CHARACTERISTIC FEATURES IN THE VASCULARIZATION OF THE WALL OF THE POPLITEAL VEIN

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Studies on the vascularization of the wall of the popliteal vein are quite limited. Literature data obtained in the course of researches into the homonymous artery (Hyrtl, 1882; Ostrogorskii, 1922, and Kurkowsky, 1932), deal mainly with the preterminal part of the intramural vascular bed. As regards its terminal part, merely indirect presumptions have been made on the ground of reports published by Short (1940), Vankov (1964), and Belyanskii (1965) — for the femoral vein, and Lang (1961), Belyanskii (1961) and Marinov (1967) — for the deep veins of the leg, all of which have a structure similar to that of the popliteal vein. However, the data referred to are characterized by considerable discrepancies. With these facts in mind, and proceeding from the circumstance that the popliteal vein becomes ever more often the object of plastic surgery for which thorough knowledge of the intramural vessels has an essential practical bearing, we set out to carry out a systematic study on its vascularization.

Material and Method

The popliteal vein of 18 individuals (32 lower limbs) aged 0—81 years is studied. The intramural vascular bed is demonstrated by means of injecting India ink—gelatin contrast via blood routes, and investigated on totally cleared preparations. Distribution and quantity of terminal vessels are studied on histological sections, thick 10 microns, after staining with hematoxylin eosin, orcein and according to Van Gieson.

Results

The intramural vascular system in the wall of the popliteal vein is represented by an adventitial vascular plexus and a spatial capillary network within the muscle layers (Fig. 1). The vascular plexus is made up of arterioles and venules of varying order, pre- and postcapillaries and single capillaries. The arterioles and venules form vascular bundles with an oblique orientation mainly, and after uniting present rhombic figures. Along the course of the vascular bundles direct branched type junctions are also established between arterioles and venules, as well as dense capillary networks with a marked venous part (Fig. 2). The adventitial plexus gives off arterioles and collects venules from the capillary network of the muscular part

of the wall. The arterioles display spiraloid coiling and consecutive branching into precapillaries and capillaries, which, in their integrity, make up the spatial capillary network. The venules are bent in a looplike fashion and delineate almost complete space figures-of-8 (Fig. 2).

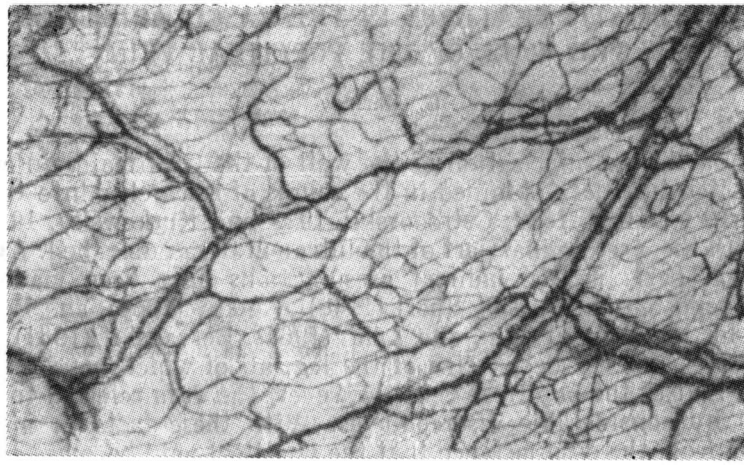

Fig. 1. Adventitial vessels and capillary network in the wall of the popliteal vein (19 years). Total cleared preparation. Microphotograph: oc. 8, ob. 1.

Vascularization of the muscle layers of the wall differs essentially from that of the adventitia. The capillaries situated in these layers form a network with rectangular loops. The long axis of the loops has mainly a transverse orientation relative to the longitudinal axis of the vessel, a fact conditioned by the circumstance that the capillary network is positioned within the borders of the circular muscle layer. The quantitative ratio between capillary network and musculature it supplies blood to, ratio which determines the degree of vascularization in the vein wall, exhibits considerable age related differences. The capillary network of newborn individuals displays a great density. In seven specimens of the popliteal vein wall from four newborn individuals, the number in intersected capillaries per 1 mm^2 cut muscle surface varies from 300 to 1150. During the growth period of the organism, the rate of vascularization of the wall of the popliteal vein decreases substantially, and its capillary network is appreciably rarefied. Measured in five specimens of two adult subjects (34—35 years), the number of intersected capillaries per 1 mm^2 cut muscle surface ranges from 40 to 86. Changes in the degree of vascularization of the wall during growth are studied in four individuals aged 4, 15 and 19 years. It was found that the capillary network density is inversely dependent, although not strictly, on the age of the individuals under study. Simultaneously with the rarefaction of the intramural capillary network, the depth of its penetration within the wall of the vein is also altered. In newborns the capillary network pene-

trates into the immediate vicinity of the vessel's lumen. The distance between the capillaries penetrating deepest and the inner surface of the endothelium, measured over fields of 250 microns each in eight objects from five newborns, ranges from 3 to 12 microns. During the growth period of the

