

Iatrogenic ureteral lesions and repair: A review for gynecologists

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Abstract. Ureter injuries are a well-known complication of gynecologic surgery and a frequent cause of medicolegal problems. Because there are no randomized, controlled trials and the available studies are small series and case reports, the evidence on which to base treatment is weak. We therefore reviewed the complete English-language literature of ureter repair since 1990. In total, 608 ureter injuries were reported. Although it is widely believed that for laceration or section the prognosis is affected by a delay in diagnosis, we could not find evidence to substantiate this. An obstruction requires stenting only. For a laceration, stenting with suturing was more effective than stenting only ($p = .006$). A ureter anastomosis was successful in over 94% of cases either by laparotomy or laparoscopy. In conclusion, the literature data are scanty and heterogeneous and do not permit solid conclusions. Evidence, however, is emerging that a laceration should be treated by stenting and suturing. A ureter anastomosis over a stent could become a valid option especially when performed by laparoscopy.

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Ureter injuries are a well-known complication of gynecologic surgery, accounting for at least 6% of all medicolegal actions¹ in obstetrics and gynaecology² with a very high risk (91-fold compared with another complication or problem at gynecologic surgery) of litigation.³ The incidence of ureter injuries has been estimated at 0.03% to 2% after abdominal hysterectomy, 0.02% to 0.5% after vaginal hysterectomy, 0.2% to 6% after laparoscopic-assisted vaginal hysterectomy, and 1.7% to 3% after urogynecologic

surgery.^{4,5} During more extensive surgery, the incidence is obviously higher, with reported incidences of 4.4% for Wertheim-Meigs hysterectomy. For severe endometriosis, data on the incidence of ureter injuries taking into account the severity of endometriosis and the degree of ureter involvement are lacking.⁶

It remains controversial whether endoscopic surgery in comparison with laparotomy is associated with a higher incidence of ureter injuries. The large national reviews show an overall increased risk of ureter injuries. This observation, however, does not permit conclusions concerning laparoscopy as a technique, because these reviews often comprise the learning curves of individual surgeons.^{7–11}

Treatment of ureter injuries ranges from a conservative repair, such as stenting with or without suturing for lacerations and anastomosis after section, to the eventual reim-

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plantation of the ureter in the bladder with a Boari flap and psoas hitch.¹² Unfortunately, but not surprising for a relatively rare complication, randomized, controlled trials comparing the outcome of the different treatment options have not been performed. Data are restricted to case reports and small series.

Because treatment of ureter injuries, in the absence of solid data, may vary from author to author, and because ureter injuries are a frequent cause for medicolegal claims in gynecology, we wanted to review the data available for the treatment or repair of ureter injuries.

Materials and methods

English-language papers only were reviewed. Original published articles since 1990 were identified by searching MEDLINE and by retrieving references mentioned in these papers when considered important. After using initially the MeSH terms “ureter” and “injury,” we used in addition as search keywords “iatrogenic,” “ureteral,” and “injury” or “injuries”; “laparoscopy”; “ureteral,” “injuries,” “gynaecologic,” and “surgery”; “ureter” and “reimplantation”; and “ureter,” “repair,” and “Boari flap.” The search was limited to the period after 1990 to cover a similar period for ureter repair by laparoscopy and by laparotomy.

In the analysis of the articles, we focused on the management of ureteral injuries in order to evaluate the relationship among the type of injury, the type of repair and the delay in diagnosis or repair, and the final outcome.

The articles were reviewed by 2 authors (CDC and JV), and data were collected in raw tables. No articles were discarded. In order to avoid bias, we decided to keep strictly to the raw data as the articles were generally not specific enough to judge quality. The data thus retrieved consisted of case reports and small reviews or series. Overall, the reports on laparoscopic repair were more detailed than those describing repair by laparotomy. Statistical significance was evaluated by χ^2 test.

