

The Complication of Ureteral Injury Induced by Gynecological Laparoscopic Surgery

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Abstract: Compared with traditional laparotomy, laparoscopic surgery has obvious advantages (smaller incisions, shorter hospital stays, and reduced blood loss). At present, more and more gynecological surgeries can be completed under laparoscopy. With the increasement of clinical treatment of gynecological laparoscopic surgery, the complications related to gynecological laparoscopic surgery and their prevention measures have become a continuous concern in the field of gynecology. The risk of injury to the lower urinary tract, consisting of the bladder and ureters, is inherent to gynecologic surgery regardless of operative technique, because the bladder and ureters lie adjacent to other critical structures. Ureteral injury caused by gynecological laparoscopic surgery is a relatively rare complication. Clinicians do not pay enough attention to it because of its low incidence. However, once it happens, the consequences are often serious. The clinical manifestations of ureteral injury caused by gynecological laparoscopic surgery vary greatly according to the location and severity of the injury. Patients with mild injury can heal themselves after conservative treatment, and patients with severe injury can have serious consequences such as peritonitis and acute renal insufficiency, and even lead to death. This paper will focus on ureteral anatomy, common causes, clinical manifestations, key points of diagnosis, treatment measures and prevention strategies of ureteral injury caused by laparoscopic surgery.

Keywords: Gynecological Laparoscopic Surgery, Ureteral Injury, Ureteral Vaginal Fistula, Complications

1. Introduction

With the continuous development of minimally invasive surgery, laparoscopic surgery has been widely used in clinical departments. Laparoscopic surgery is accepted by more and more patients and widely used in the field of gynecology because of its advantages of small trauma, less bleeding, fast postoperative recovery, beautiful incision and integration of diagnosis and treatment [1, 2]. However, minimally invasive is not equal to noninvasive. With the continuous development of laparoscopic equipment and the continuous maturity of technology, the indications of

laparoscopic surgery are also expanding, the operation difficulty is correspondingly increasing, and the incidence of surgical complications is also increasing. In particular, the anatomical relationship between ureter and uterus is very close, and there are more and more ureteral injuries [3]. Previous studies have urinary tract injury in gynecologic reported varied incidences of laparoscopy, from 0.2% to 1.6% [4, 5]. This paper will discuss the anatomy and itinerary of normal female ureter, the common causes of ureteral injury complicated by gynecological laparoscopic surgery, the clinical symptoms and diagnostic points of ureteral injury, as well as the

treatment and preventive measures of ureteral injury.

2. Anatomy and Course of Ureter in Normal Women

The ureter is a pair of flat and slender muscular organs, one on the left and one on the right, starting from the end of the renal pelvis to the bladder. The total length of the female ureter is about 25 ~ 28cm, and the lengths of the ureters on both sides are roughly the same. The diameter of ureter is uneven, with an average diameter of 0.8 ~ 1cm. The total length of ureter can be divided into abdomen, basin and inner wall.

2.1. Abdominal Part of the Ureter

Located behind the peritoneum, it is an extraperitoneal organ, which runs obliquely outward and downward along the front of the psoas major muscle. Slightly below the midpoint of the psoas major muscle, the female ureter and ovarian blood vessels intersect. The part above the intersection is the ureteral waist and the part below is the ureteral iliac part; The upper part of the left ureter is located behind the duodenal jejunal flexure, and the left colonic blood vessel crosses from its front. It descends in the posterior wall of the sigmoid space recess near the upper opening of the pelvis, behind the sigmoid colon and its mesangium, and passes in front of the lower end of the left common iliac blood vessel when entering the pelvic cavity; The upper part of the right ureter is crossed from the front by a blood vessel shaped in the duodenum. It descends near the upper opening of the pelvis, below the root of the mesentery and behind the end of the ileum. Enter the pelvis through the front of the external iliac artery.

