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ORIGINAL PAPER

Colon perforation during percutaneous renal surgery: a 10-year experience in a single endourology centre

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Abstract The use of percutaneous renal surgery has been recently revolutionised with novel endourological instruments and techniques. However, the incidence, prevention and management of severe complications such as colon perforation still lack consensus. By presenting our 10-year experience, we would like to highlight the diagnosis and management of the rare complication of colon perforation.

Keywords Colon · Perforation · Percutaneous · Stone · Nephrolithotripsy · Complication

Introduction

Complications related to percutaneous nephrolithotomy (PCNL) can be kept to a minimum in experienced hands with the development of new techniques and improved technology [1, 2]. However, incidence, prevention and management of complications of PCNL still lack consensus [1]. As a sub-specialised Endourological tertiary referral centre, we present our 10-year experience with the diagnosis and management of the serious complication of colon perforation during percutaneous renal operations.

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Patients and methods

From January 2001 to February 2011, we performed 1,620 percutaneous renal operations, including PCNL and/or percutaneous endopyelotomy. We recorded the following five cases of colonic perforation.

Case 1

A 33-year-old man underwent left PCNL and simultaneous flexible ureteroscopy (fURS) for a partial staghorn stone. In supine position, a single puncture was performed via a lower calyx. The procedure and the peri-operative course were uneventful. On the third post-operative day, bowel content was passing through the nephrostomy tube. Observation signs were unremarkable and physical examination revealed slightly tender abdomen on the left side. Subsequent CT urogram revealed perforation of the descending colon by the nephrostomy tube (Fig. 1), but no intra-abdominal collection was shown. The following day, patient developed fever (38.0°C). A JJ stent and a urethral catheter were inserted and the nephrostomy tube was retrieved into the colon, under fluoroscopic control, creating a controlled colocutaneous fistula. Parenteral nutrition and antibiotic medication with ampicillin, metronidazole and gentamicin were instituted. On the seventh post-operative day, the patient was afebrile and asymptomatic. The colostomy tube remained in situ for one more week and, when the colon material drainage was minimal, it was gradually (1 cm/day) removed. Thereafter, oral diet was resumed and the patient was discharged with oral ciprofloxacin. A follow-up repeat CT urogram, 3 months post-operatively, did not demonstrate any pathology regarding the left kidney and retro-renal colonic loop.

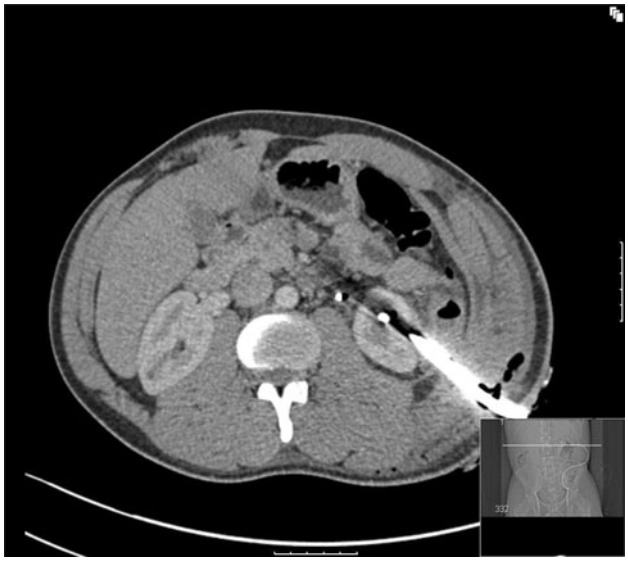

Fig. 1 Transcolonic position of the Malecot catheter

Case 2

A 54-year-old man with a 2 cm pelvic stone and right pelvic-ureteric obstruction was submitted for right PCNL and simultaneous antegrade endopyelotomy. It was a single tract procedure in supine position and the operation was uneventful. During the first post-operative day, he spiked temperature up to 38.5°C and faecal output was noticed through the nephrostomy tube. The physical examination was unremarkable. The CT urogram revealed a perforation of the ascending colon (Fig. 2) without surrounding collection. A urethral catheter was inserted and the nephrostomy tube was placed into the colon (Fig. 3). Parenteral nutrition and antibiotics (imipenem-vancomycin-metronidazole) were administered resulting in no fever on the fifth post-operative day. The colostomy tube was removed on the 11th post-operative day and the endopyelotomy stent after 6 weeks. Follow-up CT urogram was normal as well as the MAG3 renogram.

