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ORIGINAL ARTICLE

Ureteral injuries management in gynaecologic surgery: the role of the conservative approach

Short title: Conservative approach in ureteral injuries

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ABSTRACT

Objective. Ureter is one of the most important landmarks to be taken into consideration during gynaecological surgery. Today, mini-invasive techniques are available to treat ureteral injuries in a more conservative way. This study aims to propose a progressive operative model to manage ureteral injuries by comparing conservative and open approaches.

Materials and Methods. This retrospective study analysed 27 injuries in 24 patients admitted for ureteral injuries following gynaecological surgery (in 3 cases, ureteral injuries were bilateral). We obtained data from 16 lacerations, 5 stenosis, and 6 fistulas. Patients in the study were treated with three different techniques for ureteral injuries: cystoscopy with retrograde ureteral stenting, interventional radiology and ureterocystoneostomy.

Results. In a retrospective analysis for ureteral lacerations, success rates of the various techniques were: 100% ureterocystoneostomy, 67% Rendezvous, 58% percutaneous nephrostomy plus ureteral stenting, 33% Percutaneous Nephrostomy, 33% cystoscopy with ureteral stenting. Considering ureteral stenosis, success rates were: ureterocystoneostomy 100%, percutaneous nephrostomy plus ureteral stent 33%, Rendezvous, Percutaneous Nephrostomy and cystoscopy with ureteral stent 0%. For ureteral fistula, success rates were ureterocystoneostomy 100%, Rendezvous 100%, percutaneous nephrostomy plus ureteral stent 100%, cystoscopy with ureteral stent 33%, Percutaneous Nephrostomy 0%.

Conclusions. According to the obtained results, conservative radiologic procedures represent a valid alternative to open surgery. We propose a progressive operative model: interventional radiology represents an effective approach that could postpone or avoid invasive procedures. Ureterocystoneostomy is the procedure with higher success rates.

Key words: ureteral fistula, ureteral laceration, ureteral stenosis, rendezvous, interventional radiology.

Abbreviations

UCN; ureterocystoneostomy; CpS: cystoscopy + stent; NpS: percutaneous nephrostomy + stent; RV: Rendezvous; NP: Simple percutaneous nephrostomy; IR: Interventional Radiology.

Introduction

Ureter is one of the most important landmarks to be taken into consideration during gynaecological surgery, as it is one of the organs most involved in complications during this type of surgery. Ureteral injury incidence is 0.1-1.5% for benign surgery (myomectomy, hysterectomy etc.) and 5% for oncologic surgery(radical hysterectomy, cytoreduction etc.; if we consider surgery for endometriosis, incidence increases to 21% [1-6]. A separate note appears to be important for cancer patients who may present an increase in perioperative morbidity and frailty, scores have been created for this type of patient to prevent and reduce these complications [6-11].

Cystoscopy may help in the identification of ureteral injury and insertion of ureteral stents could help in the diagnosis and its reparation [12, 13]. Regarding treatment, ureteral stenosis is generally treated with the insertion of a ureteral stent or with ureteral reimplantation surgery. If stent insertion is complicated, contemporary laparoscopy may be useful to completely diagnose the type of ureteral injury and to avoid ureteral perforation [3, 14]. A simple suture is generally avoided

because it can cause subsequent stenosis, so the ureteral reimplantation must be considered [15]. Recently, other techniques are available to treat ureteral injuries in mini-invasive ways, like interventional radiology. In this category, various procedures may be used, like percutaneous nephrostomy with or without the insertion of a ureteral stent and the endoscopic-radiologic procedure also known as Rendezvous. This procedure has higher success rates, until 88% and is a valid alternative to laparoscopic or laparotomy ureteral reimplantation [16]. After the procedure, if patients are asymptomatic and/or creatinine levels are stable, nephrostomy may be removed, and the stent is substituted or removed after 6 months or less [17-18].

The study aims to propose a progressive operative model to manage ureteral injuries by comparing conservative and open approaches; we also propose a therapeutic algorithm to reduce invasiveness.

Materials and methods

This is a retrospective study conducted in the Department of Gynecology, Campus Bio-Medico University Hospital Foundation Rome on 24 patients admitted for 27 ureteral injuries caused by gynaecological surgical procedures between 15th January 2016 and 6th September 2021. After consultation with our local Ethical Committee, our study was defined as exempt from IRB since the study was observational and not interventional (no randomization was made), due to the type of retrospective study design. This study was conducted following the regulatory standards of Good Clinical Practice and the Declaration of Helsinki (1996). The clinical management of patients included in the study was identical to that routinely proposed in the same period according to our internal protocols. For this reason, all eligible patients were adequately informed of the nature and objectives of the study, and written signed consent was obtained, following the Italian Privacy Law (675/96). A database containing all data from these patients was recorded in a Microsoft Excel sheet. We recorded data regarding primary pathology, type of surgery, laparoscopic or laparotomy technique, ureteral injury, location, clinical manifestations, imaging and laboratory diagnosis, the treatment used and follow-up.

