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URETEROPELVIC JUNCTION STENOSIS: VASCULAR ANATOMICAL BACKGROUND FOR ENDOPYELOTOMY

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ABSTRACT

To help endourologists perform endopyelotomy safely and efficiently with a reduced risk of vascular complications, we analyzed the vascular relationships to the ureteropelvic junction in 146, 3-dimensional endocasts of the kidney collecting system together with the intrarenal arteries and veins. There was a close relationship between a prominent vessel (artery and/or vein) and the anterior surface of the ureteropelvic junction in 65.1% of the cases, including the inferior segmental artery with a tributary of the renal vein in 45.2% and an artery or vein in 19.9%. In the remaining 34.9% of the cases the anterior surface of the ureteropelvic junction was free of vessels. There was a direct relationship between a prominent vessel (artery and/or vein) and the posterior surface of the ureteropelvic junction in 6.2% of the cases, including an artery and vein in 2.1%, and just an artery in 1.4%. In all cases (3.5%) of an artery crossing at the posterior surface of the ureteropelvic junction, this vessel was the posterior segmental artery (retropelvic artery). In 2.7% of the cases the relationship of the prominent vessel was just with a posterior tributary of the renal vein, and in 20.5% a vessel crossed lower than 1.5 cm. above the posterior surface of the ureteropelvic junction. Among these latter cases the vessel was an artery (posterior segmental artery) in 6.8%. In the remaining 73.3% of the cases the posterior surface was free of vessels up to 1.5 cm. above the ureteropelvic junction. Due to the anatomical findings, we advise that posterior and posterolateral incisions at the ureteropelvic junction be avoided, and that deep incision alongside the ureteropelvic junction stenotic wall be done only laterally.

KEY WORDS: kidney; arteries; veins; anatomy; nephrostomy, percutaneous

A few years after the first report,[1] endopyelotomy has almost completely replaced the standard open pyeloplasty in the treatment of ureteropelvic junction obstruction,[2-7] with a success rate ranging from 72 to 88% either for congenital or acquired conditions.[8,9] Since endopyelotomy is based on the Davis operation,[10] to achieve success the endoscopist must incise the ureteropelvic junction stenotic wall to the periureteral fat.[2-7] Although endopyelotomy is much less invasive than open pyeloplasty, due to the necessary deep incision in the ureteropelvic junction, complications may occur, the most considerable of which appears to be vascular injury to a retroperitoneal vessel.[3,6-9]

An understanding of the vascular relationships to the ureteropelvic junction can greatly reduce or even eliminate the vascular complications associated with endopyelotomy. There are few studies available on the vascular anatomical relationships to the ureteropelvic junction[11-13] and none provides an analysis of the arterial and venous relationships simultaneously. Also, to our knowledge no data are available on the distance that each vessel crosses above the posterior aspect of the ureteropelvic junction. Therefore, we thought that additional study stressing the vascular relationships to the ureteropelvic junction would assist endourologists and interventional radiologists in performing endopyelotomy safely and efficiently.

MATERIALS AND METHODS

We analyzed 146, 3-dimensional polyester resin corrosion endocasts of the kidney collecting system together with the intrarenal arteries and veins simultaneously in the same kidney. The kidneys were obtained from autopsies of 73 fresh cadavers of both sexes, who died of causes not related to the urinary tract. A yellow polyester resin was injected into the ureter to fill the pelvicaliceal system. In the same kidney a red resin was injected into the main trunk of the renal artery to fill the arterial tree, and a blue resin was injected into the main trunk of the renal vein to fill the venous tree. The injections were made according to the same proportions and technique described previously.[14,15] After injections and setting of the resin, the kidneys were immersed in hydrochloric acid until total corrosion of the organic matter was achieved, leaving only the 3-dimensional endocast of the systems that had been in-

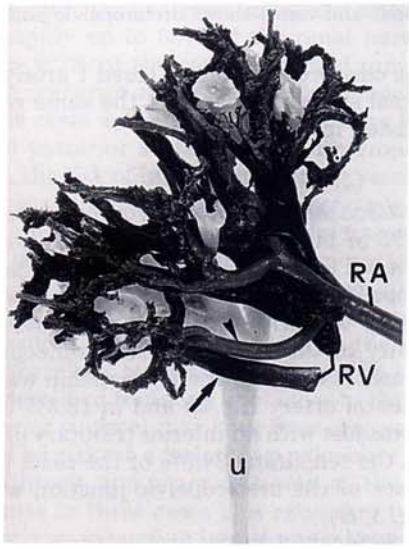

FIG. 1. Anterior view of right kidney endocast (pelvicaliceal system together with intrarenal arteries and veins) reveals anterior surface of ureteropelvic junction in close relationship with inferior segmental artery (arrowhead) and with tributary of renal vein (arrow). *RA*, renal artery. *RV*, renal vein. *u*, ureter.

