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Relation of Pre-operative Ureteral Catheter Use and Complications of Intraoperative Ureteral and Bladder Trauma in Gynecologic Oncology Patients Undergoing Major Surgical Procedures

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Abstract: Iatrogenic injury to the urinary tract is a potential complication of all surgical procedures performed in or retroperitoneum and pelvis. Gynecological surgery in particular has a risk of urinary tract injury due to the close anatomy of the urinary tract and the reproductive system in women. This study aimed to evaluate the relation between pre-operative ureteral catheter use and complications of intraoperative ureteral and bladder trauma in gynaecologic oncology patients undergoing major surgical procedures. This study used cohort data of patients undergoing major surgical procedures at Prof. Dr. R. D. Kandou Hospital, Manado, recorded in medical records from January 1, 2023 to June 30, 2023. The bivariate test showed that patients who received pre-operative ureteral catheter insertion had fewer urological trauma events (4.5%) compared to patients who did not get pre-operative ureteral catheter (95.5%). The relations between pre-operative ureteral catheters and the incidence of urological trauma was found to be statistically significant with a p-value of 0.019 and the history of chemotherapy had a p-value of 0.036, meanwhile the relations with other variables showed p-values of >0.05. Therefore, the use of pre-operative catheters could not significantly eliminate the occurrence of ureteral trauma because many of the confounding factors were accompanied by several other conditions that were also studied in the multivariate analysis. In conclusion, there is no association between the use of pre-operative ureteral catheters and complications of intraoperative ureteral trauma in gynecologic oncology patients undergoing major surgical procedures. Future studies using samples from more sources are expected to assess the relation between pre-operative ureteral catheter use and the incidence of urological trauma more accurately, and to assess the ease of use of pre-operative ureteral catheter.
Keywords: ureteral catheter; ureteral trauma; gynaecologic oncology patients

INTRODUCTION

Iatrogenic injury to urinary tract is a potential complication of all surgical procedures performed in retroperitoneum and pelvis. Gynecological surgery in particular has a risk of urinary tract injury due to the close anatomical location of the urinary tract and the reproductive system in women. Thus, coupled with variations of laparoscopic and robotic surgery, has expanded the possible causes of iatrogenic injury. Timely recognition of injuries and appropriate investigation and treatment, whether in acute or delayed circumstances, are essential in reducing the potential impact of subsequent complications for both the patient and the surgeon.[1]

Urinary tract injuries complicate about 0.2% to 1% of all gynecological procedures and pelvic surgeries. It is important to note the importance of identifying an injury to the urinary tract and to treat these complications immediately. Unfortunately, often the complications of urinary tract injury are not realized during surgery and are only identified postoperatively, causing complications and requiring additional surgery. In surgery in the pelvic cavity, the most commonly injured urinary tract organ is the bladder followed by the ureters.[2]

Iatrogenic injuries are the most common cause of ureteral injuries comprising 75% to 80% of all cases. Injuries can occur in abdominal or pelvic surgery and with all open, laparoscopic, robotic and endoscopic modalities. Similar in factors contributing to bladder injury, proper pelvic space, complex anatomy, previous procedures, or radiation therapy can all increase risk by changing the normal anatomical position of the ureter and by making it harder to identify. More than 90% of ureteral injuries occur in the distal third of the ureter. Most cases report gynecological surgery as the source of the majority (>50%) of ureteral injuries.[3]

The most common major gynaecological surgical procedure performed worldwide is hysterectomy, either open surgery or laparoscopy. In the United States, about 530,000 to 600,000 hysterectomies are performed each year. In Canada, there are about 100,000 hysterectomies and adnexal surgeries performed per year. In the United States, there are about 226,000 surgeries per year for prolapse and 135,000 surgeries per year for incontinence. Gynecological surgery can have major perioperative morbidities, including urinary and intestinal tract injuries, infections, hemorrhages, thromboembolism, and death.[4] With advances in surgical techniques, and perioperative anesthesia and postoperative care, most of these complications have been minimized. However, urinary tract injuries in gynecological surgery are still high enough that patients can suffer from significant morbidity and sequelae.[5]

