ORIGINAL ARTICLE

Vol. 40 (5): 690-696, September - October, 2014
doi: 10.1590/S1677-5538.IBJU.2014.05.15

Intravenous misplacement of nephrostomy tube following percutaneous nephrolithotomy: Three new cases and review of seven cases in the literature

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ABSTRACT

Purpose: We investigated the characteristics and management of patients with intravenous misplacement of a nephrostomy tube.

Materials and Methods: Between July 2007 and July 2013, 4148 patients with urolithiasis underwent percutaneous nephrolithotomy (PCNL) in our hospital. Intravenous misplacement of a nephrostomy tube occurred in two of these patients. Another patient with intravenous misplacement of a nephrostomy tube, who underwent PCNL in another hospital, was transferred to our hospital. The data of the three patients were retrospectively analyzed.

Results: The incidence of intravenous misplacement of a nephrostomy tube following PCNL was 0.5% (2/4148) at our hospital. A solitary kidney was present in one of the three patients. The tip of tube was located into the inferior vena cava (IVC) in two patients and into the renal vein in one patient. All three patients were successfully managed with strict bed rest, intravenous antibiotics and one-step (one patient) or two-step (two patients) tube withdrawal under close monitoring. None of the patients underwent antithrombotic therapy. The original operations were performed successfully under close observation in two patients and changed to another operation in one patient. All patients were discharged uneventfully.

Conclusions: The incidence of intravenous misplacement of a nephrostomy tube following PCNL is 0.5% at our hospital. Intravenous nephrostomy tube misplacement is an uncommon complication of PCNL. A solitary kidney may render patients susceptible to this complication. Most patients may be managed conservatively with strict bed rest, intravenous antibiotics and one-step or two-step tube withdrawal under close monitoring.

ARTICLE INFO

Key words:
Nephrostomy, Percutaneous; Urolithiasis; Kidney Calculi

Int Braz J Urol. 2014; 40: 690-6

Submitted for publication:
November 27, 2013

Accepted after revision:
April 16, 2014

INTRODUCTION

Percutaneous nephrolithotomy (PCNL) was introduced by Fernström and Johansson in 1976 (1), and is an important approach for removing kidney stones. A recent study demonstrated an increase in PCNL use in the United States over the last decade (2). Although PCNL is an established procedure, major complication rates of up to 7% have been reported (3). Furthermore, there has been an increase in surgical complications over the last decade (2). Intravenous misplacement of a urologic catheter is an uncommon complication of percutaneous renal surgery (2-6). Improper treatment of patients with this complication could lead to serious consequences, such as hemorrhage,

embolization, perforation and infection (7,8). Therefore, the mechanism and proper management of this injury should be investigated. However, few publications have reported on the intravenous misplacement of a nephrostomy tube. We report our experience with three cases of intravenous nephrostomy tube misplacement following PCNL and review the few such cases published in the literature.

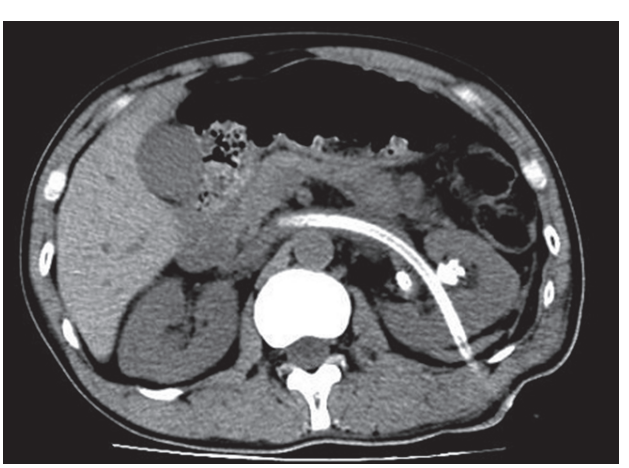
MATERIALS AND METHODS

We retrospectively reviewed the records of patients who were treated for urolithiasis in our hospital between July 2007 and July 2013, and identified 4148 patients who underwent PCNL. Intravenous misplacement of a nephrostomy tube following PCNL occurred in two of the 4148 patients. Another patient with intravenous misplacement of a nephrostomy tube, who underwent PCNL in another hospital, was transferred to our hospital. The data of these three patients were retrospectively analyzed.