Ureteral injuries included in our study were: lacerations, stenosis, and ureterovaginal fistulas.

- Stenosis is defined a reduction of ureteral lumen and it may be a consequence of coagulation, trauma, kinking or ligation. In our database, we divided stenosis into complete stenosis (ligation) and partial stenosis (stricture).
- A laceration is a partial opening of the ureteral wall.
- Fistula is pathologic communication between ureter and vagina. We distinguished two types of fistulas: ureterovaginal and ureteral-peritoneal-vaginal fistulas, according to the type of fistular link.

Regarding the clinic, for each patient we recorded data about fever, abdominal pain, vaginal discharges, stranguria and polyuria. For laboratory data, we registered changes in inflammatory factors (VES, PCR, WBC count) or data about renal function (creatinine). We also registered the postoperative day in which clinical manifestations appeared. Treatment approaches were divided into three main procedures: cystoscopy with retrograde stent insertion (CpS), interventional radiology and laparotomy ureteral reimplantation. Another analysis was then conducted dividing radiological procedures in simple percutaneous nephrostomy (PN), percutaneous nephrostomy plus ureteral stent (NpS) with anterograde insertion and combined radiologic-endoscopic procedure, Rendezvous (RV).

Cystoscopy and stent positioning: Bladder filling is carried out at low pressure, with cannulation of the ureter with a guide for ureteral stent in its soft portion. Double J stent is placed on the soft guide and location inside the bladder is controlled with cystoscopy

Rendezvous (RV): This procedure consists of two phases: the first one is represented by nephrostomy. The second phase is the RV. It can be divided into an anterograde and a retrograde approach. In the anterograde approach, a guidewire is advanced through the nephrostomy catheter reaching the ureter. Then, in the retrograde approach, a guidewire, thanks to a cystoscope, is advanced through the ureteral orifice till the ureter. At this point, a device (Gooseneck) takes the guidewire introduced through the bladder. Subsequently, a double J stent is inserted to maintain the alignment and to help the reparation of ureteral injury.

Laparotomy/Laparoscopy ureteral reimplantation/Ureterocystoneostomy: The technique allows the creation of a new ureteral orifice on the bladder wall in the portion of the trigone. It crosses one or both ureters depending on whether one or both ureters are replanted.

Regarding follow-up, we registered eventual complications after the failure of the abovementioned procedures or the simple removal of ureteral stents when patients needed no other procedures. We excluded from the study patients that received the positioning of a prophylactic ureteral stent, patients with non-iatrogenic ureteral injuries and patients lost at follow-up.

Data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Results

Retrospectively analyzing our database for ureteral injuries in patients undergoing gynaecologic surgical procedures between 15th January 2014 and 6th September 2021, we identified 33 ureteral injuries in 30 patients, of which 6 did not meet the inclusion criteria: 4 were lost at follow-up and 2 because of prophylactic ureteral stent. In this paper, we analysed 27 ureteral injuries in 24 patients: 3 patients had bilateral ureteral injuries. More specifically, we obtained data from 16 lacerations, 5 stenosis (4 ligations and 1 stricture) and 6 fistulas. Two of these fistulas were ureterovaginal and four of them were ureteral-peritoneal-vaginal. The characteristics of the patients and their ureteral damage are reported in Table I. The procedures leading to ureteral damage were laparotomic in 67% of cases and laparoscopic in 33%. Injuries' diagnosis was intraoperative in 2 cases (7%) and postoperative in 25 cases (93%). Diagnosis was based on clinical suspicion, laboratory exams and imaging. Abdominal pain and abdominal distension were found in 15 patients, fever (T>38°C) in 9 patients, vaginal discharges in 7 patients and urinary symptoms in 3 patients. These clinical manifestations appeared in different intervals from surgery, all in a maximal lapse of 45 days. Around 58% of laboratory data were considered to clinically diagnose injuries. TC was the gold standard for the diagnosis of ureteral injuries. Ureteral stents were removed after 6 months in patients that received successful treatment.