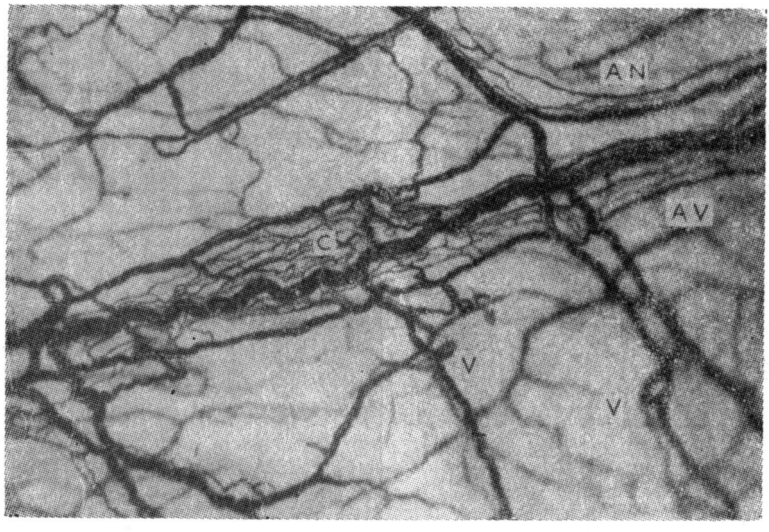

Fig. 2. Adventitial vessels in the wall of the popliteal vein:
AV — vascular bundle; *C* — perivasal capillary network; *V* — double bending of a venule; *A* — direct arteriovenous anastomosis. Total cleared preparation (19 years). Microphotograph: oc. 8, ob. 4.

organism, an inner avascular muscle layer is formed in the wall of the popliteal vein. Measurements in 10 objects from three adult individuals (34, 35 and 59 years) show that the thickness of this layer is 64—149 microns in the average, while in 60 per cent of the objects it is between 67 and 89 microns (Fig. 3). The formation of the inner avascular layer results in a change of the correlation between vascularized and avascular part of the vein wall. While in newborn individuals, the thickness of the vascularized part constitutes 77.5 per cent of the total thickness of the wall, in adults it is only 58.7 per cent. The dynamics of formation of the inner avascular layer is studied in four individuals, aged 4, 5 and 19 years. It is established that the thickness of the inner avascular layer is directly dependent on the age of the individual.

The musculature in the popliteal vein strip in contact with the homonymous artery is rather often avascular. The capillary network of the neighbouring vascularized zones displays a characteristic termination in the avascular zones of the type described. Usually it is contiguous to the avascular zones through its venous part, or else, gives off capillary loops long 250 to 270 microns in the same direction. In the newborns these loops are absent. They differentiate during the process of growth. In all cases under study,

the avascular zones show much less developed musculature compared with neighbouring vascularized zones. Usually, the thickness of the muscle layer in the avascular zones never exceeds the average thickness of the inner avascular layer for this particular vein, being beneath 8—6 microns in new-

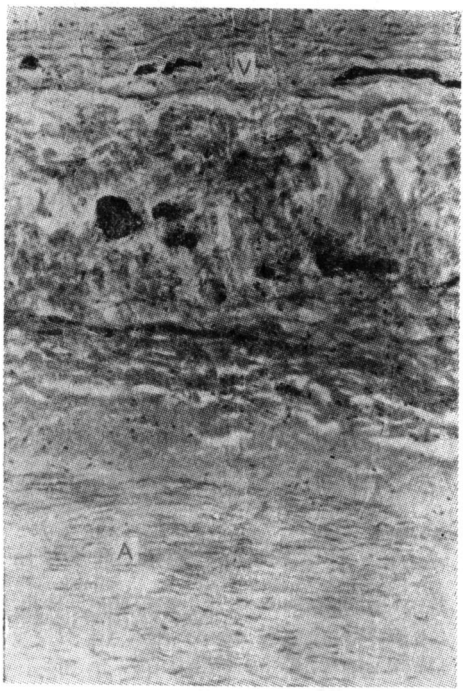

Fig. 3. Longitudinal section through the wall of the popliteal vein (19 years). Staining with metaxylin-eosin. Microphotograph: oc. 10, ob. 10.

Fig. 4. Transverse section through the wall of the popliteal artery and vein in the touching strip. Penetration of the earliest capillaries at the junction between vascularized and avascular zone. Hematoxylin-eosin. Microphotograph: oc. 10, ob. 10.

borns, and beneath 90—70 microns in grown up individuals. It is evident that occurrence of vessels in the muscular part of the wall depends on its thickness. The fact that upon tracing the transition from avascular to vascularized zones, the first capillaries are established in the area where the thickness of the musculature reaches 6—8 microns in the newborns, and 70—90 microns in the adults, is in support of the inference reached (Fig. 4).