Case Reports

Patient 1 was a 42-year-old man admitted to our hospital with the main complaint of repetitive left flank pain. His medical history was unremarkable. White blood cells (12/μL) were detected in the urine. Empirical antibiotics were started. After imaging examination, the patient was diagnosed with staghorn renal calculi and mild hydronephrosis, and underwent PCNL. The procedure of PCNL through the superior calyceal tract was uneventful, and the stones located in the superior calyx and renal pelvis were cleared. A sheath was kept in place temporarily. Additional lower pole calyceal puncture was required for complete clearance of stones in the inferior and middle calyces. The puncture site of the inferior calyceal fornix was localized under radiological monitoring using contrast material, producing an antegrade nephrostogram. Clear urine was seen on withdrawal of the stylet. After renal puncture, a flexible-tip guidewire was inserted. The tip of guidewire curled within the calyx around the stone under fluoroscopic visualization. The tract was dilated with fascial dilators to accommodate an 18F sheath. Immediately after dilator removal, brisk venous bleeding was noted. An 18F nephrostomy tube was inserted promptly through the sheath to tamponade the tract and was then closed. Another 18F nephrostomy tube with a safe guidewire was inserted through the former superior calyceal sheath to drain the collecting system. The drain fluid from the nephrostomy tube in the superior calyx became clear several hours later. An attempt at opening the inferior calyceal tube on the second postoperative day resulted in brisk bleeding and the tube was immediately sealed. Postoperative computed tomography (CT) showed that the tube had pierced the renal parenchyma, entered the left renal vein and extended up to the inferior vena cava (IVC; Figure-1). On postoperative day 12, the closed tube was pulled back and repositioned in the renal vein just proximal to the sinus under CT monitoring with a cardiac surgery and anesthesiology team standing by. A second-look PCNL was performed in the operating room on postoperative day 15. The intravenously misplaced tube was not discovered within the collecting system, and was removed under ultrasound monitoring, with a surgical team on standby ready to intervene. The postoperative course was smooth and no bleeding occurred. The patient was discharged on postoperative day 22, and the residual stones were treated subsequently by elective PCNL.

Figure 1 - Computed tomography revealing the nephrostomy tube piercing the renal parenchyma, into the left renal vein and ending in the inferior vena cava.



Patient 2 was a 38-year-old woman who was admitted to our hospital with the main complaint of consistent, dull pain in the left flank. She had undergone a right ureteroscopic lithotomy due to a middle ureteral calculus 5 days before. White blood cells (18/μL) were detected in the urine. Antibiotics were started, according to the results of prior urine culture and sensitivity. The patient was diagnosed with staghorn renal calculi and moderate hydronephrosis, and underwent PCNL. Access to the middle calyx was achieved using fascial dilators, under fluoroscopic guidance. Immediately after dilator removal, heavy venous bleeding was noted through the sheath. A nephrostomy tube was inserted through the sheath. Fluoroscopy with contrast material opacified the renal vein, demonstrating that the tube had lodged within the IVC. The tube was immediately withdrawn and positioned at the site of entry into the renal vein. The tube was spigotted. Another simultaneous PCNL through the inferior calyceal tract was performed uneventfully (Figure-2). The former spigotted tube was not discovered within the collecting system and was removed under ultrasound monitoring with a surgical team on standby, during the second-look PCNL on postoperative day 7. No bleeding occurred. The postoperative course was smooth.

Patient 3 was a 48-year-old man who had undergone a right open nephrectomy owing to kidney trauma 2 years ago. His serum creatinine level before surgery was 1.2mg/dL (normal range, 0.6-1.4mg/dL). The patient was diagnosed with left upper ureteral calculus and mild hydronephrosis, and undergone a PCNL in a community hospital 3 days before. Intense bleeding led to a sudden interruption of the PCNL. A nephrostomy tube was promptly inserted and closed in order to control the bleeding. The patient suffered an 800mL blood loss. In view of the massive hemorrhage and the solitary kidney, the patient was transferred to our hospital on the second postoperative day with the tube closed.

