# MORPHOLOGY AND PATHOMORPHOLOGY

## CONTRIBUTION TO ANGIOARCHITECTONICS OF THE KIDNEY

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The vascular supply of the kidneys is still insufficiently known. Outstanding questions of great theoretical and practical importance are whether there exists a poorly vascularized zone of the kidney, whether there exist intrarenal arterial anastomoses, and what is the capacity of the collateral vascular bed of the organ.

Girtl and Tuffier found that the branches of the renal artery forming the anteropelvic system are isolated from the retropelvic branches, and Girtl found a similar distribution of the branches of the renal artery in most mammals. A line dividing one system from the other, and passing through the convex margin of the kidney was termed by him "the renal equator".

Tuffier suggested that the kidney should be sectioned along this line, as such a section damages fewest arteries, and exposes the pelvis widely.

Zondek [16], using an injection and clearing procedure, was able to confirm Girtl's basic findings, and found that the "line of natural division" lies not along the convex margin of the kidney, but is about 0.5-1 cm posterior to it. On these grounds, Zondek proposes a nephrotomic section along the plane of natural divisions, which was long used by surgeons. However, both Zondek's section and the usual one not infrequently caused fatal hemorrhages.

Later work on the angioarchitectonics of the kidney showed that it varies widely from individual to individual, so that there is a considerable inconstancy in the location of the "line of natural division" and of the poorly vascularized zone.

Of recent years a number of authors have questioned the very existence of relatively avascular zones; they believe that there are large arterial trunks within the kidney passing from one half of the organ to the other, with numerous venous and arterial anastomoses between the antero-and retro-pelvic systems [5, 9, and others].

The question of the existence of relatively avascular zones is thus closely bound up with that of the existence of intrarenal arterial anastomoses, which has not as yet been settled definitively.

Numerous workers, headed by Cohnheim [14], considered that the branches of the renal artery are terminal ones, not forming anastomoses. Hardly a year passes, however, without the appearance of new papers claiming to have established the presence of intrarenal arterial anastomoses, such as those of Lee-Brown [15], Belt and Joelson [13], G. K. Boreisho [3], B. Ya. Dakhovsky, D. S. Tsibadze, and others.

A. P. Lyubomudrov [8] considers that accessory renal arteries play an important part in the collateral circulation of the kidney.

L. D. Tsiskarishvili emphasizes the importance of the ureteral arteries for the indirect blood supply of the kidney.

G. P. Gorbasheva draws attention to the potential role of the perforating capsular arteries.

Finally, the studies of B. A. Dolgo-Saburov [6] and of A. T. Akilova [1] on the para-arterial and para-venous collateral circulation of the kidney have contributed considerably to our knowledge of the vascular anastomoses of this organ.

In our studies of the angioarchitectonics of the kidney we examined 50 normal and diseased kidneys, using the methods of stereo-and micro-angioroentgenography, with subsequent histotopographic study of the organ [4].

We used lead carbonate in gelatin solution as a contrast medium. The kidneys were fixed in formalin at a definite pressure before injecting the vessels. Preliminary fixation of the vessels with formalin under pressure has been shown by E. E. Kikaion [7] and N. N. Anichkov [2] to prevent rupture of their walls, and to allow of their examination in a condition approaching their normal distension, and so to afford a more nearly correct impression of the size of their lumina.

In each case we prepared stereoroentgenograms of the whole kidney in two projections, of its anterior and posterior halves, and also of serial slices of different thicknesses; roentgenograms of these slices were examined under a hand-lens and microscopically. For the study of the finest vessels we made photographic enlargements (× 50-70) of parts of the roentgenograms.

Our studies showed that where the renal artery divides into anterior and posterior branches on entering the hilus of a kidney (we found this in more than half the specimens examined), these two systems are not isolated from each other. The large main-branch arteries (third degree branches) of the anterior branch system, which are more numerous and have a greater capacity than does the posterior branch system, usually penetrate to the posterior half of the kidney, and contribute to its blood supply (Figs. 1 and 2). The branches of both systems intermingle profusely in the boundary zones of the two halves of the kidney, and at the poles, so that considerable parts of the renal parenchyma receive their blood supply from both the anterior and the posterior branches of the renal artery. This is found also when only one of the anterior branches is injected (Fig. 3).

