VASCULARIZATION OF THE WALL OF THE VISCERAL AFFLUENT BRANCHES OF VENA CAVA INFERIOR IN MAN

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The microvascularization of the wall of the visceral affluents of vena cava nferior is scarcely studied. R. A. Voyner (1950), V. S. Tzarev (1955) and A. T. Akilova (1958) report on data about the blood supply sources in the wall of renal veins in normal conditions and in hypertension. V. A. Belyanskii (1949, 1954, 1957a, b, 1958, 1968, 1970) finds a three-layer capillary network in the wall of the same veins. M. Y. Sapozhkova (1965) in the course of innervation of the hepatic veins studies, describes also some details in their vascularization, while P. F. Stepanov and L. S. Molodtzova (1968) investigate the sources of their blood supply. V. Y. Bocharov (1968) was successful in demonstrating that their wall is supplied up to the intima at the expense of vasa vasorum, while V. A. Belyanskii (1949) describes in their wall a three-layer capillary network. The only literature evidence of the testicular veins' vascularization, dealing exclusively with the issue of their vascularization sources, are published by R. A. Voyner (1950), whereas insofar as vascularization of the ovarian veins is concerned, there are no literature data at all. Regarding the veins in the area under study similarly no literature data are available about the detailed architectonics of the intramural vascular bed and its position amidst the structural elements of the wall, as well as about the degree of vascularization of the wall and its dependence on the peculiarities of the wall structure. Systematic investigations on veins from other regions (V. Vankov — 1965, 1968; G. Marinov — 1969) show that it is exactly these data that provide the most accurate characteristics of the venous wall vascularization. Thus, the chief goal of our present study is outlined — systematic investigation of the microvascularization of the wall of the renal, hepatic, testicular and ovarian veins in man giving a strict account of their structural characteristic features.

Material and Method

The studies are conducted on cadaveric material obtained from 10 individuals: five children aged 3—4 years, one 9-year-old child and four grown up subjects aged 18, 39, 55 and 88 years. Indian ink — gelatin contrast material is injected into the blood stream (according to V. Vankov — 1968) for intramural vascular bed demonstration. The vessels under study are separated and totally cleared. From complete demonstration of the intramural vascular bed areas histological sections are prepared with thickness 10 μm, subsequently stained with hematoxylin-eosin, orceine and after van Gieson, as well as clear-

