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Risk factors for lower urinary tract injury at the time of hysterectomy for benign reasons

Mamta M. Mamik[1], **Danielle Antosh**[2], **Dena E. White**[3], **Erinn M. Myers**[4], **Melinda Abernethy**[5], **Salma Rahimi**[1], **Nina Bhatia**[5], **Clifford R. Qualls**[6], **Gena Dunivan**[6], and **Rebecca G. Rogers**[6]

[1]Icahn School of Medicine at Mount Sinai New York, NY, USA

[2]MedStar Washington Hospital Center, Washington, DC, USA

[3]University of Oklahoma, Oklahoma City, OK, USA

[4]University of North Carolina, Chapel Hill, NC, USA

[5]Institute for Female Pelvic Medicine and Reconstructive Surgery, Allentown, PA, USA

[6]University of New Mexico School of Medicine Albuquerque, New Mexico, USA

Abstract

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OBJECTIVE—To identify risk factors associated with lower urinary tract injury at the time of performing hysterectomy for benign indications.

METHODS—We conducted a multi-center case–control study of women undergoing hysterectomy for benign disease. Cases were identified via ICD-9 codes for lower urinary tract injury at the time of hysterectomy from 2007 to 2011: controls were two subsequent hysterectomies following the index case in the same institution that did not have lower urinary tract injury. Logistic regression was used to perform univariate and multivariate comparisons between groups.

RESULTS—At 7 centers, 135 cases and 270 controls were identified. Cases comprised 118 bladder injures and 25 ureteral injuries: 8 women had both bladder and ureteral injury. Bladder injury was associated with a history of prior cesarean section OR 2.9 (95% CI 1.7–5), surgery by a general obstetrician and gynecologist OR 2.4 (95% CI 1.2–5.2), and total abdominal hysterectomy OR 1.9 (95% CI 1.06–3.4). Ureteral injury was more likely among women who underwent laparoscopic-assisted vaginal hysterectomy (LAVH) OR 10.4 (95% CI 2.3–46.6) and total abdominal hysterectomy (TAH) OR 4.7 (95% CI 1.4–15.6).

CONCLUSION—Bladder injury at the time of benign hysterectomy is associated with a prior history of Cesarean section and TAH as well as surgery by generalist OB-GYN; ureteral injury is associated with LAVH and TAH.

This study was conducted at the University of New Mexico, Albuquerque

Keywords

Bladder injury; Ureter injury; Hysterectomy; Risks

An estimated 600,000 women undergo a hysterectomy each year in the United States [1]. Although rare, lower urinary tract injury is a potentially devastating complication of hysterectomy. Ureteral injury and bladder injury may be associated with increased operating time and significant postoperative morbidity, including possible loss of renal function if unrecognized [2, 3]. Gynecological surgery is responsible for up to 64–75 % of cases of iatrogenic injury to the ureter [4, 5]. The incidence of lower urinary tract injury at the time of hysterectomy ranges from 0.13 to 3.6 % for bladder injury and from 0.1 to 1.8 % for ureteral injury [2, 6–8].

Prior studies have suggested that risk factors for lower urinary tract injury at the time of hysterectomy include older age, higher body mass index, longer operating times, increased blood loss, and an increase in uterine size [2, 7]. Data regarding risk factors based on the route of hysterectomy are conflicting. Some studies suggest that the risk of bladder injury is highest among laparoscopic-assisted vaginal hysterectomy (LAVH) and total vaginal hysterectomy (TVH) [2, 9], while one study reported a higher risk of injury to both the ureters and the bladder with total laparoscopic hysterectomy compared with laparoscopic-assisted vaginal hysterectomy [8]. For cases of ureteral injury, some studies report increased risk with the abdominal route [7, 9], while another study reported an increased risk with use of the laparoscopic route for hysterectomy [10]. Risk factors for lower urinary tract injuries based on the route or type of hysterectomy performed have been difficult to identify due to the low prevalence rates of injury. The purpose of our study is to determine risk factors for lower urinary tract injury at the time of hysterectomy for benign indications using a multi-center case–control study design.

