Urol Res (1987) 15:245–248

Urological Research

Areas for Safe Percutaneous Nephrocentesis – A Study of Practical Anatomy

Z. X. Su[1], Z. H. Chen[1] and X. M. Zhou[2]

[1] Jinan University Medical College of Guangzhou, People's Republic of China
[2] Hospital Affiliated to Nanjing Railway Medical College, People's Republic of China

Accepted: November 21, 1986

Summary. The safest percutaneous nephrocentesis route is through the posterolateral aspect of the kidney. From study of 160 kidneys from adults at autopsy, we conclude that the most favorable nephrocentesis area is the lower major renal calyx and its minor calyces or the upper minor calyces. We believe that the lateral aspect of the middle calyces may be an area for safe nephrocentesis.

Key words: Percutaneous nephrocentesis, Blood vessel distribution, Safe puncture areas.

Removal of a renal calculus through a percutaneous nephrostomy tract was first described by Fernström and Johansson in 1976 [1]. As a result of recent developments in radiology, ultrasonography, computerized tomography, and endourologic instrumentation, the technique of percutaneous nephrocentesis has become useful to most urologists.

In summarizing his experience with 450 cases of percutaneous renal stone extraction, Korth [2] indicated that selection of an appropriate point for nephrocentesis was of greatest importance. Stable [3] believed that the safest area for nephrocentesis was the inferior minor calyx of the lower major calyx. However, this procedure may injure blood vessels or cause a failure of the percutaneous renal stone extraction from the upper calyces when the nephrostomy tube cannot be passed into the upper and middle calyces. In seeking safer areas for nephrocentesis we studied the anatomy of the blood vessels in the posterior parts of the kidney.

Materials and Methods

We examined 160 routinely preserved kidneys from adults at autopsy. In 35 kidneys, chloroethylene plastic was infused into the renal arteries and pelvis and into the urether. The distribution of renal arteries and their relationship to the pelvis and calyces was investigated through the nephrocentesis tract. The outside diameter of the vessels was measured in the posterior part of the kidney (60 kidneys) and also in the relatvely avascular area of the middle calyces (160 kidneys).

Results

Arterial Distribution in Posterior Part of the Kidney

There are three types of arteries, which ride over the posterior part of the pelvis and calyces as follows (Fig. 1): (i) posterior-segmental artery, found in 159 kidneys (99.4%); (ii) upper calyceal artery, its posterior branches occasionally riding over the posterior part of the superior calyx, found in 7 kidneys (4.4%); and (iii) lower calyceal artery, its upper branches sometimes riding over the lower major calyx or over the upper and lower parts of several minor calyces, in 4 cases coming form an accessory renal artery-found in 41 kidneys (25.6%).

Relationship Between Renal Posterior Artery and Pelvis and Calyces

The renal posterior-segmental artery enters the renal sinus form the upper part of the renal hilus and crosses the upper part of the pelvis, almost at the junction of the pelvis and the major calyx (Fig. 1). Form there the artery divides into treelike branches or arches along the posterior lip of the kidney and then down into deep tissue. There are many branches along its way, parallelling the posterior or upper part of the major and minor calyces and continuing into the renal parenchyma. The renal veins usually have no segmental distribution but do have extensive anastomoses, forming venous plexuses embracing the arteries near the minor calyces.

In about 30% of the specimens with double vessels passing over the posterior part of the pelvis and calyces, the branches derived from apical segmental arteries are usually