Results

The literature search yielded 28 articles, with 608 cases of iatrogenic ureteral injury of which 57 were managed by laparoscopy^{13–26} and 551 by open surgery or stent placement only.^{27–40} The raw data are listed in Tables 1 and 2. Of the 468 injuries for which the type of lesion was described, 95 (20.3%) injuries were an obstruction due to a kinked, crushed, or ligated ureter; 116 (24.8%) injuries were lacerations or urinomas; 131 (28%) ureters were sectioned; and in 126 (26.9%), other types of injuries such as strictures or fistulas were found.

Overall, the outcome was similar after a repair by laparotomy or by laparoscopy, the repair being uneventful in

52/57 (91.3%) women when treated by laparoscopy versus 481/532 (90.4%) women after treatment by laparotomy.

Intraoperative versus postoperative management

It seems widely accepted that early recognition and treatment of ureter injuries are important for the final outcome. In this review, the injury was identified intraoperatively in 243 women (39.9%) and postoperatively in 333 women (54.8%). The time of identification was not specified in 32 women (5.3%). After a careful and specific review, we did not find any data specifying a different outcome between intraoperative or postoperative diagnosis or any data supporting the widely held belief that a late diagnosis is associated with a less favorable outcome. Although data do not permit a valid conclusion about the role of a delay in diagnosis upon the outcome, we want to stress that available data do not support the widely held belief that a late diagnosis affects outcome. We specifically looked for and did not find data to support that a delay in diagnosis affects the outcome.

Etiology and treatment of injuries

During or after laparoscopic surgery, 127 injuries were reported; 52 were treated by laparoscopy and 56 by laparotomy, and in 19 women, the treatment was not specified. During laparotomy, 481 injuries were reported, and 476 were treated by laparotomy and only 5 by laparoscopy.¹⁴

In the 127 ureteral injuries occurring during laparoscopy, the type of injury was reported in 89 cases. The injury was a kinked, crushed, or ligated ureter in 14 (15.7%), a laceration in 10 (11.2%), or a transection in 38 (42.7%). Other types of injury, such as strictures and fistulas, were reported in 27 (30.4%). Of the 481 laparotomic injuries, the type of injury was reported in 356 cases. There was a kinked, crushed, or ligated ureter in 98 (27.5%), a laceration in 57 (16.1%), or a transection in 91 (25.5%). There were 110 (30.9 %) other types of injuries.

Treatment by laparotomy

Obstructive injury

In 5 women, the management of a crushed or kinked ureter was described. The obstruction was managed with a double-J stent in 2 women, a psoas hitch and reimplantation in another 2, and a transureteroureterostomy in 1. In all women, the further outcome was uneventful. Ligation was reported in 78 ureters. This was managed by stenting in 24 women, deligation and stenting in 21, anastomosis in 1, uretero-ileocystostomy in 1, psoas hitch/Boari flap in 6, and implantation in 25 women. The outcome was uneventful in 73/78 women (93.6%). In 2 women treated by implan-

Table 1 Iatrogenic ureteral injuries treated by laparotomy (literature review from 1/1/1990 to 1/7/2006)

