
Radioanatomy : The Ascending Colon In The Right Pararenal Space

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Abstract

The anatomy of the ascending colon in the right pararenal space is important. To prevent iatrogenic complications that arise as a result of the right kidney percutaneous procedures, it is essential to know the normal anatomy of this space, and different anatomical variations. The aim of our study was to objectively determine the rate of ascending colons at risk during percutaneous maneuvers of the right kidney.

In a series of 911 patients, we studied on abdominal CT scan sections the position of the ascending colon in the right pararenal space, relative to the line of insertion of percutaneous nephrostomies.

The ascending colon was found at risk in 8.2 % of cases. For patients aged over 50 years old, we found ascending colons at risk with a male predominance; and for patients aged under 50 a female predominance was noted.

The advent of percutaneous surgery of the right kidney requires taking into account anatomical variations of the ascending colon in the right pararenal space. The knowledge of these anatomical variations would reduce iatrogenic risk on the ascending colon during a percutaneous nephrostomy.

INTRODUCTION

Before any percutaneous maneuver in the right kidney, it is important to recognize abnormal anatomical situations of the ascending colon in the right pararenal space [1,2]. The presence of the ascending colon on the insertion path of a percutaneous nephrostomy needle can expose to a risk of colonic perforation [3].

The purpose of this radioanatomical study is to determine the position of the ascending colon in the right pararenal space in relation with the insertion line used during

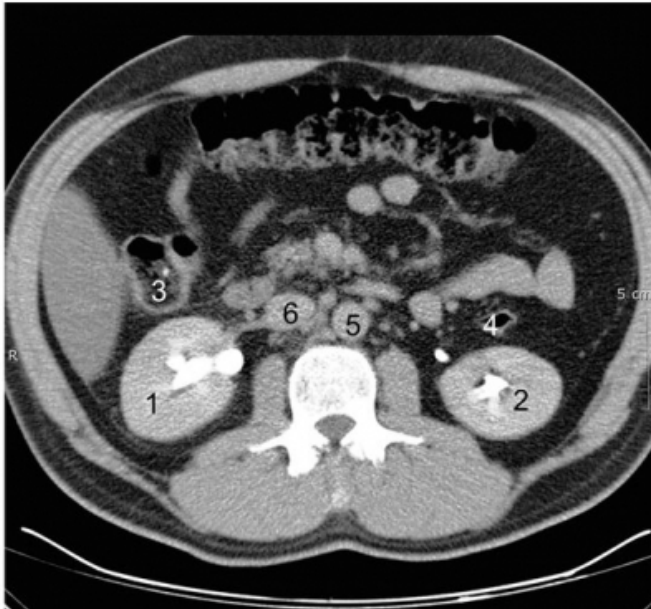
percutaneous nephrostomy, so to identify when the ascending colon is at risk of injury.

MATERIAL AND METHODS

1084 abdominal CT scans were selected in order to determine the position of the ascending colon in relation with the right kidney. Despite the sample of 1084 subjects, 173 selected CT scans were excluded for technical reasons. Thus, 911 CT scans were included in our study: 469 men and 442 women. All CT scans represented patients in supine position (see Fig. 1).

Figure 1

Abdominal CT scan at the level of kidneys in a patient in the supine position. 1: Right kidney ; 2: Left kidney ; 3: Ascending colon ; 4 Descending colon ; 5 : Abdominal Aorta ; 6: Inferior Vena Cava.



The relationship between the ascending colon and the right kidney was studied on the line of insertion of a percutaneous nephrostomy needle. Prassopoulos [4] defined this path as passing through the anterolateral margin of the body of the corresponding vertebra, and by the middle of the renal hilum (see Fig. 2). When the ascending colon is superimposed on this line or lies behind it, it is considered to be at risk during a percutaneous nephrostomy (see Fig. 3).

Figure 2

Abdominal CT scan at the level of renal hila , showing the path of percutaneous nephrostomy (arrow). This path goes from the anterolateral margin of the corresponding vertebral body, and passes through the renal hilum toward the posterolateral wall of the abdomen. 1: Right kidney ; 2: Left kidney ; 3: Ascending colon ; 4: Descending colon ; 5 : Abdominal Aorta.



Figure 3

Abdominal CT scan at the level of lower poles of kidneys. The insertion line of a percutaneous nephrostomy is shown in the right kidney (black arrow). The ascending colon is partially located behind the insertion line (white arrow). 1: Right kidney ; 2: Left kidney ; 3: Ascending colon ; 4 Descending colon ; 5 : Abdominal Aorta.



