Colon Radiological Delineation Technique Prior to Percutaneous Nephrolithotomy in Patients With Horseshoe Kidney

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OBJECTIVE To develop a technique that helps avoid colonic injury during percutaneous nephrolithotomy (PCNL) in these patients.

PATIENTS AND METHODS PCNL was prospectively performed in a cohort of adults with renal stones in a horseshoe kidney (HSK). PCNLs were done using a standardized technique in prone position in all patients. The colon was radiologically delineated by injecting air—through a catheter in the anal canal—to help localize its position in relation to the pelvicalyceal system (PCS). Patients were observed in hospital for 48 hours postoperatively to detect any potential complications related to the PCNL or to the colon insufflation modification.

RESULTS Thirteen adult patients (11 men and 2 women) with renal stones in a HSK were included in the study. The colon was well radiologically delineated with air in all cases. The PCS was successfully accessed, subcostally, with a single access at the upper calyx in 11 cases and multiple accesses in 2 cases. The colon was in the way of the puncture in 2 cases in which we used a more medial access and the colon was successfully avoided. Stones were completely removed during the PCNL in 11 of the 13 cases (84.6%). One case necessitated intraoperative blood transfusion. No other complications were reported by any of the patients who were discharged home after 48 hours.

CONCLUSION Colonic radiological delineation technique is helpful in accessing the PCS quickly, saving the colon, and causing no discomfort to patients with renal stones in a HSK. UROLOGY 86: 686–689, 2015. © 2015 Elsevier Inc.

The incidence of horseshoe kidney (HSK) is 1 in every 400 live births, and male-to-female ratio is 2:1. In these patients, the upward migration of the kidneys, in utero, is arrested at the level of inferior mesenteric artery because of fusion of the lower poles—in most cases—of the renal units. This results in malrotation of the kidneys with renal pelvis facing anteriorly, renal calyces placed dorsolaterally and dorsomedially, and isthmic calyces entering the renal pelvis at acute angle. The ureters course over the isthmus, increasing the possibility of having pelviureteric junction obstruction, and in some cases, they have high insertion in the renal pelvis. Therefore, the incidence of urinary tract infection and urolithiasis in patients with HSK is higher than in normal population. Around 21%-60% of patients with HSK have renal stones. In addition, the presence of aberrant vessels in these patients is highly anticipated. Consequently, any attempt to approach the renal calyces, either percutaneously or ureteroscopically, is a great deal of challenge.[1-3]

Shock wave lithotripsy (SWL) could be a valid approach only for small-sized stones. Moreover, the procedure is associated with technical difficulties that can lead to nonsatisfying stone-free rate.[2,4,5] PCNL provides a good solution for larger stone burden in these patients. However, it can be associated with a number of complications. For instance, the incidence of colonic injury during PCNL is 5.9% compared to 1% incidence in patients with orthotopic kidneys. The incidence of colonic injury during PCNL in general population is less than 1%.[6,7]

The primary goal was to evaluate our technique—colon radiological delineation during PCNL—in terms of feasibility, validity, and any potential patient discomfort or postoperative complications related to this modification.

PATIENTS AND METHODS

The study has been approved by the local ethical committee. From December 2010 to December 2014, 13 PCNLs were performed for calculi in 13 patients with a HSK (11 men and 2 women). Five patients had a previous renal surgery. All cases were evaluated by preoperative abdominal ultrasonography,

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plain x-ray urinary tract, and intravenous urography. Non-contrast computed tomography (CT) was saved for cases of inconclusive plain x-ray urinary tract especially in cases with a history of renal surgery. Routine laboratory investigations were done in all cases in the form of urine analysis, bleeding profile, and renal and liver function tests. Any cases with urinary tract infection were treated according to the culture sensitivity.

PCNL was performed under fluoroscopic guidance in prone position in all cases. The procedures followed a standardized technique except for an additional step of colonic radiological delineation with air.

To insufflate the colon, a 24F Foley catheter was inserted in the rectum, then the balloon was inflated with 20 mL of 0.9% NaCl followed by mild traction to prevent any leakage of air during rectal inflation. The colon was inflated with multiple injections of room air using a 50-mL syringe through the working channel of the catheter, until sufficient radiological delineation of the colon was fluoroscopically confirmed (Fig. 1). The rectal tube was left in place for 6 hours postoperatively to ensure complete deflation of the colon. Postoperative signs or symptoms of colonic injury were evaluated in the form of persistent fever, paralytic ileus, abdominal distension, vomiting, and fecal matter discharge from the site of the nephrostomy tube.

Statistical Analysis

Data were analyzed using SPSS 17 under Windows XP.