Author	No.	Intraoperative diagnosis (%)	Causes	Types	Management	Complications	
Al-Awadi et al ²⁷	82	68.3	2 Postradiation 7 Ob/Gyn 4 General surgery 69 Urologic surgery	Ligation 4 Obstruction 4 Laceration 64 Transection 10	Stent 48 Psoas hitch/Boari flap 7 Other 27	3 strictures	
Vakili et al ²⁸	8	100	471 Hysterectomies	Ligation 2 Obstruction 2 Transection 4	Deligation Stent Implantation	1 (1 ligation) 3 (2 obstruction + 1 ligation) 4 (4 transections)	0
Matani et al ²⁹	19	36.8	N/A	Ligation 10 Obstruction 4 Laceration 1 Transection 1 Fistula 3	Stent Implantation Transureteroureterostomy	9 (6 ligations + 3 fistulas) 9 (4 ligations + 3 obstructions + 1 laceration + 1 transection) 1 (1 obstruction)	1 fistula persisted-implantation 1 implantation developed stenosis-new implantation
Rafique and Arif ³⁰	20	0	Gynecologic surgery	Ligation 3 Obstruction 6 Fistula 11	Deligation Anastomosis Implantation Psoas hitch/Boari flap	2 (2 ligations) 1 (1 obstruction) 14 (11 fistulas + 3 obstructions) 3 (2 obstructions + 1 ligation)	1 ligation treated with deligation developed leakage-implantation
Sakellariou et al ³¹	88	37.5	Gynecologic surgery	Ligation 49 Obstruction 2 Laceration 8 Transection 20 Fistula 9	Deligation Stent Stent + Suture Anastomosis Implantation	18 (18 ligations) 18 (16 ligations + 2 fistulas) 18 (8 lacerations) 15 (15 transections) 29 (5 transections + 15 ligations + 7 fistulas + 2 obstructions)	1 anastomosis-leakage-stent
Liapis et al ³²	18	50	Gynecologic surgery	N/A	Anastomosis Implantation	13 5	0
Ghali et al ³³	32	28	20 Gynecologic surgeries 9 Urologic procedures 3 General surgery procedures	N/A	Deligation Stent Anastomosis Implantation Other	7 4 9 10 2	1 fistula 5 strictures
Tamussino et al ³⁴	4	25	Gynecologic surgery	Transection 1 Fistula 3	Stent Psoas hitch/Boari flap	1 (1 fistula) 3 (2 fistulas + 1 transection)	1 Psoas hitch performed for a transected ureter developed leakage-> repeated Psoas hitch
Selzman and Spimak ³⁵	165	52	70 Urologic procedures 95 Extraurologic injuries	Ligation 14 Obstruction 39 Laceration 37 Transection 55 Fistula 20	Deligation Stent Anastomosis Implantation Nephrostomy Other	5 30 41 36 44 9	4 ureterocutaneous fistulas 1 urinoma 8 strictures 10 other complications
Goodno et al ³⁶	19	27	Gynecologic surgery	N/A	Deligation Anastomosis Implantation	3 6 10	0

Table 1—Continued

Author	No.	Intraoperative diagnosis (%)	Causes	Types	Management	Complications
Assimos et al ³⁷	27	N/A	All types of surgery	Ligation 8 Obstruction 2 Laceration 8 Transection 7 Fistula 2	Stent 10 (7 laceration + 1 ligation + 1 transection + 1 fistula) Implantation Psoas hitch/Boari flap Other 8 (5 ligations + 1 laceration + 2 transections) 7 (4 transections + 2 ligations + 1 fistula) 2	4 ligations treated by implantation persisted-2 implantation + 2 psoas hitch 4 perforations treated with stent developed stricture in 3 and leakage in 1-2 ileal ureter + 1 dilatation + 1 Psoas hitch 1 fistula treated with stent and 1 transection treated with stent persisted leakage-2 psoas hitch 1 fistula treated with psoas hitch developed stricture-ballon dilation 2 strictures treated with stent persisted-psoas hitch
Blandy et al ³⁸	43	0	Hysterectomies	N/A	Psoas hitch/Boari flap 43	0
Neuman et al ³⁹	18	11	Ob/Gyn procedures	Ligation 6 Obstruction 4 Laceration 3 Fistula 5	Anastomosis 3 (2 lacerations + 1 ligation) Implantation Psoas hitch/Boari flap 2 (1 ligations + 1 obstruction) Nephrostomy 6 (3 ligations + 3 fistulas) Other 2 (1 laceration + 1 fistula + 1 obstruction) 4 (1 ligation + 2 fistulas + 1 obstruction)	0
Onwudiegwu et al ⁴⁰	8	37	Gynecologic surgery	Ligation 1 Transection 4 Fistula 3	Deligation 1 (1 ligation) Anastomosis 4 (4 transections) Implantation 1 (1 fistula) Other 2 (2 fistulas)	0