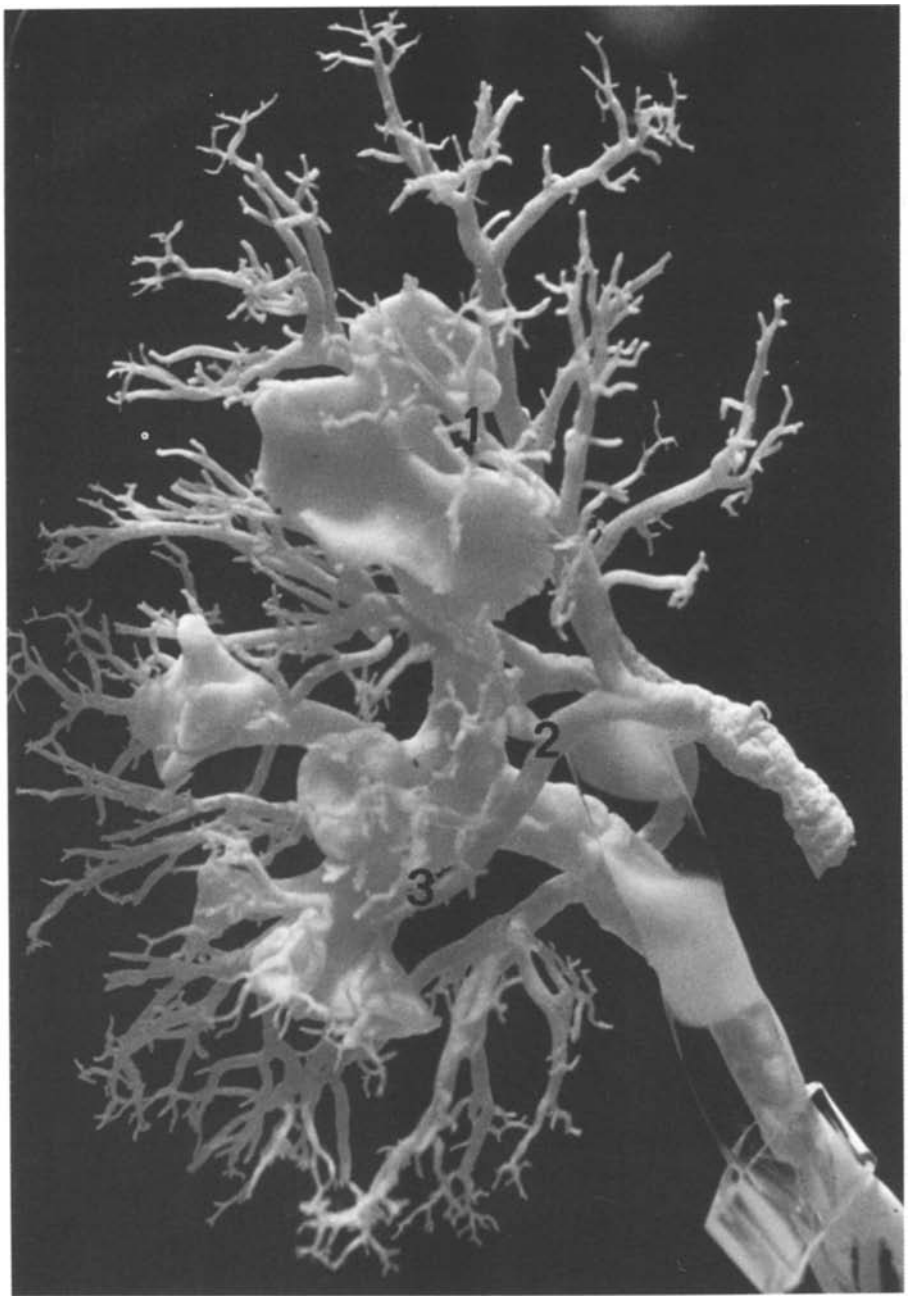

Fig. 1. Arterial distribution in the posterior part of the kidney: *1*, upper calyceal artery; *2*, posterior segmental artery; *3*, lower calyceal artery

