Original Articles

ANATOMICAL RELATIONSHIP BETWEEN THE RENAL VENOUS ARRANGEMENT AND THE KIDNEY COLLECTING SYSTEM

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ABSTRACT

The anatomical relationships between the renal venous arrangement and the pelviocaliceal system were studied in 52, 3-dimensional polyester resin corrosion endocasts. In 53.8% of the cases, there were 3 large venous trunks and in 28.8% there were 2 venous trunks joining to form the main renal vein. Intrarenal veins demonstrated free anastomoses that were disposed in 3 systems of longitudinal arcades (stellate, arcuate and interlobar veins). There were large venous collars around caliceal necks and also horizontal arches crossing over calices to link anterior and posterior veins. In 84.6% of the cases the upper caliceal group was encircled anteriorly and posteriorly by venous plexuses, which coursed parallel to the infundibulum. In 50.0% of the cases the lower caliceal group also was enriched by 2 venous plexuses. A close relationship existed between a large inferior tributary of the renal vein and the anterior aspect of the ureteropelvic junction in 40.4% of the cases. In 69.2% of the cases there was a posterior (retropelvic) vein: in 48.1% this vein had a close relationship to the junction of the pelvis with the upper calix and in 21.1% it crossed the middle posterior surface of the renal pelvis. (*J. Urol.*, 144: 1089–1093, 1990)

Many physicians have studied the intrarenal arteries, including the surgical aspects,[1-3] applied anatomy of the pelviocaliceal system[4-8] and even, more recently, the anatomical relationship between the intrarenal arteries and kidney collecting system.[9,10] However, no particular attention has been paid to renal veins, since unlike the arteries the veins do not have a segmental model.[11-13] Despite the existence of free circulation throughout the venous system, veins are worth attention because a lesion of 1 large vein will result in important back bleeding during and after the operation.[11]

Although some studies have been done on the intrarenal venous arrangement[13-16] we believe that additional information is necessary in regard to the 3-dimensional relationships between the intrarenal veins and the collecting system.

MATERIAL AND METHODS

We studied 52, 3-dimensional endocasts of the kidney collecting system together with the intrarenal veins obtained from 26 fresh cadavers of both sexes (cause of death not related to the urinary tract). A polyester resin (volume approximately 15.0 ml.) was injected by manual pressure into the main trunk of the renal vein to fill the kidney venous tree and into the ureter (approximately 5.0 ml.) to fill the collecting system. A styrene monomer was added to the resin as a diluent and a methyl ethyl ketone peroxide was added as a catalyst, according to the proportions and the technique described by Tompsett.[17] A pigment (yellow for the ureteral and blue for the venous injections) was used to color the translucent polyester resin (opaque casts proved to be more satisfactory than translucent casts). After injection and setting of the resin, the perirenal fat was removed and the kidneys were immersed in commercial

hydrochloric acid for 48 hours until total corrosion of the organic matter was achieved and the endocast was obtained. During the cast preparation we fixed 1 or 2 large veins to the collecting system to maintain the same relationship as existed in vivo.

RESULTS

The intrarenal venous arrangement demonstrates free anastomosis between the veins. The small veins of the cortex, called stellate veins, drain into large vessels that form a series of arches. Within the kidney substance these arches were arranged in arcades, which lie mainly in the longitudinal axis. There usually are 3 systems of longitudinal anastomotic arcades (fig. 1). These anastomoses occur in different levels: between the stellate veins (more peripherally), between the arcuate veins (at the base of the pyramides) and between the interlobar veins (close to the renal sinus) (fig. 1, arrows). Around the caliceal necks there were large venous anastomoses (similar to collars), formed mainly when the veins draining the posterior half of the kidney cross over at the necks of the minor calices to join the anterior main trunks (fig. 2, A). There were also horizontal arches crossing over the calices to link the anterior and posterior veins, as well as the longitudinal systems at different levels (fig. 2, B). The venous arcades join each other in the longitudinal and horizontal planes to produce larger veins that unite to form large trunks. The main renal vein was formed by these trunks, which course toward the hilus where they unite before emptying into the vena cava. In our series we found 3 trunks (28 of 52 casts, 53.8%) and 2 trunks (15 of 52 casts, 28.8%) joining each other to form the main renal vein (fig. 3). Less frequently, we found 4 trunks (8 of 52 casts, 15.4%) and 5 trunks (1 of 52 casts, 1.9%). There was an extensive plexus of veins related to the upper and lower caliceal groups and infundibula.