Table 2 Iatrogenic ureteral injuries treated by laparoscopy (literature review from 1/1/1990 to 1/7/2006)

Author	No.	Intraoperative diagnosis (%)	Causes	Types	Management	Complications
Kaloo et al ¹⁵	1	100	790 Laparoscopic excisions of endometriosis	Transection	1 Anastomosis 5 × 3/0 PDS sutures	0
Ou et al ¹³	4	25	3 Laparoscopic hysterectomies 1 Deep endometriosis	Transection	4 4 anastomosis (4–5 separate suture with 5-0 Vicryl)	0
Modi et al ¹⁴	6	0	3 Abdominal hysterectomies 1 Laparoscopic hysterectomy 2 Vaginal hysterectomies	Ligation Obstruction	5 Stent placement 1 After failure: 6 nephrostomies After failure: laparoscopic psoas hitch	0
Branco et al ¹⁶	1	0	Laparoscopic oophorectomy	Obstruction	1 Ureteral implantation	0
Fugita et al ¹⁷	3	0	N/A	Obstruction	3 3 Laparoscopic Boari flap	0
Oh et al ¹⁸	12	0	Laparoscopic surgery	Ligation Obstruction	5 4 Low lesions-> implantation 7 1 Midureteral lesion-> anastomosis 7 Lesions at pelvic brim-> Psoas hitch	In 9 patients, primary stenting was tried: only 3 cases were successful, but 2 had leakage and 1 had a stricture, so they needed implantation
Nezhat et al ¹⁹	1	100	Infiltrative endometriosis of the ureter	Obstruction	1 Implantation	Due to persisted stricture, a laparoscopic psoas hitch was performed
Cuillier et al ²⁰	1	100	Laparoscopy for endometriosis	Transection	1 Anastomosis (5 × 3/0 PDS sutures)	0
Nezhat et al ²¹	9	100	Laparoscopic surgery for endometriosis	Transection	9 9 Laparoscopic anastomosis	1 Stricture-> dilatation
Koninckx et al ²²	1	100	CO ₂ laser excision of endometriosis	Laceration	1 Laparoscopic suture on stent	0
Nezhat et al ²³	11	100	Surgery for ureteral endometriosis	Pinpoint laceration Laceration Transection	5 5 Pinpoint laceration-> Stent placement 2 placement 4 2 Partial wall resection-> 1–3 sutures (4/0 polydioxanone) 4 Transection-> 3 anastomosis + 1 implantation	1 Renal silent necrosis due to late diagnosis of chronic endometriotic obstruction of the ureter
Saidi et al ²⁴	5	0	953 Consecutives gynecologic laparoscopies 1990–1994	Ligation Obstruction Transection	2 2 Ligations-> 1 deligation + 1 anastomosis 1 anastomosis 2 2 Transections-> 1 anastomosis + 1 implantation 1 Stricture-> ureterolysis	N/A
Nezhat et al ²⁵	1	100	Ureteral stenosis for infiltrating endometriosis below the pelvic brim	Stenosis due to infiltrating endometriosis	1 Laparoscopic resection and anastomosis with 4 stitches of polydioxanone 4/0	0
Gomel ²⁶	1	100	Deep endometriosis	Laceration	1 Stent + 4/0 single suture	0

tation, the ureteral obstruction persisted, and implantation was repeated. In 1 woman treated by implantation, the ureteral stricture persisted, and a psoas hitch was performed. In 1 woman, a fistula developed after implantation, and a psoas hitch was performed. And in 1 woman, leakage developed after deligation, and a psoas hitch was performed. We specifically searched for whether the duration of the delay of diagnosis affected treatment or outcome, but failed to find any data.