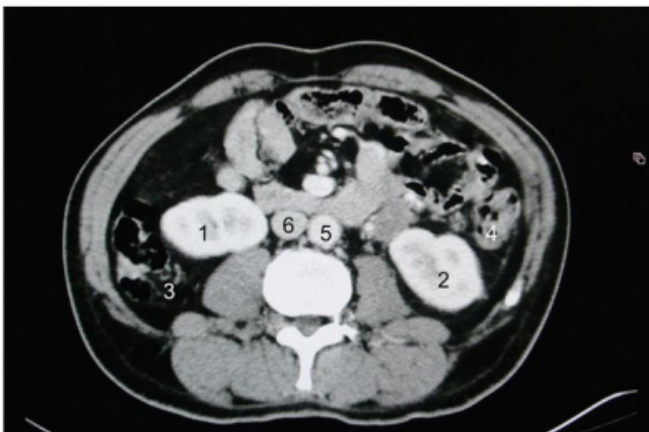
Figure 4

Abdominal CT scan at the level of the lower pole of kidneys in a male patient of 72 years old. The retrorenal location of the ascending colon predisposes to a risk of perforation if a percutaneous procedure is performed in the right kidney. RK : right kidney ; LK : left kidney ; AC: ascending colon ; DC: descending colon ; AA: abdominal aorta ; IVC: inferior vena cava.



Figure 5

Figure 5. Abdominal CT scan performed at the level of kidneys, illustrating an abnormal location of the ascending colon relative to the posterior margin of the right pararenal space. 1: Right kidney ; 2: Left kidney ; 3: Ascending colon; 4 : Descending colon ; 5 : Abdominal Aorta ; 6: Inferior vena cava.



RESULTS

The results of our study are presented in Tables I and II, and illustrated in Figures 1-5.

Table 1

Position of the ascending colon relative to the insertion line of a percutaneous nephrostomy, at the level of both poles and renal pelvis.

	Anterior to the insertion line	Posterior to the insertion line	Superimposed to the insertion line	Total	Total at risk (posterior and superimposed to the insertion line)
Upper pole	887 (100%)	0	0	n=887	0
Renal pelvis	880 (97,6%)	18 (2%)	4 (0,4%)	n=902	22 (2,4%) M: 9 / F : 13
Lower pole	843 (94,1%)	37 (4,1%)	16 (1,8%)	n=896	53 (5,9%) M: 35 / F : 18

Table 2

Ascending colons at risk of injury (posterior and superimposed to the insertion line of a percutaneous nephrostomy) relative to the age and sex of patients, at both poles and renal pelvis.

	Age (years) and sex	15-30 (n=97)	30-40 (146)	40-50 (n=118)	50-60 (n=163)	60-70 (n=114)	70-80 (n=131)	80-90 (n=142)	Total (n=911)
Upper pole	Males	0	0	0	0	0	0	0	0
	Females	0	0	0	0	0	0	0	0
Renal pelvis	Males	0	1	1	1	2	3	1	9
	Females	2	4	3	0	1	2	1	13
Lower pole	Males	2	6	3	7	8	6	3	35
	Females	3	5	5	1	3	1	0	18
Total	Males + Females	7 (7,2%)	16 (11%)	12 (10,2%)	9 (5,5%)	14 (12,3%)	12 (9,2%)	5 (3,5%)	75

DISCUSSION

The position of the colon related to the kidney has grown in importance since the popularization of percutaneous procedures for renal surgery. Concerning percutaneous nephrostomy, it is recommended a posterolateral approach 3-4 cm lateral to the paraspinal muscles and below the 12th rib [5]. This approach is more risky than the direct posterior right kidney approach. However, our work shows that no approach is 100% safe since it is always possible to find an ascending colon in a retrorenal position.

Percutaneous nephrostomy is a procedure used to access the upper urinary tract. During this procedure, the nephrostomy tube is percutaneously introduced to the desired kidney. This procedure has both diagnostic and therapeutic purposes [6]. It can be performed in a patient in prone position, anterior oblique position or supine position.

The advantage of the supine position is to facilitate technical gesture and decrease the complication rate [6]. Because of the advantages of this position, we decided to study relationships of the ascending colon in the right pararenal space in patients only installed in supine position. In this position, the skin is punctured on the posterior axillary line

2.5 cm above the iliac crest, with a 16-gauge needle. The procedure is performed under radiological control.

