

Delayed-onset ureteral lesions due to thermal energy: An emerging condition

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INTRODUCTION

Energy-based surgical devices (ESD) are increasingly used both in laparoscopic and open procedures in many surgical branches, including Urology and Gynecology, with the aims of reducing operative time and providing haemostasis and clear vision, enhancing the efficiency of dissection and tissue fusion.

The most frequently used systems are electrosurgical (monopolar, bipolar, impedance-controlled bipolar) and ultrasonic (1). However the extent of tissue damage beyond the area of energy application due to peripheral energy spread is a potential drawback of modern era surgery with ESD.

An extensive description of the physics of thermal energy in ESD is beyond the scope of this presentation. In brief monopolar energy is a form of high-frequency *alternating current* (AC) causing a thermal effect flowing from the active electrode to a grounding plate. In the coagulation mode the AC flows in bursts causing evaporation of water within the tissues, without cell rupture, while in the cutting mode the AC flow is continuous, determining cell rupture and water evaporation. Bipolar energy flows from one tip of the instrument to the other (active and return electrode), limiting diffusion to surrounding tissues (2). A further development is impedance controlled bipolar (*LigaSure TM*; *Valleylab, USA*), where the system itself rather than the surgeon controls the energy delivered to the tissues, determining fusion without

charring and further reducing the thermal spread (3). Ultrasonic systems (*Harmonic scalpel, Ultracision TM, Ethicon, USA*) are piezoelectric transducers converting electricity into vibrations under the form of ultrasounds. The combination of pressure, mechanical vibration, water evaporation and collagen denaturation at relatively low temperatures determine tissue fusion.

All the described systems however can cause thermal damage to neighboring structures, even the more sophisticated and theoretically safer ones, particularly around the tips of the instruments where high temperatures are reached even with ultrasonic systems.

The ureter, due to its relatively small caliber and continuous flow of urine is particularly susceptible to inadvertent damage with thermal energy: experimental studies have evaluated in animal models the extent of ureteral injury with direct application of different energy sources (1, 4, 5). Monopolar energy was found to cause more extensive damage compared to the other ESD, and laparoscopic injuries are more severe than those occurring in open cases, due to less heat dispersion within the closed abdomen and greater impedance caused by lack of frequent cleaning of the instrument jaw surface (1).

We report herein our experience with the management of inadvertent ureteral lesions due to ESD occurring during both open and laparoscopic gynecological and urological procedures.

Table 1.
Patient demographics and relevant clinical data.

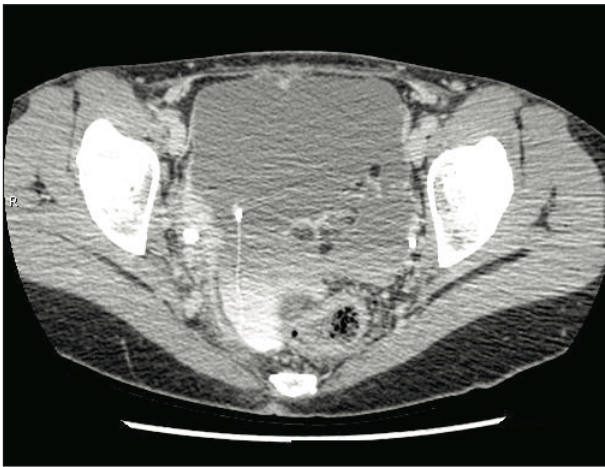
Case	Age	Gender	Procedure	Source of energy	Time of presentation	Treatment performed
1	50	F	Laparoscopic-robot assisted vaginal hysterectomy	Mono & Bipolar cutting and coagulation	20 days after surgery	Right ureterocystoneostomy
2	52	F	Laparoscopic-assisted vaginal hystero-salpingo-oophorectomy	Mono & Bipolar cutting and coagulation	15 days after surgery	Left ureterocystoneostomy
3	53	F	Laparoscopic-assisted vaginal hystero-salpingo-oophorectomy	Mono & Bipolar cutting and coagulation	15 days after surgery	Right ureteral JJ stent
4	71	M	Enucleation of right renal tumor	Bipolar forceps coagulation	120 days after surgery	Inferior right nephropexy and uretero-ureterostomy
5	77	M	Enucleation of right renal tumor	Computer-based, temperature-controlled bipolar electrocoagulation (<i>LigaSure Impact™</i>)	60 days after surgery	Right nephrectomy

CASE 1.

A 50-y.o. woman underwent robot-assisted vaginal hysterectomy for multiple uterine leiomyomata in June 2011 using bipolar grasper and monopolar scissors. 20 days later she came to our observation complaining abdominal pain and distension. Physical examination showed a tender, swollen abdomen. Bowel sounds were absent in the lower quadrants and at percussion the upper abdomen was tympanic and the lower abdomen dull. A chest and abdomen X-ray revealed the small bowel packed in left hypocondrium and epigastrium; only the right colon was visible in place. A CT scan was therefore performed, showing diffuse abdomino-pelvic free fluid and right mild ureterohydronephrosis. Contrast study demonstrated a jet of contrast medium originating from the right pelvic ureter (Figure 1) being responsible for the uoperitoneum. A double J stent was placed, and left indwelling for 2 months, while the patient was asymptomatic. One week after the stent was removed, right hydronephrosis was documented at sonography. A repeated uro-CT scan showed a 1 cm stricture of the paravesical tract of the right ureter. Ureteral reimplantation was therefore performed in November 2011, with an uneventful followup after 13 months.

Figure 1.

Case 1. Uro-CT scan demonstrating uoperitoneum and a jet of contrast medium originating from the right pelvic ureter.



