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INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Percutaneous antegrade ureteral stent placement: single center experience

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PURPOSE
We aimed to present our clinical experience with percutaneous antegrade ureteral stent placement in a single center.

METHODS
Electronic records of patients who underwent percutaneous image-guided ureteral stent placement between September 2005 and April 2017 were reviewed. A total of 461 patients (322 males, 139 females; age range, 19–94 years; mean age, 61.4±15 years) were included in the study. Patients were classified into two main groups: those with neoplastic disease and those with non-neoplastic disease. Failure was defined as persistence of high level of serum creatinine or an inability to place stents percutaneously. Postprocedural complications were grouped as percutaneous nephrostomy and stent placement related complications.

RESULTS
A total of 727 procedures in 461 patients were included in the study: 654 procedures (90%) in 407 patients (88.3%) were in the neoplastic group and 73 procedures (10%) in 54 patients (11.7%) were in the non-neoplastic group. Our technical success rates were 97.7% and 100% and complication rates were 3.1% and 4.1% in neoplastic and non-neoplastic groups, respectively. Seven stents retrievals and 112 balloon dilatations were performed successfully.

CONCLUSION
Percutaneous antegrade ureteral stent placement is a safe and effective method for management of ureteral injuries and obstructions due to both malignant and benign causes when the retrograde approach has failed.

Because of its anatomical relationship to the adjacent organs and its long and narrow structure, ureters are easily affected by benign or malignant conditions resulting in the interruption of urinary drainage. Cause of ureteral obstruction is malignancy in the majority of cases, and treatment of obstructions caused by malignancy has a higher risk of failure with the retrograde approach. Ureteral injuries may occur iatrogenically during surgery, with gynecologic surgery being traditionally responsible for more than 50% (1). Ureteral stents have been widely used for the management of these patients since their first description by Zimskind et al. (2) in 1967. A variety of techniques and materials have been utilized for ureteral stenting by urologists and interventional radiologists (3–7).

Generally, internal drainage devices such as double-J stents are placed in retrograde transvesical route by urologists via a cystoscope (5, 6). Percutaneous antegrade ureteral stenting (PAUS) under the guidance of ultrasonography (US) and fluoroscopy is an alternative technique in patients who are unsuitable for the retrograde approach (6, 7). Due to potential complications of percutaneous nephrostomy (PN) and patient discomfort, which is necessary for antegrade stent insertion, the percutaneous way is not preferred as a first-line method (7). In comparison with PAUS, the success and complication rates of the retrograde ureteral stent placement are well reported (8–13). In this article, we aimed to present the clinical outcome including technical success, clinical success, and complications of PAUS.

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Methods

Patients

The research was approved by IRB (2017/171) and included a retrospective review of the electronic medical records of the patients who underwent PAUS between September 2005 and April 2017 as obtained from the interventional radiology division database.

A total of 461 patients (322 males, 139 females; age range, 19–94 years; mean age, 61.4±15 years) and 727 procedures were included in the study. Twenty patients were excluded from the study due to incomplete medical records. According to the patients' files, the indication for PAUS was clearly mentioned in 176 procedures (24.2%) only. The vast majority of these (166 procedures, 94.3%) were due to unsuccessful retrograde attempts, while the rest were due to patient request (5 procedures, 3%), adjacent abscess formation at the ureterocutaneostomy site (2 procedures, 1.1%), distal ureter stones (2 procedures, 1.1%) and proximal ureteral stent migration (1 procedure, 0.5%). For 551 procedures (75.8%), indication of PAUS was not stated exactly in medical records.

Demographic data, indications for the procedure, postprocedural laboratory blood results, technical details of the procedure, and postprocedural complications were collected from the relevant records, retrospectively. Patients were classified into two main groups: those with neoplastic disease and those with non-neoplastic disease.

Postprocedural complications were grouped as PN and stent placement related complications. Minor and major complications for PN were defined according to the guidelines of the Society of Interventional Radiology (14). Complications related to antegrade ureteral stent placement were defined according to the review published by Hausegger et al. (7).