Superior pole. In 44 of 52 cases (84.6%) the venous drainage related to the upper caliceal group originated from 2 plexus; 1 positioned anteriorly and the other positioned posteriorly. The
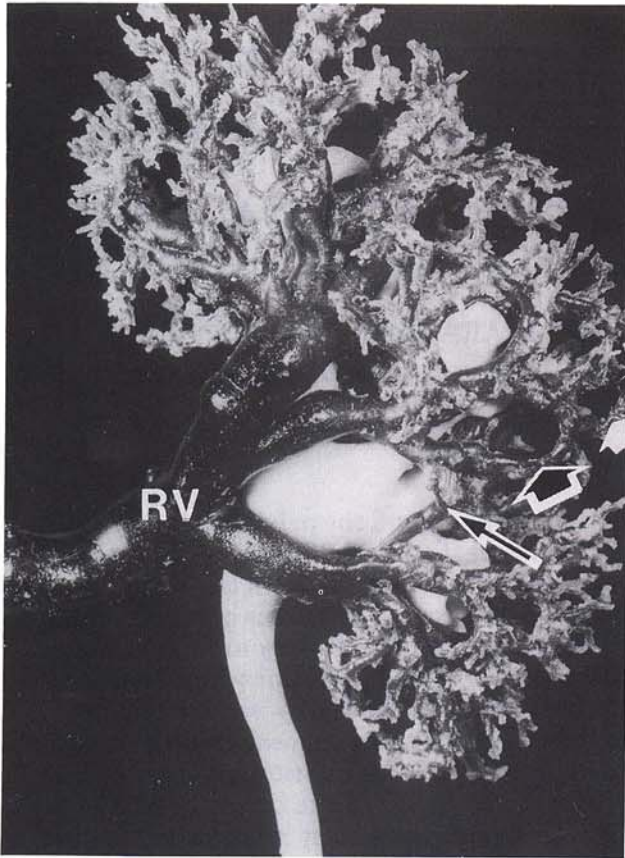
FIG. 1. Anterior view of left kidney endocast of pelviocaliceal system together with venous vascular tree shows 3 systems of longitudinal anastomotic arcades (arrows). From lateral (periphery) to medial (hilar) are stellate veins, arcuate veins and interlobar veins. *RV*, renal vein.

upper caliceal group was involved by these 2 venous plexus, from which the originated veins coursed parallel to the anterior and posterior surfaces of the upper infundibulum (fig. 4). In the remaining 8 casts (15.4%) there was only the anterior plexus.

Inferior pole. In 26 of 52 casts (50.0%) the venous drainage related to the lower caliceal group originated also from 2 plexus; 1 anterior and the other posterior (fig. 4). In the other 26 casts (50.0%) there was only the anterior plexus, being the posterior aspect of the lower infundibulum free from large veins.

Relationship to the ureteropelvic junction. In 21 of 52 casts (40.0%) there was a close relationship between the anterior aspect of the ureteropelvic junction and a prominent inferior tributary of the renal vein (fig. 5, *A*). In 1 case there was a tributary of the renal vein related to the anterior aspect of the ureteropelvic junction and another tributary related to its posterior aspect, simultaneously. In the remaining 31 casts (59.6%) the ureteropelvic junction was not in relation to the large veins (fig. 5, *B*).

