The Distance between Ureter and Cervix in a Retrograde Hysterectomy Technique: Combination of Anurach Uterine Manipulator and Colpotomy for avoiding Ureteral Injury during Total Laparoscopic Hysterectomy

Chamnan Tanprasertkul MD, PhD*,
Anurach Kulvanitchaiyanunt MD**

** Department of Obstetrics and Gynecology, Faculty of Medicine, Thammasat University, Pathumthani, Thailand*
*** Department of Obstetrics and Gynecology, Pranangklao Hospital, Nonthaburi, Thailand*

Objective: *To measure the distance between the ureter and the cervix (UCD) when using a retrograde hysterectomy technique with combination of Anurach uterine manipulator (AUM) and colpotomy to minimize ureteral injury.*
Material and Method: *Twenty participants, mean age of 39.8 years who underwent total laparoscopic hysterectomy (TLH) during January 2016 and June 2016 at our institution, gave their consents and were enrolled. The combination of AUM and colpotomy in a retrograde technique was used, and the UCD measured before and after applying pressure. Real time fluoroscopy was used to identify and measure the between the lateral cervicovaginal angle and the ureteral catheters in each patient. Kidney-ureter-bladder (KUB) ultrasonograms were evaluated at 48 hours, one week and one month following the surgery in every case.*
Results: *All procedures were successfully completed without major complications or conversion. The average time of surgery was 113.40 minutes. The range of distances before applying pressure (pre_UCD) on both sides was 1.50 to 1.8 cm with the mean distances of 1.62 cm and 1.63 cm on the left and right sides, respectively. Following this technique, the total distance (post_UCD) was demonstrated in the range of 3.0 to 3.6 cm. The mean increases in the distances (increase_UCD) were 1.50 and 1.58 cm on the left and right sides, respectively. There was no abnormalities of KUB ultrasonograms including the signs and symptoms of urinary complications after operation through one month of follow-up.*
Conclusion: *With this technique, the surgeons could expect a safer distance of operative area. In the first series of patients, data demonstrated the safety and the benefit of this technique during TLH in decreasing the incidence of ureteral injury. However, evaluation in a larger variety of patients is warranted.*

Keywords: *Laparoscopic hysterectomy, Ureteral injury, Colpotomy, Ureter to cervix distance*

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Total laparoscopic hysterectomy (TLH) by definition means the removal of all parts of uterus, including cervix, by laparoscopy ligation of the ovarian arteries and veins with the removal of the pathologic tissue vaginally or abdominally, along with laparoscopic closure of the vaginal cuff [1]. TLH is the procedure which gains popularity widely because of the advantages of TLH as compared to abdominal hysterectomy. The short term benefits of TLH have been proven including less postoperative pain, shorter recovery period and decrease hospital stay. However, the major and long term complications are still an issue of concern. The ureteral injury is the one of serious major complications even with surgeons with extensive experience. The incidence of ureteral injury during gynecologic surgeries were reported to range between 0.3 to 0.5 percent[2-5]. One of the most common sites of injury is the cardinal ligament where the ureters pass inferiorly to the uterine arteries[6]. The authors developed the technique of TLH which uses the uterine manipulator with retrograde technique of hysterectomy starting from posterior and anterior colpotomyto

Correspondence to:
Tanprasertkul C, Department of Obstetrics and Gynaecology, Faculty of Medicine, Thammasat University, Pathumthani 12120, Thailand.
Phone: +66-2-9269343, Fax: +66-2-9269485
E-mail: chamnandoctor@gmail.com

decrease the chance of ureteral injury.The aim of the present study was to measure the distance between the ureter and the cervicovaginal angle when using this technique.

Material and Method

The present descriptive prospective study was conducted at the Department of Obstetrics and Gynecology at Pranangklao Hospital, Nonthaburi, Thailand, during January 2016 to July 2016 following the approval by the local ethical committee. The authors enrolled the patients with benign gynecologic diseases who underwent laparoscopic hysterectomy with or without salpingoophorectomy. They completely understood the process of the present study and signed the informed consent.