METHODS

This study was conducted with secondary data analysis, using cohort data of patients undergoing major surgical procedures at Prof. Dr. R. D. Kandou Hospital Manado which were recorded in medical records from January 1, 2023 to June 30, 2023. The target population of the study was gynaecologic oncology patients undergoing major surgical procedures. Data collection was carried out after obtaining approval from the Ethics Committee of the Faculty of Medicine, Universitas Sam Ratulangi/Prof. Dr. R. D. Kandou Hospital. Medical record data were taken in accordance with the inclusion and exclusion criteria from gynecological oncology patients with a history of major surgery. Data were analyzed using the bivariate and multivariate statistical tests.

RESULTS

Overall, data were obtained from 230 samples in this cohort study. Table 1 showed the characteristics of patients. The median age of the patients was 47 (14-80) years, with significant association between age and urological trauma ($p \leq 0.05$) and a standard deviation of ±12.83. There were 65 patients (28.5%) had a history of surgery with details, namely sectio caesaria (55.3%), laparotomy (27.7%), appendectomy (5%), hysterectomy (3%), salphingophoreectomy (3%), and cholecystectomy, lower anterior resection, sterilization, and transvaginal hysterectomy (TVH, each amounted 1.5%). Samples with a history of chemotherapy were found to be nine people with

a total of no radiotherapy samples. Samples who received ureteral catheters during pre-operative amounted to 132 people (57.9%).

Table 1. Characteristics of the patients

Variables	Total (N=230)
Age (years), median (min-max)	47 (14-80)
History of surgery, n (%)	
Yes	65 (28.5)
- Sectio caesaria	36 (55.3)
- Laparotomy	18 (27.7)
- Appendectomy	3 (5)
- Hysterectomy	2 (3)
- Salphyngoophorectomy	2 (3)
- Cholecystectomy	1 (1.5)
- Lower anterior resection	1 (1.5)
- Sterilization	1 (1.5)
- Transvaginal histerectomy	1 (1.5)
No	165 (71.5)
History of chemotherapy, n (%)	
Yes	9 (3.9)
No	221 (96.1)
History of radiotherapy, n (%)	
No	230 (100)
Diagnosis, n (%)	
Neoplasma ovarium	105 (45.6)
Myoma uteri	49 (21.1)
Endometrium carcinoma	14 (6.1)
Cervical carcinoma	12 (5.2)
Endometrial cyst	7 (3.1)
Adenoma cyst	6 (2.6)
Ovarian cyst	5 (2.2)
Endometrial hyperplasia	4 (1.7)
Leiomyoma	4 (1.7)
Ovarian tubes abscess	4 (1.7)
Adenomyosis	3 (1.3)
Dermoid cyst	3 (1.3)
Pregnancy with complications	3 (1.3)
- Placenta previa	2 (66.7)
- Congenital disorders	1 (33.3)
Mature teratoma	3 (1.3)
Uterine carcinoma	2 (0.8)
Abnormal bleeding in uterine	2 (0.8)
Fibrosarcoma	1 (0.4)
Cervical myoma	1 (0.4)
Cervical polyps	1 (0.4)
Pseudomyxoma peritonei	1 (0.4)
Surgical treatment, n (%)	
Total hysterectomy salpingo-oophorectomy bilateral	157 (68.8)
- Total	151 (96.1)
- Radical	6 (3.9)
Salpingo-oophorectomy	34 (14.9)
Laparotomy	29 (12.7)
Sectio caesaria	3 (1.3)
Salpingo-oophorectomy dextra	1 (0.4)
Salpingo-oophorectomy sinistra	1 (0.4)
Tubectomy	1 (0.4)
Excision	1 (0,4)

Variables	Total (N=230)
Extirpation	1 (0.4)
Pre-operative ureteral catheter, n (%)	
Yes	132 (57.9)
No	96 (42.1)

Table 2 showed that 15 patients (7.3%) experienced urological trauma with details, namely ureteral trauma (53.4%) and bladder trauma (46.7%). Identification of intraoperative abnormalities was found in as many as 15 patients out of 15 patients who experienced urological trauma.