Main points

- Ureters are easily affected by benign or malignant conditions resulting in the interruption of urinary drainage.
- Ureteral stents have been widely used for the management of patients with ureteral obstruction or ureteral injury.
- Generally, ureteral stents are placed through retrograde transvesical route by urologists via a cystoscope.
- Percutaneous antegrade ureteral stenting is a safe and effective alternative technique in patients who are unsuitable for a retrograde approach.

Technique

Informed consent was obtained from the patients or their relatives. All procedures were performed with US and fluoroscopy guidance under intravenous sedoanalgesia. After patient preparation, the procedure was performed in two stages: first PN was performed, then the ureteral stent was placed in an antegrade fashion. In patients who had nephrostomy catheter, the second stage of the procedure was performed directly. Generally, both procedures were not performed on the same day. In some cases, the indication for stent placement was determined after PN by urologists depending on whether the kidney is functional or not.

Percutaneous nephrostomy was carried out with the patient in a 30° prone oblique position. After localization of the collecting system with the US, lower pole collecting system was punctured with an 18-gauge Chiba needle (Cook Medical) by a dorsal approach with the Seldinger technique. If necessary, the middle or upper calyces were punctured, also. Then, collecting system was opacified with nonionic contrast material (Iopromide, Ultravist® 370, Schering). Thereafter, a 0.035-inch guidewire was advanced into the renal pelvis via the needle, and the needle was withdrawn. After tract dilatation, an 8 or 10 French (F) drainage catheter (Bioteque Corporation) was placed into the renal pelvis.

For ureteral stent placement procedure, antegrade pyelography containing whole ureteric segments and the ureterovesical junction was performed by contrast material injection via the nephrostomy catheter, and pathology of the ureter such as stricture, occlusion, or leakage was demonstrated. After exchanging the nephrostomy catheter over the J-tipped guidewire, 5 F multipurpose (45° tip) diagnostic vascular catheter (Cordis Corporation) was inserted. Once the pelviureteric junction was crossed and the ureter accessed, a straight hydrophilic guidewire (Roadrunner® PC Wire Guide, Cook Medical) and a catheter were used. Then, the catheter was advanced into the bladder over the wire, this guidewire was exchanged for an ultra-stiff guidewire (Back-up MeierTM steerable wire guide, Boston Scientific), an 8/10 F double-pigtail plastic ureteral stent (Flexima Ureteral Stent SystemTM, Boston Scientific) was placed over the guidewire, and the safety kit of the stent was removed. A final fluoroscopic image was stored for correcting the stent position. An 8 F nephrostomy drainage catheter was placed and this was removed in 48-hours following a satisfactory nephrostogram. Stent length was 12 cm for transplant kidney patients, 22 cm, 24 cm, or 26 cm for other patients. Stent length selection was based on personal experience. In our center, the proper time of stent replacement is 3 months. However, due to complications of the process, stent revision was performed for some patients (n=15) before the suggested time of replacement (15).

In some cases, the procedure was performed for patients who underwent renal transplantation (n=8), ureterocutaneostomy (n=52), or ileal conduit urinary diversion (n=46). Balloon dilatation was applied to severe ureteric strictures using an 6–8 mm in diameter angiographic balloon dilatation catheter (XXL, Boston Scientific/Medi-tech) in 112 patients.

Placement of the ureteral stent and completion of the interventional procedure was accepted as technical success. Clinical success was defined as <2 mg/dL blood creatinine level and complete resolution or reduction of symptoms.

Statistical analysis

Statistical analysis was performed using SPSS version 24.0 for Windows (IBM Corp.).

Results

A total of 727 procedures in 461 patients were performed in our interventional radiology department: 73 procedures (10%) in 54 patients (11.7%) were in the non-neoplastic group, while 654 procedures (90%) in 407 patients (88.3%) were in the neoplastic group (Tables 1 and 2; Fig. 1).

Of the patients, 142 underwent antegrade insertion of double-J stents more than once (127, two times; 9, three times; 4, four times and 2, six times). A total of 99 procedures were performed bilaterally and 8 on renal allografts (Fig. 2). For some patients, the distal end of the stent was placed into an urostomy bag (n=52) or ileal conduit (n=46) (Fig. 3). Just before ureteral stenting, 7 ureteral stent retrievals and 112 balloon dilatations were successfully performed as shown in Table 3.