2.2. Pelvic Part of the Ureter

The pelvic part of the ureter is shorter than the abdominal part, Walk down the lateral wall of the pelvic cavity, passes through the internal iliac vessels, lumbosacral trunk and the anteromedial side of the sacroiliac joint, crosses the starting part of the umbilical artery, the medial side of the obturator nerve and blood vessels, turns to the anteromedial side at the level of the sciatic spine, and reaches the bladder floor through the connective tissue above the pelvic floor. The upper part of the ischial spine is called the ureteral wall, and the lower part is the visceral part. The wall of the female ureter and pelvis crosses the front of the internal iliac artery and passes through the later lateral side of the ovary. The visceral part of the female ureter basin moves inward, passes through the connective tissue near the base of the broad ligament of the uterus, to both sides of the cervix and vaginal fornix, about 2.5cm away from the uterus, bypasses the posterior and lower part of the uterine artery, and passes through the front of the vagina to the bottom of the bladder. When the ureter passes through the front of the vagina, there are certain differences between the two sides. Because the uterus tilts to one side, the contact range between the tilted

ureter and the front wall of the vagina is wider. The relationship between female ureter and uterine artery, cervix and vaginal fornix has certain clinical significance in hysterectomy 1.3 interior of ureteral wall

2.3. Interior of Ureteral Wall

It refers to the ureter that runs obliquely in the bladder wall, about 1.5cm long, which can prevent the reflux of urine to the ureter. The middle and lower segments of the ureter are adjacent to multiple pelvic organs, so gynecological surgery is easy to cause ureteral injury. The injury sites were mostly located in the cervical isthmus, where the uterine artery crossed the ureter, uterosacral ligament and near the entrance of ureter bladder, that is, the lower 1/3 segment of ureter.

3. Common Causes of Ureteral Injury in Gynecological Laparoscopic Surgery

3.1. Surgical Accidental Injury

The accidental injury of ureter in gynecological laparoscopic surgery is mainly related to the mode of operation and the difficulty of operation [6]. When the following factors exist, the risk of ureteral injury caused by surgery will be greatly increased.

3.1.1. Enlargement of Uterus

The abnormally enlarged uterus compresses and displaces the ureter, which affects the exposure and operation of the surgical field, thus increasing the chance of ureteral injury;

3.1.2. Variation of Ureteral Course

Endometriosis, pelvic inflammatory disease, pelvic surgery history, etc. cause pelvic adhesion, resulting in unclear levels between tissues, displacement of ureter to the midline, and ureter is easy to be damaged during operation;

3.1.3. Changes in Operating Technology

Laparoscopic surgery is a device dependent surgery. Compared with traditional open surgery, laparoscopic surgery field is a two-dimensional space, the operator lacks a sense of depth, and requires higher experience and skills [7]. Unskilled operation under the microscope or unfamiliar with pelvic anatomy, easy to damage or puncture the ureter by mistake;

3.1.4. Other Factors

In case of accidents such as massive bleeding during operation, it is easy to accidentally injure the ureter by blind clamping, electrocoagulation or suture; In addition, a large number of free ureters are easy to lead to insufficient ureteral blood supply and ischemic necrosis, resulting in secondary ureteral injury such as ureteral fistula.

3.2. Thermal Damage

That is, intraoperative electrothermal injury, which is a unique complication of laparoscopic surgery. Because

laparoscopic surgery often adopts electrocoagulation and electroresection, thermal injury is the most important cause of ureteral injury caused by laparoscopic surgery [8]. The range and degree of heat conduction are related to the use of electrocoagulation, the length of electrocautery time, the power and the scope of operation [9]. When unipolar electrocoagulation is applied, the tissue damage range may exceed 3 ~ 5cm of the contact point. Although the heat conduction range of bipolar electrocoagulation is only 5mm, there is still a risk of direct thermal damage [10]. Too long electrocoagulation time, too much power or electrocoagulation range are more likely to cause ureteral ischemia and necrosis, and ureteral thermal injury is not easy to be found during operation. Almost all symptoms occur 1 ~ 3 weeks after operation, and the clinical symptoms are not typical, which is easy to be confused with postoperative infection. Therefore, the diagnosis time of ureteral thermal injury is generally late, but the consequences are often serious, such as ureteral leakage, chronic renal function damage and so on.

4. Clinical Symptoms and Diagnosis of Ureteral Injury

4.1. Clinical Symptoms of Ureteral Injury

The occurrence time of clinical symptoms of ureteral injury is often related to the type and degree of injury. If it occurs in a short time after operation is generally serious, which may be ureteral fracture or transverse clamp; If it appears later after operation, the injury is more mild and the symptoms are not typical. Ureteral injury can be manifested as ureteral stenosis, obstruction, rupture and ureteral fistula [3]. The most common symptoms are oliguria, abdominal distension, abdominal pain, low back pain, fever, hematuria and vaginal fluid. In severe cases, pelvic mass, peritonitis, acute renal insufficiency and leukocyte elevation can occur.

