DOI: 10.4081/aiua.2023.10928

REVIEW

Early diagnosis and management of arterio-ureteral fistulas: A literature review

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Summary *Objectives: Arterio-ureteralfistula (AUF) is an infrequent but potentially life-threatening condition. The aim of this study was reviewing the literature to build a flow-chart useful for an early and effective diagnosis and treatment of this pathology.*
Materials and methods: A literature search in PubMed was conducted. In addition, retrieved articles were cross-referenced. Data parameters included oncologic, vascular and urological history, diagnostics, treatment, and follow up were collected using a standard template by 2 independent reviewers.
Results: A total of 140 cases of AUF out of 172 available in the literature at the time of the review, were considered. All patients presented gross hematuria. Chronic indwelling ureteral catheter (CIUC); history of pelvic surgery (HPS) and history of pelvic radiotherapy (HRT) were present respectively in 81%, 62.1% and 58.6% of the sample. The most predominant location of AUF was at the common iliac artery ureteral crossing. Angiography with provocative measures had the highest diagnostic sensitivity (50%) and endovascular treatment with stent-graft placement across the fistula is the current state of the art treatment choice.
Conclusions: Failure to diagnose can postpone a potentially life-saving targeted therapy and lead to complications. The identification of the Trifecta hematuria, history of pelvic surgery (HPS) and history of pelvic radiotherapy (HPR) would allow the identification of patients at high risk of AUF, who may benefit from more sensitive early diagnostic investigations such as CT angiography and provocative angiography. The treatment of choice in case of AUF to date consist in endovascular prosthesis placement.

KEY WORDS: *Hematuria; Stents; Urinary fistula; Arterioureteral fistula; Endovascular procedures; Angiography.*