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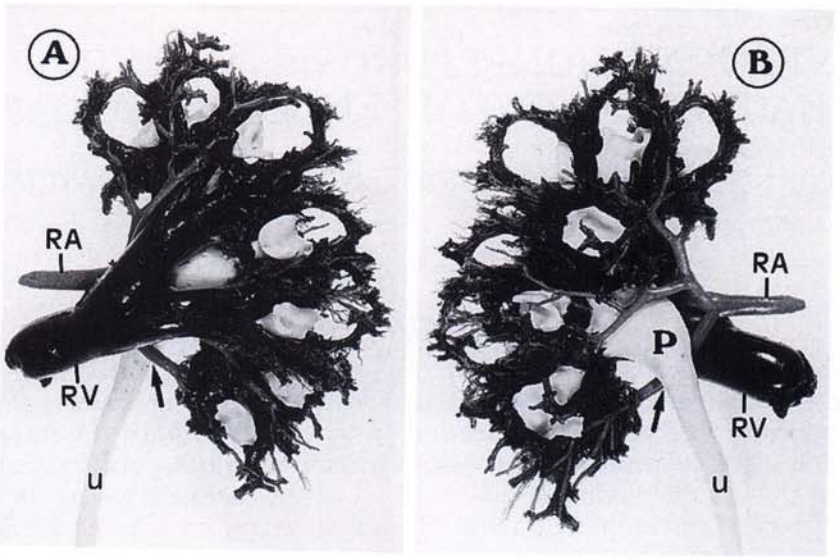

FIG. 2. Left kidney endocast (pelvicaliceal system together with intrarenal arteries and veins). *A*, anterior view reveals close relationship between inferior segmental artery (arrow) and anterior aspect of ureteropelvic junction. *B*, posterior view. Arrow indicates inferior segmental artery. *P*, posterior aspect of renal pelvis. *RA*, renal artery. *RV*, renal vein. *u*, ureter.

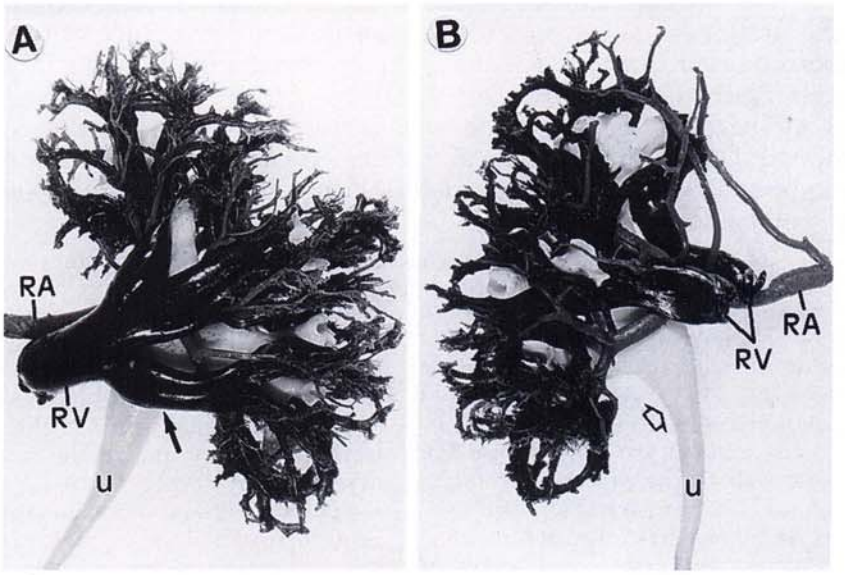

FIG. 3. *A*, anterior view of left kidney endocast (pelvicaliceal system together with intrarenal arteries and veins) reveals close relationship between ureteropelvic junction and tributary of renal vein (arrow). *B*, anterior view of right kidney endocast (pelvicaliceal system together with intrarenal arteries and veins) shows ureteropelvic junction free of vessels (open arrow). *RA*, renal artery. *RV*, renal vein. *u*, ureter.

jected. During cast preparation we glued 1 artery and 1 vein to the pelvicaliceal system to preserve the same relationships as those that existed in vivo.

