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Original Articles

ANATOMICAL RELATIONSHIP BETWEEN THE INTRARENAL ARTERIES AND THE KIDNEY COLLECTING SYSTEM

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ABSTRACT

The anatomical relationship between the intrarenal arteries and the renal collecting system was studied in 82, 3-dimensional endocasts. Some anatomical details that have importance for urologists were observed. The arterial supply related to the upper caliceal group arises from 2 arteries that encircle these calices (in 86.6% 1 trunk originated from the anterior division and 1 from the posterior division of the renal artery). The artery to the mid kidney courses horizontally in the mid renal pelvis in 64.6% of the cases while the arterial supply to the inferior pole (front and back) arises from the inferior segmental artery of the anterior division in 62.2%. The posterior segmental artery is related to the upper infundibulum or to the junction of the pelvis with the upper calix in 57.3% of the cases and to the middle posterior aspect of the renal pelvis in 42.7%. (*J. Urol., 143: 679–681, 1990*)

Hyrtl first recognized that the renal arterial system is separated by the pelvis into an anterior and posterior vascular segment.[1] Brödel described the branching of the renal artery and emphasized the lack of anastomosis between the segmental branches.[2] Nevertheless, Graves described the reasonably constant pattern of intrarenal arterial distribution, which usually divides the renal parenchyma into specific anatomical segments.[3] Others also studied the intrarenal arteries, including surgical aspects of the renal blood supply[4–7] and the applied anatomy of the pelviocaliceal system.[8–12] However, we believe that to assist better endourological applications and intrarenal surgery a study is necessary on the relationship between the intrarenal arteries and collecting system.

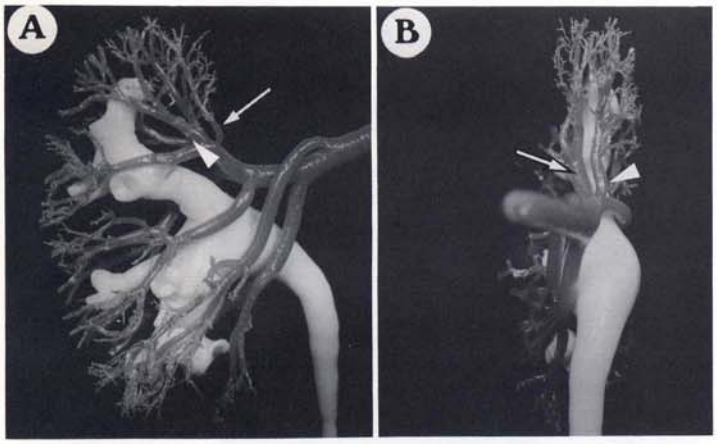

FIG. 1. *A*, anterior view of endocast from right kidney shows arterial supply related to upper caliceal group (arrowhead). Arrow shows superior (apical) segmental artery. *B*, medial view of same cast shows branch originating from anterior division of renal artery (arrow) and branch originating from posterior division of renal artery (arrowhead). Upper caliceal infundibulum is encircled by these arteries.

A serious complication of percutaneous manipulation and intrarenal operations is injury to a major blood vessel.[13–15] To avoid such injury one must know the position of the renal artery and its branches in relation to the pelvis and calices. Excretory urograms (IVPs) show the collecting system in only 1 plane and do not show the arterial system. Thus, it is extremely difficult to imagine these intrarenal structures and their relationships in 3 dimensions, as they are in reality.[8,9,13,16] To assist urologists in imaging and to learn the spatial position of the anatomical relationship between the renal collecting system and intrarenal arteries we made a systematic study of these structures in 3-dimensional endocasts.