For the operation techniques for laparoscopic hysterectomy, all patients underwent the surgical procedure under general anesthesia. The patients were placed in low lithotomy position. After being sterilized at the surgical site, the Anurach uterine manipulator (AUM) was installed, and the cuff was inflated to prevent the leakage of gas in peritoneum cavity; this procedure had been described elsewhere[7]. The ureteral catheters were placed along inside the ureteral lumenon both sides by cystoscopy.

Laparoscopic pneumoperitoneum was created by CO_2 insufflation by semi-open technique entry that was passed through a 10-mm umbilical incision until the intraabdominal pressure reached 15 mmHg. Following pneumoperitoneum, umbilical 5-mm trocar and telescope entries were made. Then, three of 5-mm trocars were inserted from both suprainguinal region and right lateral umbilical area under direct laparoscopic observation.

After visualizing the pelvic organ and disease, theretrograde hysterectomy technique was started with posterior colpotomy. The incision was made on the edge of the vaginal cuff, then extended to the insertion of both uterosacral ligaments. Then, anterior colpotomy was made in the same fashion with care to avoid injuring the urinary bladder. Both round ligaments were cut, and windows were made at broad ligaments, and then the cardinal ligaments were sutured and ligated with Vicryl No. 1.

The distance between the ureter and the cervix (UCD), specifically the distance from theureteralca theters to the lateral border of cervical cup in the exact length at the level of cardinal ligament was measured by real time fluoroscopic imaging. The fluoroscopy machine was placed in perpendicular to the body of the patient. The AUM was handled in midline position, using public symphysis as a landmark. The distance was calculated by using the length of cervical plate as the reference. First measurement, the UCD before pushing (pre_UCD) or the neutral position of holding AUM without pressure application, was taken. Second measurement was for the distance between ureter and cervix after the pushing position of holding AUM with moderate pressure application until both anterior and posterior edges of cervical cuff in the blue color were clearly seen (post_UCD). Both left and right sides were measured in the same pattern.

After measurement, the standard technique of TLH was utilized. In the manner of steps, both cardinal ligaments were coagulated by bipolar cautery and cut by harmonic scalpel, and the adnexa were coagulated and cut in the same fashion. Whether the ovaries were left intact depended on the preoperative counselling. The cervix was excised by cutting cervicovaginal tissue along the edge of the cervical cuff. All bleeding points were meticulous stopped by bipolar coagulation. The uterus and all pathologic tissues were vaginally removed. The vaginal cuff was closed with polydioxanone (PDS) suture in double layers. Both ureters were carefully checked for peristalsis and signs of hydroureter.

All specimens were assessed by visual examination for any evidence of malignancy. Histo-pathological examination of removed specimens was always done. The patients were kept under observation in the in-patient department for 24 to 48 hours following the operation to avoid any complications associated with the surgery or anesthesia. The KUB ultrasonograms were evaluated at 48 hoursfor any suspicious urinary complications, and the patients were then discharged. All patients were followed-up at one week and one month following the surgery. KUB ultrasonography was performed in each patient at every visit.

Results

Twenty participants, mean age of 39.8 years who underwent TLH during January 2016 and June 2016 at our institution, were included. The diagnosis was leiomyoma in 16 cases (80%) and benign ovarian cyst in 4 cases (20%). The mean operative time was 113.40 minutes with the average blood loss of 120 cc. All patients underwent the surgery uneventfully. There were no detectable complications in the operative or recovery room. The KUB ultrasonograms at 48 hours,one week and one month following the operation

Table 1. The distance between ureter and cervix before and after applying pressure on the Anurach uterine manipulator in the reverse hysterectomy technique during total laparoscopic hysterectomy