RESULTS

Anterior relationships to the ureteropelvic junction. In 65.1% of the casts (95 of 146) there was a close relationship between a prominent vessel (artery and/or vein) and the anterior surface of the ureteropelvic junction. In 45.2% of the casts (66 of 146) this relationship was with the inferior segmental artery and with a tributary of the renal vein simultaneously (fig. 1). In 9.6% of the casts (14 of 146) the relationship was just with the inferior segmental artery (fig. 2) and in 10.3% (15 of 146) the relationship was just with an inferior tributary of the renal vein (fig. 3, *A*). In the remaining 34.9% of the casts (51 of 146) the anterior surface of the ureteropelvic junction was not related to vessels (fig. 3, *B*).

Posterior relationships to the ureteropelvic junction. In 6.2% of the casts (9 of 146) there was a direct relationship between a prominent vessel (artery and/or vein) and the posterior surface of the ureteropelvic junction. In 2.1% of the casts (3 of 146) this relationship was with an artery and a vein simultaneously (fig. 4). In 1.4% of the casts (2 of 146) the posterior relationship was just with an artery (fig. 5). In all cases of an artery crossing at the posterior surface of the ureteropelvic junction (3.5%, 5 of 146 casts) this vessel was the posterior segmental artery (retropelvic artery) (figs. 4, *B* and 5). In 2.7% of the casts (4 of 146) the relationship was just with a posterior tributary of the renal vein (fig. 6). In 20.5% of the casts (30 of 146) there was a vessel crossing lower than 1.5 cm. above the posterior surface of the ureteropelvic junction (fig. 7). Among these casts the vessel was the posterior segmental artery in 6.8% (10 of 146) and a posterior tributary of the renal vein in 13.7% (20 of 146). In the remaining 73.3% of the casts (107 of 146) the posterior surface was free of vessels up to 1.5 cm. above the ureteropelvic junction.

DISCUSSION

Regardless of the approach chosen (via nephrostomy tract[2,3,5,6] or via ureteroscopy[4,7,9]) and the instrument used to incise the stricture (cold knife[2,3,5,6,8] or electrosurgical probe[4,7,9]), the standardized technique of endopyelotomy is to incise the full thickness of the ureteropelvic junction stenotic wall until the yellowish periureteral fat becomes visible.[2-9] It is

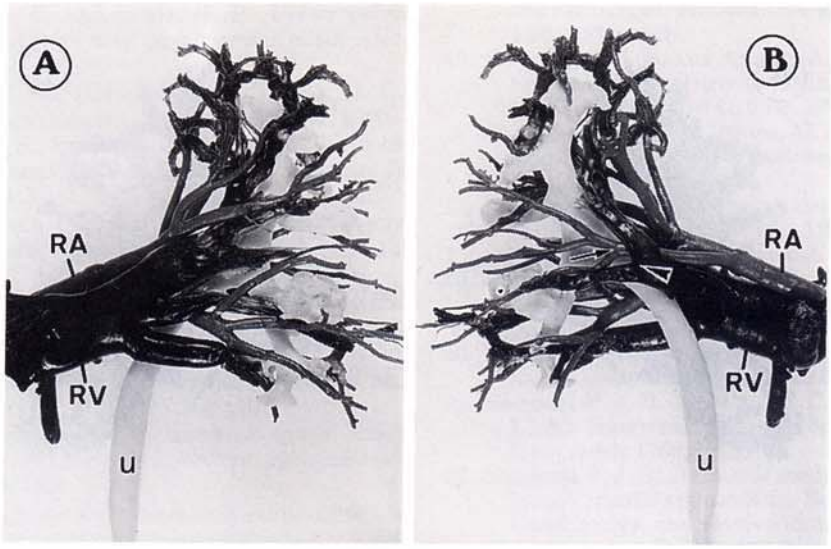

FIG. 4. Left kidney endocast (pelvicaliceal system together with intrarenal arteries and veins). *A*, anterior view. *B*, posterior view reveals tributary of renal vein (arrowhead) and posterior segmental artery (retropelvic artery, arrow) in close relationship to posterior aspect of ureteropelvic junction. *RA*, renal artery. *RV*, renal vein. *u*, ureter.