Table 1. Outside diameter of renal arteries in 60 kidneys

Finding	No. of kidneys	Outer diameter, mm [mean ± SD (range)]
Posterior segmental arterial stem	59	3.0 ± 0.5 (2.1–4.2)
1 upper calyceal artery	47	2.6 ± 0.8 (1.2–2.5)
2 upper calyceal arteries	8	1.2 ± 0.6 (0.1–2.3)
3 upper calyceal arteries	5	1.4 ± 1.1 (0.2–1.6)
1 middle calyceal artery	10	1.5 ± 0.7 (0.3–2.2)
2 middle calyceal arteries	49	1.5 ± 0.4 (1.1–2.5)
No middle calyceal artery	1	–
1 lower calyceal artery	38	1.3 ± 0.4 (0.5–2.1)
2 lower calyceal arteries	22	1.4 ± 0.5 (0.3–2.5)

smaller and cover only the superior posterior part of the minor calyx. The branches from the lower calyceal artery are larger and sometimes ride over the posterior part of the lower major calyx or the upper and lower parts of the posterior part of the minor calyces.

Measurement of Blood Vessels in Posterior Part of Kidney

We chose the origin of every blood vessel and measured the vessels in the posterior part of the kidney (Fig. 2). The results are presented in Table 1.

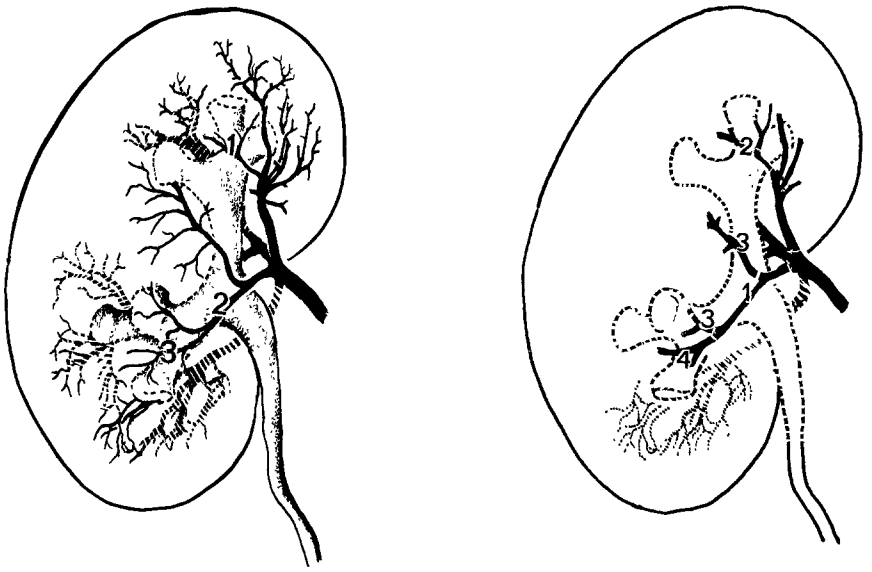

Fig. 2. Measuring point of blood vessels in posterior part of the kidney: *1*, posterior segmental arterial stem; *2*, upper calyceal artery; *3*, middle calyceal artery; *4*, lower calyceal artery

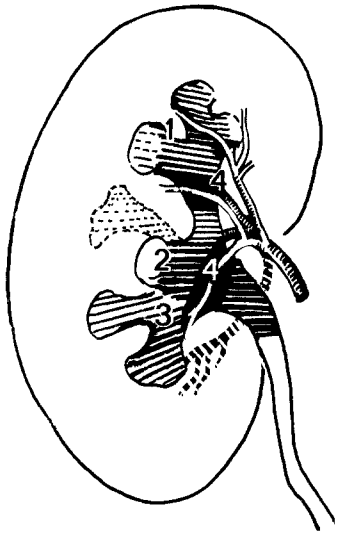

Fig. 3. Nephrocentesis areas in the posterior part of the kidney; *1*, superior minor calyx; *2*, middle calyces; *3*, lower major calyx and its minor calyces; *4*, risk area of nephrocentesis

Determination of Relatively Avascular Area in Middle Calyx

The middle calyceal artery always comes form the posterior segmental arterial stem as treelike branches running along the middle calyx into the deeper part around the renal papillae and then into the parenchyma. In most cases there are two middle calyceal arteries running along the upper and lower wall of the middle calyx, with some distance separating the arteries from each other and from the calyceal wall. In a few instances we found only one middle calyceal artery passing near the lower middle part of the middle calyx. There are also arterial branches into the upper and lower calyces. These regions form a relatively avascular area. The course of the middle calyceal artery gives the avascular area of the middle calyces a distinctive triangular or quadrilateral form. In 160 kidneys, the avascular area averaged 1.1 ± 0.8 cm in length (range, 0.3–2.5 cm) and 1.4 ± 0.8 cm in breadth (range, 0.8–2.6 cm).