Number = 20	Pre_UCD		Post_UCD		Increase_UCD	
	Left	Right	Left	Right	Left	Right
Range cm.	1.5 to 1.8	1.5 to 1.8	3.0 to 3.5	3.0 to 3.6	1.4 to 1.8	1.4 to 1.8
Mean (SD) cm.	1.62 (0.1)	1.63 (0.09)	3.12 (0.35)	3.21 (0.25)	1.50 (0.26)*	1.58 (0.24)*

* $p<0.001$

Pre_UCD = the distance between ureter and cervix without pressure apply; Post_UCD = the distance between ureter and cervix with moderate pressure apply, Increase_UCD = the difference of post_UCD and pre_UCD

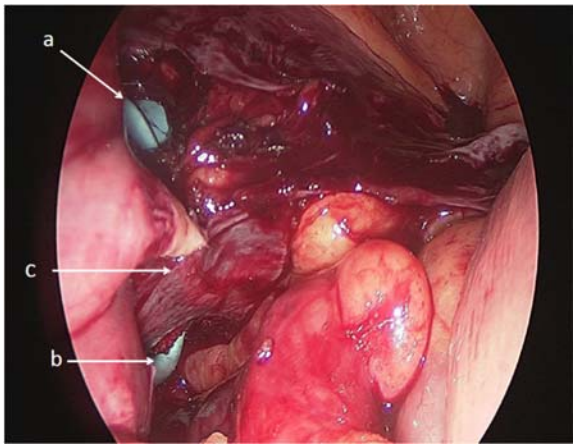

Fig. 1 Laparoscopic view at right side of uterine-pelvic area a) anterior and b) posterior edges of cervical cuff c) uterine vessels.

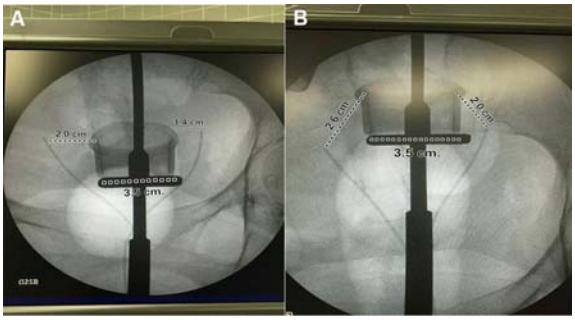

Fig. 2 Fluoscopic imaging study of distance between cervicovaginal angle to ureteric catheter A) before and B) after pushing the Anurach uterine manipulator in the reverse hysterectomy technique, respectively.

demonstrated no urinary tract injury. Also, no patients had signs or symptoms of urinary tract injury.

The distance between the lateral cervicovaginal angle and the ureteric catheters before and after applying pressure on the uterine manipulator was demonstrated in Table 1. The range of the distance before pushing (pre_UCD) on both sides was 1.50 to 1.8 cm with the mean distance of 1.62 cm and 1.63 cm on the left and right sides, respectively. After using this technique, the total distances of UCD were demonstrated in the range of 3.0 to 3.6 cm. The mean increases in the distances (increase_UCD) were 1.50 and 1.58 cm on the left and right sides, respectively.

Discussion

During gynecologic surgeries, particularly laparoscopy, the ureter is the main organ to which the injury is likely to occur. Assessing the preoperative risk factors could assist the surgeons to identify the high chance of complications. The presence of pelvic endometriosis, large fibroids and BMI above 30 kg/m^2 were associated with increased risks of ureteral injury[5,8]. However,more than half of injured patients have no detectable risks[9].

Prophylactic ureteral catheterization is utilized for preventing ureteral injury.The catheterization has been placement by cystoscopy.Evidence has supported its efficacy[10,11], but cost-effectiveness is concerned, and it might distort the normal anatomical position of the ureter.