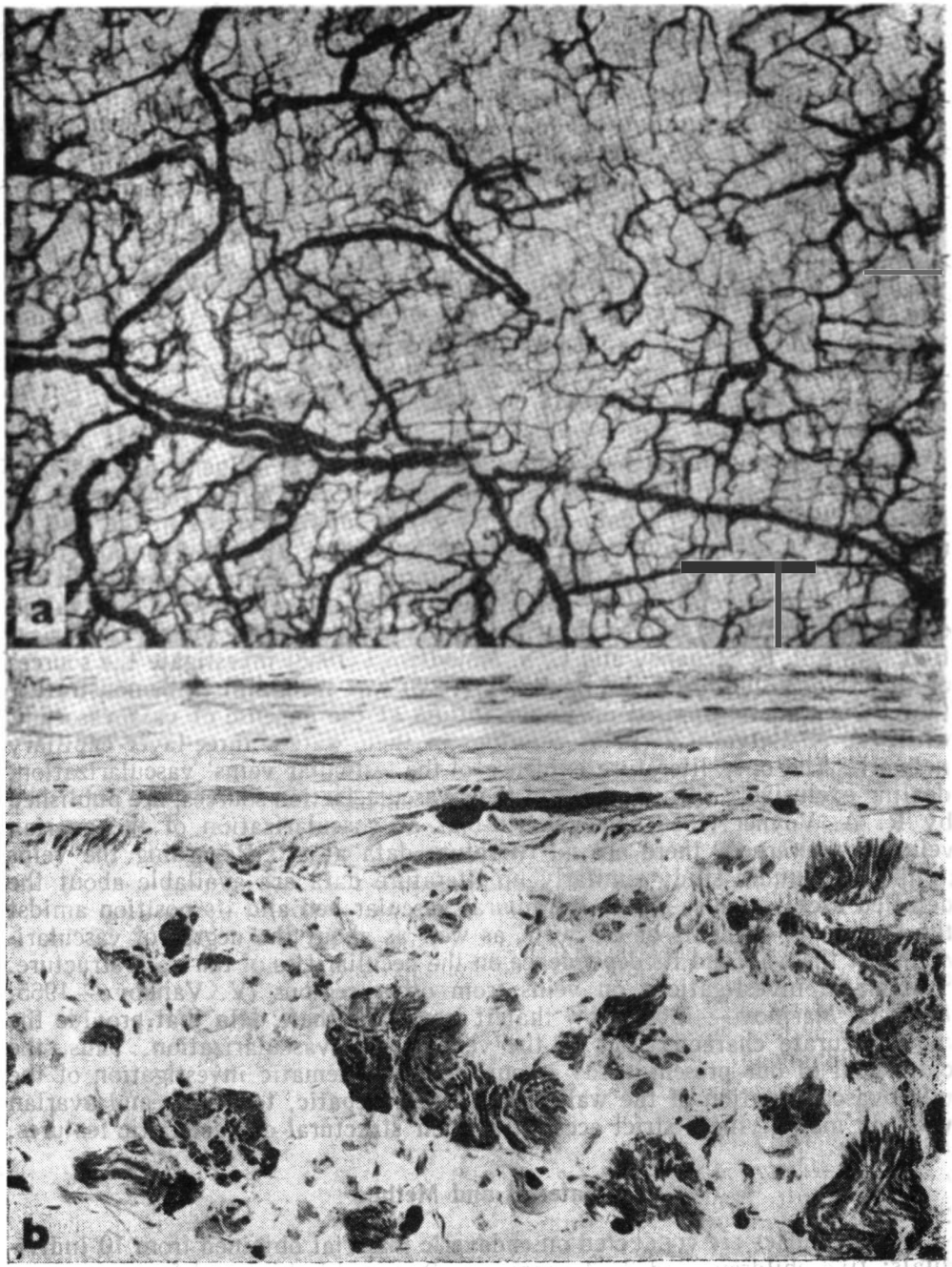


Fig. 1a. Spatial capillary network with vessels of the adventitial plexus visible through it in the wall of the renal vein of a 39-year-old individual. India ink — gelatin injection. Total cleared preparation. Microphotogr.: oc. 8; ob. 4

Fig. 1b. Capillaries in the circular muscular layer of the media and in the longitudinal muscular layer of the adventitia in the wall of the renal vein of a 39-year-old individual. India ink-gelatin injection. Transverse histological section. Staining with hematoxylin-eosin. Microphotogr.: oc. 3.2; ob. 25

ed unstained histological sections thickness 50, 75, 100 and 150 μm. In this manner 20 specimens from the renal veins, and 4 specimens from the hepatic, testicular and ovarian veins each are studied.

Results

The wall of the renal, hepatic, testicular and ovarian veins has two permanent layers — a thicker one with longitudinal orientation in the adventitia, and a thinner one with circular orientation in the media. With aging,