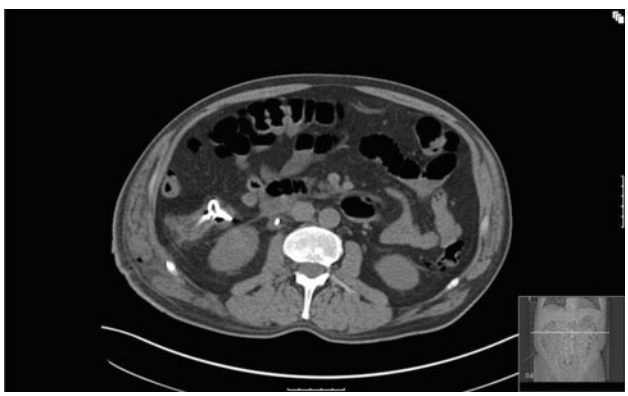

Fig. 2 Malecot catheter perforating the colon

Fig. 3 Reposition of the Malecot catheter into the colon at the hepatic flexure

Case 3

A 59-year-old man was planned for a right supine PCNL for a 2 cm lower pole stone and a simultaneous antegrade endopyelotomy. After a subcostal middle calyceal puncture and dilatation, the nephroscope was found to be located in the ascending colon as colonic mucosa was visualised. This was because we thought that the guide wire was curled next to the stone, although it was curled inside the colonic lumen. The guide wire was further inserted into the colon, while the nephroscope and the sheath were removed. A Malecot catheter was inserted over the wire, creating a controlled colocutaneous fistula. Contrast instillation through the Malecot catheter did not reveal any extravasation. The operation was not abandoned and a second, more superior access was established. At the end of the endopyelotomy and PCNL, the endopyelotomy stent and the nephrostomy tube were inserted. As in the above cases, parenteral nutrition and antibiotics were initiated. The Malecot catheter was removed on the seventh post-operative day and the nephrostomy tube the day after. The endopyelotomy stent was removed 6 weeks post-operatively and the repeat CT urogram after 3 months was normal.

Case 4

A 58-year-old man underwent a supine left PCNL via a single subcostal lower calyceal puncture, for multiple pelvic and lower pole stones. The second post-operative day the patient developed fever up to 38°C as well as non-specific abdominal pain. Due to the history of acute diverticulitis, elemental diet and antibiotic coverage were instituted. Two days later, faecal content was noticed along the full-length Malecot catheter. The antegrade pyelography demonstrated the presence of contrast into the colon and the CT urogram confirmed colonic perforation by the

Malecot catheter. The long Malecot was exchanged for a short one positioned into the colon, while a JJ stent and a urethral catheter were inserted. With triple antibiotic therapy, the patient became afebrile on the fifth post-operative day and the Malecot catheter was removed after 3 days. Follow-up CT imaging was normal.

Case 5

A 78-year-old man with multiple renal stones (pelvic and lower pole) underwent a prone left PCNL, via a single lower supracostal puncture. Alken telescopic metallic dilators were used for dilatation of the tract due to the history of open nephrolithotomy. During the procedure there was bleeding from the tract; nevertheless, the stones were removed and a full-length Malecot catheter was inserted. The third post-operative day, the patient developed high fever of 39°C and pain in the upper left abdominal area, along with abdominal distension, nausea and vomiting.

Initially, we thought the patient developed urosepsis; nevertheless, a nasogastric tube was inserted and broad-spectrum antibiotics as well as parenteral nutrition were initiated. The following day, faecal content along with gas was noticed through the Malecot catheter. The CT urogram demonstrated perinephric hematoma, opacification and perforation of the descending colon (Figs. 4, 5). The long Malecot catheter was replaced by a short one into the colon and a JJ stent was inserted. The following day the patient developed respiratory distress, pneumonia as well as pseudomembranous colitis. Due to worsening of the respiratory distress, the patient was transferred to the Intensive Care Unit on the tenth post-operative day. The Malecot catheter was removed after 2 days and the colitis was resolved. Unfortunately, the patient developed adults' respiratory distress syndrome (ARDS) and passed away on the 14th post-operative day.