Submitted 11 October 2022; Accepted 3 November 2022

INTRODUCTION

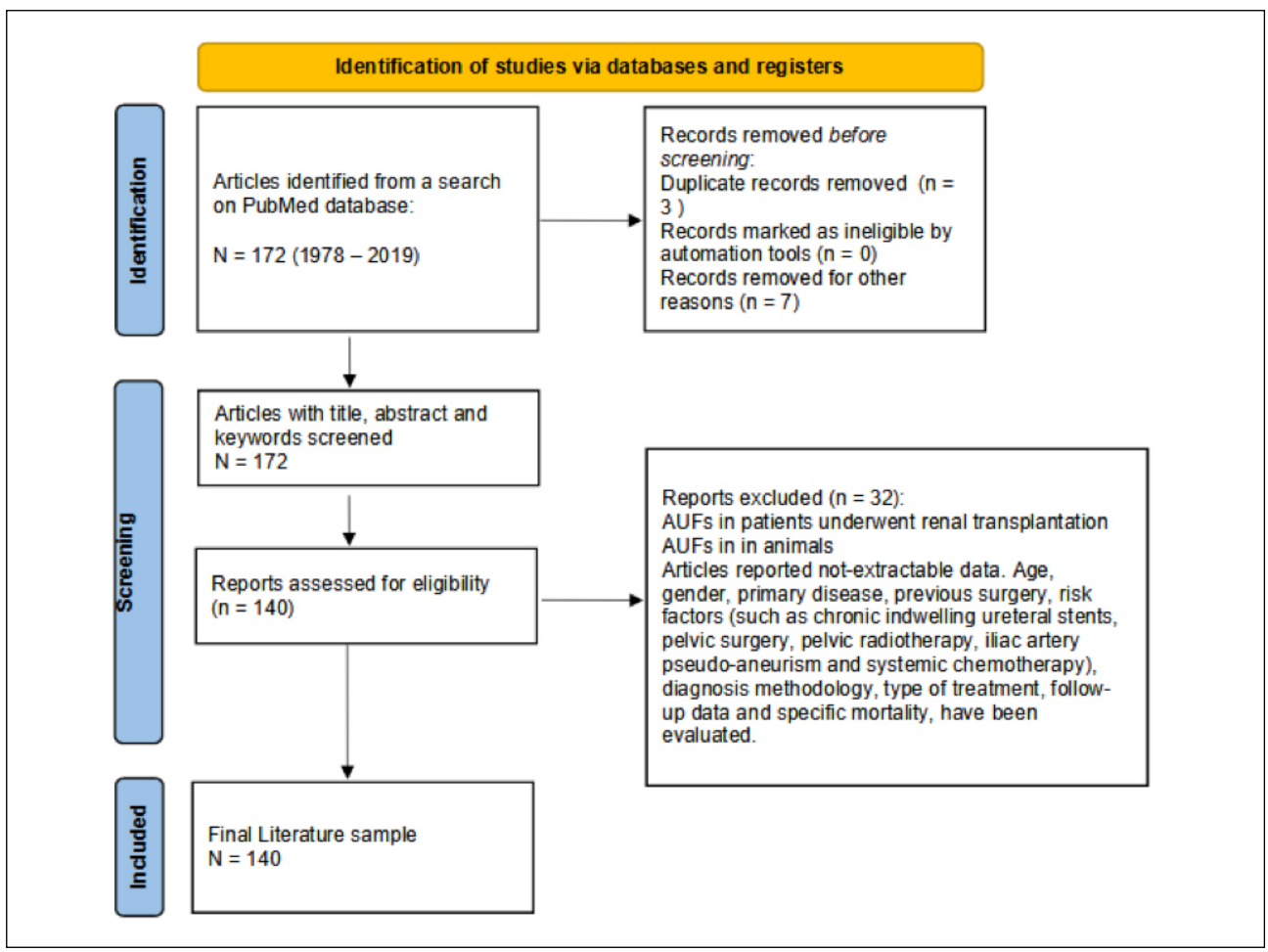
Arterioureteral fistulas (AUFs) represent infrequent but potentially life-threatening conditions, due to a pathological communication between artery and the ureter, with consequent hematuria. The first case described in literature dates back to 1908 and was reported by *Moschowitz*, who treated the patient with bilateral ligation of the external iliac arteries (1). Nowadays, more advanced therapeutic possibilities are certainly available. Beyond the classic "*open*" approaches, including vascular ligations, patch grafts placement, urinary derivations, positioning of nephrostomies and even nephrectomy (2), other less-invasive techniques can be offered to these patients. Embolization with bypass (3), transurethral occlusion using the Gianturco coil (4), and the endovascular treatment represent useful and safe less-invasive techniques that are considered as a valid alternative to the surgery, mostly for patients with important comorbidities and history of previous pelvic surgery (5), although no long term follow up has been published to assess the possible complications arising from this kind of techniques, such as prosthetic infections. On the other hand, to obtain a precise and early diagnosis represents another important factor in terms of reducing mortality of these patients. The clinical presentation of the AUF is not always immediately suggestive. It can complicate the history of patients affected by many kinds of pathological conditions (urological, gynecological, vascular, etc.) and present with heterogeneous symptomatology (such as massive or intermittent hematuria, flank pain, hydronephrosis, fever, acute urinary retention, anemia until hypovolemic shock). Only 22% of these patients received a correct diagnosis before treatment (6). From a pathogenetic point of view, AUFs are classified into primary (15%) and secondary (85%) on the basis of their etiology (15).
Primary causes are natural diseases of the arterial system such as aneurysms, vascular malformations, or aberrant vessels that may erode into the ureter (7-20).
Secondary AUFs are relatively more frequent developing in patients with specific risk factors, such permanent ureteral stenting with periodic replacements, previous abdominal or pelvic radiotherapy, previous abdominal-pelvic and vascular surgery, and changes in the micro circulation of major vessels (8-10). Pelvic surgery (89%) combined with radiation (43%) and with ureteral stent placement (67%) leads to inflammation and fibrosis that, in turn, result in fixation of the ureter to the adjacent artery (8). Radiation damage of the vasa vasorum of the iliac artery or aorta can cause ischemic injury to the arterial wall, being the severity of the ischemic injury radiation dose dependent (21). In addition, the ureteral stent causes abrasive erosion of the ureteral wall. Many of those patients are also taking anticancer biotherapies that impair the normal healing processes (22, 23). High arterial pressure is transmitted by the juxtaposed arterial to the ureteral wall resulting in pressure necrosis and fistula

formation (14, 8). A third condition, pregnancy-associated AUF, has been reported in three cases (15) that occurred in pregnant patients with severe urinary tract infection before the era of modern antibiotics (15).
Most Authors recognize chronic indwelling ureteral stents, pelvic surgery, pelvic radiotherapy, iliac artery pseudoaneurism and systemic chemotherapy, as the most important risk factors related to AUFs development (1-12). According to this evidence and considering the clinical heterogeneity related to the AUFs' presentation, the early identification of the specific risk factors and the immediate use of the most sensitive and specific diagnostic tools, could allow the clinicians to quickly obtain a correct diagnosis, reducing the high mortality related to this pathology (ranging from 7 to 38% according to some Authors) (12, 13) and due to the consequent hemodynamic instability.
The end point of the present study is to propose a a diagnostic-therapeutic flowchart based on personal experience and the analyses of the data from Literature review from 1978 and 2019, in order to improve the sensibility and specificity of the AUFs' diagnostic evaluation, searching for suggestive clinical and anamnestic elements useful to achieve a correct diagnosis and a consequent specific treatment as timely as possible.