MATERIALS AND METHODS

This was a retrospective multi-center case–control study of women undergoing hysterectomy for benign reasons performed at seven clinical sites through the Society of Gynecologic Surgeon’s Fellows’ Pelvic Research Network (SGS FPRN). All women who underwent a hysterectomy at the respective clinical sites between January 2007 and December 2011 were identified by the appropriate ICD-9 and CPT codes (Table 1). Cases were then identified as any patient with a lower urinary tract injury sustained at the time of hysterectomy and controls were identified as the next two sequential patients undergoing hysterectomy for benign reasons (Table 1). Two controls were identified for each case. Subjects undergoing gynecological, oncological or urogynecological surgery were excluded (Table 1). IRB approval was obtained through each participating institution prior to data collection.

Medical records were reviewed for demographics, estrogen status, smoking history, medical co-morbidities, and surgical history. A Charlson co-morbidity [11] index score (predicts the 10-year mortality for a patient who may have a range of comorbid conditions) was calculated for each subject. Operative outcomes included indication for surgery, route of hysterectomy, concomitant procedures, duration of procedure, uterine weight (grams), blood

loss, and any intraoperative procedures. Postoperative outcomes of interest included treatment and treatment outcomes for lower urinary tract injury. Bladder and ureteral injuries were analyzed separately.

POWER CALCULATION

A sample size of 120 cases and 240 controls gave 80% power at a significance level of 0.05 to find a difference in lower urinary injury between minimally invasive (laparoscopic and vaginal) versus abdominal hysterectomy with an OR of 1.9 for increased lower urinary tract injury with minimally invasive hysterectomy. We based our estimates on a prior study by Frankman et al. [8], which found a similar OR.

STATISTICAL ANALYSIS

Statistical analyses were performed using SAS v9.2 (SAS Institute, Cary, NC, USA). Summary statistics were calculated for the study population. Demographic information of the two groups was compared using Student's *t* tests for continuous variables and Pearson's Chi-squared for categorical data. Univariate logistic regression was used to evaluate the association among lower urinary tract injury and completed route of hysterectomy, surgeon type (general gynecologist, gynecological oncologist, or urogynecologist), cystoscopy, and prior abdominopelvic surgery. All covariates found to be significant on univariate analysis were incorporated into a multivariate model. Backward stepwise logistic regression entered these potential covariates as predictors associated with lower urinary tract injury and to evaluate for interaction and confounding within the model. Model fit was confirmed with likelihood ratio and c-statistics. When evaluating for confounding, a difference greater than 15 % between the adjusted and crude odds ratio was considered significant. A two-sided *p* value of <0.05 was considered significant for all analyses.

RESULTS

At seven centers 135 cases and 270 controls were identified. Cases comprised 110 bladder injuries only, 17 ureteral injuries, and 8 women who had both bladder and ureteral injury. Cases and controls did not differ in age, (mean age 45.2 ± 7.6 vs 46.1 ± 9.5 years, *p*= NS) or ethnicity/race (45 vs 49 % Caucasian, *p*= NS), and body mass index (27.9 ± 11.6 vs 29.1 ± 12.1 kg/m2, *p*=NS; Table 2). The majority of hysterectomies among cases were performed with a minimally invasive approach with 34 vaginal, 40 laparoscopic, and 61 abdominal hysterectomies. On multivariate analysis after controlling for cystoscopy, total abdominal hysterectomy was associated with bladder injury OR 1.9 (95 % CI 1.06–3.4) as well as ureteral injury OR 4.7 (95 % CI 1.4–15.6). Bladder injury was also associated with a history of prior cesarean section OR 2.9 (95 % CI 1.7–5), and surgery by a general obstetrician and gynecologist OR 2.4 (95 % CI 1.2–5.2; Table 3). Women with bladder injury were more likely to have concurrent bowel injury OR 8.9 (95 % CI 5.6–17). Ureteral injury was more likely among women who underwent laparoscopic-assisted vaginal hysterectomy (LAVH) OR10.4 (95 % CI 2.3–46.6), and total abdominal hysterectomy OR 4.7 (95 % CI 1.4–15.6). Patients with ureteral injuries were more likely to undergo blood transfusion OR 33.4 (95 % CI 7.3–153.2), and similar to those with bladder injuries, women with ureteral injuries have