Fig. 4 Opacification of the retro-renal colon with nephrostogram

Fig. 5 Perirenal hematoma and colon perforation

Results

All patients were males (mean age 56.4 years) that underwent a single tract percutaneous access. Stone formers included a patient with a staghorn stone, two with multiple stones and two patients with single stones. In our 1,620 percutaneous procedures, the prone position was used in 1,253 cases (77.3%) and the supine position in the remaining 367 cases (22.6%). Since 2008, we have been performing supine PCNL in the vast majority of the cases (approximately 80%). Therefore, our overall incidence of colonic perforation was 0.3% (5/1,620); among the supine PCNLs, it was 1% (4/367) and among the prone cases, it was 0.08% (1/1,253).

The puncture was made on the right side in two patients and on the left side in three cases. It was subcostal in three cases and supracostal in two patients. A lower calyceal percutaneous tract was performed in four patients and a mid-calyceal access in one patient. In one case, the diagnosis of colonic perforation was established intraoperatively; nevertheless, the operation was not abandoned as another percutaneous access was performed. Collectively, the study results are thoroughly presented in Table 1.

All colonic perforations were confirmed with CT urogram, which demonstrated that all injuries were retroperitoneal. As there were no intraperitoneal injuries, all cases were managed conservatively with placement of the nephrostomy/colostomy tube a couple of centimetres into the lumen of the colon and a triple regime of antibiotics, along with placement of JJ stent, urethral catheter and parenteral nutrition. Once the patients were afebrile and asymptomatic, the nephrostomy/colostomy tube was gradually removed. In our practice, when the colonic material drainage was less than 100 ml per day, the colostomy tube was progressively pulled out by 1 cm per day and placed outside the colon in the pericolic space under fluoroscopy guidance. When the drainage was

Table 1 Patients' characteristics and study results

Patient	1	2	3	4	5
Age	33	54	59	58	78
Side	Left	Right	Right	Left	Left
Sex	Male	Male	Male	Male	Male
Stone former	Recurrent	Recurrent	Recurrent	Recurrent	Recurrent
Stone number	Partial staghorn	Single + endopyelotomy	Single + endopyelotomy	Multiple	Multiple
Renal status	Normal	Normal	Renal failure	Normal	Renal failure
Position	Supine	Supine	Supine	Supine	Prone
Dilatation	NephroMax™	NephroMax™	NephroMax™ + Alken dilators	NephroMax™	NephroMax™
Site of puncture	Subcostal	Supracostal (12th)	Subcostal	Subcostal	Supracostal (12th)
Punctured calyx	Lower	Lower	Mid	Lower	Lower
Diagnosis	Post-operative	Post-operative	Intraoperative	Post-operative	Post-operative
Treatment	Conservative	Conservative	Conservative	Conservative	Conservative
Nutrition	Elemental	Elemental	Parenteral	Elemental	Parenteral
Antibiotics used	Ampicillin/gentamicin/ metronidazole	Imipenem/vancomycin/ metronidazole	Cefuroxime/ metronidazole	Ciprofloxacin/ metronidazole	Ampicillin/gentamicin metronidazole
Blood transfusion	Not required	Not required	Not required	Not required	Required
Hospital stay	7 days	9 days	13 days	12 days	14 days (deceased)

minimal, antegrade opacification was performed (7th–14th post-operative day) in order to exclude a fistula, and if no communication between the colon and kidney was confirmed, the colostomy tube was completely removed. Our conservative management of colonic perforation was successful in all five patients; however, one patient passed away due to pneumonia complicated with ARDS.

Discussion

According to the modified Clavien classification system of post-operative complication in PNL, the colonic perforation can be classified as a complication of grade III and up to grade IV–V when it presents with subsequent sepsis, peritonitis and hemodynamic instability [1, 2]. Recently, a single-centre study on 671 consecutive patients undergoing PCNL, reported a 0.3% incidence of colonic perforation [3]. Our series is the second largest after the one by El-Nahas et al. [4] with 5,036 PCNLs and 15 cases of colonic perforation (0.3%). All injuries were retroperitoneal and in the left side in 66.6% of the cases. Colonic perforation complicated lower calyceal puncture in 12 procedures (80%) and upper calyceal punctures in those with horseshoe kidneys or chronic colonic distension. The diagnosis was established intraoperatively in 5 patients and post-operatively in 10 patients, who presented with colocutaneous fistula. The diagnosis was confirmed with CT or opacification of the colon during antegrade or retrograde imaging studies. Conservative treatment was successful in all but two patients who required colostomy.