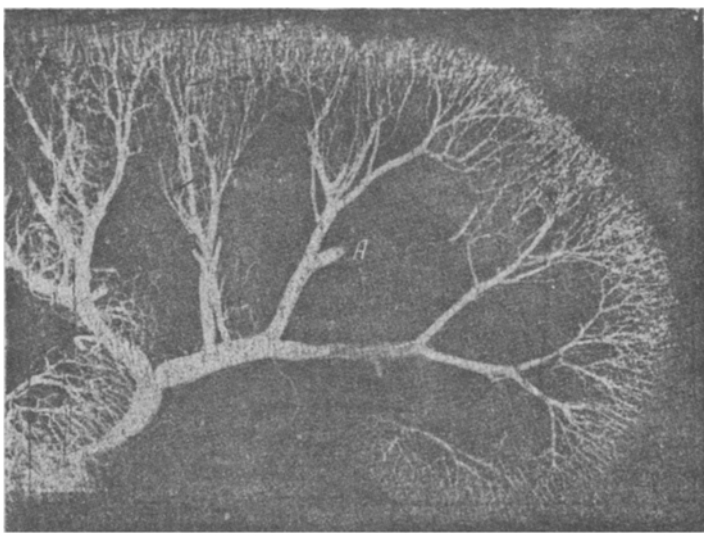


Fig. 1. Anteropelvic system of the renal artery. A) a third degree branch, passing into the posterior half of the kidney.

We have been unable to discern any regular distribution of the branches of the renal artery into antero- and retro-pelvic systems, either with ordinary division of the main arterial stem into anterior and posterior branches, or, as found by us in about a quarter of the cases, when there are accessory renal arteries.

Our findings do not therefore support the existence of a "line of natural division" of the vessels, or the existence of a relatively avascular zone of the kidney.

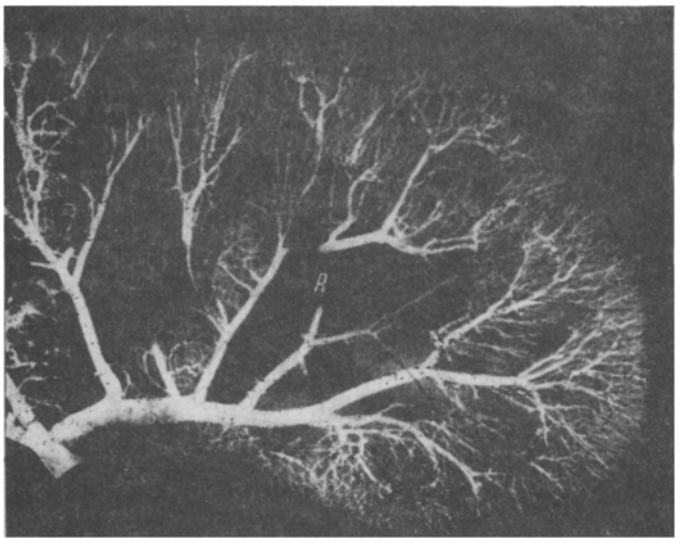


Fig. 2. Branching of stems of the third degree of an anterior branch of the renal artery (A), among equivalent stems of the posterior branch system.

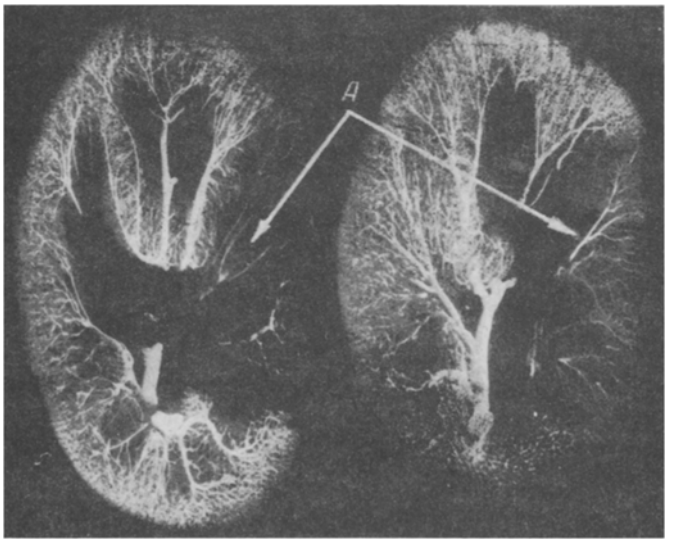


Fig. 3. Angioroentgenograms of slices of the middle third of a kidney with injection of an anterior branch of the renal artery. Branching of stems of the anteropelvic system into the posterior half of the kidney (A).

Counterindications to nephtotomy are provided not only by surgical experience, but also by anatomical considerations. The method of stereoscopic microangioroentgenography, in conjunction with subsequent histotopographic study of the kidney, allows of the demonstration of a system of intrarenal arterial anastomoses. These were found in the boundary layers of the kidney, between some of the intralobular arteries; anastomoses between interlobular arteries are also encountered (Fig. 4). The size of these anastomoses does not exceed 150-200 $\mu$. Long and short arterial arches of fairly large size are sometimes seen at the apex of the pyramids. Perforating capsular arteries are quite common and anastomizefreely with intrarenal branches of the renal artery.