Laceration of the ureter

Treatment of ureter lacerations was reported in 20 women. In 2 women, lacerations were treated by implantation of the ureter and in 1 by nephrostomy only, both with no further complications. In 7 women, lacerations were treated by stenting only; in 3 of these, a stricture developed, and leakage continued in 1 and required another intervention. In 10 women, lacerations were treated by stenting and suturing over the stent, and all of the procedures were uneventful ($p = .006$, χ^2).

Transection of the ureter

In 37 women, a transection was described. Treatment consisted of implantation in 12 women, Psoas hitch/Boari flap in 5, anastomosis with a stent in 18 and without a stent in 1, and stenting only in 1. With the exception of 3 patients, all treatments were uneventful. In the woman treated by stenting only, leakage developed and a Boari flap-bladder implantation was subsequently performed. In 1 woman treated by anastomosis without stenting, a leak developed that resolved by stenting only. In 1 woman treated by implantation and psoas hitch, a leak developed that was treated by a repeated psoas-hitch.

Treatment by laparoscopy

Obstructive injury

Ligation of 7 ureters was reported. These were managed by deligation and stenting in 1 woman and by anastomosis in 1, both with an uneventful outcome. In 5 women, the

ligation was managed by a psoas hitch and implantation after a failed attempt of stenting. In 7 women with a stricture or stenosis, the treatment consisted of anastomosis in 1, psoas hitch/Boari flap in 4, and implantation in 2. All outcomes were uneventful except in 1 woman treated by implantation in whom the stricture persisted; she was subsequently treated by Boari flap.

Laceration of the ureter

Ureter laceration during or after laparoscopic procedures was reported in 9 women. In 4 women, laceration was treated by stenting and suturing over the stent. In 5 women with "pinpoint" laceration, the treatment was stenting only. Outcome was uneventful in all.

Transection of the ureter

In 22 women, management of transection was described. Two were treated by implantation and 20 by anastomosis. Stenosis developed in 1 woman after anastomosis, managed subsequently by dilatation only.

Discussion

Ureter injuries can be the cause of serious and permanent medical problems, and they are an important cause of medicolegal claims. Besides the obvious importance of prevention and recognition, a thorough knowledge of all the alternative methods of treatment and of their outcome seems fundamental. This has become even more important since the introduction of endoscopic surgery has generated new controversies. The discussion whether the risk of ureter damage is similar or increased during endoscopic procedures is still going on and will not be settled soon in the absence of solid data such as from randomized, controlled trials.

These trials are, however, very difficult to perform, for the obvious reason that surgeons who are equally proficient in both laparoscopic and laparotomic procedures are rare. Moreover, the assessment of relative risks would require a prospective, randomized trial of several thousands of women, which is a prohibitive number. We should be aware that the available data on the risk of ureter injuries, therefore, probably reflect the skill of the individual surgeon rather than a difference in technique. In the last decade, laparoscopic ureter repair such as ureter anastomosis and suturing have become technically feasible. Similar to the practical impossibility of performing randomized trials concerning the prevalence of ureter trauma, these laparoscopic procedures clearly cannot be performed as randomized, controlled trials. Even if it would be attempted, there would be the risk that the results would more likely reflect the skill and experience of an individual surgeon than any differences due to approach or techniques.

Because the basis of evaluation of a new treatment alternative is a thorough knowledge of the available data concerning the treatment modality and its outcome, we performed a complete review of all peer-reviewed data over the last 16 years. The first observation we made is that the number of women reported is relatively small, probably reflecting underreporting of individual ureter injuries. As might be expected, the literature is predominantly urologic, and only after the introduction of laparoscopic urology-gynecology did combined reports become available. Laparoscopic literature of multidisciplinary collaboration for ureter repair starts to be consistent since 1996.