1. Results analysed according to the approach

Three main approaches were used for the management of ureteral injuries: cystoscopy with retrograde ureteral stent (CpS), interventional radiology (RI) and ureterocystoneostomy (UCN). Data showed that 44% of ureteral injuries were solved with a single approach, meanwhile 56% of cases were solved using additional or multiple procedures.

Two of the 27 injuries were diagnosed intraoperatively and managed at first instance with ureterocystoneostomy (UCN) with a success rate of 100%.

Five of the 27 injuries were treated with CpS as first approach, with only one case solved at first glance (success rate 20%) with subsequent failure of the other 4 injuries (Fig. 1A). In one of the 4 injuries in which CpS failed, a RV was attempted, with a success rate of 100%. In the other 3 cases, treatment was NpS as second approach; one case was solved uneventfully, in the other 3 cases, RV approach was tempted, but unfortunately failed with a subsequent need for ureteral reimplantation (fourth approach) that was resolutive in all the cases.

Interventional Radiology (NpS, PN and RV) was used in the first instance in 20 of the 27 injuries with a resolution of 9/20 ureteral injuries (global success rate of 45%) (see Fig. 1B). In 11/20 injuries NpS was used in the first instance with the resolution of 7 injuries (success rate of 64%); in the other 4 cases attempt failed and a second approach was used. In 6/20 injuries PN was used in the first instance: in all cases, the approach failed, and a second procedure was used. In 3/20 injuries RV was used in the first instance, with the resolution of 2 cases (success rate of 67%), and failure in 1 case (failure rate of 33%) and a second approach was attempted. Interventional Radiology was not resolutive as the first approach in 11 of the 20 ureteral injuries and in these 11 injuries a second procedure was used. Four of the 11 cases were treated with UCN with resolution in all cases (success 100%). 2/11 ureteral injuries were treated with NpS as second approach with the resolution of 1 injury (success of 50%). RV was used in 1/11 injury as the second approach with success (success rate 100%). The second radiological procedure brought to resolution in 6/11 injuries (global success if 67%). 5/11 were treated with CpS as second approach which was not decisive in any case. 5/11 injuries were not resolved with a second procedure and continued with a third approach. 3/5 underwent laparotomy ureteral reimplantation with a 100% success rate. 1/5 of injuries resolved with CpS as third approach and 1/5 of injuries resolved with PN as third approach. 7/20 injuries treated in the first instance with IR in the end underwent UCN with subsequent resolution (success rate 100%). All these last approaches solved the problem. (Fig. 1B). The combined radiologic-endoscopic approach of RV had a success rate of 67% at the first attempt with only one injury that required stent apposition with nephrostomy, with resolution at the second intervention.

Sub-analysis showed global success rates of the different methods used. These data were obtained from the success and failure rates of each approach used. In this way, we found a success rate of 25% for CpS, 100% for ureteral reimplantation and 58% for all interventional radiology procedures. The success rate for each radiological procedure was 14% for simple PN, 57% for RV and 56% for NpS.

2. Results analysed for injury

A further analysis was done on the result for injury classification (stenosis, lacerations and fistulas) concerning the different techniques used for the treatment.

The 5 stenotic injuries were treated as follows (Fig. 2A): in two of the 5, Ligations CpS was used, in two of the 5, Ligation PN was used, and in one of the 5, strictures NpS was used. CpS as first approach had a negative outcome in bilateral ureteral ligation and required other 3 interventions (NpS, RV and UCN) before definitive resolution. Globally, PN as first approach showed a failure rate of 100%: injuries were treated with laparotomic ureteral reimplantation, and half of them first received cystoscopy with a negative outcome. In this type of ureteral damage, conservative techniques did not conduce to resolution and, in 80% of cases, patients received laparotomy: CpS, RV and PN never solved ureteral damage, while NpS positioning had a success rate of 33% (Fig. 3).

The 16 lacerations were treated (Fig. 2C) with UCN in 2 of the 16 ureteral injuries, RV in 2 of the 16 injuries, PN in 2 of the 16 injuries and NpS in the other 10 cases. The combined anterograde and retrograde approach had direct success in 50% of cases; in the other 50% of cases, NpS was necessary. PN in the first instance had negative results in all cases and injuries required RV in half cases and ureteral reimplantation in other cases. In the end, NpS positioning had a 60% success rate in the first instance. The Conservative procedure mainly used in lacerations was RV with a 67% success rate, followed by NpS (58% success rate). PN and CpS had good results with a rate of 33%. Ureteral reimplantation was effective in 5 lacerations with a success rate of 100% (Fig. 3).