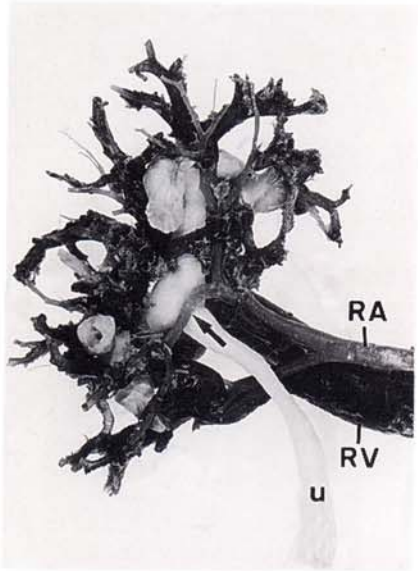

FIG. 5. Posterior view of left kidney endocast (pelvicaliceal system together with intrarenal arteries and veins) reveals posterior segmental artery (retropelvic artery) in close relationship to posterior aspect of ureteropelvic junction (arrow). *RA*, renal artery. *RV*, renal vein. *u*, ureter.

obvious that this deep incision carries a risk of injuring a retroperitoneal vessel. Therefore, the understanding of the renal vessels and their 3-dimensional relationships to the ureteropelvic junction is a requisite to perform endopyelotomy safely and efficiently.

Concerning the anterior surface, we found a close relationship between an artery and/or a vein and the ureteropelvic junction in 65.1% of the cases. In 45.2% of these cases the relationship was with the inferior segmental artery, which is not an aberrant or an accessory vessel,[16] but a normal segmental artery that maintains a consistent anatomical relationship to the ureteropelvic junction. It was reported that a multiple renal artery accompanies hydronephrosis in 25 to 32% of surgical cases[17,18] and that this vessel cannot be demonstrated simply on the basis of excretory urography. To avoid arterial lesions arteriography is performed by some in cases of suspected crossing vessels at the ureteropelvic junction.[6,19] Also, to protect the arteries from the lesion, it has been recommended to examine via intrarenal endoscopy the area to be incised for any arterial pulsation and to avoid incising this site.[4,7,9] Nevertheless, arterial pulsations are not always readily identifiable endoscopically during surgery, mainly because patients may be hypotensive due to anesthesia.[20]

We found a vein on the anterior surface of the ureteropelvic junction in 55.5% of the cases. Although no particular attention has been paid to the renal veins during endourological procedures,[15,20,21] they are noteworthy because a lesion of 1 large vein can result in significant back bleeding during and after surgery. In addition, because the veins do not pulsate, endoscopic examination of the area to be incised is not effective in avoiding a venous lesion.[15,20]

Concerning the ureteropelvic junction posterior surface, we found a close relationship between an artery and/or a vein and the dorsal aspect of the ureteropelvic junction in 6.2% of the cases. This relationship involved the posterior segmental artery (retropelvic artery) in 3.5% of the cases (figs. 4, *B* and 5) and a posterior tributary of the renal vein in 4.8% (fig. 6). Since the majority of authors incise the ureteropelvic junction alongside its posterolateral aspect,[2-7,9,19] there is a serious risk of injuring a retropelvic vessel or the posterior segmental artery (figs. 4, *B* and 5) which, in addition to hemorrhage, can be associated with loss of a great portion of functioning renal tissue. In some cases the posterior segmental artery (retropelvic artery) may supply up to 50% of the renal parenchyma.[22] In addition to the 6.2% of the cases described previously (vessel crossing at the posterior surface of the ureteropelvic junction), in 20.5% of the casts we found a vessel crossing lower than 1.5 cm. above the posterior surface of the ureteropelvic junction (fig. 7). Hence, the risk of injuring a posterior vessel is especially important because in many cases it is necessary to extend the ureteropelvic junction incision into healthy tissue for 1 to 2 cm. on each side (above and below) of the stenosis. As a matter of fact, an 11.9% incidence of severe hemorrhage during endopyelotomy has been reported.[9] It is difficult to suppose that these significant bleeding problems originated in the small ureteral vessels[23] and, therefore, we strongly believe that 1 of the vessels that we have described (crossing at or close to the ureteropelvic junction posterior surface) may have been associated with such hemorrhage. The risk of a lesion is particularly high in cases of extensive fibrosis and scarring tissue at the ureteropelvic junction, because in these cases it is necessary to make a long incision, sometimes extending into the renal parenchyma.

In conclusion, due to the anatomical findings presented, anterior incision at the ureteropelvic junction is prohibitive and posterior or posterolateral incisions must be avoided. We advise that the deep incision alongside the ureteropelvic junc-