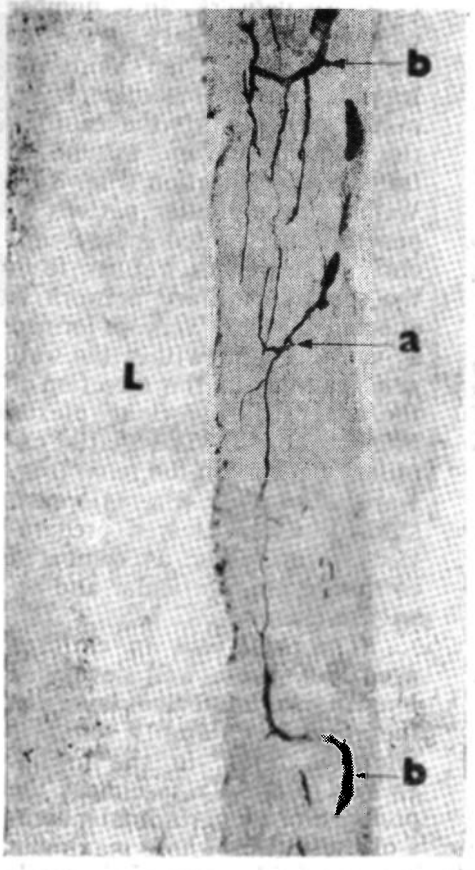


Fig. 2. Afferent (a) and efferent (b) vessel of the capillary network in the wall of the hepatic vein of individual aged 88. L-lumen of the vein. India ink-gelatin injection. Longitudinal cleared unstained histological section thick 75 μm. Microphotogr. oc. 5; ob. 4

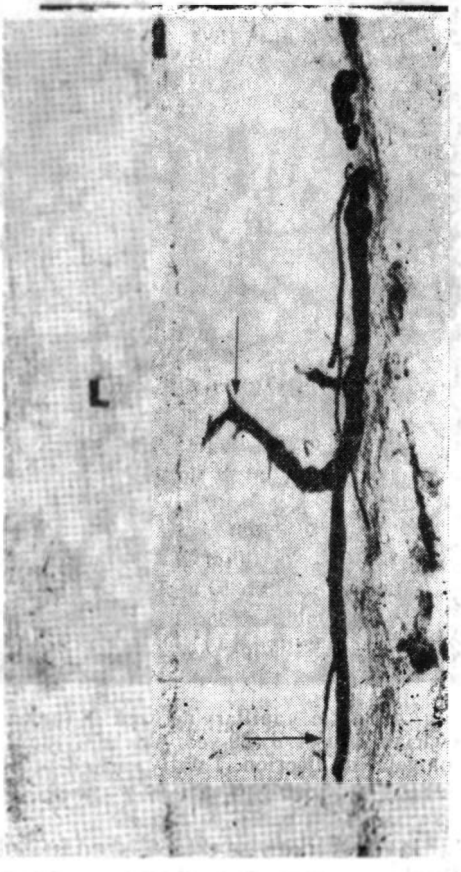


Fig. 3. Formation of efferent venules (indicated with arrows) at varying depth within the wall of the ovarian vein of individual aged 55 years. L — lumen of the vein. India ink-gelatin injection. Longitudinal unstained histological section thick 75 μm. Microphotogr.: oc. 8; ob. 4

a third muscular layer with a longitudinal orientation in the intima also develops in the renal, testicular and ovarian veins. The intramural vascular

bed within the wall of the veins under study is represented by a vascular plexus in the adventitia, and a spatial capillary network in the muscular layers of the wall (Fig. 1, a b). The adventitial vascular plexus is made of arterioles and venules, most frequently running a course in paired bundles. It gives of arterioles penetrating the longitudinal muscular layer of the adventitia dividing branches until capillaries with a longitudinal orientation are formed (Fig. 2). These capillaries form a spatial capillary network. In a number of cases the capillary network of the renal and ovarian veins enters the circular muscular layer of the media where the capillaries building it up assume a transverse orientation (Fig. 1-b) With aging a similar pattern o penetration is noted more frequently. The venous return from the spatial capillary network is effected through venules formed at varying depth within the wall and draining in the direction of the adventitial vascular plexus (Figs. 2 and 3). The spatial capillary network in the renal (Fig. 1-a) and ovarian (Fig. 4) veins, studied in total cleared preparations, seems larger as compared to that in the testicular and hepatic veins.