The 6 fistulas comprised 2 ureterovaginal fistulas and 4 ureteral-peritoneal-vaginal fistulas (Fig. 2B). Ureterovaginal fistulas are solved, 1 with RV and 1 with CpS for a 100% success rate,

respectively. The 4 ureteral-peritoneal-vaginal fistulas had a negative outcome in all the procedures first attempted: 2/4 CpS failed and also 2/4 PN. After radiologic failure, in 2 cases laparotomic ureteral reimplantation was used with a 100% success rate. In the other 2 cases with the previous failure of CpS, one was solved using RV and the other one with NpS (Fig. 2B). For this type of injury, UCN was effective in 2 of the 6 ureteral injuries. In the other 4 cases, IR conservative approaches had good outcomes: RV was used in two cases with a 100% success rate, and also for NpS 1/6 and CpS had a 33% resolution rate when applied in three cases. PN failed in both of the cases in which it was used (Fig. 3).

Subsequently, a global rate for IR was calculated. We reported a success rate for lacerations (67%) and fistulas (60%). IR procedures for stenosis showed a lower success rate (25%).

Discussion

Ureteral injuries are associated with high morbidity rates because the ureter is near to vascular structures and pelvic organs. Around 75% of ureteral injuries are iatrogenic: in particular, the third tract of the ureter has a higher risk because it is the most accessible during gynecologycal surgery [19]. Incidence varies according to surgery complexity: 0.03-2% for abdominal hysterectomy, 0.02-0.5% for vaginal hysterectomy, 0.2-5% for LAVH, 1.7-3% for urogynaecological procedures [20].

Although ureteral repair is historically an open technique, we believe that the recent technological advancements in the field of minimally invasive surgery lead to the possibility of evaluating, as first option, a more conservative management: laparoscopic reimplantation or IR techniques. The advent of interventional radiology with the RV technique in addition to the classic techniques can allow the restoration of ureteral integrity, especially in the case of lacerations or ureteral transections [21].

The recent evidence in literature supports the use of a minimally invasive approach by IR (e.g., RV or NpS) as a first step in the case of ureteral injuries, as it presents a low risk of perioperative complications, shorter hospital stays and good success rate [22, 23].

In this paper, we analysed 27 ureteral injuries from 24 patients (three patients had bilateral injuries). The diagnosis was made during surgery in 2 cases (7%) and postoperative in 25 cases (93%). These data concerning post-operative diagnoses is in line with the literature, as the injuries are often not immediately visible. A large number of post-operative diagnoses it is also relatable to the type of surgery that is performed in our hospital, which is a referral center for complex benign surgery, deep endometriosis and oncological surgery. The 2 injuries that were diagnosed during surgery were treated with UCN.

Laparotomic UCN is the gold standard treatment first described by Boari and modified over the years. This surgical procedure has a high success rate, which in the last decades has been revisited with a minimally invasive laparoscopic and robotic approach with similar success rates [24, 25]. Currently, the psoas hitch is a useful technique for injuries involving the lower third of the ureter. The success rate, regardless of the method, is very high among different studies. The minimally invasive approach for laparoscopic ureteral reimplantation is associated with a success rate of 95.8% (including psoas hitch, psoas hitch plus Boari flap, and extravesical ureteral reimplantation) [26]. In cases of failure, the persistence of ureteral obstruction, presenting as a long-term complication, is caused by ureteral ischemia, tension on the anastomosis, or kinking and often requires surgical management. Ureteral kinking may occur if the ureter is replaced in the lateral bladder wall, which is more mobile. A ureteral fistula may be related to ischemia, tension, and a lack of water-tight anastomosis. In case of failure of the bladder flap procedure, the UCN with psoas hitch is indicated.

In the other cases, treatment was CpS positioning or IR.

CpS had a global rate of success of 25%, but when used in the first instance in 5 ureteral injuries it had good results in 1 of 5 cases (20%). Failures are all due to endoprosthesis positioning: surgeon experience, distal location of injury and damage entity are the factors that mainly influenced the results of this procedure. Other causes of CpS failure in ureteral injuries are related to several factors, such as the impossibility of assessing the size of the lacerations, the impossibility of overcoming the strictures, and the possible risk of enlargement of small injuries. Complete stenosis and ureters-peritoneal-vaginal fistulas made difficult stent positioning. There are no good quality randomized or prospective studies in the literature that indicate the role of CpS and its outcome in the various types of injuries. The role of CpS in pelvic surgery has a recognized role only in minor ureteral injuries, ureteral decompressions and its use in the prevention of ureteral injury in patients where ureteral recognition is difficult [27,28].