Dorsal kidney. In 36 of 52 casts (69.2%) there was a posterior (retropelvic) vein that coursed on the back of the kidney collecting system either to drain into the renal vein or empty directly into the vena cava. In 25 of 52 casts (48.1%) the retropelvic vein had a close relationship to the upper infundibulum or to the junction of the pelvis with the upper calix (fig. 6, *A*). In the remaining 11 casts (21.1%) the retropelvic vein crossed and was related to the middle posterior surface of the renal pelvis (fig. 6, *B*).

DISCUSSION

Due to free anastomosis between the intrarenal veins, occlusion of venous channels can be performed without the risk of renal parenchymal loss. However, it must be emphasized that the venous trunks that lie within the substance of the kidney are of considerable size (figs. 3 and 5). Therefore, incision or lesions into 1 of them, or even into the line of a series of arcades, can constitute with no doubt a hemorrhagic hazard.[11-13,16] Moreover, after nephrotomy, a compressive suture, which may be necessary to control venous bleeding if any large vein was divided, will certainly lead to parenchymal ischemia and necrosis.[11]

There is an extensive plexus of veins whose drainage trunks are close to the upper and lower calices as well as to the infundibula (fig. 4). Due to these anatomical relationships we can realize that on endourological procedures an infundibular
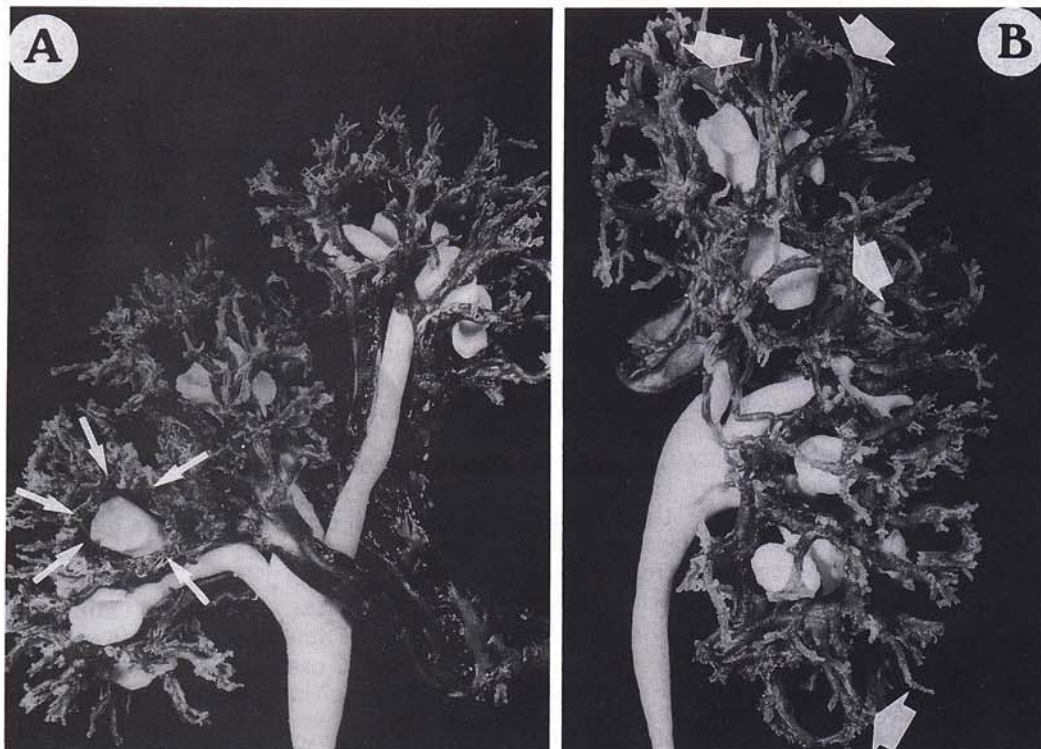