A meta-analysis of comparative studies between supine and prone PCNL, demonstrated that the rate of colonic injury in supine PCNL was approximate 0.5% [5]. Other PCNL positions such as the lateral decubitus and the modified Valdivia lithotomy position seem to prevent the complication of colonic perforation [6–8]. As most of our cases of colonic perforation took place in our initial 50 cases of supine PCNL we could attribute our higher incidence in the supine position to our relevant learning curve.

Potential risk factors for colonic perforation include thin habitus, extremely lateral PCN tract (lateral to the posterior auxiliary line), dilated pelvic-calyceal system, colonic obstruction, megacolon, kyphoscoliosis and a hyper-mobile kidney [9–11]. In the large series of 15 colonic perforations, significant independent risk factors were advanced patient age (associated with reduced perinephric fat) and the presence of a horseshoe kidney (3–19% retro-renal colon) [4]. These risk factors have been confirmed and in other studies [12–14]. More frequently retro-renal colon is

noted on the left side and it is more likely to be situated near the inferior pole of the kidney. Hopper et al. [15] in a study of 500 CT scans reported that the frequency of retro-renal colon was 1.9% in the supine position. When 90 patients were studied in the prone position, a retro-renal colon was found in 10%. Moreover, the descending colon was more posterior to the lower pole of the left kidney. These findings may explain the greater incidence of colonic perforation during left-sided, lower calyceal approaches. In an interesting study, Prassopoulos et al. [16] reviewed 1,708 consecutive abdominal CT scans and found that 0.9–14.2% of patients had parts of the colon posterior or posterior-laterally to the kidney. This anatomical abnormality cannot be picked up by intravenous urography or pre-operative ultrasound (US) both of which are commonly employed to evaluate patients prior to PCNL. Although pre-operative US could give some indication, the patient is usually in supine position and detection of this rare condition would require a high degree of suspicion [11].

The CT scan is the imaging test of choice for the diagnosis of retro-renal colon [17, 18]. Interestingly, Chalasani et al. [18] studied the position of the colon relative to the kidney in 134 patients who underwent CT in the prone position. They found that the prevalence of retro-renal colon in males was 13.6% on the right, and 11.9% on the left, whilst in females it was 13.4% on the right and 26.2% on the left. However, as Tuttle et al. [19] demonstrated the risk of colon injury is overestimated by evaluation of axial CT images alone compared with oblique parasagittal reformations. Recently, Gedik et al. [20] suggested that CT should be performed in all paediatric patients prior to PCNL in order to prevent colon perforation. In case of trans-colonic access, they converted to open surgery. Lastly, CT imaging is absolutely necessary prior to percutaneous surgery in the presence of risk factors for colonic perforation such as a horseshoe kidney [21].

Unfortunately, colon perforation is difficult to be diagnosed during the PCNL [22–25]. It may be manifested post-operatively with haemorrhage, septic shock, gas or faecal discharge through the nephrostomy tube [25–27]. Abdominal symptoms of a more general nature must lead to the active exclusion of this complication. Conservative treatment of colonic perforation includes adequate urinary drainage (JJ stent and bladder catheter), the retraction of the nephrostomy tube into the colon as a percutaneous colostomy tube, appropriate antibiotic coverage and parenteral nutrition [23–27]. Antibiotics covering gram negative and anaerobic bacteria should be administered and maintained for at least 2 weeks. In case of low-output nephrocutaneous fistulae, elemental nutrition may replace the parenteral nutrition. Surgical repair is required when the perforation is intraperitoneal or when there are complications such as peritonitis and sepsis [17]. Persistent nephrocutaneous fistula may complicate colonic perforation after PCNL. In such case, percutaneous injection of fibrin glue might be efficient [28].

Epilogue

Every urologist who performs percutaneous renal surgery should be aware of the risk of an aberrant retro-renal colon loop, the perforation of which is difficult to be noticed during the operation. Patients must be informed and consented for this rare but serious PNL complication. Pre-operative CT scan is recommended in order to diagnose the presence of retro-renal colon and plan the most safe access. Conservative management of retroperitoneal colonic perforation is efficient; however, relevant experience is still limited.

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