

How to manage total avulsion of the ureter from both ends: our experience and literature review

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Abstract

Objectives To evaluate the treatment alternatives of total avulsion of the ureter from both ends including ureteropelvic junction (UPJ) and ureterovesical junction (UVJ).

Methods Total ureteral avulsion on both ends of the ureter was examined in 4 cases performing ureteroscopy. In two male patients of the four cases, avulsion was noticed intraoperatively and ureteral re-anastomosis at UPJ and re-implantation at UVJ were performed immediately. Boari flap was performed for one female patient immediately and for the other female patient who was referred from another hospital after the ureteroscopy, 4 days later.

Results One patient who had ureteral re-implantation was followed with 3-month intervals by ultrasonography and abdominal X-ray. At the end of 1 year, it was determined that kidney parenchyma was normal and the patient had kidney and upper ureteral stones. Percutaneous nephrolithotomy was performed, and the patient was stone-free at the end of the operation.

Two years after the surgery, both kidneys were normal. This is the only case who had a successful ureteral re-implantation in literature. The other patient turned up a year later for routine checks after the ureteral stent was removed. Then, hydronephrosis and renal atrophy were detected. The patient did not accept nephrectomy or any other intervention and he was lost to follow-up. Boari flap procedure was performed after UPJ repair for the other two female patients. Their kidneys were both normal 3 months after the operation.

Conclusions In case of ureteral avulsion from both ends of the ureter in the male patients, as bladder capacity is not enough for a Boari flap, proximal anastomosis and distal re-implantation could be a good choice for the management of this untoward event. This new approach also saves time for reconstructive treatments if necessary. If bladder capacity is enough to reach UPJ, Boari flap could be a good choice in female patients.

Keywords Ureteroscopy · Complications · Ureteral avulsion · Boari flap

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Introduction

Endourology has highly improved with the renewing and developing technology. Ureteroscopy is one of the most common endourologic techniques in urology. If

standard recommendations are complied with, it is a safe method. However, it may sometimes result in some complications such as ureteral false passage, ureteral perforation, bleeding, intussusceptions and avulsion of the ureter and also with some postoperative complications include infection, fever, steinstrasse, urinoma and strictures. The frequency of complications varies between 0.5 and 10 % in the literature [1–3]. Ureteral avulsion is the most serious intraoperative complication. Fortunately, it is rare and occurring only in 0–0.5 % patients [4].

Generally, avulsion eventuates in one part of the ureter. Avulsion in both ends of the ureter is extremely rare, and there is not a standard treatment for this situation. Comorbidities of the patient, condition of the kidney, severity of the ureteral damage and experience of the surgeon can affect the choice of the treatment. We aimed at trying to determine how to manage total avulsion of the ureter off both ends including ureteropelvic junction (UPJ) and ureterovesical junction (UVJ) by presenting our experience in the light of the literature.

Materials and methods

We performed a retrospective analysis of patients who underwent rigid ureteroscopic procedures for removal of ureteral stones, in two referral hospitals. Before the operation, patients were evaluated with abdominal X-ray, ultrasonography, intravenous urography (IVU) and/or computerized tomography. Blood samples were analyzed for complete blood count, serum biochemistry and coagulation tests. Urinalysis and urine culture were also examined routinely. Patients were asked not to use antithrombotic or antiagregan agents at least 1 week before the procedure.

The ureteroscopy (URS) operations were started with the insertion of a guide-wire in to the ureter in lithotomy position. Then, the surgeon inserted the ureteroscope with the guidance of the guide-wire. Fluoroscopy was not used routinely. Balloon dilation was needed in some cases for narrow ureteral orifices. 4.5-F, 9-F, 9.5-F or 11.5-F rigid ureteroscopes were used. Stone fragmentation was performed using pneumatic energy or holmium laser. We used the basket in some cases and were careful about not pulling off the stone when there was a resistance. In some cases, the basket was out of order while picking

stones. Then, we cut the basket with a holmium laser. Ureteral j-stent was placed at the end of the operation if necessary.