increased odds of concurrent bowel injury OR 21.1 (95 % CI 1.6–167). Among the cases of lower urinary tract injury, total abdominal hysterectomy patients had a mean uterine weight of 840 g ± 1,158 g and those who had other types of hysterectomy had a mean uterine weight of 244 g ± 210 g and these differences were statistically significant ($p< 0.0001$). The estimated blood loss was also significantly different between these two groups. i.e., TAH 865 ± 986 ml, vs other hysterectomies, 439 ± 662 ml ($p< 0.0078$). There were no significant differences between patients undergoing TAH and other hysterectomy as far as body mass index, prior pelvic surgery, and endometriosis were concerned. When these factors were assessed for LAVH, none of the differences between LAVH and other hysterectomies reached significance.

Prior pelvic surgery, menopausal status (pre-/postmenopausal), medical comorbidities, history of pelvic inflammatory disease, history of pelvic malignancy, endometriosis, and chronic pelvic pain were not risk factors or protective against lower urinary tract injury. Likewise, we found that the use of energy sources such as Ligasure®, Gyrus®, and monopolar and bipolar scissors were not risk factors or protective for either injury type.

DISCUSSION

In this multi-center case—control study, we found that while the majority of lower urinary tract injury cases were noted at the time of the total abdominal hysterectomy (ureteral and bladder), there were also injuries during the minimally invasive laparoscopic-assisted vaginal hysterectomy (ureteral). With more gynecologists using minimally invasive techniques for hysterectomy, determining the risk factors associated with these surgical routes is of vital importance. A systematic review and meta-analysis [12] on the methods of hysterectomy analyzing 34 randomized controlled trials with 4,495 women included further divisions of hysterectomy like laparoscopic hysterectomy (defined as the ligation of uterine vessels laparoscopically and the remainder of the surgery done vaginally) and total laparoscopic hysterectomy, where the entire procedure was carried out laparoscopically, in addition to abdominal and vaginal hysterectomy. When bladder and ureter injuries were pooled under “urinary tract injury,” there was a significant increase in urinary tract injury for laparoscopic hysterectomy versus abdominal hysterectomy. There were no statistically significant differences in bladder, ureter, or vascular injuries between the laparoscopic and vaginal groups either. When specific laparoscopic groups were analyzed, there were more urinary tract injuries for total laparoscopic hysterectomy versus vaginal hysterectomy (OR 3.69; 95 % CI 1.11 to 12.24). There were no statistically significant differences between laparoscopic and vaginal hysterectomy. Another study [8] looking at hysterectomy and lower urinary tract injury from 1979 to 2006, which did not include total or supracervical laparoscopic approaches, found that bladder injury was highest in women undergoing LAVH (13.8 per 1,000 women) and VH (13.1 per 1,000 women). Ureteral injury recognized at the time of hysterectomy was most common with radical abdominal hysterectomy (7.7 per 1,000) and total abdominal hysterectomy (1.2 per 1,000), similar to our study. Again this study spans two decades, but unfortunately does not have the gamut of laparoscopic approaches, including robotic hysterectomy for comparison, which makes its application to the current gynecological surgical scene inadequate. Based on the recent Cochrane review [12], as well as the study by Jelovsek et al. [8], more recent comparative studies on various

approaches of hysterectomy and concurrent lower urinary tract injury are lacking to realistically compare the current gynecological surgical scenario. Multiple explanations are possible for the outcomes of our study. Total abdominal hysterectomy re- mains the commonest route of surgery and the prevalence may simply reflect the odds of getting an injury simply because of how frequently this procedure is performed. Furthermore, it is possible that easier cases are scheduled laparoscopically or vaginally rather than as abdominal hysterectomy cases, as indicated by the uterine weight and possibly the estimated blood loss, thus increasing the risk of injury. In addition, the learning curve of laparoscopic surgeries may have passed and we are back to the baseline incidence of lower urinary tract injury rates in the laparoscopic group as far as robotic, total laparoscopic, and laparoscopic supracervical hysterectomy are concerned. It does remain interesting that LAVH is a risk factor for ureteral injury, indicating that perhaps a combined approach is fraught with possible anatomical distortion and consequent injury. Since total abdominal hysterectomy is also a risk factor for ureteral injury, this seems to indicate either again the prevalence of the procedure, or possibly that more complicated cases are being performed abdominally with the advent of laparoscopic surgery, and that the complications occur at a disproportionate rate in the abdominal hysterectomy cases. Further large-scale epidemiological studies need to be per- formed to confirm these findings.