RESULTS

Stones were completely removed during the PCNL in 11 of the 13 cases (84.6%). The remaining two cases necessitated a single session of SWL 3 weeks after the PCNL and became stone free 3 weeks later.

Demographic data and outcomes of the current series, and the relevant studies in literature, are shown in Table 1. The mean age of the patients was 32 ± 5 years (range, 23-53 years). The mean size of the stones was 3.1 ± 1.1 cm (range, 2.5-5.2 cm). The stones were radiopaque in 11 cases and radiolucent in 2 cases. The stones were single in 9 cases and multiple in 4 cases. The stones were right sided in 7 cases and left sided in 6 cases. Eight patients presented with hematuria, 9 patients presented with recurrent abdominal pain, and 11 cases presented with pain and recurrent urinary tract infection.

The mean time of the inflation of the colon was 4 ± 2.3 minutes. The colon was well radiologically delineated by the air in all cases. The mean air volume used for insufflations was 180 ± 2 cm^3 for the right side and 100 ± 15 cm^3 for the left side.

On evaluation of the relation of the radiologically delineated colon to the pelvicalyceal system (PCS), it had no relation to the PCS in 9 cases, close to the lower calyx in 2 cases, close to the lower and middle calyx in 1 case, and close to the lower, middle, upper calyx in 1 case—this case had a previous renal surgery. The PCS was successfully accessed in all cases. It was a single upper calyceal in 11 cases and multiple in 2 cases. All the punctures were subcostal. The colon was in the way of the puncture in 2 cases in which we used a more medial access and the colon was successfully avoided. None of our patients necessitated performing an abdominal CT.

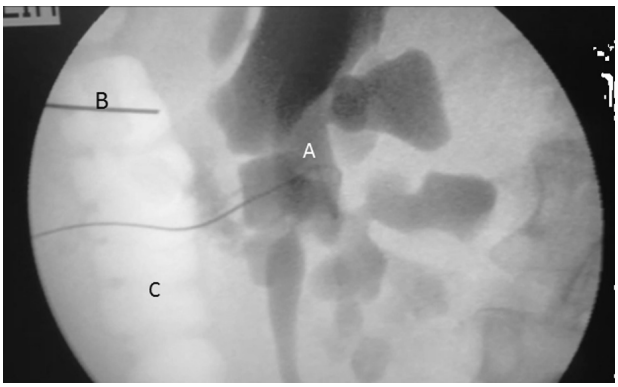

Figure 1. A fluoroscopic shot during PCNL to extract stones in the left renal unit of a horseshoe kidney. The picture depicts the following: **(A)** the safety guidewire in the renal pelvis, **(B)** puncture needle approaching the upper calyx while avoiding the radiologically delineated colon **(C)**. PCNL, percutaneous nephrolithotomy.

One case necessitated intraoperative blood transfusion. All the patients were discharged 48 hours postoperatively. There were neither reported cases of postoperative ileus or discomfort related to the colonic inflation with air nor signs or symptoms of colonic injury.

COMMENT

PCNL has been considered a very useful approach for HSK with large stone burden because SWL has been successful in treatment of only small renal stones in these patients.[8] The reason is that the stone-free rate can be as low as 50% because of technical problems having the spines interfering with optical vision of the stones during lithotripsy, and the poor drainage of the abnormally oriented renal calyces. Moreover, the kidney is anteriorly displaced, with the consequent increase in skin-to-stone distance.[2,4,5]

It had been postulated that PCNL in patients with HSK should be associated with lower incidence of vascular and bowel injuries because of the medial location of renal vasculature and dorsally displaced calyces.[2,3] However, a number of complications attributed to PCNL had been reported in these patients. One of these complications is colonic injury. On the one hand, the incidence of colonic injury during PCNL in general population is less than 1%.[6] On the other hand, it has been reported in 5.9% of patients with HSK who underwent PCNL.[7] Therefore, HSK has been considered as one of the important risk factors for colonic injury during PCNL.[7] HSK is associated with some anatomic variation of the bowel. Colon has been reported to lie either posterior or posterolateral to the renal units in 3% to 19% of patients with HSK.[9] This percentage far outnumbers the percentage of normal population with this anatomic variation—1%.[10] Consequently, the colon lies in the path of the nephrostomy tract, and therefore, it is liable for injury during developing the tract for PCNL.[11] The

Table 1. Demographics and main outcomes of the present study and relevant publications