Materials and methods

The research was carried out through PubMed database. Authors found 172 articles regarding AUFs, published from 1978 to 2019 (Supplementary Materials), using the following keywords: "*fistula*", "*ureteroarterial*", "*arterioureteral*". Both urological and radiological papers were considered. Exclusion criteria were: 1) AUFs in patients who underwent renal transplantation; 2) AUFs in in animals; 3) articles reporting not-extractables data. Age, gender, primary disease, previous surgery, risk factors (such as chronic indwelling ureteral stents, pelvic surgery, pelvic radiotherapy, iliac artery pseudo-aneurism and systemic chemotherapy), diagnosis methodology, type of treatment, follow-up data and specific mortality, have been evaluated.
The Review was performed using *Microsoft Excel* worksheet and *Prism-GraphPad* software. From the literature review presented with this manuscript, 172 articles have emerged based on title and abstract. Of these, 32 were excluded, because they didn't meet the inclusion criteria. The remaining 140 articles were included in the present study (Figure 1) (24).
The literature review and data extraction were performed concurrently by 2 investigators in order to reduce bias.

Figure 1.
PRISMA 2020 flow diagram.



Results

Eighty-two out of 140 (58.6%) patients with AUF were females and the remaining 58 (41.4%) were males. Mean age of patients was 63 years (range 29-87); mean age in women was 59 and mean age in men was 69.

Primary disease associated with AUFs

Stratifying the cohort by "*primary disease*" (Table 1) it emerged that gynecological cancer was the most frequent cause of AUFs (37.9%), followed by rectum/sigmoid cancer (20.7%), vascular disease (20%), low-urinary tract cancer (13.6%) and, finally, other kind of pelvic surgery (7.8%), including lithotomy for ureteral lithiasis, pelvic exenteration for sarcoma, surgical repair for slipped disc, surgery for melanoma, ileo-colic resection for lymphatic malignancy, left leg amputation for ischemia, left ureteral stenosis, robot assisted nephrectomy for nephrolithiasis, fistula on the ureteral stump after bilateral nephrectomy for chronic pyelonephritis and retro-peritoneal fibrosis.

Table 1.
Primary disease associated with AUFs.

	N°	%
Gynecological cancer	53	37.9
Rectum/sigmoid cancer	29	20.7
Vascular disease	28	20
Low-urinary tract cancer	19	13.6
Other kind of pelvic surgery	11	7.8

Risk factors for AUFs

Among the risk factors, the most relevant is the *Chronic Indwelling Ureteral Catheter* (CIUC) that is present in 81% of patients with AUF and hematuria (Table 2).
The association of the presence of CIUC and AUF was observed more frequently in women (64.3%) than in men (35.7%) and in the 70-79 years group (32.1%), followed by the 60-69 years group (23.2%) and the 50-59 years group (22.3%).
Furthermore, out of 140 patients with AUF 82 had an *history of pelvic radiotherapy* (HPR) and 36 of chemotherapy. HPR was observed more frequently in women (74.4%) than in men (25.6%). The distribution by age group did not show significant difference among different age groups.
Another risk factor strongly associated to the presence of fistula and hematuria is the *history of pelvic surgery* (HPS) that was observed in 62.1% of the sample of which 64.4% were women and 35.6% men. The association between HPS and the presence of AUF was observed more frequently in the 70-79 years group (35.6%) followed by the 50-59 years group (24.1%) and the 60-69 years group (19.5%).

Table 2.
Risk factors for AUFs.

	N°	%
Vascular surgery	36	25.7
Pelvic surgery	87	62.1
Radiotherapy (RT)	82	58.6
Chemotherapy (CHT)	36	25.7
Chronic Indwelling Ureteral Catheter (CIUC)	114	81.4
Pelvic Surgery+CHT+RT	31	22.1
Pelvic Surgery+RT+Stenting (Trifecta)	76	54.3

Symptoms

All patients presented gross hematuria, and 49 of them (35%) experienced gross hematuria as an emergency.
This critical event was associated to the ureteral stent exchange procedure and/or to ureteral maneuvers in 39 case reports (27.8%). Only ten patients (7.1%) developed a spontaneous aggravation of the hematuria, 6 (4.3%) of which presented a history of endoprosthesis implantation for vascular disease.
Hydronephrosis or flank pain without mention of hydronephrosis was observed in 46 cases (32.8%), 22 of them (15.7%) being previously treated with RT; 15 pts. (10.7%) who presented this pathological condition had chronic indwelling ureteral stent.
Fever and/or urinary tract infections were found in 17 pts. (12.1%), out of them nine (6.4%) had concomitant hydronephrosis (Table 3).

Table 3.
Symptoms.