Usually, the UCD at the level of internal os is approximately 1.5 to 2 cm[6]. Several techniques try to make this distance wider, which means that the ureter position would be more laterally out of the cervix. Adequate skeletonization of uterine artery would release peritoneal attachment to the ureters[12]. Maintenance of the cranial deviate of uterus with upward pressure on the uterine manipulator before cauterization of the uterine vessel is also helpful[13]. However, no previous studies measured the exact distance of these techniques. To the best of the authors' knowledge, this is the first study which has

demonstrated this length, using real time fluoroscopic imaging. The present study measured this distance during applying the retrograde technique of laparoscopic hysterectomy with uterine manipulator push cranially after colpotomy, both posteriorly and anteriorly. This makes vaginal wall around cervix loose. Hence, when the uterus is pushed in cephalad direction, the lateral pedicles on both sides of the cervix near cardinal ligaments would be further away from the ureters. The imaging measurement in the study demonstrated the mean distances of 1.62 and 1.63 cm on the left and right sides, respectively. Overall, the total UCD is 3.2 to 3.6 cm. This length is safe enough to avoid ureteral injury when dissecting uterine vessels in laparoscopic hysterectomy.

During laparoscopic hysterectomy, various coagulation devices were used, such as bipolar coagulation, harmonic scalpel, and ligature system. The burned tissue is not only at the coagulation point, but the lateral thermal burning could also spread. The lateral burned tissue was reported as far as 22 to 25 mm, which had depended on the application time and the voltage setting[14,15]. To decrease these effects, the authors' technique is to suture the pedicles of uterine vessels first, followed by bipolar coagulation for coagulating the uterine vessels medially to the sutured point. Finally, the pedicles are cut with harmonic scalpel or mono polar diathermy. The authors have observed that the duration of complete coagulation of uterine vessels is much shorter than usual after suturing the pedicles of uterine vessels first. This could reduce the chance of thermal injury to the ureter.

Theoretically, the ureteral injury should promptly be detected intraoperatively for best outcomes of management to be expected and preferred. However, it is not only that 50 to 70% of the unilateral ureteral injury is noticed after surgery, but the thermal burn could also lead to as late detection of the injury as 10 to 14 days postoperatively[16]. The thermal injury can cause delayed necrosis of the ureteral wall with a partial obstruction of the ureter. Immediate investigation must be performed when postoperative symptoms of ureteral complications, such as hematuria, fever, vaginal discharge, frank pain or rise of creatinine levels, are presented[17].

Universal cystoscopy could be helpful for early detection the ureteral injury but its benefits have to be weighed against its cost[18]. Moreover, cystoscopy cannot detect abnormalities when partial ureteral obstruction or thermal burn occurs[19]. In questionable case of injury, further investigations are used as appropriate: renal ultrasonography, intravenous pyelography, computerized tomography with intravenous contrast. In the present study, the renal ultrasonography was used because of the advantages of non-invasiveness and accuracy. Hydronephrosis or occasional urinoma can be detected with high sensitivity.

The complexity of pelvic disease is the main drawback of this technique. In the case of obliterated cul-de-sac with dense adhesion or severe peritoneal endometriosis, the incision of colpotomyin the first place is sometimes difficult or impossible. Another limitation of the study was a small number of patients. The measured distances, however, had little variation.

Conclusion

To decrease the incidence of ureteral injury, the retrograde technique of TLH with a combination of AUM and colpotomy is developed. The data on the distances measured by fluoroscopic imaging have demonstrated the safer distance of operative field. However, the benefit of this technique of TLH to decrease the incidence of ureteric injury needs to be evaluated in a larger group of patients.

What is already known in this topic?

The ureteric injury is the one of serious major complication during total laparoscopic hysterectomy. One of the most common site of injury is the cardinal ligament whereas the ureter pass inferiorly to the uterine artery. The distance between ureter to cervix at this site is approximately 1.5 to 2 cm.

What this study adds?

The technique of TLH which using the Anurach uterine manipulator with reverse technique of hysterectomy starting from colpotomy. After using this technique, the total distances were demonstrated in the ranges of 3.0 to 3.6 cm. The mean of longer distances were 1.50 and 1.58 cm at the left and right sides, respectively. This technique could decrease the chance of ureteric injury.