Our results presented in Table I show that at the level of the upper pole of the right kidney, the ascending colon is not found at risk. At the level of the renal pelvis 2.4% (n = 22) of ascending colons are found at risk, 9 men and 13 women. At the level of the lower pole of the right kidney 5.9 % (n = 53) of ascending colons are found at risk, 35 men and 18 women (Table I).

Our results presented in Table II show that ascending colons at risk are more often found between 60 and 70 years old (12.3 %) and between 30 and 40 years old (11%). Ascending colons at risk are less seen between 80 and 90 years old (3.5 %) and between 50 and 60 years (5.5%).

The more detailed analysis of our results allows us to formulate the following comments: in younger age groups (between 15 and 50 years) ascending colons at risk are predominant in women. While in older age groups (50 to 90 years) ascending colons at risk (see Fig. 4) are predominant in men (Table II).

Hadar et al. [7] review 140 abdominal CT scans to study relationships between the colon and the kidney. Despite the fact that they do not study the position of the colon in relation with the line of a percutaneous nephrostomy needle insertion, they don't find any retrorenal colon. In another study involving 200 subjects, Sherman et al. [5] find that in 9 to 10 % of cases, at least a part of the colon extends behind the line passing through the posterior margin of the left kidney. Hopper et al. [8] find in a series of 590 patients that the colon can be found behind the kidney in 1.9 to 10 % of cases according to the patient's position. More recently, Manyacka Ma Nyemb et al. [2] find a descending retrorenal colon in less than 1 % of cases in a series of 1084 patients. None of these studies reports specifically the position of the ascending colon relative to the insertion line of a percutaneous nephrostomy tube in the right kidney.

Only few authors as Boon et al. [3] study the situation of the colon relative to the path of a percutaneous nephrostomy, despite the fact that injuries of the ascending colon during the procedure of percutaneous nephrostomy are associated with significant morbidity. In Boon's study, 333 CT scans performed in supine position are studied in order to determine the position of the ascending colon relative to the line of insertion of a right percutaneous nephrostomy. In most cases, the ascending colon is found ahead the line of

insertion of a percutaneous nephrostomy. However, the colon takes a position at risk in 9 % of cases. Despite a larger sample in our study, we find a similar rate concerning the ascending colon (75 of 911, representing 8.2 % of cases at risk).

Boon [3] also finds that anatomical relationships between the ascending colon and the right kidney vary depending on the age and sex of subjects. We also find variations according to age and sex, as our study reports a prevalence of risk of perforation of the ascending colon in young women and in men over 50 years. Manyacka Ma Nyemb et al. [2] find the same trend in their study of 1084 cases.

It is important to study factors that predispose a risky situation of the ascending colon, because colonic perforation is one of the most feared complications in the percutaneous treatment of renal diseases. Despite the relatively low rate [1] of colonic perforations (0.2 to 0.8% of cases), they can have serious consequences such as septicemia, peritonitis and abscess formation, nephro-colic or colo-cutaneous fistulas.

Several risk factors may contribute to the occurrence of colon perforation during percutaneous maneuvers of the kidney [9]. Anatomical factors are represented by: procedures performed on the left side (descending colon), the "horseshoe" kidney, the retrorenal colon, an extreme thinness of the subject, a significant mobility of the kidney. However, the most important factor is of embryological nature.

The embryological factor is based on the theory of the formation of the lateroconal fascia during intrauterine life [2,5]. The right renal fascia forms a cone whose longitudinal axis is parallel to the right kidney. The anterior and posterior renal fasciae merge at their lateral edges to form a third fascia : the lateroconal fascia. The lateroconal fascia extends laterally and anteriorly to fuse with the transversalis fascia or the posterior parietal peritoneum. At a variable level, the lateroconal fascia forms the posterolateral limit of the pararenal space, because it fills the space between the renal fascia and the abdominal wall. Due to the fact that the ascending colon is contained in the anterior pararenal space, its posterior extension is determined by the presence of lateroconal fascia, and by the level at which the fascia merges with the abdominal wall. Anatomical variation of the posterior position of ascendant colon relative to the right kidney, reflects the variability in the fusion of the anterior and posterior renal fascia, and thus in the formation of the

lateroconal fascia.

Our study illustrates situations in which the right lateroconal fascia is either not formed or formed posteromedially to the normal position. This allows the ascending colon to extend beyond the posterior margin of the pararenal space (see Figure 5).

CONCLUSION

Anatomical variations of the situation of the ascending colon relative to the right kidney must be taken into account before any percutaneous procedure towards the right renal loge.

The association between the peritoneal coverage of the right kidney and the embryological development of the right pararenal space leads to an abnormal situation of the ascending colon in 8.2 % of cases.

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