an office visit (43%). Though not statistically significant, CT scans ordered in the office were less likely to be abnormal (40%) versus those ordered by the emergency department or outside hospital (69%).

Table 3: Comparison of Normal versus Abnormal CT Scan Groups

Variable*	**Abnormal CT (N = 36)**	**Normal CT (N = 38)**	**P-Value**
Age at Surgery	49.9 (12.6)	54.1 (13.5)	0.59
Race/ethnicity			0.89
Hispanic	1 (2.8%)	1 (2.6%)	
White	27 (75.0%)	30 (79.0%)	
Black	8 (22.2%)	7 (18.4%)	
BMI	30.2 (7.3)	28.9 (7.3)	0.44
Chronic Pain (Yes)	4 (11.1%)	6 (15.8%)	0.74
Pulmonary Disease(Yes)	1 (2.8%)	2 (5.3%)	1.0
Diabetes (Yes)	2 (5.6%)	6 (15.8%)	0.26
Hypertension (Yes)	16 (44.4%)	18 (47.4%)	0.80
Depression (Yes)	7 (19.4%)	10 (26.3%)	0.48
Tobacco Use (Yes)	4 (11.1%)	4 (10.5%)	1.0
Surgery Type			0.17
Laparoscopic Hysterectomy	16 (44.4%)	23 (60.5%)	
Robot-Assisted Hysterectomy	20 (55.6%)	15 (39.5%)	
Diagnosis			0.60
Benign	13 (36.1%)	16 (42.1%)	
Malignant	23 (63.9%)	22 (57.9%)	
Lymphadenectomy (Yes)	18 (50%)	17 (44.7%)	0.65
Fever (Yes)	18 (50%)	13 (34.2%)	0.17
Abnormal Physical Exam (Yes)	27 (75.0%)	25 (65.8%)	0.39
Abnormal Lab Values (Yes)	28 (77.9%)	25 (65.8%)	0.25
WBC	17.1 (6.0)	16.0 (6.9)	0.22
Hemoglobin	10.1 (1.7)	10.3 (1.6)	0.43
Pain Score	7.8 (1.9)	7.1 (2.0)	0.27
Post-Op Day #	8.8 (7.7)	7.9 (7.1)	0.37
Pathway to CT			0.30
Office Visit/Outpatient	13 (36.1%)	19 (50.0%)	
ED or Outside Hosp. CT	11 (30.6%)	5 (13.2%)	
Direct Admit to Hosp.	7 (19.4%)	7 (18.4%)	
Admitted Prior to CT	5 (13.9%)	7 (18.4%)	

*Mean (SD) are reported for age at surgery, BMI, WBC, hemoglobin, pain score, and post-op day #. Frequency (% of abnormal/normal CT group) are reported for the other variables.

The 36 abnormal CT scans were sub-categorized into four different groups: gastrointestinal, fluid collections, infectious, and urinary (Table 4). Gastrointestinal complications were the most common abnormality, occurring in 36% of patients. Ileus and bowel obstruction accounted for over half of the abnormal GI findings in this group. There were no clinical predictors relative to this group. Fluid collections were diagnosed in 30% of patients, most commonly interpreted as a hematoma. The mean Hb was 8.7 g/dl in this group of patients compared to 10.3g/dl in patients without an abnormal fluid collection (p=0.04). Nine of 36 patients (25%) with an abnormal scan had findings consistent with an infectious process and 6 of 9 patients were diagnosed with an abscess. Eight of 21 (38%) patients with a fever who had a CT scan were diagnosed with an infection compared to only one of 26 patients (4%) with a CT scan and no fever (p=0.006). Urinary complications were infrequent, two patients with hydronephrosis and one patient with a ureterovaginal fistula. Compared to patients with a normal CT scan, patients with urinary abnormalities were diagnosed an average of 21.7 days after surgery compared to 7.9 days for patient who did not have a CT scan (p=0.01) (Table 4). Four (11%) patients from the abnormal CT scan group required reoperation including two patients with bowel injuries (1 colon and 1 small intestine), one for incarcerated bowel at a trocar site, and one for peritonitis.

Table 4: Classification of CT Scan Abnormalities (n=36)

Gastrointestinal	13 (36%)	Ileus (4) Obstruction (4) Injury (2) Incarcerated Hernia (2) Colitis (1)
Fluid Collections	11 (31%)	Hematoma (8) Seroma (2) Lymphocyst (1)
Infectious	9 (25%)	Abscess (6) Vaginal Cuff Cellulitis (2) Peritonitis (1)
Urinary	3 (8%)	Injury (1) *Hydronephrosis* (2)

Seventy-four patients (9.4%) of the 784 patients who met inclusion criteria for the study and had a postoperative abdominal/pelvic CT within 30 days of surgery. Clinical findings of fever and decreased hemoglobin were the only two parameters associated with abnormal CT results in patients who had a minimally invasive hysterectomy. Several important clinical predictors were associated with utilization of a CT scan to evaluate a patient's symptoms. Patients with a preoperative diagnosis of endometriosis and chronic abdominal-pelvic pain were significantly more likely to have a postoperative CT scan, adjusting for age and BMI. Patients with endometriosis often require extensive surgery which includes lysis of adhesions, resection of endometriosis from visceral organs,

and removal of involved organs [8]. This type of surgery should create a higher index of suspicion for postoperative complications when patients present with abdominal or pelvic pain. The diagnostic difficulty is distinguishing preexisting abdominal or pelvic pain from perioperative pain related to surgical complications.