4.2. Diagnosis of Ureteral Injury

The incidence of ureteral injury caused by gynecological laparoscopic surgery is not high, but it is generally serious [11]. Timely detection and diagnosis of ureteral injury during laparoscopic surgery can avoid permanent injury and improve the success rate of injury repair. However, generally speaking, only approximate 1/3 of ureteral injuries can be found during operation [5]. Ureteral injury should be suspected when there are symptoms such as lumbar and abdominal pain, fever, vaginal leakage, oliguria and peritonitis, and the diagnosis should be checked immediately. Once the diagnosis is delayed, it will lead to the development of hydronephrosis, loss of renal function and fistula formation, resulting in serious consequences [12]. Pyelography and cystoscopy are the most valuable diagnostic methods, and biochemical examination of peritoneal exudate is also helpful for differential diagnosis [13].

5. Treatment of Ureteral Injury Ureteral

Injury caused by gynecological laparoscopic surgery mainly includes ureterotomy, suture and tissue necrosis. At present, the clinical opinions on the treatment of ureteral injury are not unified [14]. The main manifestation of intraoperative ureteral injury is that there are more wounds in the operation field and clear liquid flows out. Once the cause is clear, it should be repaired immediately, because there is no tissue edema or adhesion at this time. The operation is relatively simple and the prognosis is good. It is the best time for treatment. Once ureteral injury is diagnosed after operation, it should be treated in time to protect renal function and prevent serious infection. Corresponding treatment methods should be taken according to the location and degree of injury. For minor injury, D-J tube should be placed for internal stent drainage, which is generally curable. If the placement is unsuccessful, surgery should be performed, such as ureteral end-to-end anastomosis or ureteral bladder replantation for repair [14, 15], D-J tube should be routinely retained after operation to ensure the success of operation.

6. Precautions of Ureteral Injury

6.1. Precautions for Accidental Injury of Ureter During Operation

During the operation, the operation field should be fully exposed and the course of ureter should be paid attention to at all times [16, 17]; The improvement of operative skills can reduce the incidence of ureteral injury [4]; Strictly grasp the surgical indications. Once it is found that the operation is difficult and the possibility of injury is high during the operation, it should be converted to laparotomy decisively. Laparotomy should not be taboo because of overconfidence or deliberately pursuing a low conversion rate, resulting in serious complications; For the operation with great difficulty and possible injury, ureteral catheter or stent can be preset before operation to prevent ureteral injury [18, 19].

6.2. Precautions of Ureteral Thermal Injury

Strengthen laparoscopic technical training. Before operation, check the insulation layer of surgical instruments. During operation, the operator should control the surgical instruments and current generator control board by himself, and the electrified instruments must be accurate in place [20]; Reasonable equipment allocation and application, and do not use mismatched equipment or surgical instruments; The operator should be familiar with local anatomy, especially the relationship between ureter, uterus and ovary; When bipolar electrocoagulation is needed for bleeding in the serosa layer or adjacent tissues of the ureter, it is best to stop immediately to avoid large-scale or long-term electrocoagulation, so as to reduce thermal radiation; Fully understand the clinical characteristics of ureteral thermal injury caused by laparoscopic surgery, and deal with the unexplained

abdominal pain, low back pain, fever and the possibility of ureteral thermal injury in time.

7. Summary

To sum up, in various gynecological laparoscopic operations, we should pay close attention to whether there is ureteral injury during and after operation. Once found, we should take immediate measures to maximize the protection of renal function and improve the prognosis. However, the reconstruction of ureter has always been challenging for surgeons [11], so prevention should be given priority to ureteral injury. Technically, most ureteral injuries in gynecological laparoscopic surgery can be prevented. Therefore, surgeons should improve their operation technology, be familiar with the local anatomical relationship of pelvic cavity, maintain high vigilance during operation, and try to avoid complications. However, the thermal injury of ureter is not easy to find during operation, and often produces complications after operation, so it should be paid more attention and beware by the operator.