Parameter	Current Series	Tepeler 2014	Etemadian 2013	Gupta 2009	Al-Otaibi 1999
Number of patients	13	54	21	31 Patients (37 renal units)	12
Gender					
11	23	36	16	19	9
2	8	17	5	12	3
Age (y)	32 ± 5.4	46.03 ± 18.6	35 (15-63)	35 (18-52)	M 48 (17-66); F 60 (39-88)
Side					
7	23	22	11	15	4
6	8	32	10	16	8
				6	
Stone size (cm)	3.1 ± 1.1	2.8 ± 1.9	3.7 ± 1.6	2.4 (1-5)	
Stone number					
9	21	23	3		6
4	10	31	18		6
Retrorenal colon	3	0	0	—	5
Number of accesses					
11	27	53		34	7
2	4	1		3	5
Location of stone					
10	27	27		8	
		17			1
		10	3		3
3	4		4	17	3
			13	12	6
Access site					
13	31	31	21	30 renal units	12
0	0	23	0	3 renal units	0
Operative time (min)	45 ± 15.6	—	—	70 (30-100)	170 (67-298)
Hospital stay (d)	2		3.4 ± 0.7	2.5 (1-8)	6.8
Initial success (%)	84.6	66.7	71.4	88.5	75
Complications, n (%)	1 (15.4)	9 (16.7)	3 (14)	3/31 (9.6)	5/12 (42)
Complication type					
0	0	0	0	0	0
1	0	2	1	2	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	3	1	0	0
0	0	1	0	0	5
0	0	1	0	0	0
0	0	0	0	1	0
0	0	1	0	0	0
0	0	0	1	0	0

M, male; F, female.

present study aims at developing a new modification to the PCNL to avoid the occurrence of any colonic injury in patients with renal stones in a HSK.

Table 1 shows the demographics and main outcomes of the current series and relevant studies published in literature. The initial stone-free rate in the present study was 84.6%, and this is comparable to percentages obtained from previous studies: Shokeir et al[12] reported an initial stone-free rate of 82%, Gupta et al[13] reported 88.5%, and Al-Otaibi et al[14] reported an initial stone-free rate of 75%.

One of the 13 patients (7.7%) necessitated intraoperative blood transfusion. None of our patient reported any postoperative discomfort related to the inflation of their colons with air. The percentage of patients with complications in our series is comparable with the overall rate of complications reported in the literature—that ranged between 9.6% and 42%.[12-15] The nature of complications was prolonged urinary leakage,[14] fever,[15,16] or blood loss that necessitated transfusion.[13,15,16]

Pre-PCNL CT abdomen might help determine the relation between the kidneys and the colon.[17,18] Therefore, some authors recommended performing preoperative CT in patients with kidney stones.[9,19] In the present study, CT was not done as a routine in all patients, it was rather saved for selective cases such as patients with previous renal surgery. Thanks to the intraoperative colonic radiological delineation technique performed in the present study; retrorenal colonic position has been identified in 2 of our patients. Consequently, we were able to develop the nephrostomy tract successfully at a safe spot of the kidneys without causing injury to the colon in these patients.

Post-PCNL CT abdomen was not done in our series too because no symptoms or signs suggestive of bowel injury

was detected in any of our patients. A comprehensive review by Korkes et al[20] revealed that about 24% of cases of colonic injury can be detected during the PCNL, and in 76% of cases, the diagnosis of colonic injury was made after 2.9 ± 1.4 days. Therefore, we did not perform postoperative CT. We also believe that this approach helped us reduced the total costs of the procedure.

There are some advantages to our technique compared to other techniques adopting routine preoperative abdominal CT or intraoperative ultrasound. In the first place, it offers a real-time visualization of the colon and its relation to the PCS. In the second place, this real-time visualization of the colon gives the surgeon a better orientation to the relation of the colon to the PCS than the ultrasound does. Finally, it saves the costs of preoperative CT. The technique of colonic radiological delineation allowed identifying a retrorenal colon in 2 cases, and the puncture was modified appropriately without any need to preoperative CT.

It might be argued that intraoperative radiological delineation technique may cause unnecessary prolongation of the operative time of the PCNL procedure. Interestingly, this extra step took us, on average, about 11 minutes per case. However, the mean operative time of PCNL reported in the current series was 45 ± 15 minutes, and this is even much shorter than time reported in some previous studies: Al-Otaibi et al[14] reported operative time of 170 minutes (range, 67-298 minutes); in their study, the authors found the colon in a posterior relation to the kidneys in 5 of the 12 patients included in the study. Whereas Gupta et al[13] reported operative time of 70 minutes (range, 30-100 minutes), and none of their patients had a retrorenal colon. We successfully had visible delineation of the colon in all cases, and none of our patients had fecal impaction in the colon. However, perhaps we would suggest bowel preparation or enema before PCNL to guarantee a good quality of colon radiological delineation in further practice.