In three cases, we experienced total avulsion of the ureter from both ends and one patient was referred from another hospital when the avulsion was noticed intraoperatively. We present how we managed this unpleasant situation and follow-up results with review of the literature.

Results

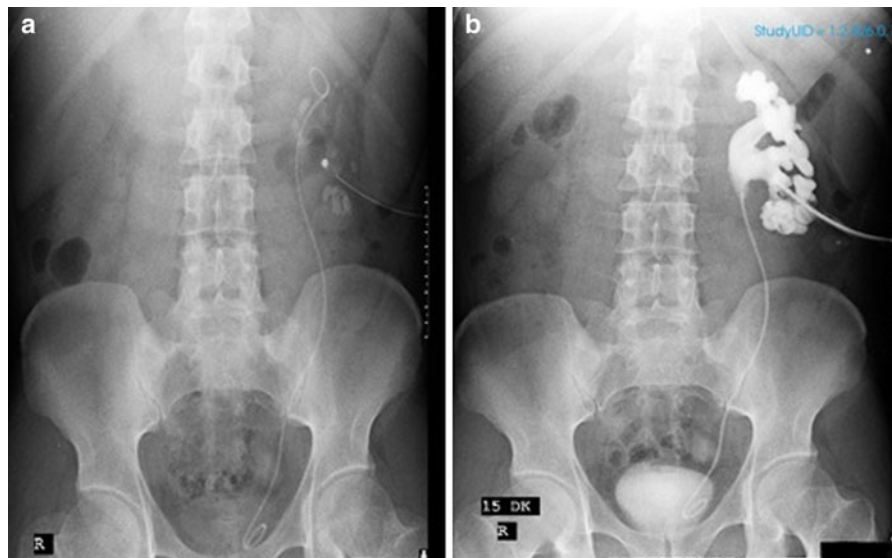
We experienced total avulsion of the ureter from both ends in four cases in two referral hospitals. The patient study included two male and two female patients, and characteristics of patients were given in Table 1.

Case 1

A 38-year-old man applied to the hospital with left renal colic and was determined a moderate hydronephrosis with ureteropelvic junction obstruction (UPJO) and multiple kidney stones. First a retrograde laser endopyelolithotomy was performed because it seemed difficult to perform anterograde endopyelotomy and percutaneous nephrolithotomy (PCNL) in the same session. During the procedure, ureterovesical junction (UVJ) obstruction was detected and this ureteral segment was extremely narrow. Therefore, balloon dilation was accomplished before the ureteroscopy. When we reached the UPJ with a Olympus 11.5-F rigid ureteroscope, we cut the tissue laterally with holmium Yag:laser for UPJO. However, when we tried to go to the pelvis through the UPJ, avulsion happened in the lower ureteral segment, and it was stucked to the instrument. When the ureteroscope was pulled out, ureteropelvic junction was torn. As a result of this, the ureter was avulsed off its bed and came out on the ureteroscope. We kept the ureter in a saline solution until re-anastomosis. We performed primary anastomosis for upper ureter to renal pelvis and an ureteral re-implantation to the bladder for lower ureter with a modified Gibson incision. We placed a nephrostomy tube and inserted a double-j ureteral stent. We did not do anything to remove kidney stones because we decided to perform re-anastomosis as soon as possible. We were also anxious about the blood supply and wound healing. There were kidney stones

Table 1 Patients and operation characteristics

Case	I	II	III	IV
Age	38	42	56	78
Sex	Male	Male	Female	Female
Diagnosis before URS	UPJO and kidney stones	Middle ureteral stone	Upper ureteral stone	Middle ureteral stone
Side	Left	Right	Left	Right
Size of ureteroscope	11.5 Fr	11.5 Fr	9.5 Fr	13.5 Fr
Operation	Ureteral re-implantation	Ureteral re-implantation	Boari flap	Boari flap
Intervention time	Immediately	Immediately	Immediately	4 days later
Follow-up	No hydronephrosis	Hydronephrosis and atrophy	No hydronephrosis	No hydronephrosis