	N°	%
Gross Hematuria	140	100
Hematuria during stent manipulation	39	27.8
Hydronephrosis	28	20
Flank pain (with no mention of hydronephrosis)	18	12.8
Fever IVU	17	12.1

Diagnostic work up

After hematuria recognition, urethro-cystoscopy was performed in almost all patients, showing blood clots in bladder and pulsatile bleeding from the ureteral meatus.
In 103 patients (73.6%) an abdomen-pelvis CT scan was performed, showing an iliac pseudo aneurism in 25 patients (17.8%). CT scan was a definitive diagnostic tool for AUFs in 23 cases (22% of all CT scans performed, and 16.4% of all patients).
A total of 94 patients (67.1%) underwent diagnostic angiography which in only 44 cases (46.8% of all angiographies performed, and 31.4% of all patients) recognized an AUF. The angiographic study shown an iliac pseudo aneurism in 11 pts out of 140 (7.8%).
Of the 83 (59.2%) retrograde pyelograms performed, 39 (46.9% of all pyelograms and 27.8% of all patients) were diagnostic.
The most sensible examination for the AUFs detection was angiography with provocative maneuvers.
Provocative angiography was described and defined as manipulation of ureteral stent or vascular catheter at the site of suspected AUF. In 15 of 30 cases provocative angiography was helpful to confirm the diagnosis of AUF, representing the most sensitive diagnostic tool available at the state of art (25).
A diagnostic *ureteroscopy* (URS) was performed in 68 pts. (48.6%), but only in 3 cases (4.4%) it was really diagnos-

tic, because of the poor vision due to the massive intraureteral bleeding (Table 4).

Table 4.
Diagnostic work up.

	N° tot	%	AUF cases diagnosed N° (%)	AUF cases diagnosed in the total population
CT	103	73.6%	23/103 (22.3%)	16.4%
Angiography	94	67.1%	44/94 (46.8%)	31.4%
Provocatory angiography	30	21.4%	15/30 (50%)	10.7%
Retrograde pyelogram	83	59.2%	39/83 (46.9%)	27.8%
URS	68	48.6%	3/68 (4.4%)	2.1%

Table 5 and 6 present the number and rate of AUFs diagnosed by different diagnostic procedures divided by gender and class ages.

Table 5.
AUF diagnosed by different diagnostic procedures by gender.

	Gender		
Diagnosis	**F**	**M**	**Total**
Angiography	23.0 52.27	21.0 47.73	44.0 (%)
CT scan / Angio TC	8.0 34.78	15.0 65.22	23.0 (%)
Provocatory Angiography	11.0 73.33	4.0 26.67	15.0 (%)
Retrograde Pyelogram	28.0 71.79	11.0 28.21	39.0 (%)
URS	4.0 80.00	1.0 20.00	5.0 (%)
Frequency missing = 315			

Table 6.
AUF diagnosed by different diagnostic procedures by age.

	Class age						
Diagnosis	**< 40**	**40-49**	**50-59**	**60-69**	**70-79**	**> 80**	**Total**
Angiography	5.0 11.36	0.0 0.00	12.0 27.27	8.0 18.18	18.0 40.91	1.0 2.27	44.0 (%)
CT scan/Angio TC	1.0 4.35	1.0 4.35	6.0 26.09	2.0 8.70	10.0 43.48	3.0 13.04	23.0 (%)
Provocatory Angiography	1.0 6.67	0.0 0.00	2.0 13.33	5.0 33.33	5.0 33.33	2.0 13.33	15.0 (%)
Retrograde Pyelogram	4.0 10.26	4.0 10.26	10.0 25.64	11.0 28.21	7.0 17.95	3.0 7.69	39.0 (%)
URS	0.0 0.00	0.0 0.00	1.0 20.00	3.0 60.00	1.0 20.00	0.0 0.00	5.0 (%)
Frequency missing = 315							

Location of AUFs

The distribution of the site of AUFs was as follow: 56 cases (40%) involved R-CIA (right common iliac artery), 44 cases (31.4%) involved L-CIA (left common iliac artery), 11 cases (7.8%) involved R-EIA (right external iliac artery), 9 cases (6.4%) involved L-IIA (left internal iliac artery), 7 cases (5%) involved R-IIA (right internal iliac artery) and 6 cases (4.3%) involved L-EIA (left-external iliac artery). In 7 patients (5%) AUFs interested other arteries, different from the iliac axis (including mesenteric artery and hypogastric arteries) (Figure 2).

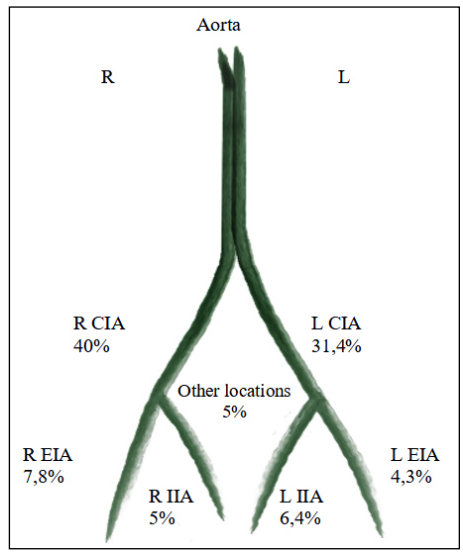


Figure 2.
Location of AUFs.
R: right;
L: left;
CIA: common iliac artery;
EIA: external iliac artery;
IIA: internal iliac artery.