The most serious complications in this patient cohort were two gastrointestinal injuries (1 colon and 1 small intestine) and one urinary tract injury, 0.4% incidence. This rate is comparable to a bowel injury rate of 0.4% from a review of 474,063 gynecologic laparoscopies [9]. Wright et al. reported a gastrointestinal and urinary tract injury rate from laparoscopic and robotic hysterectomies between 0.5-1.0% [10]. Others have reported bowel injury rates for operative laparoscopy of 0.1%-0.25% [6]. Trocar entry into the abdomen has been associated with 34% of laparoscopic complications in one series [7]. Twenty-five percent of gastrointestinal and urinary injuries are unrecognized at the time of surgery [7]. Immediate diagnosis of GI or GU injury is important as delayed diagnosis of bowel injury carries high morbidity and death rates up to 28% [11]. We perform laparoscopic trocar placement with direct visual entry into the peritoneal cavity in all patients, which has been advocated by others as safe technique into the peritoneal cavity [7]. We endorse this recommendation to insert trocars as a technique to minimize visceral organ injury. Although we reported only one GU complication, our data showed a delay in diagnosis of a GU injury [6]. Our data showed only four patients (0.5%) from the study cohort required reoperation for a complication

We categorized surgical complications into four groups: gastrointestinal, fluid collections, infections, and urinary. The most common abnormal findings on CT scan were hematoma, abscess, and bowel obstruction. An infectious process and fluid collections accounted for 56% of all abnormal diagnoses. Fever in the immediate postoperative period was predictive of an abscess demonstrated by CT scan. Hb < 8.0 gm/dl was significantly associated with hematoma. These correlations, although intuitively expected, are useful in developing a diagnostic algorithm to evaluate patients for significant complications after minimally invasive hysterectomy.

The strength of this study is the potential for clinical application. To our knowledge, this is the first study to correlate clinical parameters with abnormal CT findings in the diagnosis of complications from endoscopic minimally invasive hysterectomy. As the number of endoscopic hysterectomies continue to increase, efficient, cost effective, and accurate methods to detect complications is important. We believe our findings can assist clinicians in the diagnostic approach to evaluate patients with postoperative complaints. Our results indicate patients with previous abdominal surgery, surgery for endometriosis, and a history of chronic pain are not more likely to have an abnormal abdominal/pelvic CT scan compared to patients without these clinical parameters, despite a higher clinical index of suspicion. Based on our study findings, surgeons should consider obtaining a CT scan for patients with a postoperative anemia (Hb < 8.0 gm/dl) or fever. These patients have a statistically greater chance of having an abnormal CT finding.

Weaknesses of the study include its retrospective design and the limitations that are inherent in retrospective studies, including inconsistent medical documentation and a non-standardized postoperative evaluation of patient complaints in our office or in an urgent care facility. Patients also may have been evaluated in a non-Carolinas HealthCare System medical facility with the CT scan results not accessible in our electronic medical record. We believe this occurrence was infrequent as our hospital system offers medical services in much of the

geographic area where patients in this study live. Additional studies to expand the patient cohort may identify additional clinical parameters that support obtaining a postoperative CT scan in this cohort of patients.

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REFERENCES

1. Cohen S, Vitonis A, Einarsson. Updated hysterectomy surveillance and factors associated with minimally invasive hysterectomy. JSLS 2014; 18(3): e2014.00096.
2. Jacoby VL, Autry A, Jacobson G, Domush R, Nakagawa S, Jacoby A. Nationwide use of laparoscopic hysterectomy compared with abdominal and vaginal approaches. Obstet Gynecol2009; 114(5): 1041–1048.
3. Whiteman MK, Hillis SD, Jamieson DJ, Morrow B, Podgornik MN, Brett KM, et al. Inpatient hysterectomy surveillance in the United States, 2000-2004. Am J Obstet Gynecol 2008; 198: 34.e1–34.e7.
4. Nieboer TE, Johnson N, Lethaby A, Tavender E, Carr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev. 2009; (3): CD003677.
5. ACOG Committee Opinion No. 444: Choosing the route of hysterectomy for benign disease. Obstet Gynecol 2009; 114(5): 1156–1158.
6. Makai G, Isaacson K. Complications of Gynecologic Laparoscopy. Clin Obstet and Gynecol 2009; 52: 401-411.
7. Chapron C, Querleu D, Bruhat M, Madelenat P, Fernandez H, Pierre F, et. al. Surgical Complications of Diagnostic and Operative Gynaecological Laparoscopy: series of 29,966 Cases. Human Reproduction 1998; 13: 867-87.
8. Chen SH, Li ZA, Du XP. Robot-assisted versus conventional laparoscopic surgery in the treatment of endometriosis: a meta-analysis. Clin Exp Obstet Gynecol 2016.; 43:422-426.
9. Llarena NC, Shah AB, Milad MP. Bowel injury in gynecologic laparoscopy. Obstet Gynecol 2015; 125(6): 1407-1417.
10. Wright, JD, Burke WM, Wilde ET, Lewin SN, Charles AS, Kim JH, et al. Comparative Effectiveness of Robotic Versus Laparoscopic Hysterectomy for Endometrial Cancer. J Clin Oncol. 2012; 30(8): 783-791.
11. Brosens I, Godron A. Bowel injuries during gynaecologic laparoscopy. Gynaecol Endosc 2001; 10: 141-145.