IR was used as the first approach in 20 injuries. The global success rate was 58% for all the approaches. Despite few data are disposable about the comparison between open surgery and minimally invasive techniques, these data are similar to those obtained in other studies: Ku et al obtained a success rate of 64% for the conservative approach [29].

PN was used in the first instance in 6 cases and only once as subsequent approaches. 6 failures in the first instance out of a total of 7 PN procedures were due to complications during the procedure (stenosis and leakage), clinical complications (renal failure, hydronephrosis) or in most of the cases to impossible stent positioning in cases of total stenosis and ureteral-peritoneal-vaginal procedures. So, failure derived from PN was expected because the stent was not positioned, and did not offer support to the ureteral wall, making healing difficult in case of large lacerations or fistulas. Literature agrees that in the case of ureteral damage stent positioning is better than simple PN [30, 31]. This technique was used because of contraindications to other techniques: these aspects can explain its apparent failure in a group of radiological successful procedures.

NpS would seem to be useful for small lacerations and incomplete stenoses. The advantage over PN is the presence of the stent, which increases the repair capacity of the ureteral tissue. Ureteral stenting promotes the healing process because it allows the realignment of the two stumps, excluding the damaged site from the passage of urine into the bladder, and maintains an adequate lumen, which prevents scar stenosis by reaction of the fibroblasts [32]. The possible success linked also in non-tightened stenosis (stricture) is probably linked to the passage of the guide and therefore of the stent, safeguarding renal function.

RV turns out to be an innovative technique introduced in the last two decades with a combined percutaneous antegrade and cystoscopic retrograde approach. From our results, this approach is effective in the resolution of lacerations and fistulas with a good success rate. There are several studies in literature reporting numerous successes. Yates et al. report the resolution of 8 strictures with a rendez-vous success rate of 100%. Similar data are also reported by Macri et al. with a success rate ranging between 78-88% on strictures [21, 22]. Regarding lacerations, we found in this paper a high success rate, in line with the literature. Liu et al., using the RV technique resolved 8 ureteral transections with a mean ureteral injury length of 19 mm (range 15-30 mm) with a success rate of 100% [33].

Regarding lacerations, the global success rate of IR procedures was 67%. The conservative procedure with a higher success rate was RV, with a 67% success rate, followed by NpS (58% success rate). PN and CpS had good success rates (both 33%). UCN had success in 5 injuries (100% success rate). So, there is a high success rate considering all radiological procedures together, but these rates reduce when we consider each single specific technique: NpS and RV demonstrated to be otherwise valid techniques and good alternatives to surgery in the first instance. Despite the higher success rate of laparotomy reimplantation, IR is a valid alternative to surgery. Open surgery is associated with higher infective rate, haemorrhage, mortality and morbidity. Failures obtained with these two techniques are due to complications raised after the

procedures themselves: stenosis, fistulas and leakage. A probable cause was the excessive tissue damage due to the injury entity, the number of attempts trying to solve it and difficult diagnostic interpretation. In the case of laceration, a combined radiological-endoscopic procedure is a valid alternative to the gold standard as the first step. If NpS is used as the first approach without success, it is better to use RV because the success rate is higher. CpS and PN should be avoided. We found in our study a similar success rate, considering each radiological procedure: success rates were 58% for NpS positioning and 67% for RV similar to Ku et al [29].

Regarding iatrogenic stenosis, CpS had a 0% success rate, IR 14% with only a case of NpS that was solved in the first instance. This injury was the unique partial stenosis while the others were complete stenosis: all solved thanks to UCN. In this case, it was possible to observe a reduced success rate for IR, especially in cases of serrated stenosis. It is fundamental to analyze the grade of stenosis: in case of stricture, nephrostomy with stent positioning may be considered, but in case of ligation it is necessary to undergo open surgery. CpS should be avoided in stenosis. There are studies in literature about this topic, but they mainly concern stenosis following renal transplantation and they propose still open techniques, even if minimally invasive [34]. Despite the classic open / minimally invasive approach, some studies show good results of the endoscopic approach with laser endopyelotomy and balloon dilation especially on non-ischemic stenosis, not from malignant pathology and less than 2 cm in length [35]. These two techniques have a variable success rate based on the site of the injury, the residual vascularity, and the length of the stenosis which are 52-83% with laser endopyelotomy and from 33-100% with balloon dilation (in the case of stenosis greater than 2 cm long 0 -17%) [35, 36]. In our study in the case of stenosis, it was possible to observe a reduced success rate for IR, disagreeing with success rates reported by the abovementioned studies, especially in serrated stenosis. In case of stricture, NpS positioning may be considered, but in the case of ligation is necessary UCN [37]. Therefore, either from the literature or in our study, in the case of ureteral stenosis, it is possible to try a minimally invasive approach with interventional radiology, but the definitive and standard treatment is the classic technique.