Table 1. Characteristics of non-neoplastic disease patients

Indication	Patients	Multiple approaches	Bilateral approaches	Procedures	Clinical failure	Technical failure
Nephrolithiasis	8 (14.8)			8 (11)	1	-
Genitourinary tuberculosis	8 (14.8)	4		12 (16.4)	3	-
Kidney transplantation related	8 (14.8)			8 (11)	2	-
Ureterovesical junction obstruction	7 (12.9)	2*		11 (15)	1	-
Neurogenic bladder	6 (11.1)	2	2	10 (13.7)		-
Ureteral injury	6 (11.1)		1	7 (9.6)		-
Retroperitoneal fibrosis	4 (7.4)	1	2	7 (9.6)		-
Ureteropelvic junction obstruction	3 (5.6)	1		4 (5.5)		-
Benign prostatic hyperplasia	3 (5.6)	1	1	5 (6.8)	2	-
Hydatid cyst	1 (1.9)			1 (1.4)		-

Data are presented as number or number (percentage).
*One patient, four times.

Table 2. Characteristics of neoplastic disease patients

Indication	Patients	Multiple approaches	Bilateral approaches	Procedures	Clinical failure	Technical failure
Direct tumor invasion of genitourinary system	319 (78.3)	104	80	525 (80.2)	53	13
Bladder cancer	173 (42.5)	59[a]	36	285 (43.5)	36	7
Prostate cancer	81 (19.9)	29[b]	25	140 (21.4)	13	1
Cervix cancer	42 (10.3)	9	13	64 (9.8)	2	4
Endometrial cancer	12 (2.9)	4	4	20 (3.1)	2	
Ovarian cancer	11 (2.7)	3	2	16 (2.4)		1
Metastatic tumor	88 (21.7)	27[c]	13	129 (19.8)	8	2

Data are presented as number or number (percentage).
[a]7 patients, three times; 1 patient, four times; 2 patients, six times; [b]1 patient, three times; 2 patients, four times; [c]1 patient, three times.

In total, 314 stents were exchanged by urologists (n=291) and our interventional radiologist (n=23) during the follow-up period. The indwelling time of stents was 3 days to 24 months (mean, 5.18±4 months).

Frequent causes of the non-neoplastic group were genitourinary tuberculosis (16.4%) (Fig. 4), ureterovesical junction obstruction (15.1%), and neurogenic bladder (13.7%). All patients were successfully stented. Seven patients (nine procedures, 17.3%) had a high level of serum creatinine: Two patients were diagnosed as graft versus host disease; one patient was later treated for diabetic nephropathy; serum creatinine levels normalized after 3 months of antituberculous therapy in two patients; one patient showed normal levels of serum creatinine after transurethral prostatectomy for benign prostatic hyperplasia; and one patient with ureterovesical junction obstruction also had a 2 cm urethral stricture and normal serum creatinine level was achieved after 2–4 months of balloon dilatation treatment.

Major indications for the neoplastic group were bladder cancer (43.6%) and prostate cancer (21.4%) (Fig. 5). There were 15 (2.3%) unsuccessful attempts of ureteral stenting in 15 patients. Two of these patients underwent uretero-cutaneostomy and one patient needed open surgery. Severe ureteral invasion by tumor tissue and considerable edematous changes were the reasons for failure in 11 patients. One patient had a large calculus attached to the distal end of the ureter, which was the reason for failure. A total of 35 patients had a high level of serum creatinine for 61 PAUS (13%): 21 of these patients had normal creatinine levels at follow-ups. High serum creatinine levels were normalized after additional treatment for congestive heart failure in two patients. Four patients were lost to follow-up and one patient was transferred to the intensive care unit at another hospital and was lost to follow-up. Two patients required one session of hemodialysis after the procedure. Two patients required admission to the intensive care unit and died 3 and 20 days after the procedure. Two pa-