Tabel 2. Occurrence frequency of urological trauma in patients

Variables	Total (N=230)
Urological trauma, n (%)	
Yes	15 (6.6)
- Ureter	8 (53.4)
- Bladder	7 (46.7)
No	213 (93.4)
Abnormalities identification, n (%)	
Intra-operative	15 (100)

Table 3 showed the results of the bivariate statistical test. Patients who received pre-operative ureteral catheter insertion had fewer urological trauma events (4.5%), compared to patients who did not get pre-operative ureteral catheter (95.5%). The relation between pre-operative ureteral catheter and the incidence of urological trauma was found to be statistically not significant ($p<0.05$, PR = 4.36, 95% CI = 0.53-35.66). In patients who had a history of previous surgery, it was found that more of them experienced urological trauma events. However, the association of surgical history with the incidence of urological trauma was found to be not statistically significant ($p>0.05$, PR=1.88, 95% CI=0.43-8.17). In patients who had history of chemotherapy, more of them did not experience the incidence of urological trauma and the relationship between history of chemotherapy and urological trauma was found to be statistically significant ($p<0.05$, PR=4.05, 95% CI=0.54-30.24).

Table 4 showed that in patients who had a history of decreased glomerular fitraltion rate (GFR), more urological trauma events were found to be statistically significant (p=0.017). In patients who had history of decreased ureum there were more urological trauma events which were statistically significant (p=0.012). Patients with history of increased creatinine had more urological trauma events and were found to be statistically significant (p=0.011). Patients with history of hydronephrosis had more urological trauma events and were found to be statistically significant (p=0.012).

Tabel 3. Bivariate analysis (T-Test)

Variables	Urological trauma, n (%)		p	PR	95%CI
	Yes	No			
Pre-operative ureter catheter					
Yes	6 (4.5)	126 (95.5)	0.243	4.36	0.53-35.66
No	9 (9.4)	87 (90.6)			
Surgical history					
Yes	7 (4.6)	62 (95.4)	0.410	1.88	0.43-8.17
No	8 (2.5)	159 (97.5)			
History of chemotherapy					
Yes	5 (11.1)	8 (88.9)	0.024	4.05	0.54-30.24
No	10 (2.7)	213 (97.3)			

Tabel 4. Bivariate analysis (Mann-Whitney test)

Variables	Urological trauma, n (%)		Mean Rank	Asymp. Sig
	Yes	No		
Decreased GFR	15	215	215.4 – 108.5	0.017
Increased ureum	15	215	219.5– 108.2	0.012
Increased creatinine	14	216	207.7 – 109.7	0.011
Hydronephrosis	15	215	204.9 – 109.2	0.012

Of the seven variables that had p-values of <0.05 were pre-operative ureteral catheters and chemotherapy history, as well as decreased GFR, increased ureum, increased creatinine and hydronephrosis variables, so that these seven variables can still be tested multivariately.

Table 5 showed the results of a multivariate analysis test between pre-operative ureteral catheter variables and chemotherapy history on urological trauma events indicating no significant relationship. The pre-operative ureteral catheter had a not significant p-value of 0.019 and a history of chemotherapy had a p-value of 0.036. The variable aPR values of pre-operative ureteral catheters and chemotherapy history were 4.11 and 3.25 respectively with 95%CI values of the variables being 0.47-35.36 and 0.34-3.10, respectively.

Based on the results of multivariate analysis test between urological trauma and decreased GFR, ureum, creatinine, and hydronephrosis, it was found that there was no significant association. Increased GFR had a p-value of 0.55, increased urea had a p-value of 0.54, increased creatinine had a p-value of 0.19, and hydronephrosis had a p-value of 0.59. The aPR value of the GFR variable was 1.3, the ureal variable was 1.02, the creatinine variable was 2.4, and the hydronephrosis variable was 1.4. More detailed data related to pre-operative catheter variable multivariate test results and chemotherapy history were presented in more detail in Table 5.