At our institution, CT showed the nephrostomy tube piercing the renal parenchyma and entering the left renal vein (Figure-3). An attempt at opening the tube on postoperative day 3 did not result in bleeding, owing to tube obstruction by clotted blood. The tube was closed again to prevent secondary bleeding due to detachment of clotted blood. The nephrostomy tube was removed under ultrasound monitoring, with a surgical team on standby, on postoperative day 7. No bleeding occurred. Flexible ureteroscopy with Ho:YAG laser lithotripsy was performed 3 days later. Mucosal injury was not found during ureteroscopy. The

Figure 2 - The radiograph of the kidneys, ureters and bladder revealing the tip of nephrostomy tube (white arrow) lodged at the site of entry into the renal vein. Additional findings including another nephrostomy tube and a double-J stent.

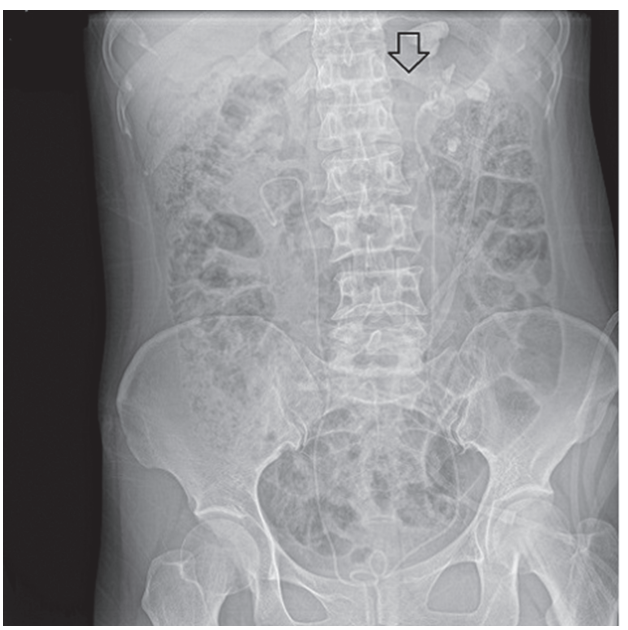
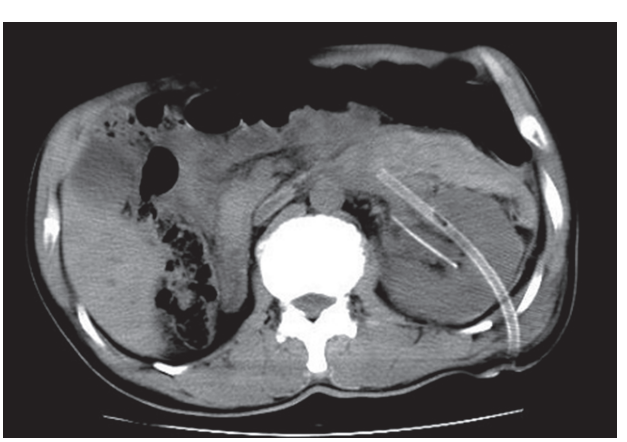


Figure 3 - Computed tomography showing the nephrostomy tube piercing the renal parenchyma into the left renal vein. Additional findings including a double-J stent



postoperative course was smooth. The postoperative serum creatinine level was 1.0mg/dL.

RESULTS

The incidence of intravenous misplacement of a nephrostomy tube following PCNL was 0.5% (2/4148) at our hospital. The data of the three patients are summarized in Table-1. The tip of the nephrostomy tube was located in the IVC in two patients and in the renal vein in one patient. The diagnosis was delayed in two of the three patients. All three patients were managed successfully with strict bed rest, intravenous antibiotics and one-step (in one patient) or two-step (in two patients) tube withdrawal under close monitoring. None of the three patients required open surgery for identifying the injured vein or removing the stone. None of the patients underwent antithrombotic therapy or developed deep venous thrombosis. The original operations were performed successfully under close observation in two patients and changed to another type of operation in one patient. All patients were discharged uneventfully.