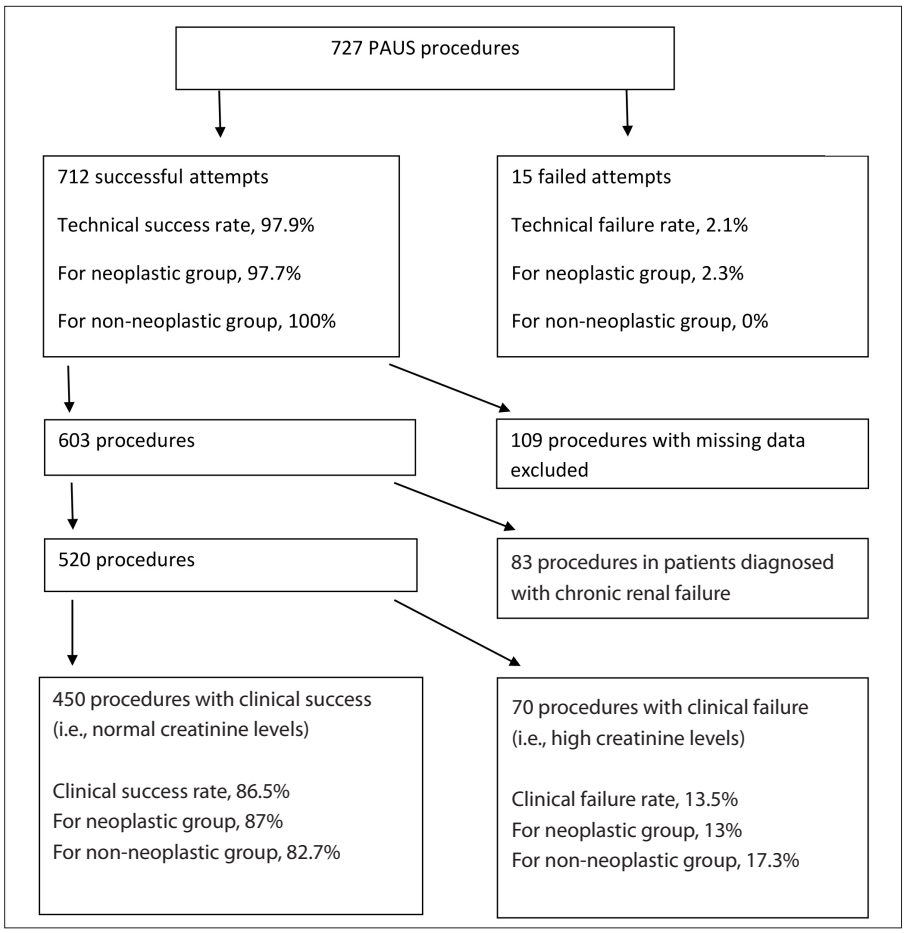

Figure 1. Summary of technical and clinical successes and failures of percutaneous antegrade ureteral stenting (PAUS).

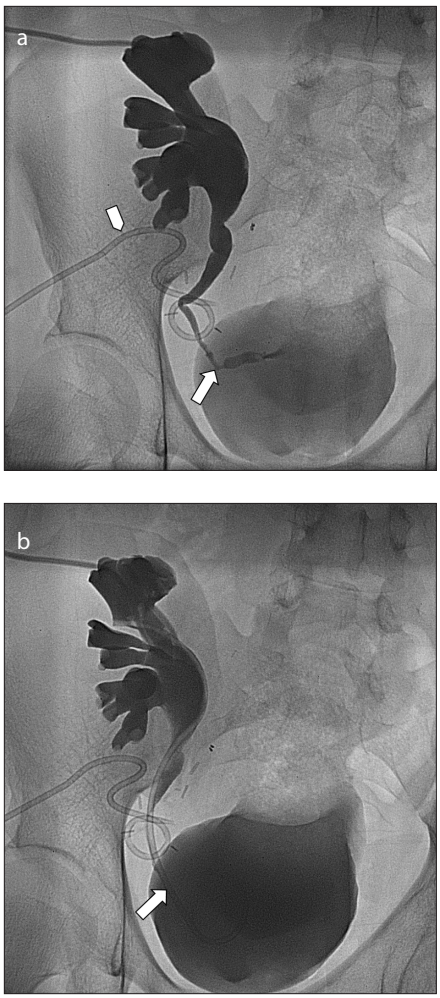

Figure 2. a, b. A 19-year-old man who had renal transplantation was referred by nephrologist because of anastomotic stricture. Antegrade pyelography **(a)** shows hydroureteronephrosis due to distal anastomotic stricture *(arrow)*. A drainage catheter *(arrowhead)* is also seen for lenfosel treatment. An 8 F double-pigtail plastic ureteral stent (**b,** *arrow)* was placed and increased urine output was observed after the procedure. Nephrostomy drainage catheter was removed three days later.