FIG. 2. *A*, posterior view of endocast from left kidney shows large venous anastomosis-like collar around neck of calix (arrows). *B*, posterior view of endocast from right kidney shows horizontal arches linking anterior and posterior veins, as well as longitudinal systems (arrows).
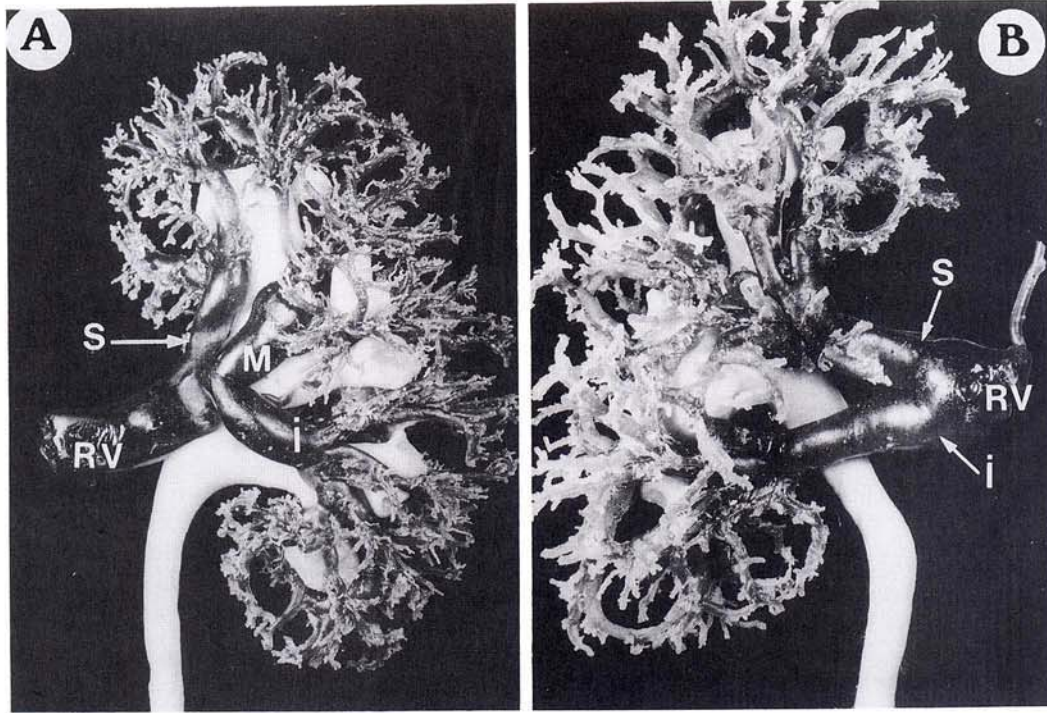
FIG. 3. *A*, anterior view of endocast from left kidney shows main renal vein (*RV*) formed by 3 trunks. *S*, superior. *M*, middle. *I*, inferior. *B*, anterior view of endocast from right kidney shows main renal vein (*RV*) formed by 2 trunks. *S*, superior. *I*, inferior.
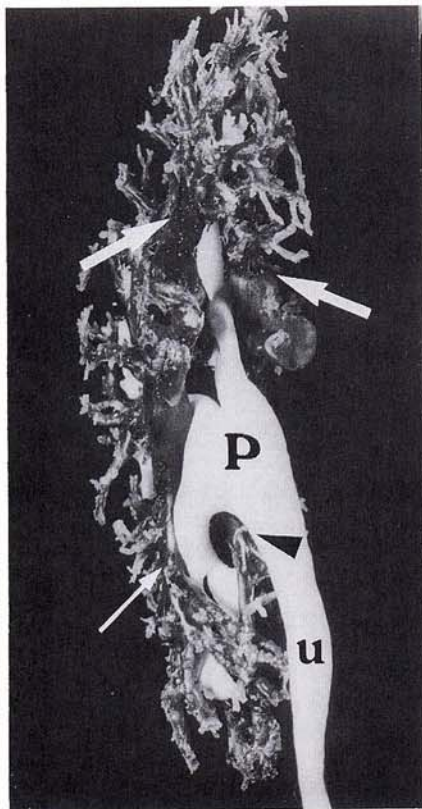