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References

- [1] Aarts JW, Nieboer TE, Johnson N, Tavender E, Garry R, Mol BW, et al. Surgical approach to hysterectomy for benign gynaecological disease. *The Cochrane Database of Systematic Reviews* 2015, Issue 8. Art. No.: CD003677.
- [2] Packiam VT, Cohen AJ, Pariser JJ, Nottingham CU, Faris SF, Bales GT. The impact of minimally invasive surgery on major iatrogenic ureteral injury and subsequent ureteral repair during hysterectomy: a national analysis of risk factors and outcomes. *Urology* 2016; 98: 183–188.
- [3] Abboudi H, Ahmed K, Royle J, Khan MS, Dasgupta P, N'Dow J. Ureteric injury: a challenging condition to diagnose and manage. *Nat Rev Urol* 2013; 10: 108–115.
- [4] Adelman MR, Bardsley TR, Sharp HT. Urinary tract injuries in laparoscopic hysterectomy: a systematic review. *J Minim Invasive Gynecol* 2014; 21: 558–66.
- [5] Wong JMK, Bortoletto P, Tolentino J, Jung MJ, Milad MP. Urinary Tract Injury in Gynecologic Laparoscopy for Benign Indication: A Systematic Review. *Obstet Gynecol.* 2018; 131 (1): 100-108.
- [6] Härkki-Sirén P, Sjöberg J, Tiitinen A. Urinary tract injuries after hysterectomy. *Obstet Gynecol.* 1998; 92 (1): 113-118.
- [7] Vajsbaher T, Ziemer T, and Schultheis H. A multi-modal approach to cognitive training and assistance in minimally invasive surgery. *Cognitive Systems Research.* vol. 2020; 64, pp. 57–72.
- [8] Pryor A, Mann WJ, et al. Complications of laparoscopic surgery. In: Marks, J, Falcone, T, editors. *UpToDate.* 2015 June.
- [9] Lipscomb GH, Givens VM. Preventing electrosurgical energy-related injuries. *Obstet Gynecol Clin North Am.* 2010; 37 (3): 369-377.
- [10] Wu MP, Ou CS, Chen SL, Yen EY, Rowbotham R. Complications and recommended practices for electrosurgery in laparoscopy. *Am J Surg.* 2000; 179 (1): 67-73.
- [11] Oh BR, Kwon DD, Park KS, Ryu SB, Park YI, Presti JC Jr. Late presentation of ureteral injury after laparoscopic surgery. *Obstet Gynecol.* 2000; 95 (3): 337-339.
- [12] Pompeo A, Molina WR, Seht D, et al. Laparoscopic ureteroneocystostomy for ureteral injuries after hysterectomy. *JLS.* 2013; 17 (1): 121-125.
- [13] Lee JH, Choi JS, Lee KW, Han JS, Choi PC, Hoh JK. Immediate laparoscopic nontransvesical repair without omental interposition for vesicovaginal fistula developing after total abdominal hysterectomy. *JLS.* 2010; 14 (2): 187-191.
- [14] Smith AP, Bazinet A, Liberman D. Iatrogenic ureteral injury after gynecological surgery. *Can Urol Assoc J.* 2019; 13 (6 Suppl4): S51-S55.
- [15] Ahn JH, Han JY, Nam JK, Park SW, Lee SD, Chung MK. Laparoscopic ureteroneocystostomy: modification of current techniques. *Korean J Urol.* 2013; 54 (1): 26-30.
- [16] Hove LD, Bock J, Christoffersen JK, Andreasson B. Analysis of 136 ureteral injuries in gynecological and obstetrical surgery from completed insurance claims. *Acta Obstet Gynecol Scand.* 2010; 89 (1): 82-86.
- [17] Nerli RB, Ghagane SC, Kadeli V, Hiremath MB. Ureteric injuries during laparoscopic gynecologic surgeries. *J Sci Soc* 2019; 46: 3.
- [18] 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 (1): 67-72.
- [19] Siow A, Nikam YA, Ng C, Su MC. Urological complications of laparoscopic hysterectomy: a four-year review at KK Women's and Children's Hospital, Singapore. *Singapore Med J.* 2007; 48 (3): 217-221.
- [20] Tulikangas PK, Smith T, Falcone T, Boparai N, Walters MD. Gross and histologic characteristics of laparoscopic injuries with four different energy sources. *Fertil Steril.* 2001; 75 (4): 806-810.