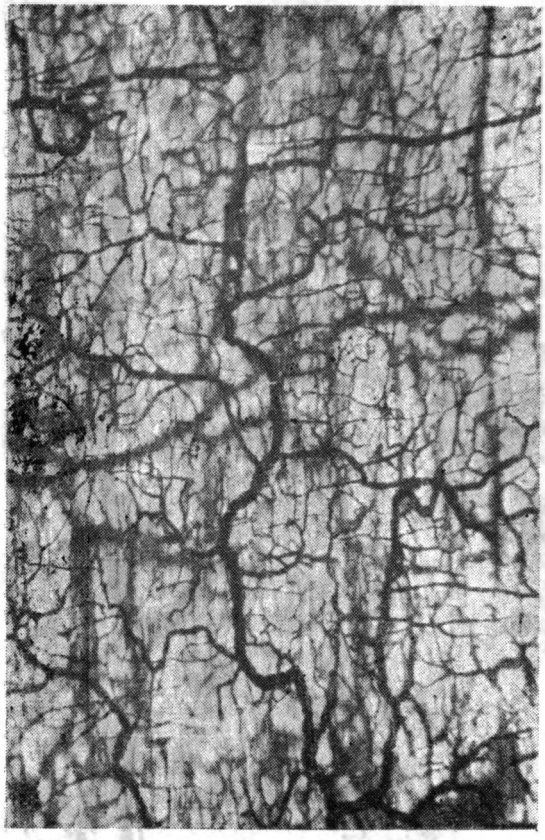


Fig. 4. Spatial capillary network in the wall of an ovarian vein of a 39-year-old individual. India ink-gelatin injection. Totally cleared preparation. Microphotogr.: oc. 8; ob. 4

The renal vein in children aged 3-9 has a well developed longitudinal muscular layer in the adventitia, and a circular muscular layer in the media. In two of the six specimens the presence of a longitudinal muscular layer is likewise estabilished in isolated fields of the intima whose maximum thickness amounts to 8 and 38 μm respectively; in one individual part of the capillaries touch the media, and in two — they penetrate it. The average thickness of the inner avascular muscular layer in the individual specimens ranges from 45 μm (at average total thickness of the muscular layers 155 μm) to 104 μm (at average total thickness — 234 μm). Among grown up individuals aged 39, 55 and 88 years, a considerable increase in the outer longitudinal muscular layer is recorded. An inner longitudinal muscular layer is established in two of the three individuals investigated, with its maximum thickness reaching 54 and 81 μm respectively. As a rule, the capillary network enters the circular muscular layer (two individuals) or at least touches it (one individual). The

average thickness of the inner avascular muscular layer varies from 61 μm (at average total thickness 345 μm) to 203 μm (at average total thickness 709 μm). The vascularized part of the wall in the three individuals under study amounts to 71, 79 and 82 per cent respectively.

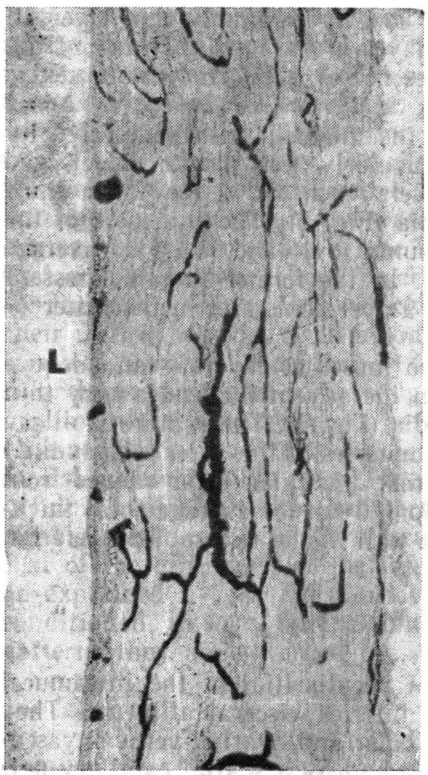


Fig. 5. Deep penetration of the capillary network in the wall of the ovarian vein of individual aged 39 years. L — lumen of the vein. India ink-gelatin injection. Longitudinal unstained cleared histological preparation with thickness 75 μm. Microphotogr.: oc. 3.2; oc. 10