Treatment

The most commonly used procedure was the endovascular prosthesis implantation, that was performed in 81 cases (57.1%) (Table 7). It was followed, in decreasing order of frequency, by surgical "*open*" vascular repair in 43 cases (30.7%), open nephrectomy with main renal artery embolization in 23 cases, and coil embolization of vascular segment in 20 cases (14.3%) (Table 8).
Out of them secondary treatments have been performed in 38 cases including 9 patients (6.4%) who underwent "*open*" nephrectomy after an endovascular treatment and others 3 patients received a coil embolization of the ureteral stump after a nephrectomy (Table 9).

Table 7.
Treatment n = 178.

	N°	%
Open nephrectomy/renal artery embolization	23	16.4
Open vascular repair	43	30.7
Coil embolization of vascular segments	20	14.3
Endoprosthesis	81	57.1
Coil embolization of ureteral stump	3	2.1
Ablation of residual ureteral stump after nephrectomy	8	5.7

Table 8.
Secondary treatment n = 38.

	N°	%
Endovascular treatment after "open" nephrectomy as first approach	26	18.6
Coil embolization of ureteral stump after "open" nephrectomy as first approach	3	2.1
"open" nephrectomy after an endovascular treatment as first approach	9	6.4

Table 9.
Recurrence.

	N° (average time to relapse)	%
	12 (8 months)	8.5

After treatment, 12 patients (8.5%) experienced a recurrence in the follow up, with mean recurrence-time of 8 months. Most of them were treated with a endovascular prosthesis implantation, only in two cases the retreatment was made by an "*open*" repair (Table 10).
Table 11 and 12 show the different procedures divided by gender and class age.

Table 10.
Re- treatment of the recurrence.

	N°	%
Open vascular repair	2	1.4
Endoprosthesis	7	5
Death from hemorrhagic shock at the time of the recurrence	3	2.1

Table 11.
Different procedures divided by gender.

Table of treatment by gender			
	Gender		
Diagnosis	**F**	**M**	**Total**
Coil embolization of ureteral stump	3.0 100.00	0.0 0.00	3.0 (%)
Coil embolization of vascular segment	15.0 75.00	5.0 25.00	20.0 (%)
Endoprosthesis	49.0 60.49	32.0 39.51	81.0 (%)
Nephrectomy or renal embolization	13.0 56.52	10.0 43.48	23.0 (%)
Open repair as first approach	21.0 48.84	22.0 51.16	43.0 (%)
Residual ureteral stump after Nephrectomy	6.0 75.00	2.0 25.00	8.0 (%)
Frequency missing = 2			

Table 12.
Different procedures divided by class age.

	Table of treatment by class age						
	Class age						
Treatment	**< 40**	**40-49**	**50-59**	**60-69**	**70-79**	**> 80**	**Total**
Coil embolization of ureteral stump	1.0 33.33	0.0 0.00	1.0 33.33	0.0 0.00	1.0 33.33	0.0 0.00	3.0 (%)
Coil embolization of vascular segment	3.0 15.00	3.0 15.00	3.0 15.00	6.0 30.00	4.0 20.00	1.0 5.00	20.0 (%)
Endoprosthesis	4.0 4.94	3.0 3.70	23.0 28.40	20.0 24.69	27.0 33.33	4.0 4.94	81.0 (%)
Nephrectomy or renal embolization	1.0 4.35	1.0 4.35	2.0 8.70	6.0 26.09	12.0 52.17	1.0 4.35	23.0 (%)
Open repair as first approach	5.0 11.63	4.0 9.30	7.0 16.28	10.0 23.26	12.0 27.91	5.0 11.63	43.0 (%)
Residual ureteral stump after nephrectomy	2.0 25.00	0.0 0.00	0.0 0.00	3.0 37.50	3.0 37.50	0.0 0.00	8.0 (%)
Frequency missing = 2							

Mortality

Authors found a global mortality of 11.4% (16 pts.). In particular, 7 pts. (43.7% of total deaths) were treated with "*open*" surgery as first approach, 6 pts. (37.5% of total deaths) were treated with coil embolization of a vascular segment, and just 3 pts. (18,75% of total deaths) were not treated but died for hemodynamic complications.