Regarding fistulas, CpS had a global success rate of 33% while IR reached 60%: PN failed in both cases it was used while RV and NpS had a 100% success rate. In 2 of the 6 fistulas, injuries were treated with ureteral reimplantation. Considering two types of fistulas, we observed that both radiological and urological conservative approaches were effective for ureterovaginal fistulas. For ureteral-peritoneal-vaginal fistulas, other approaches (50% surgical and 50% conservatives) were necessary before the final resolution. We can conclude that conservative approaches are more effective in case of ureterovaginal fistula. On the other side, a conservative approach should be avoided in ureteral-peritoneal-vaginal fistulas because of a more difficult stent positioning: in this case, ureteral reimplantation should be preferred. In literature, there are no randomized studies about the minimally invasive approach in the management of iatrogenic ureteral fistulas. In case of ureteral fistula, the vesicovaginal fistula must always be investigated as the two conditions can be associated [38]. In the study conducted by Angioli et al. on the management of vesicovaginal fistulas, even if associated with ureteral ones, an attempt at conservative management for 4-6 weeks is foreseen. We believe that the CpS approach is justified in the first instance. In our study, CpS had a global success rate of 33%, higher than that of simple waiting with an intravesical foley (15-20%), but above all with a mini-invasive approach RV and NpS had a 100% success rate [39]. Considering two types of fistulas, we observed that for ureterovaginal fistulas both radiological and urological conservative approaches were effective. On the other side, a conservative approach should be avoided in ureteral-peritoneal-vaginal fistulas because of a more difficult stent positioning: in this case, UCN should be preferred.

Limitations of this study are the small number of ureteral injuries and the fact that it is a retrospective study based on the experience of a single center.

Conclusions

According to the obtained results, conservative IR procedures are valid alternatives to open surgery. UCN is otherwise the procedure with higher success rates, despite it presents various limits of applications, especially in older patients with other pathologies. Interventional radiology represents an effective approach that could postpone or avoid the use of invasive procedures. Other studies are needed to have more data and validate various conservative treatment strategies.

We propose the following flow chart for the treatment of ureteral injuries (Fig. 4).

For ureteral lacerations, the first approach that should be used is NpS or RV and only subsequently UCN.

In case of ureteral stenosis, NpS should be used for strictures first and then UCN. In case of ligation stenosis, the intended approach is directly UCN.

In case of fistula, we distinguish the ureterovaginal fistulas and the ureteral-peritoneal-vaginal. In case of ureterovaginal fistulas, CpS or NpS should be used as the first approach, and in case of failure, UCN is the best approach.

For ureteral-peritoneal-vaginal fistulas, the best approach is to perform a UCN.

Compliance with Ethical Standards

Author Contributions:

Conceptualization: C.D.C.N., F.F., L.F., C.D.L., F.P., R.M., D.L., G.L., R.M., R.A., C.T.

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Formal Analysis: C.D.C.N., F.F.

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Investigation: C.D.C.N., F.F., L.F., C.D.L., F.P., R.M., D.L., G.L., R.M., R.A., C.T.

Methodology: C.D.C.N., F.F., L.F., C.D.L., F.P., R.M., D.L., G.L., R.M., R.A., C.T.

Project administration: C.D.C.N., F.F., CT.

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Ethical Approval: Considering the retrospective nature of the study (observational and not interventional, no randomization was made) not approval by our IRB was requested. Approval was granted by the University “Campus Bio-Medico” of Rome. This study was conducted following the regulatory standards of Good Clinical Practice and the Declaration of Helsinki (1946).

Informed consent: The enrolled patients gave their informed consent to the study.

Data sharing: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1. The characteristics of the patients and their ureteral damage.