DISCUSSION

Intravenous misplacement of a nephrostomy tube is an uncommon complication of PCNL. Few publications have reported the misplacement of a nephrostomy tube in the renal vein, IVC or atrium. To date, apart from the three cases reported here, only seven cases of this complication have been reported in six articles in the PubMed database (4,5,9-11). The data from these publications are summarized in Table-1. The manners of intravenous misplacement may be different in various patients. There are large venous collars around the calyceal necks and also horizontal arches crossing over the calyces to link anterior and posterior veins (12). The renal vein is proximal to the renal pelvis and major posterior calyces (13). The proximity of the renal vein and its branches to the renal pelvis and calyces predisposes the veins to be injury during PCNL. The perforation of a large venous trunk by the guidewire and subsequent dilatation of the injured vein can result in catheter migrating to the venous system during the nephrostomy tube exchanging procedure, when radiological monitoring is not used (4). The relatively rigid silicon catheter can easily penetrate the infected renal parenchymal tissue, pass into a major vein, and then to the renal vein and extend into the IVC if the kidney is severely infected (11). However, Mazzucchi et al. consider that a lesion in a large renal vein branch caused by the instruments used during percutaneous surgery is the most likely cause of bleeding, and that the proximity of the Amplatz sheath to the injured vein could inadvertently direct the nephrostomy tube inside the venous system (6). In our patients, the guidewire was not found to pass directly into the venous system on radiological monitoring during the procedure. Hence, we considered that the nephrostomy tube passed into a vein after the fascial dilators had torn a large vein, as described by Mazzuchi et al. (6).

Hypertrophy of a solitary kidney is a recognized risk factor for excessive bleeding, and could further contribute to the increased transfusion requirements in PCNL patients with a solitary kidney (14). The need for transfusion is almost doubled in patients with solitary kidneys compared with that in patients with two kidneys each (15). Unclear visualization of the operative field owing to bleeding in the kidney may contribute to misplacement of the tube into the vascular system (10). We found that 40% (4/10) of the patients with this complication had a solitary kidney. The high prevalence of solitary kidney indicates that a solitary kidney may render these patients susceptible to intravenous misplacement of a nephrostomy tube. A history of chronic inflammation or operation on the affected kidney was found in 90% of the patients, and might be an important risk factor for intravenous catheter migration (10). Moreover, it was puzzling that 8 of 10 affected kidneys were on the left side.

Placing a nephrostomy tube in the collecting system following PCNL is a routine practice, and, in addition to its other advantages, it is an effective method for stopping venous bleeding (16). If severe venous bleeding is noted during the PCNL process, the procedure is always interrupted, and a nephrostomy tube is inserted and kept closed. However, antegrade pyelography at the end of a percutaneous procedure in order to check the exact positioning of the nephrostomy tube is always missed, even in cases of severe

Table 1 - Reports of intravenous misplacement of a nephrostomy tube.

First Author	Age (y)	Sex	Relevant History	Solitary Kidney	Catheter	Side	Location	Delayed detection	Catheter withdrawal	Antithrombotic therapy	Original operation	Definitive Operation
Dias-Filho (4)	63	F	Uterine cervical carcinoma, pelvic external beam radiotherapy and left PTN	No	12F Foley catheter	Left	Renal vein, IVC, right atrium	Yes	1-step under fluoroscopy	No	Catheter placement	Late elective PCN
Shaw (5)	54	M	Left nephrectomy, ureterosigmoidostomy, cystoprostatectomy, right SWL	Yes	14F Foley catheter, nephrostomy tube	Right	Renal vein	No	2-step under fluoroscopy	Yes	PCNL	A exploratory laparotomy, Late elective PCNL and ESWL
Skolarikos (9)	NA	NA	NA	NA	Nephrostomy tube	NA	IVC	NA	NA -step under fluoroscopy	NA	NA	NA
Mazzucchi (6)	52	M	right nephrectomy	Yes	Nephrostomy tube	Left	Renal vein	Yes	1-step	No	PCNL	NA
	35	F	right nephrectomy	Yes	Nephrostomy tube	Left	Renal vein, IVC	Yes	2-step under fluoroscopy	No	PCNL	NA
Li (11)	32	F	Left surgical lithotomy	No	Nephrostomy tube	Left	Renal vein, IVC	Yes	2-step under ultrasound	Yes	PCNL	NA
Kotb (12)	50	M	Left PCNL , left PTN	No	12F Foley catheter	Left	Renal vein, IVC	Yes	1-step during open pyelotomy	No*	Catheter placement	An open pyelotomy
Present study Patient 1	42	M	None	No	Nephrostomy tube	Left	Renal vein, IVC	Yes	2-step under CT monitoring	No	PCNL	Late elective PCNL
Patient 2	38	F	Right URL	No	Nephrostomy tube	LIeft	Renal vein, IVC	No	2-step under fluoroscopy	No	PCNL	Simultaneous PCNL
Patient 3	48	M	Right nephrectomy	Yes	Nephrostomy tube	Left	Renal vein	Yes	1-step under ultrasound	No	PCNL	Late elective URL