FIG. 4. Side medial view of endocast from right kidney shows upper and lower calices and infundibula encircled by anterior and posterior venous plexus as well as venous trunks originating from these plexus (arrows). *P*, renal pelvis. *u*, ureter.

puncture carries the risk of lesions of these veins, with consequent back bleeding. Thus, whenever possible the puncture is directed best parallel to the calix, entering end-on into the caliceal fornix.[18,19]

When an intrarenal operation is necessary during endourological procedures (to treat narrowed infundibula or caliceal diverticulum, or to remove impacted stones), the risk of a vascular lesion is considerable. Clayman and associates reported that one must examine the area to be incised under direct vision to be certain that there are no arterial pulsations.[20] Nevertheless, since the veins do not pulse knowledge of the relationship between the collecting system structures and the intrarenal veins is useful.

During the last 4 years, it has seemed possible that relief of ureteropelvic junction obstruction might be obtained via percutaneous nephrostomy[21] and, more recently, via ureterorenoscopy,[22] since the ureteropelvic junction is so clearly and easily seen by intrarenal endoscopy. The standardized technique to perform this procedure is to incise the ureteropelvic junction under direct vision alongside the stricture until the periureteral fat becomes visible. According to our findings in 40.0% of the cases (21 of 52 casts) there is a close relationship between the anterior aspect of the ureteropelvic junction and a prominent inferior tributary of the renal vein (fig. 5, *A*), and in 1 case this relationship existed on the anterior and posterior surfaces simultaneously. Therefore, we can advise that this deep incision on the ureteropelvic junction must be done laterally to avoid the risk of dividing a large vein, followed by significant back bleeding.

Many physicians stated that there are no veins on the posterior aspect of the renal pelvis[1,14] and others reported an incidence of approximately 30% of a posterior tributary of the renal vein.[23] However, they did not refer to the topographic location. Graves identified the presence of the posterior vein but he neither gave a precise reference to its location nor to its incidence.[16] In our series we found a retropelvic vein in 69.2% of the cases (fig. 6), among which this vein crossed and was related to the middle posterior surface of the renal pelvis in 21.1% (fig. 6, *B*). Because of this anatomical relationship direct puncture of the renal pelvis will result more often in a vascular complication than a transparenchymal caliceal approach not only due to the risk of injuring the posterior segmental artery[10,19] but also to the retropelvic vein.