Potential conflicts of interest

None.

References

1. O'Hanlan KA, Dibble SL, Garnier AC, Reuland ML. Total laparoscopic hysterectomy: technique and complications of 830 cases. JSLS 2007; 11: 45-53.
2. Kiran A, Hilton P, Cromwell DA. The risk of ureteric

injury associated with hysterectomy: a 10-year retrospective cohort study. BJOG 2016; 123: 1184-91.
3. Kang HW, Lee JW, Kim HY, Kim BW, Moon CS. Total laparoscopic hysterectomy via suture and ligation technique. Obstet Gynecol Sci 2016; 59: 39-44.
4. Tan-Kim J, Menefee SA, Reinsch CS, O'Day CH, Bebchuk J, Kennedy JS, et al. Laparoscopic Hysterectomy and Urinary Tract Injury: Experience in a Health Maintenance Organization. J Minim Invasive Gynecol 2015; 22: 1278-86.
5. Teeluckdharry B, Gilmour D, Flowerdew G. Urinary Tract Injury at Benign Gynecologic Surgery and the Role of Cystoscopy: A Systematic Review and Meta-analysis. Obstet Gynecol 2015; 126: 1161-9.
6. Manoucheri E, Cohen SL, Sandberg EM, Kibel AS, Einarsson J. Ureteral injury in laparoscopic gynecologic surgery. Rev Obstet Gynecol 2012; 5: 106-11.
7. Tanprasertkul C, Kulvanitchaiyanunt A. A modified technique to simplify TLH with new developed uterine manipulator; Anurach uterine manipulator (AUM). J Med Assoc Thai 2010; 93 (Suppl 7): S154-9.
8. Barber EL, Harris B, Gehrig PA. Trainee participation and perioperative complications in benign hysterectomy: the effect of route of surgery. Am J Obstet Gynecol 2016; 215: 215-7.
9. Chan JK, Morrow J, Manetta A. Prevention of ureteral injuries in gynecologic surgery. Am J Obstet Gynecol 2003; 188: 1273-7.
10. Tanaka Y, Asada H, Kuji N, Yoshimura Y. Ureteral catheter placement for prevention of ureteral injury during laparoscopic hysterectomy. J Obstet Gynaecol Res 2008; 34: 67-72.
11. Chou MT, Wang CJ, Lien RC. Prophylactic ureteral catheterization in gynecologic surgery: a 12-year randomized trial in a community hospital. Int Urogynecol J Pelvic Floor Dysfunct 2009; 20: 689-93.
12. Ibeanu OA, Chesson RR, Echols KT, Nieves M, Busangu F, Nolan TE. Urinary tract injury during hysterectomy based on universal cystoscopy. Obstet Gynecol 2009; 113: 6-10.
13. Einarsson JI, Suzuki Y. Total laparoscopic hysterectomy: 10 steps toward a successful procedure. Rev Obstet Gynecol 2009; 2: 57-64.
14. Phillips CK, Hruby GW, Durak E, Lehman DS, Humphrey PA, Mansukhani MM, et al. Tissue response to surgical energy devices. Urology 2008; 71: 744-8.
15. Goldstein SL, Harold KL, Lentzner A, Matthews BD, Kercher KW, Sing RF, et al. Comparison of thermal spread after ureteral ligation with the Laparo-Sonic ultrasonic shears and the Ligasure system. J Laparoendosc Adv Surg Tech A 2002; 12: 61-3.
16. Wu HH, Yang PY, Yeh GP, Chou PH, Hsu JC, Lin KC. The detection of ureteral injuries after hysterectomy. J Minim Invasive Gynecol 2006; 13: 403-8.
17. Ostrzenski A, Radolinski B, Ostrzenska KM. A review of laparoscopic ureteral injury in pelvic surgery. Obstet Gynecol Surv 2003; 58: 794-9.
18. Patel H, Bhatia N. Universal cystoscopy for timely detection of urinary tract injuries during pelvic surgery. Curr Opin Obstet Gynecol 2009; 21: 415-8.
19. Dandolu V, Mathai E, Chatwani A, Harmanli O, Pontari M, Hernandez E. Accuracy of cystoscopy in the diagnosis of ureteral injury in benign gynecologic surgery. Int Urogynecol J Pelvic Floor Dysfunct 2003; 14: 427-31.

