Should PCNL patients have a CT in the prone position preoperatively?

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Objective: *Lower pole percutaneous nephrostomy is performed frequently for percutaneous nephrolithotomy (PCNL), using a variety of imaging modalities such as fluoroscopic, computed tomography (CT) or ultrasound guidance. This study was performed to estimate the potential risk of colonic injury during lower pole percutaneous nephrostomy for PCNL.*
Methods: *We observed the position of the colon relative to the kidney in 134 patients who underwent CT kidney, ureter, bladder (KUB) examinations in the prone position.*
Results: *We found the prevalence of colon lying posterior to the kidney (i.e. retrorenal) in males to be 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.*
Conclusions: *Patients at higher risk for retrorenal colon should be considered for preoperative imaging to identify those patients in whom the colon may be situated posterior to the kidney, allowing for appropriate alterations in technique to be made, such as the use of ultrasound or CT guidance.*

Key Words: percutaneous nephrostomy, percutaneous nephrolithotomy, colon, perforation, urolithiasis, retrorenal colon

Introduction

Lower pole percutaneous nephrostomy is performed for a variety of indications, including relief of upper tract obstruction and to gain access for percutaneous nephrolithotomy (PCNL). The two major structures at risk in this procedure are the colon and lung.[1,2] Furthermore, in patients undergoing PCNL, the tract is dilated to allow insertion of a sheath, potentially aggravating any occult injury.

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Lower pole percutaneous nephrostomy can be performed using a variety of techniques and imaging modalities, including ultrasound,[3-5] fluoroscopy,[6] and computed tomography (CT) scanning.[7,8] The advent of CT scanning allows anatomical variations in the relationships of the kidney to be recognized prior to percutaneous nephrostomy. While most patients undergo percutaneous nephrostomy in the prone position, CT scans are mostly performed in the supine position.

Colonic perforation is a recognized complication of percutaneous nephrostomy.[1,9] This study was performed to estimate the potential risk of colonic injury during lower pole percutaneous nephrostomy. Most of the published literature looking at the

prevalence of retrorenal colon has involved patients undergoing CT scanning in the supine position.[10] We have chosen to look at CT scanning in the prone position, since this reflects the patient position during percutaneous nephrostomy. Furthermore, several studies have noted that the anatomical position of the colon relative to the kidneys varies between the prone and supine position, with the colon noted to be located more posteriorly (i.e. retrorenal) in the prone position.[11-13]

Methods

Sixty-seven consecutive male and female patients who underwent CT scanning in the prone position were evaluated (total number of patients 134). All CT scans were performed over a 9 month period, and were reviewed by one author (VC). Individual de-identified data was collected using a Microsoft Access database, and then analyzed using Stata (version 8 for Windows).

CT kidney, ureter, bladder (KUB) examinations were performed on a 16-slice Toshiba Aquilion CT scanner (Toshiba Medical Systems, USA). All scans were performed with the patient lying in the prone position. A scout film was obtained from above the diaphragm to the symphysis pubis. Axial imaging was obtained from lung bases to the pubic symphysis, in arrested inspiration, using a kV of 120. Images were acquired using a pitch of around 1 and a slice thickness of 1 mm, and were then reconstructed automatically. Two reconstructions were performed. The first set of reconstructed images used an interval of 0.8 mm and a slice thickness of 1.0 mm; the second reconstruction used an interval of 5 mm and a slice thickness of 5 mm.

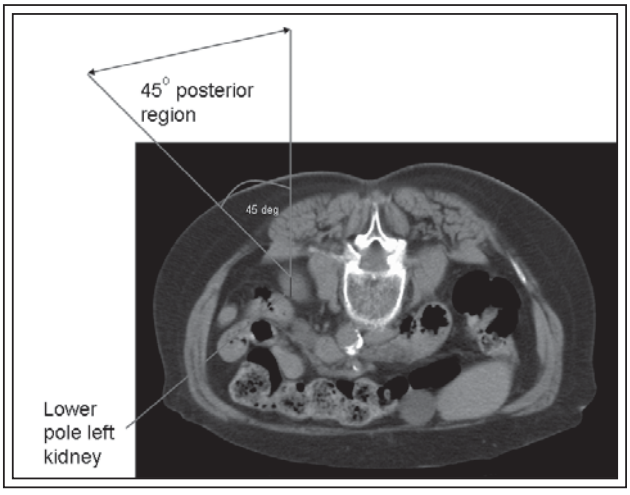

Figure 1. Example of 45 degree zone posterior to kidney.