Table 3. Number of balloon dilatations and stent retrievals

Indication	Balloon dilatation	Stent retrieval
Bladder cancer	39	3
Prostate cancer	20	3
Cervix cancer	13	
Colon cancer	8	
Rectum cancer	9	
Endometrial cancer	4	1
Gastric cancer	3	
Lung cancer	2	
Malignant mesenchymal tumor	1	
Cutaneous squamous cell cancer	1	
Nephrolithiasis	3	
Ureterovesical junction obstruction	3	
Genitourinary tuberculosis	1	
Kidney transplantation related	2	
Ureteropelvic junction obstruction	2	
Retroperitoneal fibrosis	1	

tients had creatinine levels of 2–3 mg/dL at follow-ups and required no additional medication for a year. One patient had surgery 2 days after the procedure; stent malpositioning occurred after this surgery, which was later fixed by the urologists.

Overall technical and clinical success rates were 97.9% and 86.5%, respectively (Fig. 1). Our complication rates were 3.1%, 4.1% for neoplastic and non-neoplastic groups, respectively. A total of 23 postprocedural complications (3.2%) were seen in 21 patients (Table 4). PN and ureteral stenting related complications occurred in two procedures each. There were 16 postprocedural stent-related complications,

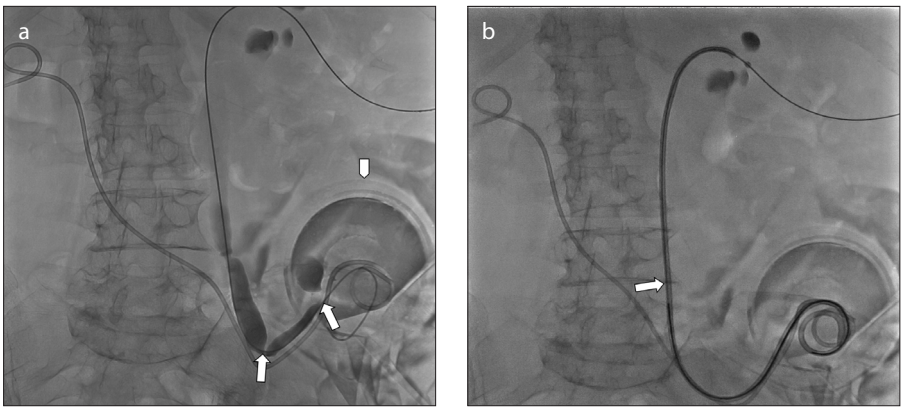

Figure 3. a, b. A 62-year-old woman with bladder cancer had radical cystectomy with ureterocutaneostomy. The patient was referred by the urologist after unsuccessful stent revision on the right side. An ultrastiff guidewire was placed in urostomy bag *(arrowhead)* through the ureterocutaneostomy tract (**a,** *arrows)*. After that, an 8 F double-pigtail plastic ureteral stent (**b,** *arrow)* was placed over the guidewire.

Figure 4. a, b. A 64-year-old male, diagnosed with genitourinary tuberculosis. Antegrade pyelography shows left hydroureteronephrosis due to distal ureterovesical junction stricture (**a,** *arrow)*. An 8 F double-pigtail plastic stent was placed (**b,** *arrow)* and a nephrostomy catheter was inserted.

namely, malpositioning of the stent (n=10), urinary tract infection (n=3), and occlusion (n=3). Therefore, 15 stents were revised and tandem ureteral stenting was performed in one patient. There were nine PN-related complications, namely, perirenal hematoma (n=5), hematuria (n=3), and perirenal abscess formation (n=1). Three of them required postprocedural hospitalization and were considered as major complications according to the guideline (14). One patient was hospitalized for perirenal abscess and two patients were hospitalized for hematuria. A drainage catheter was inserted for abscess formation and one unit of erythrocyte suspension was transfused to patients with hematuria. Perirenal hematomas resorbed spontaneously, and no blood transfusion or additional medication were required for the rest of the patients.