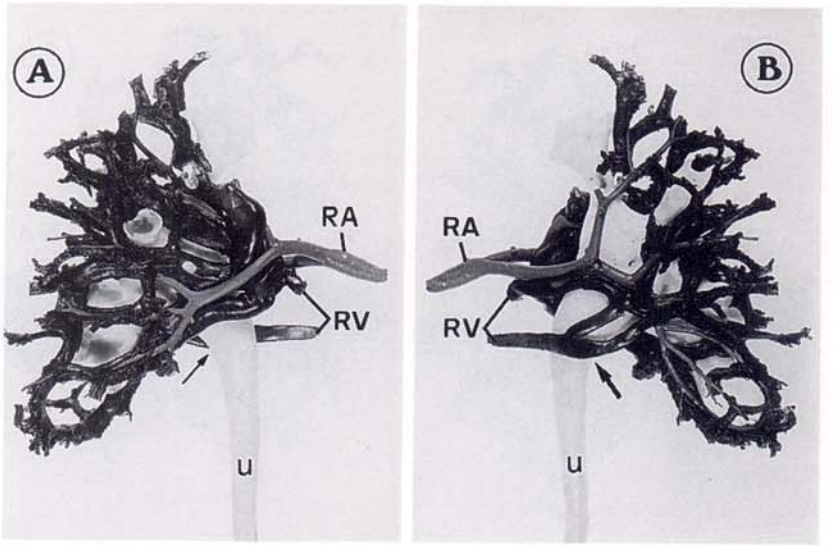

FIG. 6. Right kidney endocast (pelvicaliceal system together with intrarenal arteries and veins). *A*, anterior view reveals anterior aspect of ureteropelvic junction free of vessels (arrow). *B*, posterior view shows tributary of renal vein (arrow) in close relationship to posterior aspect of ureteropelvic junction. *RA*, renal artery. *RV*, renal vein. *u*, ureter.

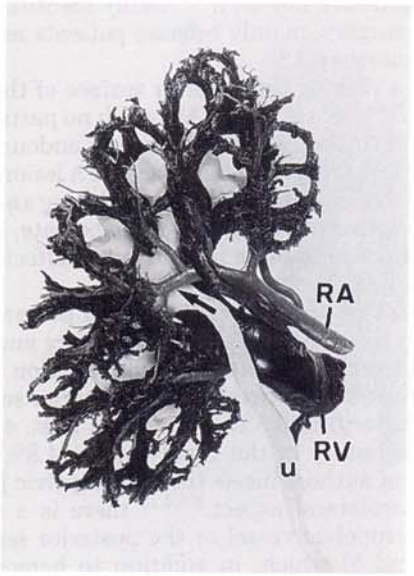

FIG. 7. Posterior view of left kidney endocast (pelvicaliceal system together with intrarenal arteries and veins) reveals posterior segmental artery (retropelvic artery) crossing lower than 1.5 cm. (0.5 cm.) above posterior aspect of ureteropelvic junction (arrow). *RA*, renal artery. *RV*, renal vein. *u*, ureter.

tion stenotic wall be done just laterally (fig. 8). An incision at this site, which we refer to as the nonvascular area of the ureteropelvic junction, will avoid the vessels that can be related anteriorly or posteriorly to the ureteropelvic junction. A lateral incision in the nonvascular area is the safest in cases of extensive scar tissue, when an extended incision into the parenchyma is required, when vessels are transposed posteriorly following previous dismembered pyeloplasty and in the rare cases of an inferior polar artery crossing posteriorly to the ureteropelvic junction.[24] We believe that our findings will improve endopyelotomy, making this procedure less invasive, less expensive and more expeditious since, based on the anatomical descriptions and regardless of the situation, the risk of a vascular lesion is minimized and the endoscopist may safely incise the nonvascular area of the ureteropelvic junction without prior arteriography.

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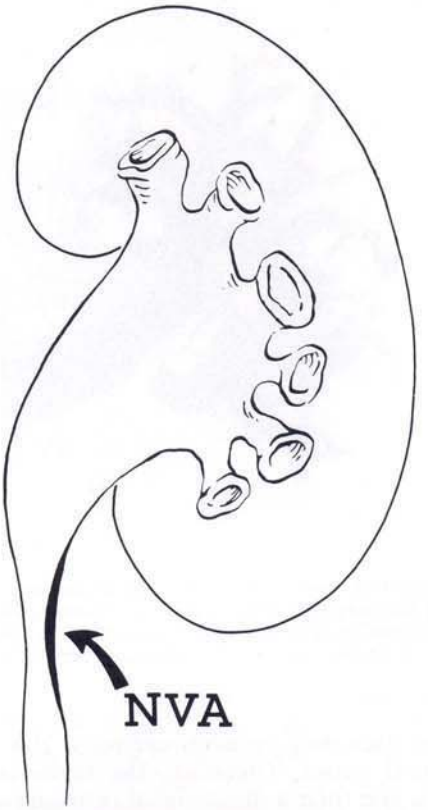

FIG. 8. Anterior view of schematic drawing from left kidney shows area to be incised in endopyelotomy (arrow). *NVA*, nonvascular area of ureteropelvic junction.

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