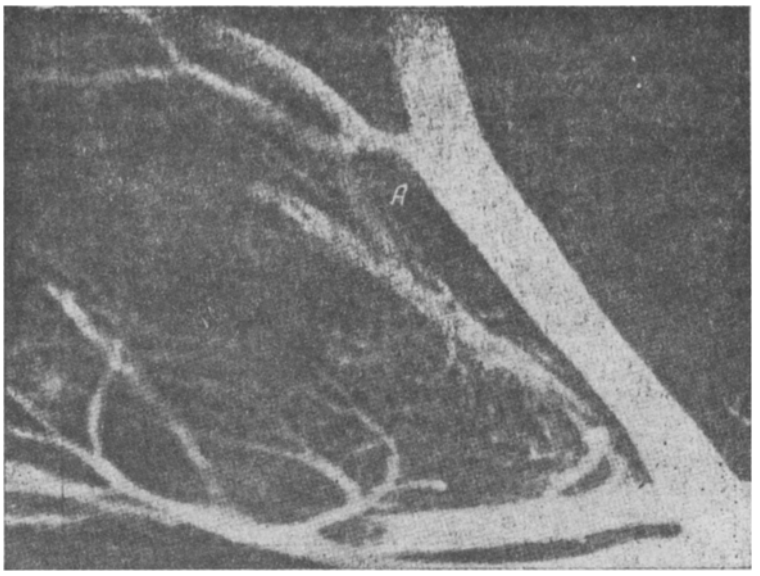


Fig. 4. Angioroentgenogram of a kidney slice. An arterial anastomosis (A) in the cortical layer of the kidney.

Where there is some interference with the renal circulation, the arterial tree of the kidneys undergoes a series of changes. The intrarenal arterial anastomoses described above increase both in number and in size, as do also the para-arterial collateral pathways, which are only feebly developed under normal conditions. The potential significance of these arterial interconnections is, however, not great.

The fact that intrarenal arterial anastomoses exist obliges us to reject Cohnheim's view [14] that the branches of the renal arteries should be regarded as being terminal. One cannot therefore but agree with M. G. Prives's statement that "the development of various theories of the origin of different diseases, based on this view, and ascribing them to thrombotic plugging of terminal arteries, should be abandoned, and replaced by new theories, which should explain the pathogenesis of these processes in a more correct way than by crude mechanical considerations" [10].

## LITERATURE CITED

[1] A. T. Akilova, Transactions of the V All-Union Congress of Anatomists, Histologists, and Embryologists (In Russian) (Leningrad, 1951), pp. 103-104.

[2] N. N. Anichkov, et al., Transactions of the All-Union Conference of Morbid Anatomists (In Russian) (Leningrad, 1954), pp 106-112.

[3] G. K. Boreisho, Works of the Tomsk Medical Inst. (In Russian) (Tomsk, 1938), Vol. 6, pp. 469-474.

[4] N. A. Bykova, T. F. Zhebro, V. V. Serov, and others. Arkhiv Pat. 1955, No. 3, 71-72.

[5] A. A. Golubev, Transactions of the 1st All-Russian Congress of Urologists (In Russian) (Moscow, 1927) pp. 36-40.

[6] B. A. Dolgo-Saburov, Arterial and Venous Anastomoses in the Human (In Russian) (Leningrad, 1953).

[7] E. E. Kikaion, Communications to the Conference of the Institute of Experimental Medicine, Acad. Med. Sci. USSR, 1953 (In Russian) (Leningrad, 1954), pp. 47-48.

[8] A. P. Lyubomudrov, Transactions of the V All-Union Congress of Anatomists, Histologists, and Embryologists (In Russian) (Leningrad, 1951), pp. 194-195.

[9] V. A. Pavlenko, Nov. Khir. Arkhiv, Vol. 2, pp. 617-619 (1922).

[10] M. G. Prives, Transactions of the Scientific Congress on the Anatomy of the Peripheral Nervous and Vascular Systems (In Russian) (Leningrad, 1952), pp. 55-57.

[11] S. A. Reinberg, Vestnik Rentgenol. i Radiol. Vol. 11, No. 2, 83-100 (1923).

[12] S. M. Rubashev, Med. Obozrenie,1910, 74, 537-556.

[13] A. E. Belt, and J. J. Joelson, Arch. Surg.,Vol. 10, pp. 117-149 (1925).

[14] J. Cohnheim, Untersuchungen über die embolischen Processe (Berlin, 1872).

[15] R. K. Lee-Brown, Arch. Surg. Vol. 8, pp. 831-852 (1924).

[16] M. Zondek, Die Topographie der Niere und ihre Bedeutung für die Nierenchirurgie (Berlin, 1903).