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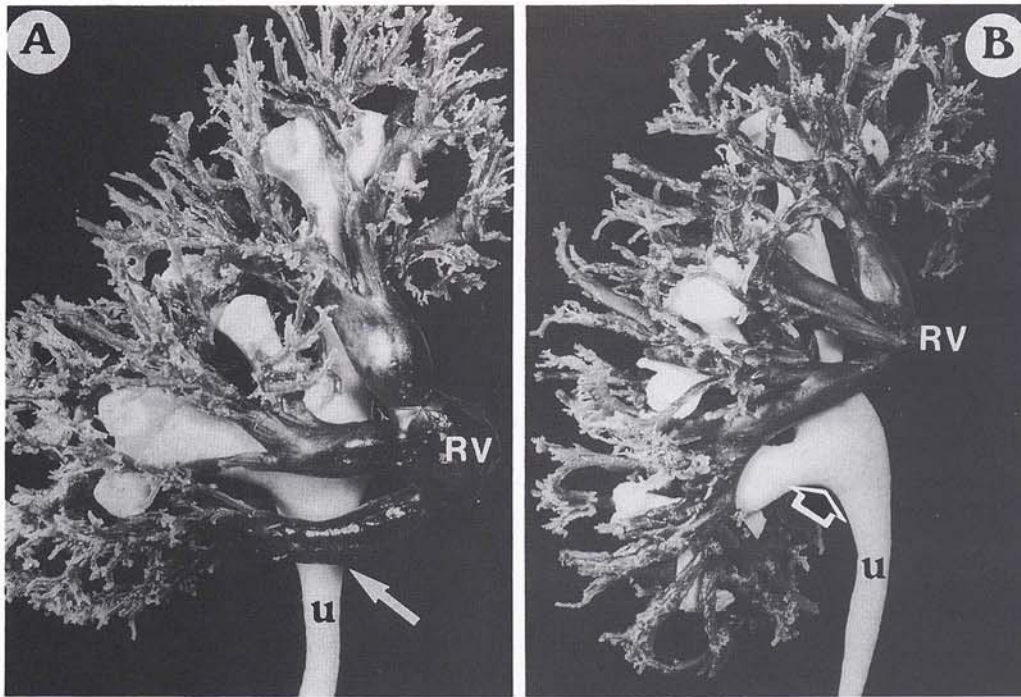
FIG. 5. *A*, anterior view of endocast from right kidney reveals close relationship between prominent inferior tributary of renal vein (arrow) and anterior aspect of ureteropelvic junction. *B*, anterior view of endocast from right kidney reveals ureteropelvic junction free from large veins (arrow). *RV*, renal vein. *u*, ureter.
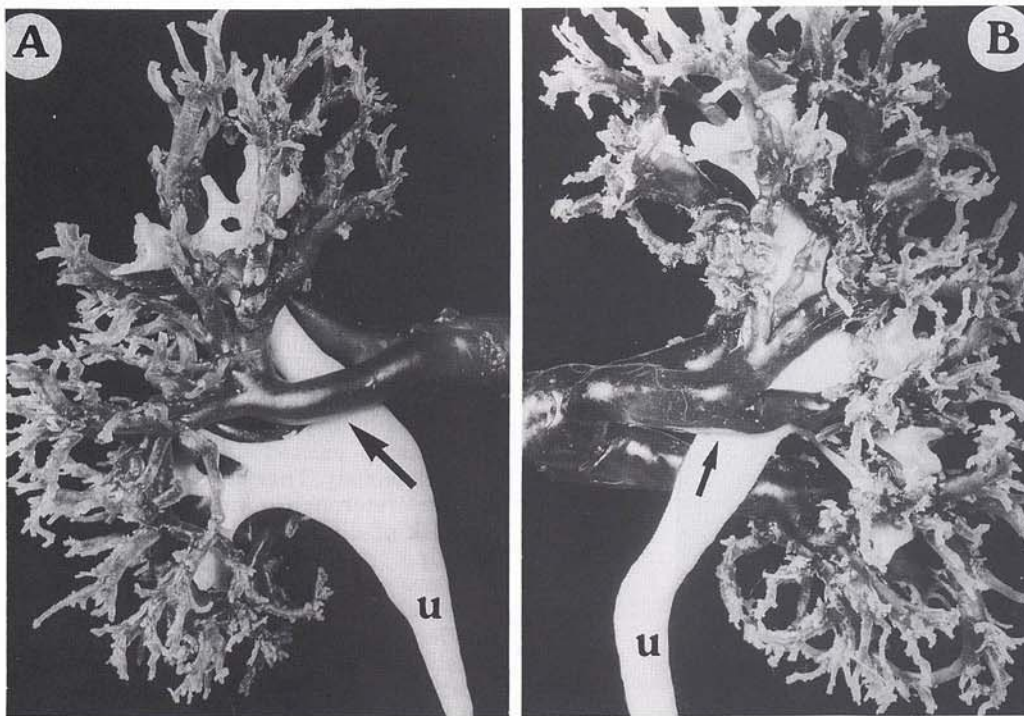

FIG. 6. *A*, posterior view of endocast from left kidney reveals close relationship between retropelvic vein (arrow) and junction of renal pelvis with upper calix. *B*, posterior view of endocast from right kidney shows prominent retropelvic vein (arrow) crossing middle posterior aspect of renal pelvis. *u*, ureter.

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