Tabel 5. Multivariate analysis of the incidence of urological trauma

Variables	p	aPR	95%CI
Pre-operative catheter	0.019	4.11	0.47-35.36
History of chemotherapy	0.036	3.25	0.34-31.10
Decreased glomerular filtration rate	0.55	1.3	0.47-3.93
Increased ureum	0.54	1.02	0.94-1.10
Increased creatinin	0.19	2.4	0.55-10.9
Hydronephrosis	0.59	1.4	0.34-6.26

DISCUSSION

In this cohort study with a total samples of 230 patients, the median (minimum-maximum) age of the sample was 47 (14-80) years. Most patients had no history of surgery (71.5%), chemotherapy (96.1%), and radiotherapy (100%). Patients in this study mostly had a history of surgery in the form of sectio caesaria (55.3%), followed by a history of laparotomy surgery (53.3%) and appendectomy (5%). However, most patients received pre-operative catheter insertion (57.9%). Some study that assessed the frequency of pre-operative ureteral catheter use on morbidity events in the implementation of major gynaecological surgery, had samples with an average age of 56.36 (age range 17-89 years). The mean age in Merritt et al's study was not much different from the median age in this study.[1.5]

Ureteral catheterization is an action performed to place a catheter into the ureter, either externally or internally. The main means of preventing injury is a clear understanding of the anatomy, especially if there is a suspicion of an anomaly. An understanding of the most common mechanisms and locations of injury to each structure is also invaluable. Finally, one should consider the effects of previous surgical procedures and apply good surgical techniques.[6]

Pre-operative ureteral catheters have been shown to produce statistically significant reductions in ureteral injury rates and are not cost effective at general levels of injury. When there is a significant anatomical distortion, a ureteral catheter may be placed to assist in identifying the course of the ureter all the way out into the bladder.[7] During oophorectomy or hysterectomy, the ureter is most likely to be injured during: ligation of uterine blood vessels, ligation of ovarian blood vessels, and closure of the vaginal cuff angle. Field exposure to surgery, careful tissue handling, and an understanding of all potential anatomical variations are paramount.[6,7]

However, routine prophylactic installation of ureteral catheters may not ensure injury prevention and is not cost effective in all cases. This may be useful in cases where the pelvic anatomy is unclear or distorted, such as a large pelvic tumor or severe endometriosis excision. Ureteral catheters also help to identify ureteral injuries when they occur. Types of gynecological surgery that can cause ureteral trauma are inter alia hysterectomy and transvaginal hysterectomy.[8]

Urological injuries are known risk factor of pelvic and retroperitoneal surgery in general and in gynecological surgical procedures in particular. Urological injuries during gynecological surgery can cause significant morbidity and if not immediately identified can delay recovery and require some additional procedures. Most published studies describe the results of gynecological surgery for benign conditions, with few specifically addressing the surgical morbidity of gynecologic oncology. During gynecologic oncology procedures, not only is the anatomy altered by the magnitude of the tumor and diffuse pathology, but urological organs may be directly involved with the tumor. Therefore, it is important to know how these planned urological injuries or resections are diagnosed and managed and how to be vigilant about potential postoperative complications for early identification and management. In a 10-year case study in Thailand, out of 28,819 gynecological surgeries, 86 of these patients had urological injuries, which accounted for the highest percentage of buli trauma, followed by ureteral injuries, and injuries to both organs.[9]

An analysis of 13 published studies concluded that the following procedures contributed to iatrogenic ureteral injury: hysterectomy (54%), colorectal surgery (14%), pelvic procedures such as ovarian tumor removal (8%), transabdominal uretropexy (8%), and vascular surgery (6%). One series reports that repeated cesarean sections could also result in the majority of ureteral injuries, in this case up to 23% of ureteral injuries reported in one hospital. Historically, open urological procedures, since they often occur near the ureters, have also been responsible for a large number (21%) of reported ureteral injuries.[8]

However, the use of pre-operative ureteral catheters can be used to facilitate ureteral identification in high-risk cases, but data published in gynecology and colectomy literature are unclear about whether they actually reduce ureteral injury. Although older studies have shown no benefit, a more recent review from the National Surgical Quality Improvement Program (NSQIP) showed that catheters were associated with lower rates of ureteral injury after colectomy.[8]