**Fig. 1** KUB and nephrostography after ureteral re-implantation

in his nephrostography, and passage was normal (Fig. 1). The nephrostomy tube was removed 2 weeks after the procedure, and the ureteral j-stent was replaced 3 months after the procedure with a metallic ureteral j-stent. He was followed with 3-month intervals with ultrasonography and abdominal X-ray. After 1 year, we determined that kidney parenchyma was normal and he still had kidney and upper ureteral stones. We performed percutaneous nephrolithotomy (PCNL). During PCNL, it was observed that UPJ and upper ureter were completely normal (Fig. 2). He was stone-free at the end of the operation. His kidneys were both normal, and he was stone-free 2 years after the ureteral proximal anastomosis and distal re-implantation (Fig. 3). This was the only case treated

successfully by re-implanting avulsed ureter on both ends in the literature.

Case 2

A 42-year-old man who presented to the hospital with right renal colic. Intravenous urography revealed a 10-mm middle ureteral stone. Biochemical examination, complete blood count, urine analysis and urine culture were normal. His stone was refractory to extracorporeal shock wave lithotripsy, and he underwent an ureteroscopy with an Olympus 11.5-F rigid ureteroscope under general anesthesia. During the procedure, it was found out that low ureteral segment was narrow. When the ureteroscope was forced,

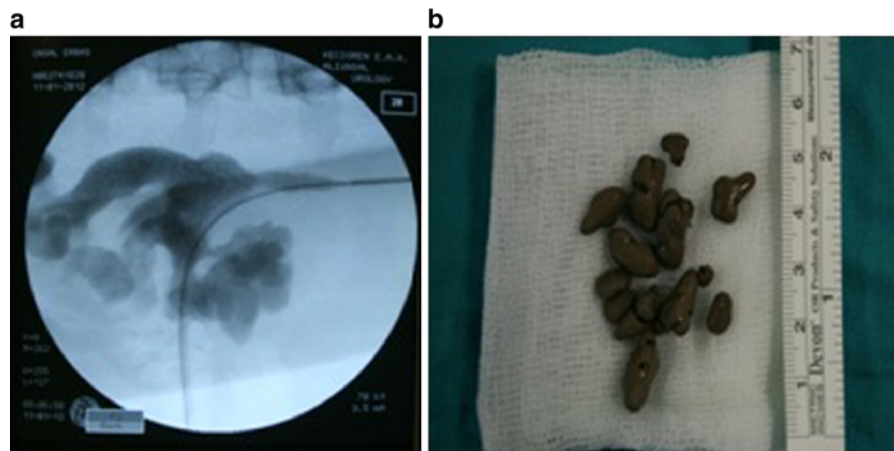


Fig. 2 For a male patient, PCNL was performed 1 year after the ureteral re-implantation. **a** Upper ureter was normal, there was no stricture in anastomosis line. **b** Stones extracted with PCNL procedure

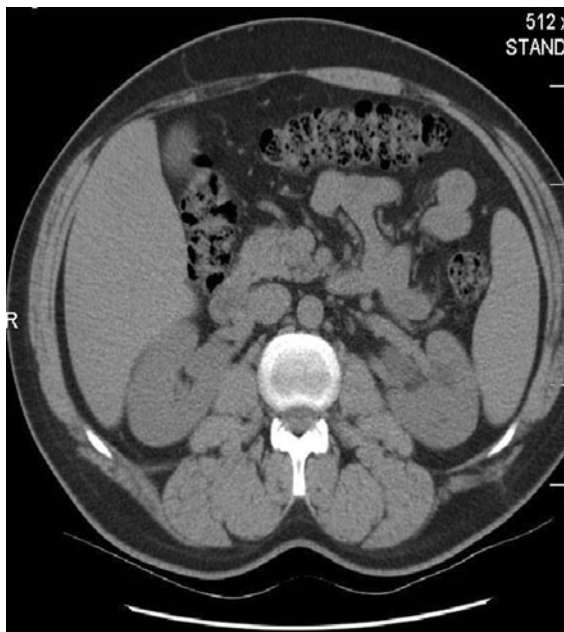


Fig. 3 Computed tomography 2 years after the ureteral re-implantation

avulsion occurred in the lower ureteral segment and this segment was stuck to the instrument. When the ureteroscope was pulled out, ureteropelvic junction was stretched and separated. The whole ureter was outside the patient on the ureteroscope. The ureter was put in a saline solution immediately. An open surgery with a modified Gibson incision was done, and bladder capacity was not enough for a Boari flap until UPJ. We performed primary anastomosis for upper ureter to