Case report

A 77-years old woman was followed at our Urology Unit for chronic indwelling ureteral catheter and periodical substitution due to a right ureteral stenosis. In 2012 she underwent an end-to-end ureteral anastomosis due to a ureteral injury during a retroperitoneal surgery for malignant melanoma. Furthermore, she had an aorto- bilateral-iliac bypass graft because of an aortic aneurysm. In January 2020, she was admitted in our Unit for periodic replacement of the ureteral JJ-stent as usual. This time the ureteral stent was calcified, so uretherolitotripsy had to be done first. No problem was encountered during the procedure.
A month later she returned for hematuria. The ureteral stent appeared dislocated. The replacement attempt was unsuccessful; therefore, a nephrostomy was placed (Figure 2). A few days later, she came back again in the emergency room and was admitted for the occurrence of anemia and hematuria both from nephrostomy and from bladder catheter. At admission in our department, she was hemodynamically stable, although intermittent hematuria was present. A CT scan revealed the presence of clots in the pelvis and calyces and the bladder, with no active vascular bleeding.
At first, a conservative management was considered with the administration of several blood transfusions due to the persistent anemia and the adjustment of the anticoagulant therapy with *low molecular weight heparin* (LMWH). However, intermittent hematuria persisted, and repeated CT scans remained unremarkable.
We decided to examine in depth the cause of bleeding and to perform a right ureteroscopy. During this procedure ureteral bleeding was observed, so we opted for a nephrectomy. During an open nephrectomy was observed that the ureter was imprisoned in a tenacious fibrous tissue at the level of the iliac cross. Unfortunately, intermittent hematuria recurred after few days. The CT scan and angiography showed no bleeding sources and there was no indication for a radiotherapy for hemostatic purposes. With the radiologists, we performed a provocative maneuver: a 5 Fr ureteral catheter was placed in the residual ureteral stump and a retrograde pyelography was performed; a subsequent selective angiography of the right iliac vessels revealed the presence of a fistula between the right ureter and the right common iliac artery prosthesis.
From an ipsilateral femoral access, a flush catheter was positioned proximal to the suspected UAF. A covered 11 mm × 5 mm Viabahn vascular stent graft (*Gore® Viabahn Endoprosthesis*) was placed in the right common and external iliac artery. After a few days, about one month later the last ureteral stent replacement, the patient no longer had hematuria and the hemoglobin was rising, therefore she was discharged. She had no recurrence of hematuria or fistula in follow-up. She is still in good condition today.

Discussion

Arterioureteral fistulas (AUFs) represent infrequent but potentially life-threatening conditions. In most of cases they have a subtle clinical presentation causing a delayed diagnosis. Even if gross hematuria is present in all of cases, only in 35% of these there is an emergency set up. In some

cases of AUF there was not enough time to intervene, and the patients died before treatment (3 of 140 in our review, 2.1%). Recognizing more common clinical aspects can be the key to achieve an adequate and timely diagnosis.

Gross hematuria (100%) or hydronephrosis with or without flank pain (32.8%) arising after ureteral stent substitution (27.8%) in a patient with history of chronic indwelling ureteral stent (81%) for previous pelvic surgery with or without radiotherapy is the most common clinical presentation.

Most of the patients have a history of gynecological (37.9%) or colorectal (20.7%) or bladder (13.6%) cancer or of vascular surgery for the correction of aneurysm (11.4%).

The mean time to onset of hematuria from stent placement is 36 months (25).

The etiology of secondary AUF is not well understood, although a possible mechanism is linked to the erosion secondary to the stent, post inflammatory reaction, and inflammatory reaction in the point of intersection of the vessels with the ureter and it is also due to the mechanical action of the pulsation of the iliac artery.

Hematuria is often intermittent; in some patients it occurs spontaneously and in others at stent change. As usual when in front of a gross hematuria, cystoscopy and contrasted CT scan are the first investigations to search the cause of bleeding. Other exams reported are angiography, retrograde pyelogram, ureteroscopy and provocative angiography.

Matsunaga et al. in 2020 proposed an algorithm for diagnostic and therapeutic management of ureteroarterial fistula (UAF) in the setting of ileal conduit urinary diversion (16), however, according to our review of the literature, a universal flow chart of investigations still does not exist.

Therefore, recurrent negative investigations can delay the diagnosis and lead to inappropriate treatments or even to the exitus.

Even if CT-scan results negative, an arterial-ureteral fistula must be suspected in patients with gross or intermittent hematuria and presenting specific risk factors, like *chronic indwelling urethral catheter* (CIUC), *history of pelvic surgery* (HPS) and *history of pelvic radiotherapy* (HPT). The early recognition of this Trifecta, according to the literature, can be helpful for smoother diagnostic orientation and consequent early treatment.

An immediate multidisciplinary approach involving the urologist, the interventional radiologist and the vascular surgeon could be the best choice. In fact, the most sensitive test for diagnosis of AUFs is the angiography concomitant to a provocative procedure (retrograde pyelogram).

Clinicians should prepare the patient to undergo to simultaneous retrograde pyelogram and angiography with subsequent endoprosthesis implantation.

The common iliac artery is the most frequent localization.