Earlier study found that the prophylactic use of bilateral ureters in major gynecological surgery required an average time of 5.4 minutes (SD 2.0, range 3.2-9.2) for experienced consultants or 8.4 minutes (SD 3.9, range 6.4-18.6). Postoperative complications were found only urinary tract infections (5/337 patients, 1.48%) and acute renal failure (2/337 patients, 9.3%). The major gynecological surgeries found in this study were total abdominal hysterectomy with a bilateral salpingo-oophorectomy (74%), bilateral salpingo-oophorectomy (5%), radical hysterectomy (11%), and others (10%). Therefore, this study concluded that the use of pre-operative prophylactic ureteral catheters could be installed quickly and easily, and had a low complication rate in urology. Regular use before major gynaecological surgery could speed up ureteral identification during surgery and could help reducing the incidence of accidental ureteral injury by operators.[1.5]

In a previous study that investigated the relationship between the use of bilateral prophylactic ureters and the incidence of urological injuries, earlier study with a total of 469 (15.3%) samples performed for ureteral catheter installation. The study found that four samples out of 3071 total included samples had ureteral injuries. All four samples with ureteral injury (0.17%) occurred in

patients undergoing exploratory laparotomy and none of the patients had ureteral injury in operative laparoscopy. However, no statistically significant difference in the incidence of ureteral injury was found between patients undergoing ureteral catheterization and patients not undergoing ureteral catheterization (p = 0.094).[2,5]

Chou's study[7] also investigated the effectiveness of using pre-operative catheterization as a prophylactic measure to prevent ureteral injury. The total sample in this study was 1,583 patients. Ureteral injuries occurred in 19 people (1.20%) of patients belonging to the group of users of prophylactic ureterial catheterization, while as many as 17 people (1.09%) from the group without prophylactic ureteral catheterization. However, the study also found no statistically significant difference in the incidence of ureteral injury between the group of users of prophylactic ureterial catheterization and the group that did not use prophylactic catheterization (p = 0.774), as reported by O'Connor et al and Gilmour et al.[5,10]

In this study, the results of the bivariate test (T-Test) found that the use of pre-operative catheters and a history of chemotherapy had p values of 0.243 and 0.024 towards the incidence of urological trauma; therefore, it could be continued into a multivariate trial.

The results of the multivariate test found that the history of chemotherapy did not have a statistically significant relationship to the incidence of urological trauma with values of p = 0.036 aPR = 3,25 and 95% CI 0,34 – 31.10. The use of pre-operative ureteral catheters was also found to have a statistically significant relationship with the incidence of urological trauma with values of p = 0.019, aPR = 4.11, and 95% CI = 0.47-35.36. The urological trauma found in this study was ureteral trauma (8 patients, 53.4%) and bladder trauma (7 patients, 467%). Decreased GFR was found to have a statistically insignificant association with urological trauma with values of P = 0.55, aPR = 1.3. Increased urea was also found to have a statistically insignificant relationship with urological trauma with values p = 0.54, aPR = 1.02. Increased creatinine was also found to have a statistically insignificant association with urological trauma with values of p = 0.19, aPR = 2.4. Hydronephrosis was also found to have a statistically insignificant relationship to urological trauma with values of p = 0.59, aPR = 1.4.

This study has several limitations, namely that the sample used in this study only used from one center, so it is less able to provide a broad sample picture. This study also still does not present the level of ease of use of pre-operative ureteral catheters in the case of gynecological surgery. Therefore, future studies should take samples from many centers by assessing the ease of use of pre-operative catheters, so as to better evaluate the ease of use of pre-operative catheters and the relationship between the use of ureteral catheters to the incidence of urological trauma in the case of gynecological surgery.

CONCLUSION

There is no association between the use of pre-operative ureteral catheter and complications of intraoperative ureteral trauma in gynecologic oncology patients undergoing major surgical procedures. Future studies using samples from more sources are expected to assess the relation between pre-operative ureteral catheter use and the incidence of urological trauma more accurately, and to assess the ease of use of pre-operative ureteral catheter.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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