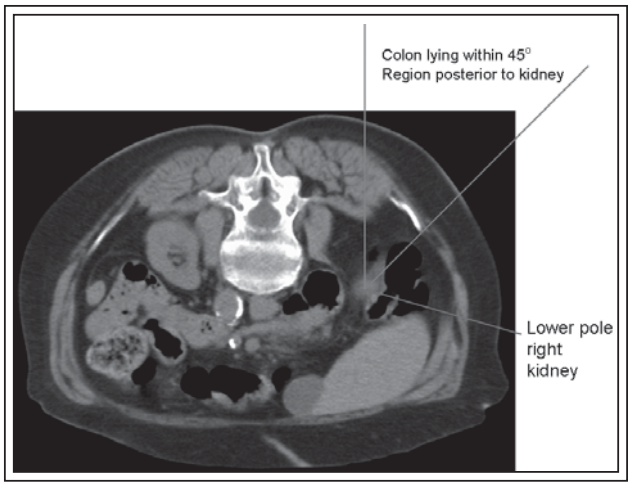

Figure 2. Example of colon lying within a 45 degree zone posterior to right kidney.

Each CT was reviewed using a methodology similar to Tuttle et al.[12] Using a scrolling digital display, axial images were reviewed and a potential percutaneous nephrostomy zone was marked on the image, extending out to 45 degrees from the vertical. The most cranial image was the lowermost slice with the collecting system visible, whilst the most caudal slice was just above the iliac crest. Any colon within this posterior zone (i.e. retrorenal) was considered at risk for injury, Figures 1 and 2.

Results

A total of 134 patients were included in the study, allowing for 268 potential kidneys to be examined. Two females and one male had solitary kidneys, so the total number of kidneys examined was 265 (132 left kidneys and 133 right kidneys). The average age of male patients was 50.1 years and female patients were 51.7 years, Table 1.

Where a 45 degree zone posterior to the kidney had been allowed for puncture, the colon was found to be at risk of injury in 16.2% of studies (43 of 265 "punctures").

TABLE 1. **Distribution of kidneys examined**

	Female	**Male**	**Total kidneys examined**
Right kidneys	67	66	133
Left kidneys	65	67	132

TABLE 2. **Proportion of potential colon injuries by approach**

	Right	Left	p-value
Males			
Posterior zone	13.6% (9/66)	11.9% (8/67)	0.77
Females			
Posterior zone	13.4% (9/67)	26.2% (17/65)	0.07

In females, there was a tendency towards a greater proportion of left kidneys being at risk when compared with right kidneys (26.2% versus 13.4%; p = 0.07), see Table 2; had the numbers been greater, this tendency may have reached statistical significance. In contrast, amongst males, similar proportions were seen between the left and right sides (11.9% versus 13.6%; p = 0.77).

In logistic regression analysis adjusted for age and sex, female sex was a significant predictor of risk for puncture of the left kidney ($p < 0.05$). There were no significant predictors of risk for right kidney puncture.

Discussion

Four published studies have looked at the position of the colon in relationship to the kidney using CT scanning in the supine position, in addition to scattered case reports about retrorenal colon.[14,15] In 1985, Sherman et al reviewed 200 cases and found the colon in the left retrorenal position in only 1% of cases.[16] Boon et al looked at 301 supine CT scans.[10] They found the descending colon to be at risk in 16% of cases, at the level of the inferior pole of the kidney. Hadar et al looked at 140 supine CT scans.[17] This study assigned quadrants to the colon, and did not give specific percentages. Prassopoulos et al have the biggest study to date.[18] They looked at 1708 supine CT scans, and found that in up to 10% of cases the colon was at risk in lower pole punctures. Unfortunately, the studies are not directly comparable, due to variability in the precise definition of a retrorenal colon.

Two studies have described the relationship between the colon and the kidney using CT scanning in the prone position. Hopper et al looked at 90 CT scans done in the prone position.[11] They found that in 4.7% of cases the colon was retrorenal.