Discussion

In this retrospective study, we investigated the effectiveness of PAUS for the management of ureteral obstructions from both malignant and benign causes and ureter injuries, and we found that PAUS is a safe and effective method in case of failure of retrograde approach.

In patients presenting with malignant ureteric obstruction, success rates for retrograde ureteral stenting have been reported as 50%–88% (8–13, 16). On the other hand, PAUS is more appropriate for these patients to deal with technical difficulties that prevent retrograde stent placement. A technical success rate of 97.7% of the 654 ureteral stenting in our series compares favorably with other published studies which have

Table 4. Summary of complications

Indication	No. of patients (procedures)	Percutaneous nephrostomy related complications		Ureteral stenting related complications
		Major	Minor	
Bladder cancer	7 (9)		2*	8
Prostate cancer	2 (2)	2		
Cervix cancer	3 (3)		1	2
Rectum cancer	4 (4)		1	3
Gastric cancer	1 (1)	1		
Endometrial cancer	1 (1)			1
Ureterovesical junction obstruction	1 (1)			1
Kidney transplantation related	2 (2)		2*	1

*In one procedure, both percutaneous nephrostomy and ureteral stenting related complications occurred.

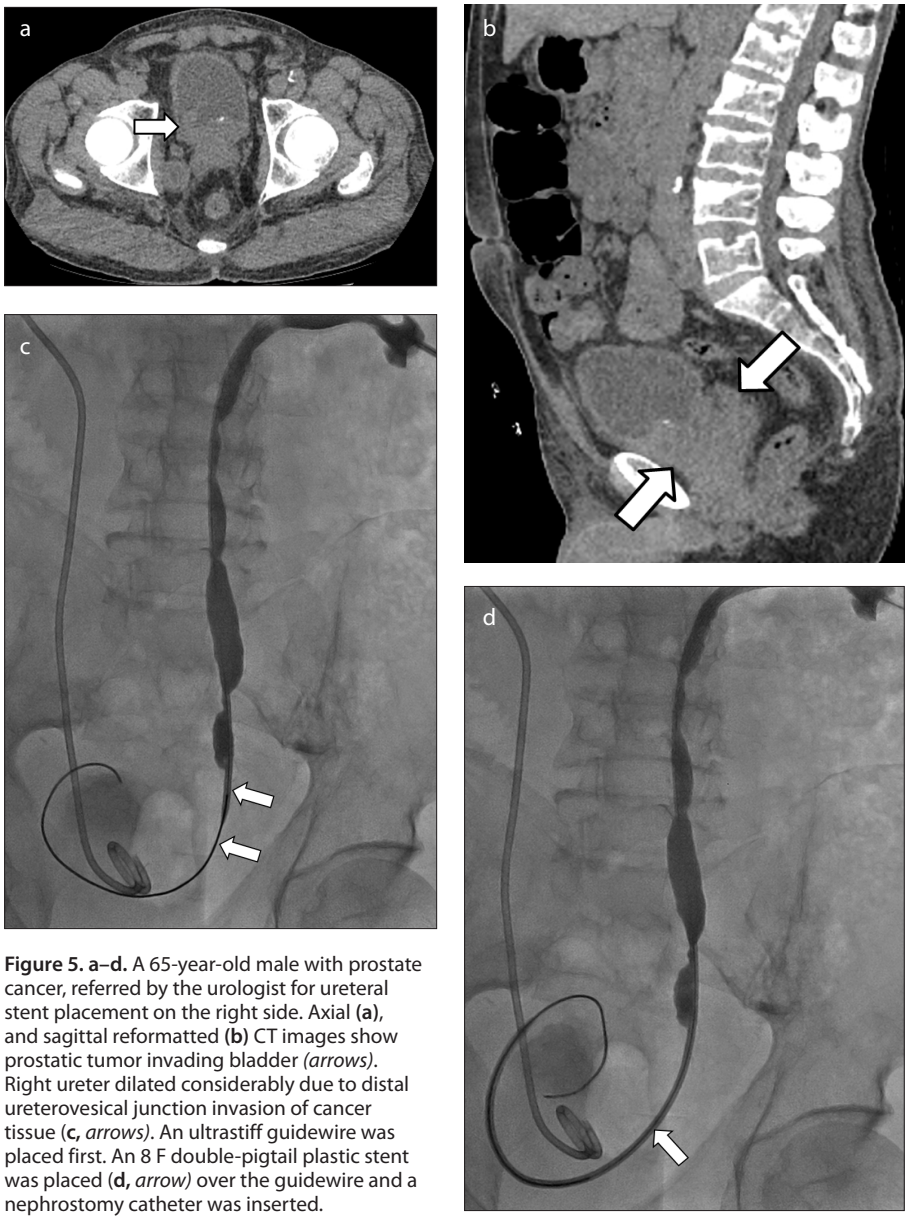

Figure 5. a–d. A 65-year-old male with prostate cancer, referred by the urologist for ureteral stent placement on the right side. Axial **(a)**, and sagittal reformatted **(b)** CT images show prostatic tumor invading bladder *(arrows)*. Right ureter dilated considerably due to distal ureterovesical junction invasion of cancer tissue (**c,** *arrows)*. An ultrastiff guidewire was placed first. An 8 F double-pigtail plastic stent was placed (**d,** *arrow)* over the guidewire and a nephrostomy catheter was inserted.

Table 5. Comparison of success rates of PAUS

Studies	PAUS success
Uthappa et al. (16)	24/25 (96%)
Chitale et al. (17)	39/40 (98%)
Harding (18)	34/37 (92%)
Mitty et al. (19)	67/78 (85%)
Current study	639/654 (97.7%)

PAUS, percutaneus antegrade ureteral stenting.

reported success rates varying from 85% to 98% (16–19) (Table 5).

Double-J stent placement has been recently preferred by urologists for the early management of genitourinary tuberculosis (20). In one series, retrograde stent placement was successful in only 41% of the cases (21). However, 12 procedures were successfully performed in 8 patients in our series.