Discussion

The results obtained contribute to extend our knowledge of the vascularization of the popliteal vein wall. They demonstrate that an adventitial vascular plexus is formed in the wall of the popliteal vein, and a spatial capillary network — in the muscle layers, i. e. that it is no exception of the general vascularization pattern of the deep veins in the lower limb, already described by Vankov (1964) for the femoral vein, and by Lang (1961) and Marinov (1967) — for the deep veins of the leg. The adventitial plexus is made by arterial and venous vessels of preterminal class, a fact conditioned by its basic function — to supply and drain the blood flow through the capillary network of the muscle layer. Arterial vessels making up the adventitial plexus do not display a terminal character since they anastomose between each other. Similar unions are also established among the venous vessels accompanying them. The arterial to venous vessels' ratio in the adventitial plexus shows a clearcut predominance in favour of the latter (venous vessels) regardless of the subdivision — from arterioles and venules of first class to pre- and postcapillary vessels. The data referred to render doubtful the statement made by Louis and coauthors (1966) to the effect that part of the arterial blood, supplying the venous wall, returns directly into the venous lumen with ensuing predomination of afferent over efferent vessels. The presence of direct arteriovenous anastomoses within the adventitial plexus suggests that it has a regulating role also. The spiraloid course of the arterioles piercing the musculature, and the loop-like coiling of the afferent venules represent, in all likelihood, an adaptive mechanism to displacements of tissue elements in the conjunctive, described by Brocmann (1937), and to shifting of the latter relative to the venous wall (Freerksen, 1938). Owing to the bradytrophic character of the surrounding tissues, the pesculiar capillary formations in the composition of the adventitial plexus may be classified with the vascular formations, reported by Lang in 1961, related to the processes of secretion and resorption of important mechanicalwise tissue fluids. There are no literature data concerning the vascularization of the muscle layers of the wall of the popliteal vein. The spatial capillary network found in the circular muscle layer shows that the statement by Komahidze (1955) about the perimuscular positioning of the capillary network does not hold true for this particular vein. The age related peculiarities in the vascularization of the wall of the popliteal vein are essentially similar to those described by Vankov (1966) in the great saphenous vein. They question the validity of the statement made by a number of authors (Komahidze, 1955; Belyanskii, 1961; Echa, 1967) to the effect that in newborns the muscle layers of the venous wall are usually avascular.

REFERENCES

1. Белянский, В. А. *Тр. VI Всес. съезд анат., гист. и эмбр.* Харьков, т. I, 1961. — 2. Белянский, В. А. *Тр. Куйбыш. мед. ин-та,* т. 35, ч. I, 1965, 124—136. — 3. Ванков, В. *Арх. анат.,* 50, 2, 1966, 19—27. — 4. Еча, Г. Я. *Тез. докл. VIII научн. конф. по возр. морф., физиол. и биохим.* М., 1967, 93—94. — 5. Комахидзе, М. *Тр. ин-та эксп. морф.* АН Грузинской ССР, Тбилиси, V, 1955. — 6. Маринов, Г. І национална конференция на аспирантите, С., 1967, 175—180. — 7. Острогорский. П. Артерии периферических сосудов. XV съезда русск. хир., 1922. — 8. Brocman (1937, cited by J. Lang, 1961. — 9. Freerksen (1938), cited by J. Lang, 1961. — 10. Hyrtl, J. Handbuch der topographischen Anatomie, Wien, Bd. II, 1882. — 11. Kurkowsky, W. *Z. Anat. Entwickl.-Gesch.,* 1932, 98, 126—139. — 12. Lang, J. *Z. Anat. Entwickl. Gesch.,* 1961, 122, 482—517. — 13. Louis, R., Y. Bailie, C. Juhan. *C. R. l'Ass. Anat.,* Nancy, 1966, 135, 621—626. — 14. Short, R. The vasa vasorum of the femoral vein. *J. Path. Bact.,* 1940, 50. — 15. Vankov, V. *Ann. Scient. Papers,* Varna, III, 1964, 1, 17—22.

НЕКОТОРЫЕ ОСОБЕННОСТИ ВАСКУЛЯРИЗАЦИИ СТЕНКИ ПОДКОЛЕННОЙ ВЕНЫ

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РЕЗЮМЕ

Кровеносные сосуды подколенной вены исследованы путем инъекции по току крови тушь-желатина и последующего изготовления тотально просветленных гистологических препаратов. Установлено наличие адвентициального сосудистого сплетения и поперечно ориентированной пространственной капиллярной сети в мышечном слое. С ростом индивида формируется внутренний бессосудистый слой. В течение первых двадцати лет жизни он нарастает быстрее абсолютной толщи мышечного слоя и у взрослых индивидов составляет в среднем между 70 и 100 микронами для отдельных полей. В полосе, которой вена соприкосается с одноименной артерией, мышечный слой зачастую лишен сосудов. Очевидно он тоньше критической в отношении его васкуляризации толщины. Капиллярная сеть соседних васкуляризованных участков огораживает бессосудистые поля, преимущественно посредством венозной части капиллярных петель, послекапиллярными венулами или проникает путем петлеобразных капилляров. Эти особенности ангиоархитектоники находятся вероятно в связи с циркуляцией тканевых жидкостей в стенке.