	Ureteral lesion (n=27)
Age, year (mean ± SD)	54.20 ± 9.95
Pathology	
Fibromatosi uterina n, (%)	3 (11.1)
Endometrial cancer n, (%)	3 (11.1)
Cervival cancer n, (%)	8 (29.6)
Ovarian cancer n, (%)	4 (14.8)
Endometrial Hyperplasia n, (%)	4 (14.8)
Endometriosis n, (%)	2 (7.4)
Ovarian Cysts n, (%)	1 (3.7)
Leiomyosarcoma n, (%)	2 (7.4)
Type of surgery	
Laparotomic hysterectomy ± bilateral adnexectomy n, (%)	15 (55.6)
Laparoscopy hysterectomy ± bilateral adnexectomy n, (%)	7 (25.9)
Laparotomic radical hysterectomy ± bilateral adnexectomy n, (%)	3 (11.1)
Laparoscopy ovarian cyst removal n, (%)	2 (7.4)
Type of lesion	
Laceration n, (%)	16 (59.3)
Stenosis n, (%)	5 (18.5)
Ligation n, (%)	4 (14.8)
Stricture n, (%)	1 (3.7)
Fistulas n, (%)	6 (22.2)
Ureterovaginal fistulas n, (%)	2 (7.4)
Ureteral-peritoneal-vaginal fistulas n, (%)	4 (14.8)
Clinical Manifestation, days (mean ± SD)	13.29 ± 12.72
Clinical Manifestation	
Fever n, (%)	9 (33.3)
Abdominal pain n, (%)	15 (55.6)
Vaginal discharges n, (%)	7 (25.9)

Dysuria, Anuria n, (%)	3 (11.1)

Figure 1: A) Treated in first instance with retrograde positioning of ureteral stent. B) Patient treated in first instance with Interventional Radiology. UCN: ureterocystoneostomy; CpS: cistoscopy + stent; NpS: percutaneous nephrostomy + stent; RV: Rendez-Vous; NP: Simple percutaneous nephrostomy; IR: Interventional Radiology.

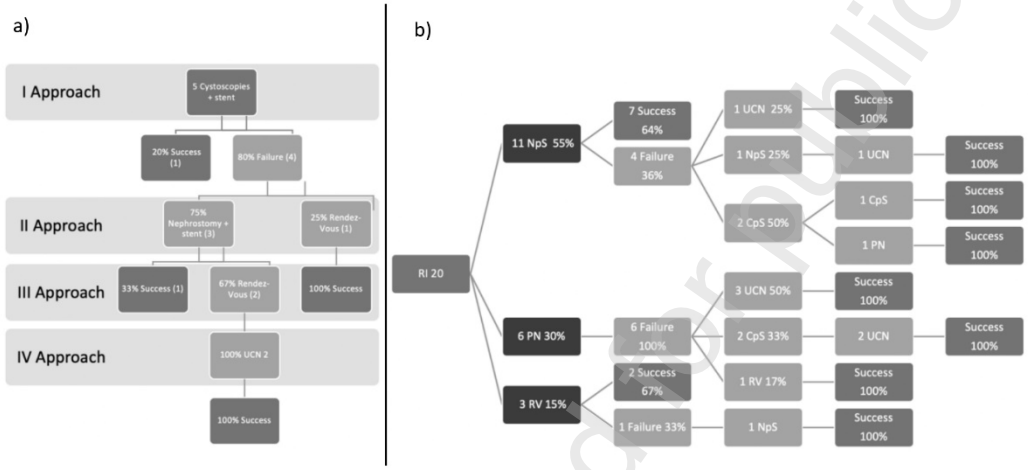

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Figure 2: A) Stenosis treatment. B) Fistula treatment. C) Laceration treatment UCN: ureterocystoneostomy; CpS: cistoscopy + stent; NpS: percutaneous nephrostomy + stent; RV: Rendez-Vous; NP: Simple percutaneous nephrostomy; IR: Interventional Radiology.