The mean volume of air insufflated in the colon in our series ranged between 100 ± 15 cm^3 and 180 ± 2 cm^3, which is a relatively small volume when compared to the total anatomic capacity of the colonic compartments (rectum, sigmoid, descending, transverse, and ascending colons). Therefore, we think that the mean volume of air that was insufflated in the colon in our series is not supposed to cause remarkable distension of the colon, and therefore, the risk of perforating the colon was not high. However, too much air insufflations into the colon should be discouraged to avoid overdistension of the colon and consequent risk of colonic perforation during PCNL.

A single access was enough to achieve a successful PCNL in 9 of 13 patients in our study. All PCNL procedures in the present study were done through a subcostal approach, and there was no need to access any of the renal units via a supracostal one. This can be explained by the lower position of the renal units in patients with HSK.

We think that the colonic radiological delineation technique together with patient selection and well preoperative preparation helped us perform a rather safe and quick PCNL. The technique would be of value in performing PCNL not only in patients with HSK but also in other renal anomalies and musculoskeletal deformities.

CONCLUSION

Colonic radiological delineation technique proved to be helpful in establishing the nephrostomy tract in a quick and safe way and caused no discomfort to patients with renal stones in a HSK.

References

1. Stein RJ, Desai MM. Management of urolithiasis in the congenitally abnormal kidney (horseshoe and ectopic). *Curr Opin Urol*. 2007;17:125-131.
2. Yohannes P, Smith AD. The endourological management of complications associated with horseshoe kidney. *J Urol*. 2002;168:5-8.
3. Janetschek G, Kunzel KH. Percutaneous nephrolithotomy in horseshoe kidneys. Applied anatomy and clinical experience. *Br J Urol*. 1988;62:117-122.
4. Esuvaranathan K, Tan EC, Tung KH, et al. Stones in horseshoe kidneys - results of treatment by extracorporeal shock wave lithotripsy and endourology. *J Urol*. 1991;146:1213-1215.
5. Ray AA, Ghiculete D, D'A Honey RJ, et al. Shockwave lithotripsy in patients with horseshoe kidney: determinants of success. *J Endourology*. 2011;25:487-493.
6. Ozturk H. Gastrointestinal system complications in percutaneous nephrolithotomy: a systematic review. *J Endourology*. 2014;28:1256-1267.
7. El-Nahas AR, Shokeir AA, El-Assmy AM, et al. Colonic perforation during percutaneous nephrolithotomy: study of risk factors. *Urology*. 2006;67:937-941.
8. Serrate R, Regue R, Prats J, et al. ESWL as the treatment for lithiasis in horseshoe kidney. *Eur Urol*. 1991;20:122-125.
9. Skoog SJ, Reed MD, Gaudier FA, et al. The posterolateral and the retrorenal colon - implication in percutaneous stone extraction. *J Urol*. 1985;134:110-112.
10. Vallancien G, Capdeville R, Veillon B, et al. Colonic perforation during percutaneous nephrolithotomy. *J Urol*. 1985;134:1185-1187.
11. Goswami AK, Shrivastava P, Mukherjee A, et al. Management of colonic perforation during percutaneous nephrolithotomy in horseshoe kidney. *J Endourology*. 2001;15:989-991.
12. Shokeir AA, El-Nahas AR, Shoma AM, et al. Percutaneous nephrolithotomy in treatment of large stones within horseshoe kidneys. *Urology*. 2004;64:426-429.
13. Gupta NP, Mishra S, Seth A, et al. Percutaneous nephrolithotomy in abnormal kidneys: single-center experience. *Urology*. 2009;73:710-714.
14. Al-Otaibi K, Hosking DH. Percutaneous stone removal in horseshoe kidneys. *J Urol*. 1999;162:674-677.
15. Tepeler A, Sehgal PD, Akman T, et al. Factors affecting outcomes of percutaneous nephrolithotomy in horseshoe kidneys. *Urology*. 2014;84:1290-1294.
16. Etemadian M, Maghsoudi R, Abdollahpour V, et al. Percutaneous nephrolithotomy in horseshoe kidney: our 5-year experience. *Urol J*. 2013;10:856-860.
17. Hadar H, Gadoth N. Positional relations of colon and kidney determined by perirenal fat. *Am J Roentgenology*. 1984;143:773-776.
18. Hopper KD, Sherman JL, Luethke JM, et al. The retrorenal colon in the supine and prone patient. *Radiology*. 1987;162:443-446.
19. Ghani KR, Rintoul M, Patel U, et al. Three-dimensional planning of percutaneous renal stone surgery in a horseshoe kidney using 16-slice CT and volume-rendered movies. *J Endourology*. 2005;19:461-463.
20. Korkes F, Lopes Neto AC, Lucio J 2nd, et al. Management of colon injury after percutaneous renal surgery. *J Endourol*. 2009;23:569-573.