An "*open*" repair attempt and nephrectomy should be avoided, when possible, because they may result very challenging due to the previous pelvic surgery and radiotherapy. Furthermore, laparotomic approaches have the highest mortality rate and nephrectomy may not be conclusive because the ureteral stump remains. In this last case, a second procedure is necessary, and coil embolization of the ureteral stump is a good option.

Management of AUF has evolved from open repair to minimally invasive modalities owing to the development of stent-grafts and the higher morbidity and mortality associated with definitive surgical repair in a hostile anatomic environment. Accordingly, endovascular and endoureteral treatment modalities compare favorably with surgical approaches in terms of UAF-related mortality (7.1% *vs* 13.3%) and complication rates (28.6% *vs* 26.7%). These findings mirror results from smaller previous studies analyzing all the forms of treatment of UAF and suggesting the noninferiority of endovascular treatment compared with surgical approaches (6; 13-15, 26).

Reinterventions after endovascular and endoureteral procedures were largely secondary to fistula recurrence or hemorrhage or to stent occlusion or infection within the first 6 months. Although recurrence or hemorrhage and stent occlusion may be managed with repeat endovascular reintervention, stent infection has historically required explantation and conversion to an extra anatomic bypass to definitively remove the infectious nidus and prevent additional complications.

From the review proposed, it is not possible to evaluate adequately the long-term efficacy of the various treatments because of the heterogeneity of follow up adopted by Authors.

The most frequent treatment performed is the placement of endoprostheses. It was proposed to 81 patients and 56 of these underwent a follow-up (16 months of mean follow-up) with a relapse rate of 12.5% (7/56 patients) and a mean time to relapse of 14 months.

Coil embolization treatment was performed in 20 patients (14.3% of the sample); of these only 14 underwent follow up (mean follow up 11.6 months) with 2 recorded relapses (relapse rate 14% at an average time of 8 months).

The small size of data does not allow a satisfactory statistical analysis although from the sample examined the treatment with coil embolization has a higher relapse rate than the treatment with endoprosthesis.

Nowadays angiography with provocative measures has the highest diagnostic benefit and endovascular treatment with stent-graft placement across the fistula is the current state of the art choice for treatment (23).

The advantage of a correct and fast diagnosis are the preservation of overall renal function (no nephrectomy needed) and the reduction in management costs.

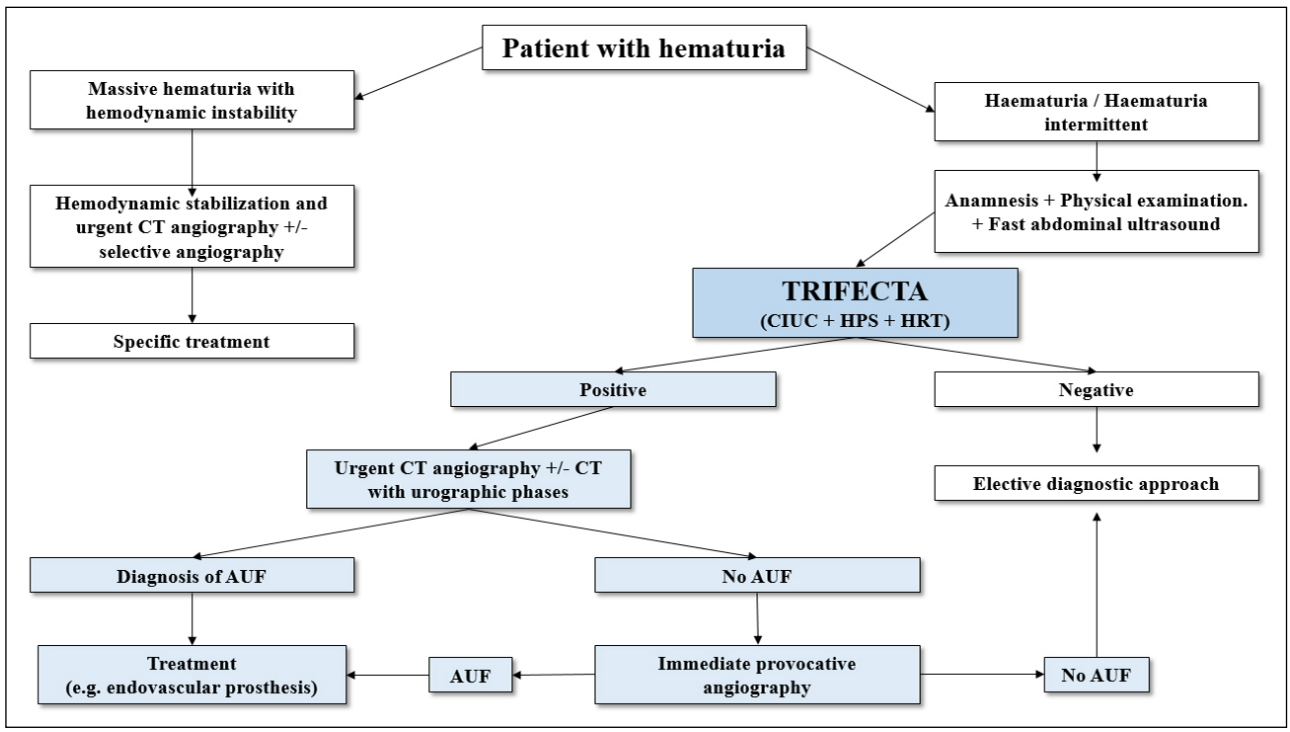
A universal diagnostic-therapeutic flowchart could be a useful diagnostic tool in order to offer an early diagnosis and effective treatment (Figure 3).