Discussion

More than 99% of the posterior segmental renal artery covers the posterior part of the renal pelvis and calyceal system. About 4.4% of the apical segmental artery covers the superior minor calyces; 25.6% of the lower calyceal artery covers the inferior minor calyces of the lower major calyx. The superior minor calyces are higher; and from the standpoint of arterial distribution, nephrocentesis should be performed at the upper edge of the twelfth rib. This, however, can injure the pleura and lung, producing severe complications from pneumothorax. Therefore the nephrocentesis area of the upper calyces (Fig. 3) is used only for stones in a calyceal diverticulum in the upper calyces. The lower major calyx or its minor calyces should be considered the most favorable area for nephrocentesis (Fig. 3). Nephrocentesis at this location is less likely to injure a large artery even if the procedure is not done along Brödel's line.

If the catheter is passed too deeply, the anterior segmental artery or another large artery may be injured or the contralateral wall of the renal pelvis may be perforated. Injury secondary to too-deep nephrocentesis can be prevented by filling the pelvis with contrast medium and keeping the area under fluoroscopic control during the procedure.

Determination of the boundaries of the relatively avascular area showed that there are relatively avascular areas between the middle calyceal arteries and either the upper or lower calyceal arteries. Thus we feel that the outer side of the middle calyces is a safe area for nephrocentesis (Fig. 3). Nephrocentesis can easily be performed in hydronephrosis; but most calyces containing stones are not distended, and in this situation nephrocentesis can be quite difficult. In difficult cases we may perform retrograde pyelography to dilate the pelvis and calyces. The middle calyces can then be demonstrated clearly under fluoroscopic control, and nephrocentesis can be performed successfully.

The selection of areas for nephrocentesis as described above is based on the regularity of the distribution of the

interior renal artery. In every distributive area of the renal segmental arteries, the arteries are largest in the center and smaller at the edge. There is no collateral circulation in the parenchyma between different calyceal segmental arteries. Because of the vascular network in the kidney, manipulations during the nephrocentesis may injure some small arteries; but resultant bleeding generally stops spontaenously. The large arterial stem, however, must not be injured. The junction of the major calyx and the pelvis where the posterior segmental arterial stem crosses is a risk area of nephrocentesis. This risk area is analogous to the area of the upper half of the renal sinus.

Acknowledgement. We wish to thank the PLA First Army Medical University for their assistance with materials for this study. We thank Professor Zhong Shizhen, Department of Anatomy, PLA First Army Medical University; Professor Mei Hua, Department of Urology, First Hospital Affiliated to Zhongshan University of Medical Sciences; Professor Zhang Yunshang, Department of Urology, the Tongji Hospital Affiliated to Tongji Medical University; Professor Gu Fangliu, Institute of Urology, Beijing University of Medical Sciences, People's Republic of China; and Professor G. Rutishauser, Universitäts-Klinik, Basel, Switzerland, for their help and suggestions.

References

1. Fernström I, Johansson B (1976) Percutaneous pyelolithotomy: a new extraction technique. Scand J Urol Nephrol 10:257–259
2. Korth K (1985) Technik der perkutanen Steinchirurgie. Urologe (B) 25:5–7
3. Stable DP et al (1975) Permanent nephorstomy via percutaneous puncture. J Urol 114:684–687

Z. X. Su, M.D.
Department of Urology
Jinan University
Medical College of Guangzhou
People's Republic of China