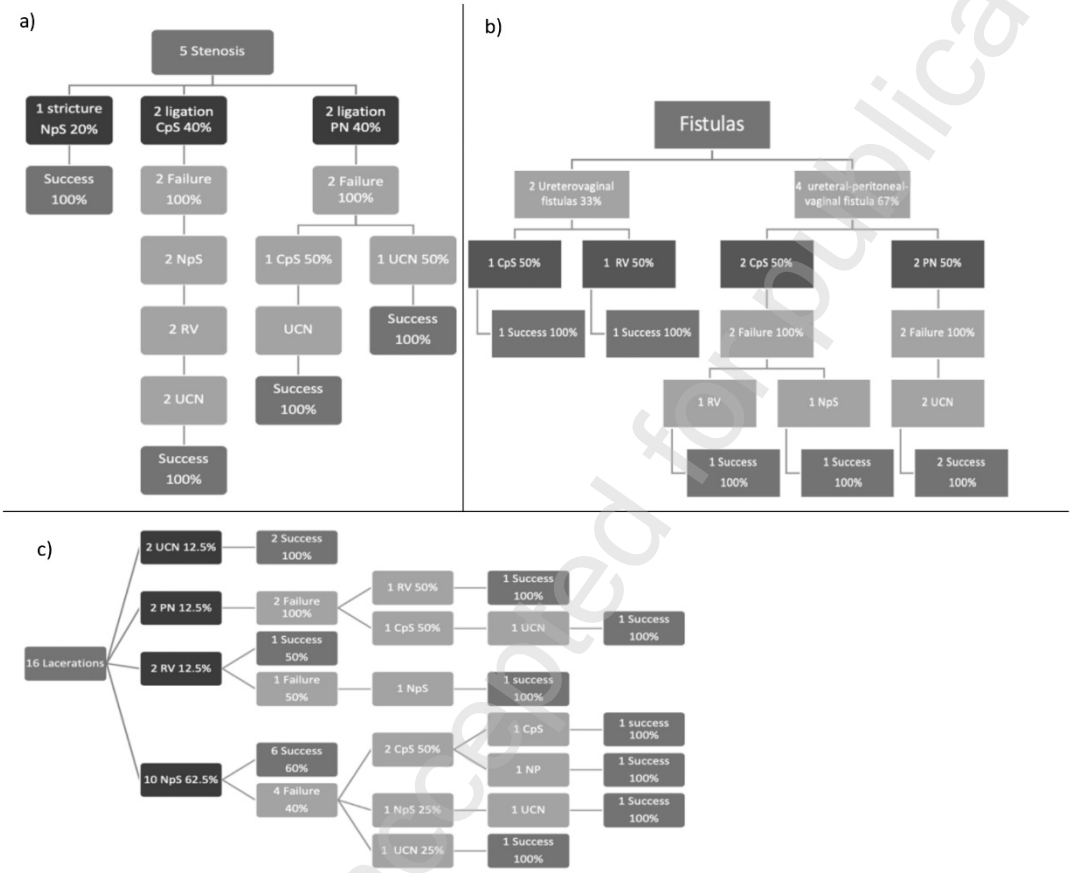

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Figure 3. Ureteral injuries - global success rates according to techniques. UCN: ureterocystoneostomy.

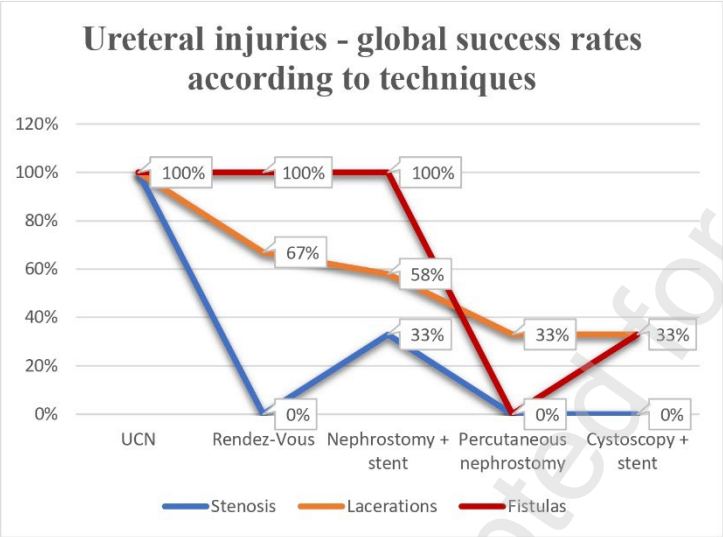
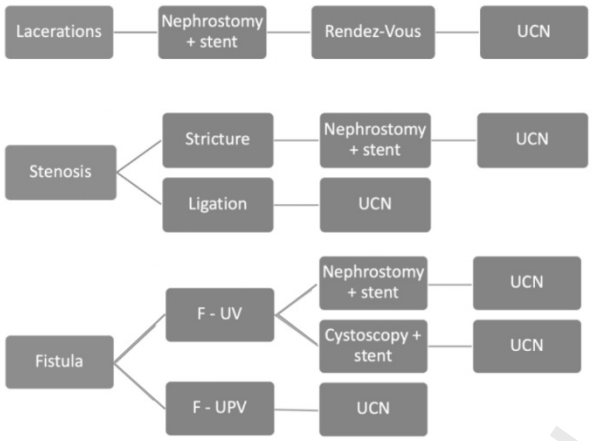


Figure 4. Flow chart for the treatment of ureteral injuries. UCN: ureterocystoneostomy. CpS: cistoscopy + stent. NpS: percutaneous nephrostomy + stent. RV: Rendez-Vous. NP: Simple percutaneous nephrostomy



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