The diagnosis of AUF must be a diagnosis of exclusion. The first step should be the correct collection of clinical history, physical examination, and performing of abdominal ultrasound.

The exclusion of "macroscopic" sources of lower urinary tract bleeding is the first diagnostic goal in case of massive and intermittent hematuria. In patients without hemodynamic instability immediate angio-CT with urogram should be performed. From the analysis of the literature data, we have verified that angio-CT has not a high predictive diagnostic power for AUF. In patients with gross or intermittent hematuria and the presence of Trifecta the clinical suspicion of AUF is strong.

In case of negative angio-CT we propose the contextual and immediate execution of a provocative angiography.

Figure 3.
Flow-chart for early diagnosis and treatment of AUFs

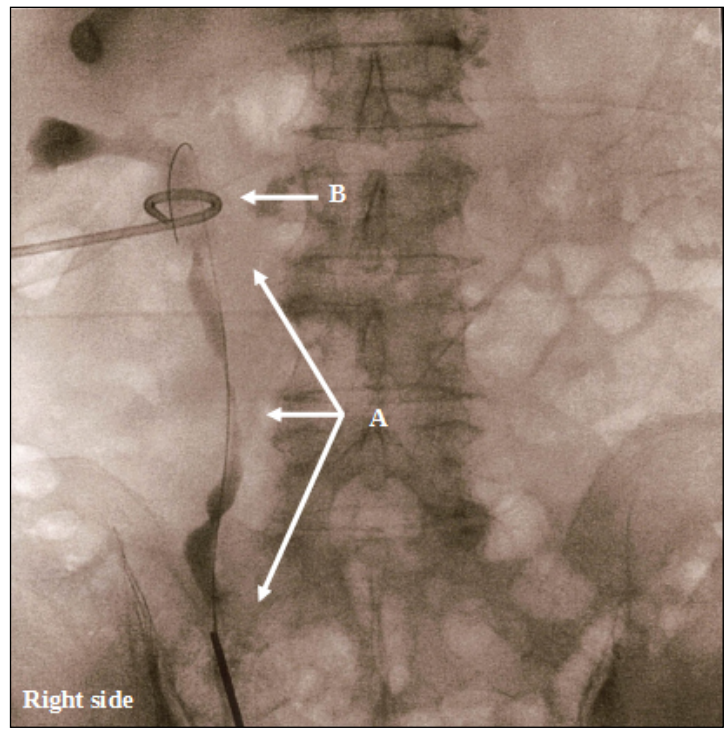


In patient with unknown AUF the removal of the ureteral stent could trigger massive bleeding and therefore it should be deferred at the time of the placement of the endovascular prosthesis, moreover the presence of a stent and its mobilization could be a diagnostic aid during the provocative angiographic study (Figure 4). In presence of a massive hematuria with hemodynamic instability an immediate hemodynamic stabilization and urgent angio-CT, with consequent selective angiography, represent the safest approach. The limitations of the current review include its heterogeneous sample size derived predominantly from retrospective case reports. However, despite these limitations, inferences derived from systematic reviews of case reports and case series are recognized as valid and useful decision-making aid, particularly with uncommon entities such as UAF for which there is an absence of strong evidenced-based recommendations and guidelines (17).

Conclusions

Management of AUFs may be facilitated by using the aforementioned diagnostic and therapeutic algorithmic approach in a multidisciplinary modality involving interventional radiology, urology, and vascular surgery services. The early recognition of the proposed Trifecta (CIUC, HPS and HRT) can be helpful for smoother diagnostic orientation and consequent early treatment, performing Angio-CT examination and immediate provocative angiography. Endovascular and endoureteral modalities afford clinical outcomes comparable with those of surgical approaches but close postprocedural follow-up is required. Management of this challenging clinical entity may be facilitated by using a standardized and multidisciplinary diagnostic and therapeutic algorithmic approach.

Figure 4.
Right retrograde ureteropyelography with no spillage (A) in patient with left nephrostomy (B).



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Conflict of interest: The authors declare no potential conflict of interest.