* The patients developed a deep venous thrombosis.

bleeding. The detection of intravenous misplacement of a nephrostomy tube was delayed in 5 of 6 patients (4-6,10,11). The timing of detection in the four other patients was unavailable. In our hospital, the detection of tube misplacement was delayed in two of the three patients, as antegrade pyelography was not performed at the end of the percutaneous procedure. Delayed active bleeding may result in large blood loss, if the undiscovered intravenous tube is open. Early detection of the misplaced intravenous tube in the operation room may allow earlier withdrawal of the tube and prevent late hemorrhage. Thus, antegrade pyelography must be routinely performed at the end of a percutaneous renal procedure in order to check the exact positioning of the nephrostomy tube, even in patients with severe bleeding (6).

Our patients, like the other patients reported in the literature, were safely managed with strict bed rest, antibiotics and one-step (one patient) or two-step (two patients) withdrawal of the tube under close monitoring. Central venous pressure (CVP; 5-12cm H_2O) is generally similar to intrapelvic pressure (< 15 cm H_2O) when the renal pelvis does not communicate freely with the outside (e.g., nephrostomy tube was closed) (10). Contaminated urine reflux through the injured large vein due to the urinary tract obstruction may result in sepsis or even septic shock when the intrapelvic pressure is higher than CVP. Therefore, the use of prophylactic antibiotics should be considered.

Among the 10 patients, all of whom were discharged uneventfully, three patients underwent the original procedure, and two underwent another type of procedure; the type of procedure in the remaining five patients was unavailable. Among our three patients, two underwent the original procedure. We considered that the original procedure could be performed under close observation if no active bleeding occurred.

Venous thrombosis was founded in one of the seven patients who did not receive antithrombotic therapy. None of our 3 patients received antithrombotic therapy or developed venous thrombosis. The anti-coagulation mechanisms can avoid the formation of atrial thrombi and consequent pulmonary embolism (4), and thrombotic phenomena are probably not observed due to the high blood flow and low venous pressure inside these veins (6). Thus, antithrombotic therapy is not necessary for these patients. Moreover, bleeding into the renal tract secondary to antithrombotic therapy can occur postoperatively. Therefore, we suggest that antithrombotic therapy should not be routinely administered to these patients. However, since embolism is a potentially major complication, antithrombotic therapy is essential for patients with hypercoagulable states.

On the basis of our own experience and the findings of the literature review, we suggest managing these patients as follows (Table-2). First, once intravenous misplacement is detected, the tube should be closed immediately. Second, the closed tube should be pulled back and repositioned immediately at the site of entry into renal vein under CT, ultrasound or fluoroscopic monitoring, if its tip is located in the renal vein trunk, IVC or even the atrium. The closed nephrostomy tube can be removed in the operating room under CT, ultra-

Table 2 - The procedure of managing an intravenously misplaced nephrostomy tube.

Location of the tube's tip	steps	When	Monitoring method
Renal vein adjacent to the sinus	One step: Remove the tube	about 7 days later	CT, ultrasound or fluoroscopy
renal vein trunk, IVC or atrium	Two step: First step: repositioning immediately into the renal vein just proximal to the sinus	immediately	CT, ultrasound or fluoroscopy
	Second step: remove the tube	about 7 days later	CT, ultrasound or fluoroscopy

sound or fluoroscopic monitoring after 7 days when a pericatheter tract has formed. Antegrade pyelography must be routinely performed at the end of a percutaneous procedure to check the exact position of the nephrostomy tube.

CONCLUSIONS

The incidence of intravenous misplacement of a nephrostomy tube following PCNL is 0.5% at our hospital. Intravenous misplacement of a nephrostomy tube is an uncommon complication following PCNL, and this finding is supported by a literature review. Patients with a solitary kidney may be susceptible to this complication. Most patients may be managed conservatively with strict bed rest, intravenous antibiotics, and tube withdrawal. The misplaced nephrostomy tube can be successfully removed by one-step or two-step withdrawal under close monitoring.

ABBREVIATIONS

CT = computed tomography
CVP = central venous pressure
IVC = inferior vena cava
NA = not available
PCNL = percutaneous nephrolithotomy
PTN = percutaneous tube nephrostomy
SWL = shock wave lithotripsy
URL = ureteroscopic lithotripsy

CONFLICT OF INTEREST

None declared.

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