Unlike prior reported data, we did not find an association between patient age, BMI, or menopausal status, and the risk of lower urinary tract injury. However, higher rates of bladder injuries occurred among women who have undergone a prior cesarean section. This is consistent with published data as well as with generalized knowledge regarding the altered anatomy of the vesicovaginal space following prior dissection in this area. Interestingly, we also noted higher rates of bladder injuries when the surgery was performed by a general gynecologist, compared to a subspecialist in the field. While it is difficult to extrapolate further information from this finding, it points to the necessity of appropriate education for all gynecologic surgeons regarding risk-lowering procedural steps during hysterectomy.

Injury to the lower urinary tract at the time of hysterectomy is also associated with other unfortunate sequelae, including higher rates of blood transfusion and concurrent bowel injuries indicating that anatomical complexities and possibly operator experience could predispose an individual to higher risks of injury and increased blood loss.

A recent case analysis of 31 ureteral injuries incurred at the time of laparoscopic hysterectomy was completed in the Netherlands [13]. Researchers asked all 95 gynecologists performing laparoscopic hysterectomy to recall all cases of known ureteral injuries that occurred at their hospital and complete a structured interview focusing on the identification of possible predisposing factors. While severely limited by the recall and associated biases of performing surgeons, the study did acknowledge interesting areas for improvement in the prevention of lower urinary tract injury at the time of minimally invasive hysterectomy. Specifically, the importance of having an experienced surgeon as part of the surgical team (in 25 % of cases, the combined surgical experience of the first surgeon and primary assistant was fewer than 30 laparoscopic hysterectomies), and differences in surgical approach (i.e., standardized use of a uterine manipulator, dissection of the ureter in cases of

distorted anatomy or willingness to place additional trocars) were noted as possible avenues to avoid injury. Such a discussion may point to areas of future investigation.

Our study is limited in its retrospective nature. It is a case–control study, which although helps to look for risks in relatively rare cases, such as lower urinary tract injury, may have selection bias. However, it does provide a multi-centered basis for researching hysterectomy-associated lower urinary tract injuries and provides a broader analysis of a relatively rare occurrence. Our approach highlights some of the potential sequelae of lower urinary tract injury, and reiterates the importance of continued research and education regarding ways in which surgeons can avoid such devastating complications.

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Table 1

Inclusion and exclusion criteria of ICD-9 and CPT codes for lower urinary tract injury in patients undergoing hysterectomy for benign reasons