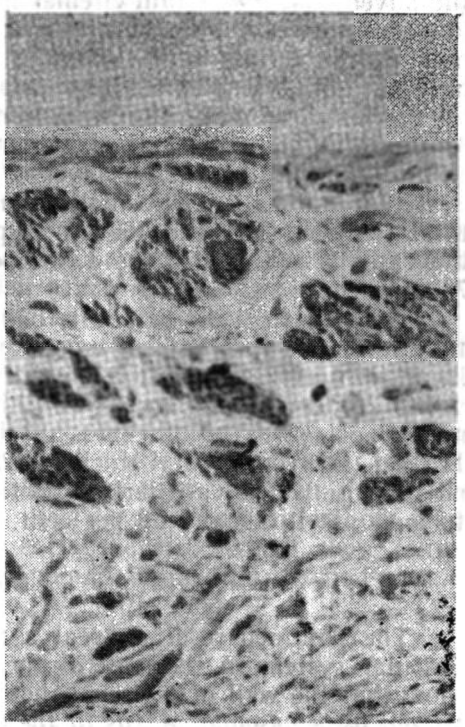


Fig. 6. Poorly developed circular muscular layer in the hepatic vein wall of individual aged 55. The capillary network is confined in the longitudinal muscular layer of the adventitia. Transverse histological section. Stained with hematoxylin — eosin. Microphotogr.: oc. 8; ob. 12.5

The testicular vein, investigated in a 9-year-old child, is endowed with a powerful longitudinal muscular layer in the adventitia, a thin and inconstant circular muscular layer in the media, and comparatively well developed longitudinal muscular layer in the intima whose maximum thickness measures up to 65 μm. The same vein in a 88-year-old individual has a longitudinal muscular layer in the adventitia, and a constant circular muscular layer in the media, while the intima is deprived of muscles. In either of the individuals under study the capillary network lies within the longitudinal muscular layer of the adventitia, its capillaries have a longitudinal orientation and virtually

reach the junction between adventitia and media. The avascular muscular layer thickness in the 9-year-old individual amounts to 87 μm (at average total thickness 280 μm), and in the 88-year-old individual — 94 μm (at average total thickness 382 μm). In the latter the thickness of the vascularized part of the wall is 75 per cent.

Vena ovarica in adults has a powerful longitudinal muscular layer in the adventitia, and a thin circular muscular layer in the media. In one of the two individuals of the series reviewed the presence of a longitudinal muscular layer in the intima with maximum thickness 38 μm is likewise found. Apart from the outer longitudinal muscular layer, the media is also penetrated by the capillary network. The penetration is particularly deep in the subject aged 39 since the principal part of intramural vessels reach up to the inner third of the thin circular muscle layer of the media (Fig. 5). The thickness of the avascular muscle layer in single instances amounts to 16 and 96 μm at average total thickness 235 and 366 μm respectively. In the former the thickness of the vascularized part of the wall amounts to 93 per cent, and in the latter — 74 per cent.

The hepatic vein in adults has only two muscular layers — an adequately developed longitudinal muscular layer in the adventitia, and a very thin inconstant circular muscular layer in the media (Fig. 6). The spatial capillary network is completely enclosed within the boundaries of the outer longitudinal muscular layer. The thickness of the avascular muscular layer ranges from 113 μm (at average total thickness 221 μm) to 176 μm (at average total thickness 416 μm). The vascularized portion of the wall in the two subjects referred to amounts to 49 and 58 per cent.