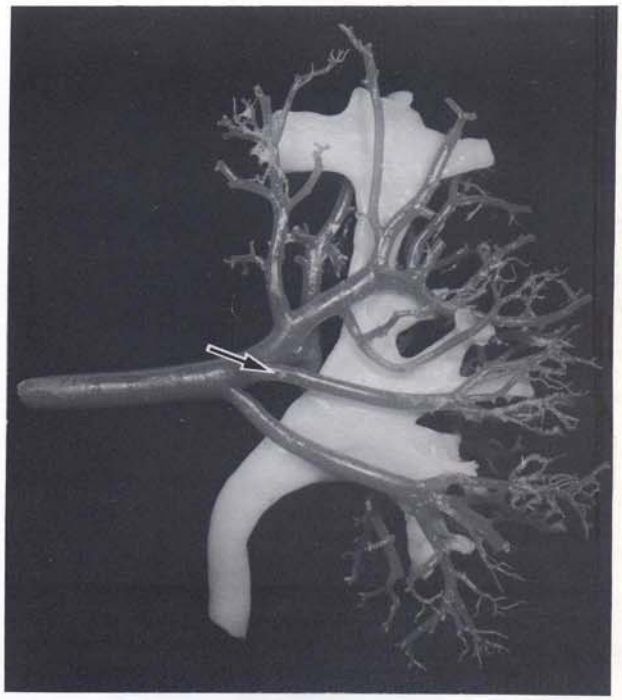

FIG. 2. Anterior view of endocast from left kidney shows artery to mid kidney coursing horizontally in mid renal pelvis (arrow).

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MATERIAL AND METHODS

Our material consisted of 82, 3-dimensional endocasts of the renal collecting system together with the intrarenal arteries obtained from 41 fresh cadavers of both sexes (cause of death not related to the urinary tract).

A polyester resin (volume approximately 5.0 ml.) was injected by manual pressure into the ureter to fill the collecting system and into the main trunk of the renal artery to fill the renal arterial tree. Added to the resin was a styrene monomer as a diluent and a methyl ethyl ketone peroxide as a catalyst, according to the proportions and technique described by Tompsett.[17] A pigment (yellow for the ureteral and red for the arterial injections) was used to color the translucent polyester resin (opaque casts proved to be more satisfactory than translucent casts). After the injected resin had set 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 arteries to the collecting system to maintain the same relationship as existed in vivo.

RESULTS

Superior pole. The superior segmental artery (apical) can have different origins but it usually arises from the anterior division of the anterosuperior segmental artery being positioned in the medial midline. This artery passes far from the upper infundibulum to reach the superior (apical) segment (fig. 1, *A*).

In 71 of 82 casts (86.6%) the arterial supply related to the upper caliceal group arose from 2 arteries: 1 originated from the anterior division and 1 from the posterior division of the renal artery. The upper caliceal group was involved by these 2 arterial trunks, which coursed beside the anterior and posterior surface of the caliceal infundibulum (fig. 1). In the remaining 11 casts (13.4%) these 2 arteries originated only from the anterior division or only from the posterior division of the renal artery.

Mid zone (hilar). In all cases the artery to the mid zone arose from the anterior division of the renal artery. In 53 of 82 casts (64.6%) this artery coursed horizontally in the mid renal pelvis (fig. 2). The relationship between the calices and anterior artery varied amply and followed the caliceal variations, which were large in the mid kidney.