renal pelvis and an ureteral re-implantation to bladder for lower ureter as it was done in the previous case. A nephrostomy tube was placed, and a double-j ureteral stent was inserted. The nephrostomy tube was removed 1 week after the procedure and ureteral j-stent over 3 months. When the patient turned up one and a half years after the surgery, hydronephrosis and renal atrophy were detected. The patient was fed up with hospitalization and did not accept nephrectomy or any other intervention. Then, we lost his follow-up.

Case 3

A 56-year-old women applied to our emergency clinic with left renal colic. Urine analysis showed microscopic hematuria. Serum creatinine level was normal. Serum calcium level was a little higher from upper limit of normal range. She was diagnosed with parathyroid adenoma after further investigations. In radiological investigations, there was a 10-mm stone in upper part of the left ureter with left hydronephrosis. After placing percutaneous nephrostomy to protect left kidney, the patient was decided to be firstly operated for parathyroid adenoma by general surgeons. Four weeks after parathyroidectomy, the patient was accepted to our clinic again for the treatment of left ureteral stone. We planned to perform stone fragmentation using ureterorenoscopy. After placing the patient in lithotomy position, we inserted 9.5-F semirigid ureterorenoscope over guide-wire into ureter. There was a narrow area in middle part of the ureter. This area was passed by pushing

ureterorenoscope forward over a guide-wire. However, semirigide ureterorenoscope was not moved up to the stone located in upper part of the ureter. Therefore, we changed our treatment plan and decided to perform flexible ureterorenoscopy. Semirigide ureterorenoscope was removed under direct vision. After removal of ureterorenoscope, ureter about 20 cm long was found on semirigide uretero-reno-scope. Then, we opened the abdomen through midline incision. Bladder capacity was sufficient. Proximal ureter was detached just from uretero-pelvic junction. This area was dissected, and uretero-pelvic junction was prepared for repairment. As the bladder capacity was large enough, Boari flap ureteroplasty and Psoas hitch were performed. Left kidney was freed to get down, and bladder was mobilized to take left side. Bladder was opened, and a 2-cm wide, semicircular flap from front bladder wall was prepared. This flap was tubularized over 14-F feeding tube. Length of the flap was about 13 cm. As the kidney and the bladder were mobilized, this flap was enough to make renal pelvis anastomosis without tension. After completing flap tubularization and renal pelvis anastomosis, the feeding tube was removed and a 6-F ureteral j-stent was inserted. Nephrostomy tube was kept in place. Early postoperative period was uneventful. On the fourth postoperative day, the nephrostomy catheter was removed. D–J catheter was taken after 6 weeks. The patient had no problem including lomber pain and difficulties in voiding. Radiological investigation by IVU was done in third month. Both kidneys were functional, and no significant dilatation was seen.

Case 4

A 78-year-old woman who had an ureteroscopy for middle ureteral stone in 7 mm diameters in another hospital. The surgeon said that he used a 13-F Storz ureteroscope. He had noticed an avulsion on the distal ureteral segment and decided to perform an ureteroneocystostomy immediately. But when he had opened the patient with a Gibson incision, he saw that avulsion occurred on both UPJ and UVJ. As he had no experience in these conditions, he inserted a Foley catheter to the retroperitoneum as a drain and referred the patient to our clinic with urethral Foley catheter. Her biochemical examination includes creatinine and electrolytes, complete blood count; urine analysis and urine culture were normal. On physical examination,