Discussion

The obtained results reveal a number of peculiarities of the intramural vascular system in the wall of the v. cava inferior visceral affluents. They show that the wall of the renal, hepatic, testicular and ovarian veins is vascularized by a vascular plexus in the adventitia, and by a spatial capillary network in the muscular layers. The general vascularization pattern is conditioned by the overall structural layout of these veins. The spatial capillary network is located in the longitudinal muscular layer, while in the renal and ovarian vein it may penetrate the circular muscular layer of the media also. The capillaries lying amidst the longitudinal muscular layer have a longitudinal orientation, while those lying in the circular layer — a transverse one. The submitted data are noteworthy since literature reports on the architectonics of of the intramural vascular system in the wall of the listed veins are quite few. Regarding the renal veins our present knowledge is based on Voyner's publication (1950) according to which there is a dense network of vasa vasorum in their wall, as well as on data reported by V. A. Belyanskii (1949, 1954, 1957a, b, 1958, 1968, 1970) according to which their blood supply is accomplished by three capillary networks — subintimal with circular orientation, intramuscular with longitudinal orientation and adventitial one. For the hepatic veins the available data are virtually reduced to the statement made by M. Y. Sapozhkova to the effect that their wall is profusely supplied by vasa vasorum, V. A. Belyanskii (1949) who described three vascular networks identical with those in the renal veins, and V. Y. Bocharov (1968) who established a vascular

plexus in the adventitia and a capillary network in the muscular layer of the adventitia and media. As regards the testicular veins R. A. Voyner (1950) was the only one to point out that in their wall a network of vasa vasorum exists, whereas insofar as ovarian veins are concerned there is no information whatsoever. Againts the background of the great paucity of data, our results appear to be much more exhaustive. For the first time, in the same material a comprehensive characteristics of the intramural vascular system architectonics within the wall of all major visceral affluents of the inferior vena cava has been made, with exact data about its positioning among the structural elements of the wall being also submitted. Hence, our data give us a precise idea of the depth of penetration of the intramural vascular bed into the wall of the veins under study, as well as of the vascular/avascular part of the wall ratio. We failed to come across literature data concerning the numerical characteristics of the above two parameters which represent to a great extent the degree of vascularization of the venous wall (V. Vankov — 1974). Only general conclusions have been reached by V. A. Belyanskii (1954, 1957b, 1958) for the renal, and by V. Y. Bocharov (1968) for the hepatic veins, stating that their wall is supplied with blood up to the intima at the expense of vasa vasorum. Our results show that in the wall of all studied veins an avascular muscular layer is present comprising the intima, parts of the media or the entire media. Insofar as comparison between the results of this study and the results obtained in the study of v. cava inferior is concerned (V. Vankov, G. Marinov, S. Bakardzhieva — in press), it is evident that the vascularization of hepatic veins is analogical with that particular segment of the inferior vena cava adjoining the liver, while the vascularization of renal veins is rather similar to that of the other part of the inferior vena cava length. Such differences may be explained by the substantial similarities in the structure of these veins conditioned, in turn, by the similar topographo-anatomical and hemodynamic patterns they are governed by.

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ВАСКУЛЯРИЗАЦИЯ СТЕНКИ ВИСЦЕРАЛЬНЫХ ПРИТОКОВ НИЖНЕЙ ПОЛОЙ ВЕНЫ У ЧЕЛОВЕКА

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РЕЗЮМЕ

Прилагая инъекционно туш-желатиноаую контрастную массу, авторы изучают микроваскуляризацию стенки висцеральных притоков нижней полой вены — почечных, печеночных, семенниковых и яичниковых — на трупном матерьяле индивидов различного возраста. Установлено наличие сосудистового сплетения в адвентиции и пространственная капиллярная сеть в мышечных слоях всех исследованных вен. В печеночных и семенниковых венах капиллярная сеть располагается только в пределах адвентициального продольного мышечного слоя и имеет продольную ориентацию. В стенке почечных и яичниковых вен капиллярная сеть более объемиста и часть ее капилляров проникает и в циркулярный мышечный слой медии, где имеют поперечную ориентацию. Толщина васкуляризированной части стенки печеночных вен меньше, чем у других исследованных вен.