ICD-9	CPT
Inclusion Codes	
57.81 Suture of laceration of bladder	51860 Cystorrhaphy, suture of bladder wound, injury or rupture; simple
57.82 Closure of cystotomy	51865 Cystorrhaphy, suture of bladder wound, injury or rupture; complicated
57.89 Other repair of bladder	51900 Closure of vesicovaginal fistula— abdominal approach
56.74 Ureteroneocystostomy	57320 Closure of vesicovaginal fistula— vaginal approach
56.75 Transuretero-ureterostomy	50930 Closure of ureterovisceral fistula
56.79 Other anastomosis or bypass of ureter	57330 Closure of vesicovaginal fistula— transvesical and vaginal approach
56.82 Suture of laceration of ureter	50700 Ureteroplasty
56.83 Closure of ureterostomy	50760 Uretero-ureterostomy
56.84 Closure of other fistula of ureter	50780 Ureteroneocystostomy
	50947 Ureteroneocystostomy with cystoscopy and ureteral stent placement (laparoscopic)
56.86 Removal of ligature from ureter 56.89 Other repair of ureter:	50948 Ureteroneocystostomy without cystoscopy and ureteral stent placement (laparoscopic)
867.0 Urethral/bladder injury	
867.2 Ureteral injury	
57.84 Vesicovaginal fistula repair	
56.84 Ureterovaginal fistula repair	
Exclusion codes	
68.6 Radical abdominal hysterectomy	58200 TAH including partial vaginectomy, with para-aortic and pelvic lymph node sampling with or without removal of tube/s, with or without removal of ovary/ovaries.
68.61 Laparoscopic radical abdominal hysterectomy	58210 Radical abdominal hysterectomy with para-aortic sampling and pelvic lymphadenectomy with or without removal of tube/s, with or without removal of ovary/ovaries.
68.69 Other and unspecified radical abdominal hysterectomy	58285 Vaginal hysterectomy (Schauta)
68.7 Radical vaginal hysterectomy	57240 Anterior colporrhaphy, repair of cystocele with or without repair of urethrocele
68.71 Laparoscopic radical vaginal hysterectomy	57250 Posterior colporrhaphy, repair of rectocele with or without perineorrhaphy
68.79 Other and unspecified radical vaginal hysterectomy	57260 Combined anteroposterior colporrhaphy
70.50–70.55 Repair of cystocele and rectocele	57265 Combined anteroposterior colporrhaphy with enterocele repair
70.77–70.79 Vaginal suspension and fixation, with or without graft/prosthesis, including other repair	57267 Insertion of mesh or other prosthesis for repair of pelvic floor defect, each site (anterior, posterior compartment), vaginal approach
	57268 Repair of enterocele, vaginal approach
70.92–70.93 Other operations on cul-de sac with or without graft/prosthesis	57270 Repair of enterocele, abdominal approach
	57280 Colpopexy, abdominal approach
	57282 Colpopexy, vaginal; extra-peritoneal approach
	57283 Colpopexy, vaginal; intra-peritoneal approach (uterosacral, levator-myorrhaphy)
	57284 Paravaginal defect repair (including repair of cystocele, if performed); openabdominal approach

ICD-9	CPT
	57285 Paravaginal defect repair (including repair of cystocele, if performed); vaginal approach
	57288 Sling operation for stress Incontinence
	56.85 Urethropexy
	58240 Pelvic exenteration

Codes used for identification of patients; patients who had a hysterectomy for benign indications were identified by ICD-9 codes 68.3–68.9 and CPT codes 58150, 58541, 58542, 58543, 58544, 58180, 58260, 58262, 58550, 58552, 58553, 58554, 58290, and 58291

Table 2

Demographic information

	Cases (*n*= 135)	**Controls (*n*=270)**	***p* value**
Age (years) ± SD	45.2± 7.6	46.1± 9.5	0.33
Ethnicity	Caucasian (45 %)	Caucasian (49 %)	0.37
	Hispanic (40 %)	Hispanic (36 %)	
	Asian (13 %)	Asian (9%)	
	Other (2 %)	Other (6%)	
Body mass index (kg/m^2) ± SD	27.9± 11.6	29.1 ± 12.1	0.36
Uterine weight (g) ± SD	459.4 ± 719.6	379.9 ± 510.5	0.21
Medical comorbidities (%)	39 %	36 %	0.51
Injury detected after surgery (%)	2 %	0 %	0.36
Total abdominal hysterectomy (%)	39 %	37 %	0.69
Total vaginal hysterectomy (%)	20 %	17 %	0.51
Abdominal supracervical hysterectomy (%)	6 %	8 %	0.49
Laparoscopic-assisted vaginal hysterectomy	10 %	7 %	0.2
Total laparoscopic hysterectomy (%)	10 %	10 %	0.98
Laparoscopic-assisted supracervical	10 %	14 %	0.37
Robotic-assisted total laparoscopic	5 %	7 %	0.18
Bilateral salpingo-oophorectomy (%)	37 %	40 %	0.6

Table 3

Risk factors for lower urinary tract injury

Risk factor	Bladder injury OR (95% CI)	Ureteral injury, OR (95% CI)
Prior cesarean section	2.9 (1.75–5)	NS
Total abdominal hysterectomy	1.9 (1.06–3.4)	4.7 (1.4–15.6)
Surgery by generalist OB/GYN	2.4 (1.2–5.2)	NS
Blood transfusion	NS	33.4 (7.3–153.2)
Laparoscopic-assisted vaginal hysterectomy	NS	10.4 (2.3–46.6)
Concurrent bowel injury	8.9 (5.6–17)	21.1 (1.6–167)