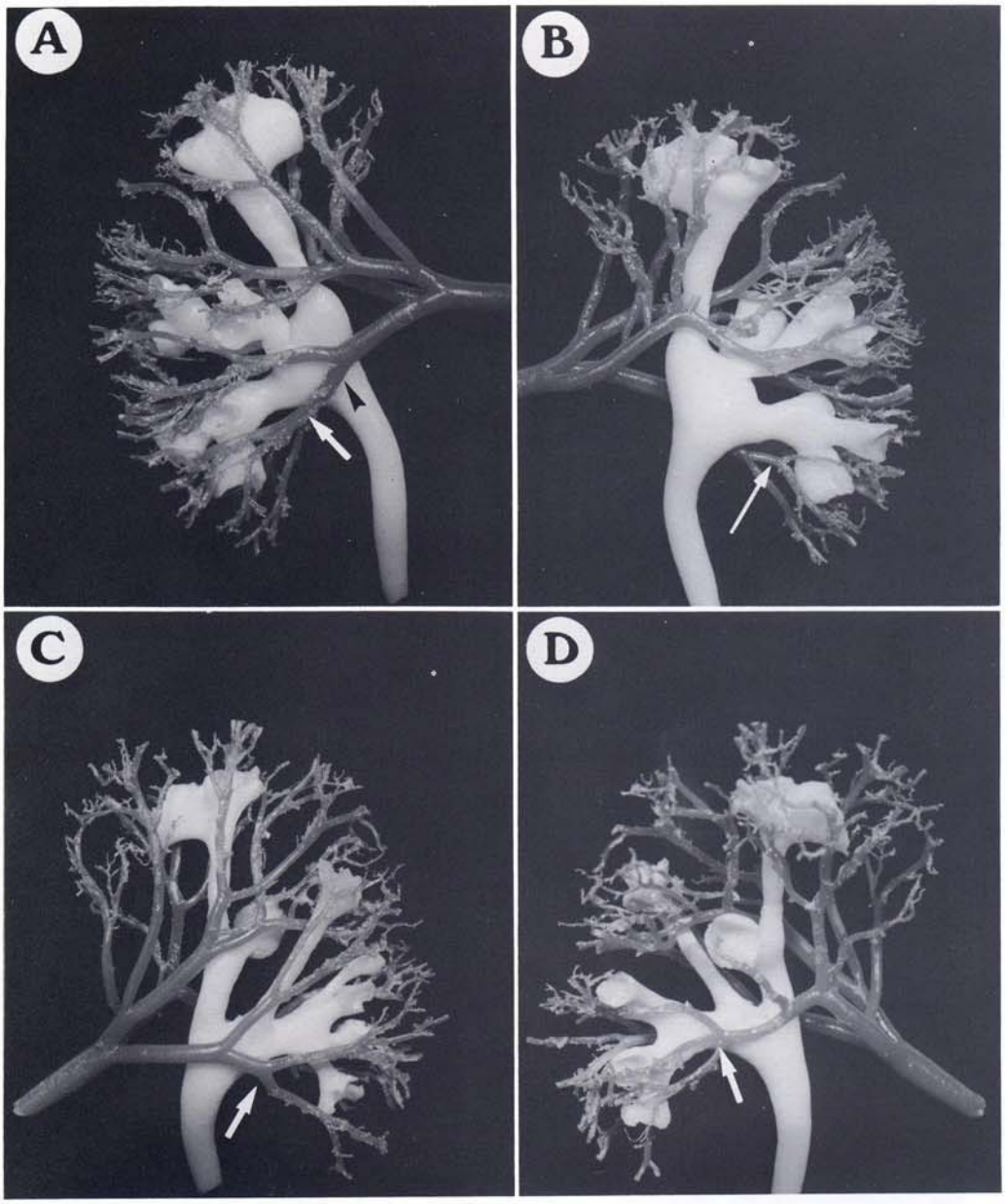

FIG. 3. *A*, anterior view of endocast from right kidney demonstrates front and back arterial supplies to inferior pole (arrow) arising from inferior segmental artery (arrowhead) of anterior division. *B*, posterior view of same cast shows posterior arterial supply to inferior pole (arrow). *C*, anterior view of endocast from left kidney reveals anterior branch to inferior pole arising from anterior division of renal artery (arrow). *D*, posterior view of same cast shows posterior branch to inferior pole arising from posterior division of renal artery (arrow).

Inferior pole. In 51 of 82 casts (62.2%) the arterial supply to the inferior pole (front and back) arose from the inferior segmental artery of the anterior division. This vessel passes in front of the ureteropelvic junction and after entering the inferior pole divides into an anterior and a posterior branch. The anterior branch is related to the anterior surface of the lower infundibulum. The posterior branch progresses under the neck of the lower calix to reach the posterior aspect of the kidney (fig. 3, *A* and *B*). In 31 of 82 casts (37.8%) the anterior branch arose from the anterior division of the renal artery and the posterior branch arose from its posterior division, respectively (fig. 3, *C* and *D*).