ระยะห่างระหว่างท่อไตถึงปากมดลูกในเทคนิคการผ่าตัดมดลูกแบบย้อนทางโดยการใช้กระดกมดลูกอนุราชร่วมกับการตัดเข้าช่องคลอดเพื่อหลีกเลี่ยงการบาดเจ็บต่อของท่อไตระหว่างการตัดมดลูกผ่านกล้อง

ชำนาญ แท่นประเสริฐกุล, อนุราช กุลวานิชไชยนันท์

วัตถุประสงค์: เพื่อวัดระยะห่างระหว่างท่อไตถึงปากมดลูกระหว่างการการตัดมดลูกผ่านกล้องในเทคนิค การผ่าตัดมดลูกแบบย้อนทางโดยการใช้กระดกมดลูกอนุราชร่วมกับการผ่าตัดเข้าช่องคลอด

วัสดุและวิธีการ: ได้ทำการวัดระยะห่างระหว่างท่อไตถึงปากมดลูกในผู้ป่วย จำนวน 20 ราย ที่มาผ่าตัดมดลูกผ่านกล้อง โดยใช้เทคนิคการผ่าตัดมดลูกแบบย้อนทาง ร่วมกับการใช้กระดกมดลูกอนุราชร่วมกับการตัดเข้าช่องคลอดด้วยการใช้สายในท่อไตและตรวจดูภาพรังสีบนจอหรือฟลูโอสโคป ระหว่างเดือนมกราคม พ.ศ. 2559 ถึง เดือนมิถุนายน พ.ศ. 2559

ผลการศึกษา: ผู้ป่วยจำนวน 20 ราย อายุเฉลี่ย 39.8 ปี ได้ผ่าตัดมดลูกแบบย้อนทางเวลาผ่าตัดเฉลี่ย 113.40 นาที ทุกรายได้ถูกวัดระยะห่าง มีระยะห่างก่อนการใช้เทคนิคตั้งแต่ 1.5 ถึง 1.8 เซนติเมตร ระยะเฉลี่ย 1.62 และ 1.63 เซนติเมตร ในข้างซ้ายและขวาตามลำดับ ระยะห่างหลังใช้เทคนิคตั้งแต่ 3.0 ถึง 3.6 เซนติเมตร ระยะเฉลี่ย 3.12 และ 3.21 เซนติเมตร ในข้างซ้ายและขวาตามลำดับ โดยมีระยะห่างเพิ่มขึ้น เฉลี่ย 1.50 และ 1.58 เซนติเมตร ในข้างซ้ายและขวาตามลำดับ ไม่พบภาวะแทรกซ้อนใดๆ และได้ตรวจคลื่นเสียงความถี่สูงของระบบไตและกรวยไตที่ 48 ชั่วโมง ในหนึ่งสัปดาห์แรก และหนึ่งเดือนหลังการผ่าตัด

สรุป: โดยเทคนิคการผ่าตัดนี้แพทย์ผ่าตัดสามารถเพิ่มระยะห่างของการผ่าตัดในตำแหน่งนี้ของท่อไตอย่างปลอดภัยมากขึ้นในผู้ป่วยกลุ่มแรกที่ได้ศึกษา พบว่าเทคนิคการผ่าตัดนี้ได้ประโยชน์ในการลดโอกาสการบาดเจ็บท่อไต อย่างไรก็ตามควรจะได้มีการประเมินในผู้ป่วยจำนวนที่มากขึ้นและหลากหลายขึ้น