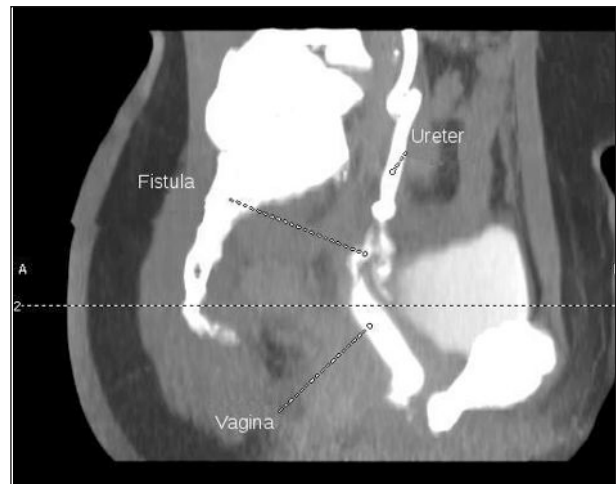
CASE 2

In March 2012 a 52 y. o. woman come to our observation complaining fever and clear vaginal leakage. 15 days prior to our visit, she underwent laparoscopic-assisted vaginal hysterectomy-salpingo-oophorectomy for a right serous cystadenoma, with the use of both monopolar scissors and bipolar grasper. Physical examination showed a soft, non-tender abdomen, with normal bowel sounds. Vaginal examination revealed an inflamed erythematous mucosa with clear fluid pooling at its apex. An uretero-vaginal fistula was suspected. An abdominal CT scan was therefore performed, showing a fistulous tract extending from the terminal tract of the left ureter to the left lateral aspect of the vaginal dome, with

extraperitoneal diffusion of contrast medium (Figure 2). Since an attempt at double J stent placement was no successful, a left nephrostomy was placed. In April 2012 an antegrade pyelography demonstrated tapering and complete obliteration of the distal tract of the left pelvic ureter, while the fistulous tract was no longer visible. A left ureterocystoneostomy was performed two months later. A CT scan performed 1 month postoperatively documented grade II uretero-hydronephrosis, while at 6 months follow-up the patient is asymptomatic with grade I hydronephrosis at sonography.

Figure 2.

Case 2. CT scan showing left uretero-vaginal fistula 15 days after gynecological surgery



CASE 3.

In January 2013 a 53-y.o. woman underwent laparoscopic-assisted vaginal hysterectomy-salpingo-oophorectomy for low stage cervical carcinoma. She was discharged uneventfully on the 5th post-operative day, but she presented again 10 days later with abdominal pain of sudden onset and vaginal discharge. Uro-CT scan revealed a right uretero-vaginal fistula with dilation of the upper urinary tract. A guidewire was successfully negotiated above the fistula and over it a 6F x 28 cm double J stent was positioned. The bladder was drained with an indwelling catheter for 5 days and vaginal discharge stopped. Three months later the stent was removed and at 6 months follow-up the patient is asymptomatic and without evidence of right hydronephrosis at sonography.

CASE 4

In October 2011 a 71-y.o. man with bilateral renal tumors and normal renal function underwent right enucleation for an inferior pole 3 cm pT1a G1 clear cell cancer. One month later left radical nephrectomy for a meso-renal 8 cm pT2a G2 clear cell cancer was performed. During the first procedure an inadvertent brief touch of the upper ureter with a bipolar forceps occurred while dissecting the perirenal fat. Serum creatinine remained 1.5 mg/dl for 3 months, and started to rise in

February 2012 (8.3 mg/dl), with preserved diuresis. Sonography revealed mild hydronephrosis of the right kidney. Ureteral stent placement was unsuccessful: a nephrostomy was therefore positioned and an antegrade contrast study showed a stricture 2 cm below the uretero-pelvic-junction. In March 2012 open repair with excision of 1 cm stenotic ureteral segment, inferior nephropexy and uretero-ureterostomy was performed. Pathologic examination of the ureter tract reported marked chronic and acute inflammatory infiltrate of the ureteral wall. At 9 months follow-up the patient is asymptomatic with stable renal function.

CASE 5

In February 2012 a 77-y.o. man underwent enucleation of a 3,5 cm renal mass at the inferior pole of the right kidney, with use of LigaSure Impact TM for renal isolation. The pathological report confirmed a clear cell renal cancer pT1a G2 according to Fuhrman Classification. 2 months postoperatively the patient presented at our institution reporting right flank pain and right renal pain. An US examination was performed, showing grade II hydronephrosis. Retrograde pyelography demonstrated "string of beads" irregularities of the upper right ureter, with scant extravasation (Figure 3). Since a double J stent could not be passed, a right nephrostomy was placed. Surgical open repair was therefore attempted: an extensive ureterolysis was performed, and the ureter was thereafter incised in its lumbar tract. We tried to place a stent over a rigid guidewire, but the attempt was unsuccessful due to multiple strictures of the upper ureteral tract. Considering the presence of extensive adhesions and the existence of a normal contralateral kidney, nephrectomy was preferred. At 9 months follow-up the patient is asymptomatic with normal serum creatinine.

CONCLUSION

Inadvertent ureteral damage by different thermal energy sources is an emerging condition, requiring awareness, prompt recognition and adequate treatment with the principles of reconstructive urology. When adopting the new operative technologies, relying mostly on ESD, careful visualization of the ureter, delicate isolation and respect of the surrounding tissues by minimizing the use of thermal energy are the basic principles that must be respected, in order to prevent this kind of complication.

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Figure 3.

Case 5. Retrograde pyelography demonstrating multiple strictures of the upper ureter and scant extravasation (arrow).