In the most recent study, Tuttle[12] and colleagues reviewed 83 CT examinations using supine, prone and multiplanar reformations. Interestingly, patients had both supine and prone CT examinations performed on the same day. They found the colon to be at risk in 15% of cases in the prone position, but only 6% of cases in the supine position. These images were then compared to oblique parasagittal reformatted CT, where they found the colon to be at risk in 3% (prone) and 0% (supine) of cases. Our findings our similar to those described by Tuttle for patients undergoing CT scanning in the prone position, without the multiplanar reformations. The one striking difference was the high prevalence of colon at risk in female left kidneys, which was not observed in either of the two aforementioned studies looking at CT examinations in the prone position.

Rather than looking at the prevalence of retrorenal colon, we have focused on colon at risk for injury during percutaneous nephrostomy, and so our definition varies from that used elsewhere in the literature. From a practical viewpoint, the line of entry of a percutaneous nephrostomy tract will not always be perfectly 30 degrees to the vertical, and so we chose to look at a wider angulation to cover most possible potential percutaneous nephrostomy tracts.

There are scattered reports of colonic perforation following percutaneous nephrostomy in the literature, with rates varying from 0.2%-1.6%.[1,19-36] The largest series had 15 colonic perforations, and found that significant risk factors were horseshoe kidneys and advanced patient age.[37] The low rate of colonic injury contrasts with the higher rate of retrorenal colon which we and others have noted. Possible explanations for this include the definition of retrorenal colon being too liberal, variations in the angulation and technique used to perform percutaneous nephrostomy,[13] the lack of a prospective trial specifically excluding colonic injury in all patients with fever postoperatively, and the use of axial rather than multiplanar reformatted CT[12] when judging the location of the colon relative to a percutaneous nephrostomy tract. Individual clinicians must balance the risk of colonic perforation with the risks of CT scanning. These relate to the radiation dosage and the implication that other, incidental, abnormalities may be discovered. With the aforementioned cautions borne in mind, non-contrast CT scanning in the prone position is an easy test to perform and interpret with minimal morbidity. Patients deemed to be at risk would then have their percutaneous nephrostomy placed using CT guidance, or, alternatively, using ultrasound guidance with the operator particularly aware of the potential risk of colonic presence.

Groups of patients for whom colonic injury during PCNL seems more likely are those with horseshoe kidneys,[37] advanced age,[37-39] thin patients,[1,29,39] a history of prior colonic surgery,[1] and patients with decreased perinephric fat.[17] For the last two decades

there have been sporadic suggestions in the literature that preoperative imaging should identify the position of the colon. In 1985 LeRoy et al[22] suggested using fluoroscopic imaging prior to nephrostomy placement; Skoog et al[40] and Goswami et al[31] recommended that CT scanning should be performed in patients with horseshoe kidneys or other such fusion anomalies to identify the colonic position relative to the kidney. Gerspach et al[29] in 1997 suggested using a preoperative CT scan in thin patients prior to nephrostomy placement to identify the position of the colon relative to the kidney.

Further prospective studies are needed. Until then, we would agree with other authors who have suggested that high risk patients having elective percutaneous nephrostomies (e.g. for PCNL) should be considered for a CT KUB in the prone position preoperatively, or have the percutaneous access performed using an imaging modality such as ultrasound which permits real time visualisation of structures adjacent to the kidney such as bowel.[10,41] In patients undergoing an emergency percutaneous nephrostomy, we propose that the delay in treatment by undergoing a prone CT KUB (with the attendant logistic difficulties) would outweigh any potential benefits.

Our study has been limited by the fact that it was performed in patients undergoing CT scanning for renal colic; therefore the study population may be different to the target population. Patients scheduled for percutaneous nephrostomy may have anatomical variations secondary to a dilated collecting system or the presence of stones for example, which have produced surrounding chronic inflammatory changes leading to reduced organ mobility in the retroperitoneum. Our study has also not taken into account the effect of previous surgery on the position of the colon (for instance if the patient had a prior hemicolectomy). However, one would not anticipate that the colon would lie more posteriorly after mobilization; rather, it would come to lie more anteriorly after it has been mobilized. Lastly, we acknowledge that there are numerous definitions available for retrorenal colon, and the definition we have chosen may have led to a higher prevalence being noted.

Conclusion

Further studies need to be performed in patients undergoing percutaneous nephrolithotomy; until then, we would recommend consideration being given to CT scanning in the prone position to ascertain the position of the colon prior to PCNL in patients at higher risk for retrorenal colon or colonic injury. □

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