Dorsal kidney. In 47 of 82 casts (57.3%) there was a close relationship of the posterior segmental artery to the upper infundibulum or to the junction of the pelvis with the upper calix (fig. 4, *A*). In the remaining 35 casts (42.7%) the posterior artery crossed the middle posterior surface of the renal pelvis (fig. 4, *B*).

DISCUSSION

These anatomical findings must be considered during endourological manipulations, an intrarenal operation and IVP analysis. Obviously, in endourological procedures any puncture and subsequent dilation tract should avoid transection of any major artery. The endourologist should have a clear mental image of the anatomical relationship between the intrarenal arteries and collecting system when he chooses the puncture site.[18] The segmental arteries lie in a deep plane within the kidney running close to the infundibula near the hilar area[13,15,16] as we have shown. For this reason the puncture should be made as far peripherally as possible because in this region the arterial branches are considerably smaller. Ideally, the puncture should enter the collecting system end-on through the fornix of a calix.[13,15,16] An approach through an infundibulum, especially the upper or lower infundibulum, may be dangerous because of the presence of large vessels and major branches of the renal artery that cross the infundibular surface. Puncture at this site carries the risk of significant bleeding from intralobar (infundibular) arteries in the renal sinus. For example, the upper infundibulum may almost be encircled by the anterior branch of the anterosuperior segmental artery and by the superior branch of the posterior segmental artery (fig. 1).

If any intrarenal operation is necessary during endourological procedures to free entrapped stones, correct anomalies that can cause stone formation or treat strictures and diverticula[18] the operator must recall and image the arterial relationship found more frequently in the area to be incised. Clayman and associates reported that one must examine this area under direct vision to be certain there are no arterial pulsations,[19] and we believe that the knowledge concerning the relationship between the pelviocaliceal system and arteries is considerably useful in these cases, being an additional factor to perform these procedures safely and efficiently.

Direct puncture of the renal pelvis will result more often in a vascular complication than a transparenchymal caliceal approach[15] because the segmental posterior artery may be injured, since it crosses the midline posterior aspect of the renal pelvis in 42% of the cases according to our findings (fig. 4, *B*).

During radiological analysis it is important to remember that the anterosuperior segmental artery courses tenuously upward and crosses the anterior surface of the upper infundibulum, where it may produce a vascular impression or even obstruction, as cited by Fraley.[20] Baum and Gillenwater showed that vascular impressions on the renal pelvis may cause filling defects demonstrated by IVPs and that the majority of the responsible vessels are ventral branches of the renal artery.[21]

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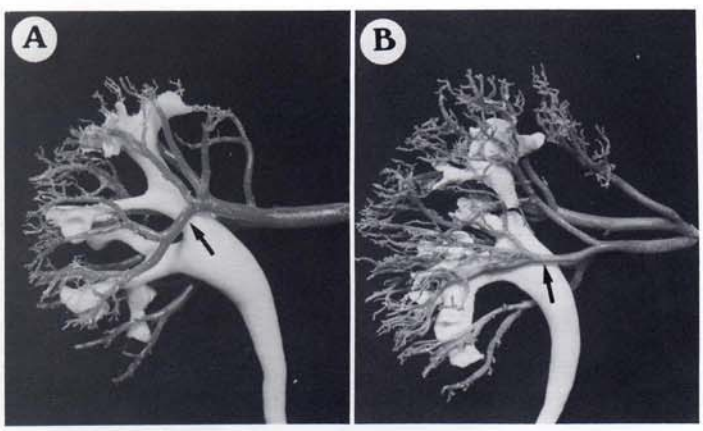

FIG. 4. *A*, posterior view of endocast from left kidney shows relationship of posterior segmental artery to junction of pelvis with upper calix (arrow). *B*, posterior view of endocast from left kidney reveals posterior artery coursing in mid renal pelvis (arrow).

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