there was a sensitivity on right flank region. An extravasation to the retroperitoneum from UPJ was detected by computed tomography. The amount of urine came from drain was about 500 cc/day. She was an old patient, so she did not accept an ileal interposition because of the possible bowel complications. She and her family only accepted two options include Boari flap and nephrectomy. Her bladder capacity was large enough and a Boari flap in 18 cm length with a midline incision was performed (Fig. 4). Boari flap was tabularized over a 14-F nelaton tube. Then, a double-j ureteral stent and a nephrostomy tube were placed. We detected no extravasation on nephrostography 1 week after the operation (Fig. 5). The nephrostomy tube was removed 9 days after the procedure and the urethral Foley catheter 12 days later. We discharged the patient 2 weeks after the operation with the medicine of an anticholinergic. The ureteral j-stent was removed 6 weeks later. Her maximum bladder capacity was more than 350 cc 3 months after the Boari flap ureteroplasty. There was no hydronephrosis, and both renal parenchymas were normal in magnetic resonance imaging (MR-urography) (Fig. 6). She had no complaint about urinary system. She is still in our follow-up program.

Discussion

Ureteroscopy is commonly used for diagnosis and treatment of ureteral disease and stones. It is a safe method if standard recommendations are complied with. But sometimes it can result in some complications like ureteral false passage, ureteral perforation,



Fig. 4 Intraoperative view of Boari flap procedure



Fig. 5 Nephrostography after Boari flap



Fig. 6 MRI 3 months after Boari flap

bleeding, intussusceptions and avulsion of the ureter and also with some postoperative complications include infection, fever, steinstrasse, urinoma and strictures. The frequency of complications varies between 0.5 and 10 % in the literature [1–3]. Ureteral avulsion is the most serious and catastrophic

intraoperative complication. Fortunately, it is rare and occurring only in 0–0.5 % patients [4]. There are not as many articles in literature as expected, maybe because it is an infrequent event. However, it should be taken into consideration while performing an ureteroscopy, and a urologist should be aware of the possible complications as well as management options.

The most important risk for ureteral avulsion is to remove a large stone, especially if it is impacted, with the use of extreme force. And it generally befalls while using a stone basket. Muscle in proximal ureteral tissue is weaker and that is why removing a stone by a basket in the upper third of ureter increases the risk for avulsion [5]. So we generally prefer to use a grasping forceps to remove stone fragments. Rigid ureteroscope is also a risk factor for the ureteral avulsion as presented in literature [6, 7] and in four patients of our series.

It can be difficult to manage a complete ureteral avulsion because surgeon has to decide immediately if it is recognized intraoperatively. Comorbidities and age of patient, condition of kidney, location and severity of ureteral damage, expectations of patient and experience of surgeon can effect the choice of the treatment. For the proximal ureteral avulsion, end-to-end anastomosis can be a good choice. Boari flap and Psoas hitch are recommended for the middle third of ureteral avulsion. And for the distal ureteral injuries, ureteral re-implantation is recommended [8]. If it is diagnosed in the postoperative period, a percutaneous nephrostomy can be placed and a definitive treatment can be performed when the patient is stable [5]. For the extensive injuries like the four cases in our series, there are limited options like ileal interposition or renal autotransplantation. Nephrectomy is also reported as an option for extensive injuries of the ureter in the literature [1, 5, 7–10]. Appendix interposition is also reported as a treatment option for extensive injuries in some literature [11–13].

There are less literature present approachments for total avulsion of the ureter from both ends. Ordon et al. reported 3 cases like our series, and they named it as “the scabbard avulsion.” They placed a nephrostomy tube postoperatively, and finally, all patients were underwent a nephrectomy [10]. Ge et al. [14] presented 4 cases of ureteral avulsion, and 2 of them were occurred on both ends of the ureter. They reported that one patient was treated by

autotransplantation and other one underwent pyeloureterostomy plus greater omentum investment outside. The kidney of the patient who underwent autotransplantation was normal in his follow-up while other patient underwent nephrectomy after 25 months of follow-up. In other article, Taie et al. [15] reported six ureteral avulsion in their series. Five of them had avulsion on both UPJ and UVJ. They preferred nephrectomy for 1 patient; Boari flap for 2 patients; ileal interposition for 1 patient; ureteral re-implantation for 1 patient. For one patient, they performed proximal anastomosis and distal refluxing ureteral re-implantation with double-j-stent inserting. Patient lost his follow-up 2 years after the surgery, and he underwent a nephrectomy due to missing reconstructive surgery. To our knowledge, this was the only case performed proximal anastomosis and distal re-implantation for ureteral avulsion on both ends of the ureter in the literature. Our first case we present is the only one treated successfully by performing proximal anastomosis and distal re-implantation for ureteral avulsion on both ends (Table 2).