Standard treatment for ureter repair seems to be a laparotomy during which a ureter implantation with or without Boari flap is performed. The results overall are excellent. It is unclear why this method of treatment seems to be preferred over ureter anastomosis. It seems logical to speculate that when laparotomy is performed, the method with a known excellent outcome is chosen in order to prevent another intervention in case of failure. With the introduction of laparoscopic procedures, it seems important to reassess critically the outcome of the different procedures because when performed by laparoscopy, an anastomosis is technically easier to perform than an implantation, and a Boari flap would be extremely difficult.

A key question is whether a delay in the diagnosis of a laceration or section (i.e., an intraabdominal ureter leak) will jeopardize the further outcome of the patient and if degree of outcome impairment depends on the delay. Although this seems to be a frequently heard opinion and sometimes mentioned in textbooks, we could not find any evidence supporting this, not even a hint, in the peer-reviewed literature. It seems logical to expect that a delay in diagnosis of several weeks will cause an inflammatory reaction and that this will increase the risk of adhesions, and eventually the outcome of ureter anastomosis or implantation. Common sense equally suggests, however, that a delay of a few days (i.e., during surgery or in the days after surgery) will not make any difference in outcome. Unfortunately, data are lacking.

Another question is which technique should be preferred for the ureter transection. A low transection will be treated by an anastomosis or an implantation; whereas for a mid-pelvic transection, an anastomosis or a Boari flap implantation can be performed. Although no data were found to support either option, the impression prevails that implantation is traditionally the most frequently performed technique, not because of a demonstrated better outcome, but because the outcome is known to be successful in almost all women, and that the risk of a second laparotomy thus is avoided. It is also obvious that in the choice of treatment, tradition plays an important role. It is surprising that no well-designed trials in animals were found describing the outcome of a microsurgical ureter repair, as was done for tubal anastomosis. Although a laparoscopic anastomosis has been reported in only 20 women, which is insufficient for

final conclusions, the available data suggest that the outcome is comparable to the laparotomic procedures. We therefore would suggest that a less-traumatic laparoscopic procedure should at least be attempted when the diagnosis is made during a laparoscopy. Moreover, if delay in diagnosis of a few days would not make any difference in outcome, as discussed previously, we would suggest that the less-traumatic laparoscopic procedure should also become the first choice of treatment. If the laparoscopic procedure indeed would be proved to have similar outcome, one might question whether a ureter injury should not preferentially be referred to a more skilled endoscopist if the first surgeon does not have these skills. Given the technical difficulty of the anastomosis of small structures as the oviduct and the ureter, this will remain a significant problem for many years to come. If, for instance, it would be proved that a robotic-assisted tubal anastomosis would improve the pregnancy rates, the discussion will even become more difficult. One might then conclude that specialized centers, skilled in robotic ureter anastomosis, should become a preferable option.

What emerged in this review is that treatment of laceration by a stent and a suture is superior to the use of a stent only ($p = .006$). The data also confirm that in women with a kinked or crushed ureter, when the viability is not compromised, a conservative approach with stenting only is sufficient. If the diagnosis of leak or obstruction is made after surgery, stenting together with laparoscopic assistance to guide stenting and eventual suturing thus seems to become the first option.

Conclusion

Data concerning the techniques to be used for ureter repair after injury remain anecdotal. Yet all data taken together are informative. For obstructive injuries, simple stenting seems to be sufficient, whereas for lacerations one might tentatively conclude that stenting with a suture is to be preferred. Both procedures should obviously be performed laparoscopically assisted since this permits suturing, removal of a stitch, and guidance of the stent. For transections, the results of anastomosis seem to be excellent, with similar results after anastomosis performed by laparoscopy than after laparotomy. These conclusions seem in contradiction to the widespread use of implantations for treatment of ureter injuries. We speculate that this is a remnant of the usual repair by laparotomy. Today, a laparoscopic anastomosis over a stent or a suture of a laceration seems to have become the method of choice. In order to accumulate data, reporting of all ureter injuries should therefore be encouraged.

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