For the management of ureteric injury, success rates for retrograde ureteral stenting have been reported to range from 14% to 84% (22–26). As an alternative technique of double-J stenting, PAUS has a success rate of 72%, as reported by Koukouras et al. (27). Toporoff et al. (28) and Liatsikos et al. (29) reported the success rate of PAUS as 100% for the treatment of ureteric injuries. The technical success rate of PAUS for the management of ureteric injuries was 100% in our experience.

Complications such as ureteric and vascular injury at the time of insertion of the double-J stent, arteriovenous fistula formation caused by vascular injury, and perforation of the artery at the time of stenting leading to hemoperitoneum have been documented in the literature (30). In our study there were only three major complications, all PN related. Stenting related complications which have been documented in the literature such as malpositioning of the stent, urinary tract infection, and occlusion occurred in our study (7, 31).

The technical success rate in our series was 97.7% and 100% for neoplastic and non-neoplastic groups, respectively. Even though antegrade approach has an increased risk of PN-related hemorrhage and the ideal stent length in the bladder is more difficult to achieve, PAUS overcomes retrograde ureteral stent placement because it does not require general or spinal anesthetic and does not necessitate the use of operating theatre facilities. The most important requirement is the skill of an experienced interventional radiologist.

Although this is one of the largest series on PAUS, this study was limited by the nature of retrospective studies where clinical conditions of the patients may be underreported. Long-term stent-related complications such as bladder irritability due to the irritation by the lower end of the stent and stent encrustation may not have been reported accurately. We defined clinical failure as high blood creatinine level anytime up to seven days after the procedure; some patients underwent emergency hemodialysis (n=24) just before the procedure which affected our clinical success and failure rates.

In conclusion, PAUS is a safe and effective method for management of ureteric obstructions due to both malignant and benign causes and injuries, when the retrograde approach has failed.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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