We present four cases experienced ureteral avulsion as described “scabbard avulsion” before. We did not prefer an ileal interposition immediately because this was thought to be a complex procedure and could be concluded some complications include anastomotic stenosis, ileus, urinary obstruction and infection. We did not have much experience for autotransplantation so we performed proximal anastomosis and distal re-implantation for two male patients. We noticed the avulsion intraoperatively and decided an open surgery

immediately. Fresh ureter was kept in a saline solution, and ureteral anastomosis on two ends was performed. We hoped that the ureter could live with diffusion from the tissues around. These two patients were male, and bladder capacity was not enough for a long Boari flap.

Other two female patients were undergone a Boari flap and Psoas hitch procedure because their bladder capacities were sufficient and avulsed ureters were looking pale. One had this surgery immediately, while other one had 4 days after the avulsion.

The bladder fixation to the psoas major muscle is called as Psoas hitch. Although this procedure can result in some rare complications like femoral nerve injury, it is widely used with Boari flap procedure for treating short distal ureters in cases of ureteral avulsion [16]. Boari flap procedure is mostly recommended for the middle third of ureteral avulsion [8]. But Boari flap and Psoas hitch can also be used for upper ureteral reconstruction with downward nephropexy [17]. Getting kidney free to get down with Psoas hitch helped us to perform a Boari flap procedure until UPJ in 2 cases of our series.

We think the reason for total avulsion on both ends was that in each four cases, the size of rigid ureteroscopes were big (11.5 F and 13 F) and lower part of ureters were relatively narrow and forceful maneuvers had been done during ureteroscopy. If an ureteral stent had been inserted preoperatively for one or 2 weeks in four cases, these complications could be prevented.

During the follow-up, one patient still has well functioning kidney without any obstruction 2 years

Table 2 Series of ureteral avulsion from both ends in the literature and in our own series

Literature	Case number	Reason	Treatment	Kidney in follow-up
Ordon et al. [10]	3	Ureteroscope	3 Nephrectomy	–
Ge et al. [14]	2	NA	1 Autotransplantation 1 Pyeloureterostomy plus greater omentum investment outside	Normal Underwent nephrectomy
Taie et al. [15]	5	Ureteroscope	1 Ureteral re-implant 2 Boari flap 1 Ileal interposition 1 Nephrectomy	Underwent nephrectomy Both normal Normal –
Our series	4	Ureteroscope	2 Ureteral re-implant 2 Boari flap	1 normal, 1 hydronephrosis Both normal

later; one patient who indifference to his follow-up program has lost his kidney. Two patients who had Boari flap are completely normal 3 months after the surgery.

We conclude that proximal anastomosis and distal re-implantation can be an option for avulsion on both ends of ureter instead of nephrectomy, autotransplantation or ileal interposition. This new approach gives surgeon and patient time to overcome this situation. The re-implanted ureter can be well functioning without problem or it can be obstructed in time. If renal deterioration is detected during the follow-up, patient could have chance for other reconstructive treatments such as ileal interposition or autotransplantation in an experienced center.

Conclusion

In case of ureteral avulsion of the ureter from both ends in the male patients, as bladder capacity is not enough for a Boari flap, proximal anastomosis and distal re-implantation can be a good choice for the management of this untoward event. This new approachment also saves time for reconstructive treatments if necessary. In female patients, if bladder capacity is enough for a Boari flap to reach UPJ, it could be a good choice.

Conflict of interest The authors declare that they have no conflict of interest.

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