

AGE CHANGES OF ATP-ASE ACTIVITY IN HUMAN ARTERIAL AND VENOUS WALL

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The maintenance of functional activity and the realization of plastic and transport processes inherent in vascular wall depends on its energy supply as well as on the presence of compounds rich in macroergic links and especially on the energy liberated during their hydrolysis (1). That is why ATP-ase activity level is an index of energy providing of vascular wall and particularly of vascular smooth muscle as well as an indicator of intensity of active electrolyte transport required for cation homeostasis maintenance in smooth muscle cells (SMC) (3, 7, 8, 15—17).

Proceeding from the literature data about the presence of age differences of ATP-ase activity in arterial (2, 13) and venous vessels (10) with some animal species (rat, rabbit) we decided to study ATP-ase activity of vascular wall SMC during different periods of human life.

Material and methods

Vascular walls of abdominal aorta, femoral artery, inferior caval, portal, femoral and long saphenous veins from 11 cadavers of suddenly deceased persons aged 45 and 120 days as well as 2, 5, 15, 27 (two cases), 33, 39, 48, and 50 years were studied. Myosin ATP-ase was ascertained after calcium-cobalt method of Padycula-Herman (1955) at pH 9.2 and non-myosin one — after lead method of Wachstein-Meisel (1957) at pH 7.2. Both methods were applied in modification of Lojda, Gossrau, Schiebler (1979). The specificity of the methods used was controlled as followed: 1. an incubation of the cuts without substrate to determine the level of background reaction; 2. heating of the cuts in distilled water at 80°C for 10 min to eliminate the non-enzymatic substrate hydrolysis; 3. parallel incubation in equimolar β -glycerophosphate concentration to eliminate the participation of non-specific esterases, and 4. preincubation with 0.0363 per cent water solution of L-cysteine at 37°C for 30 min and postincubation with an addition to the incubation solution of L-cysteine in concentration of 0.0363 per cent to eliminate the participation of alkaline phosphatase.

Results and discussion

Our results show that both myosin and non-myosin ATP-ase reactions are positive in endothelial cells, SMC and intramural vasa vasorum. As SMC are quantitatively the main cellular component of the vascular wall the presence

of these enzymes in vessels of different kind and structure as well as in single vascular wall layers is determined predominantly by SMC attendance; the re-

Reactions for both myosin and non-myosin ATP-ases are slightly positive in SMC of the main vascular tunic — the media — when abdominal aorta during the first months of life (45 and 120 days after birth) is concerned. In ca-

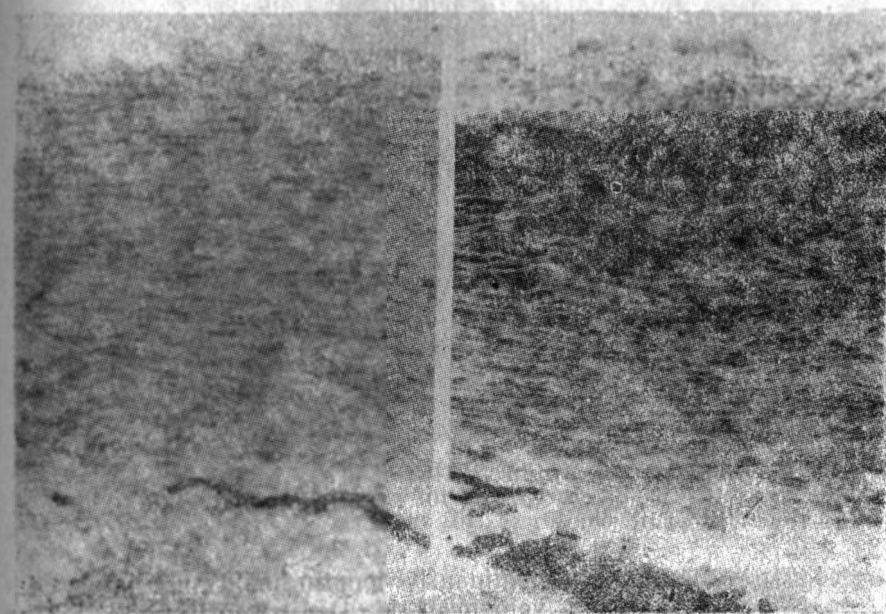


Fig. 1. Aorta abdominalis. Reaction for myosin ATP-ase.

a) 4-month old infant. Microphoto: ob. 10, oc. 10.

b) 2-year old infant. Microphoto: ob. 10, oc. 10.

ses of intinally located SMC as single cells only reactions are weaker than those in SMC in the media. There is an outlined contrast to the intensive reaction product sedimentation in vasa vasorum walls of the same vessel (fig. 1-a, b). Wall thickness increases on the account of the intima and media in children aged between 2 and 5 years. Intensity of both reactions in the media increases reaching in single areas up to that of vasa vasorum. However, intensity of reactions is considerably weaker in the intima (fig. 1-a, b). During growth intensity of both reactions in aortic media continues to increase and in adult individuals it is much more positively expressed. Despite intima thickness increase reaction intensity remains considerably weaker than that in the media.

Concerning the femoral artery which is an artery of muscular type both reactions are slightly positive but more expressed than these in the aorta during the first months of life. During growth wall thickness increases on the account of intima and media both (fig. 2-a, b). Besides reaction intensity increases in the media and intima. This increase is much more considerable in the media than in the intima (fig. 3).

During the first months of life reactions are positive in the longitudinal layer of the adventitia and slightly positive in the media when veins with pre-



Fig. 2. Arteria femoralis. Reaction for myosin ATP-ase.

a) 45-day old infant. Microphoto: ob. 10, oc. 10.

b) 5-year old child. Microphoto ob. 10, oc. 10.

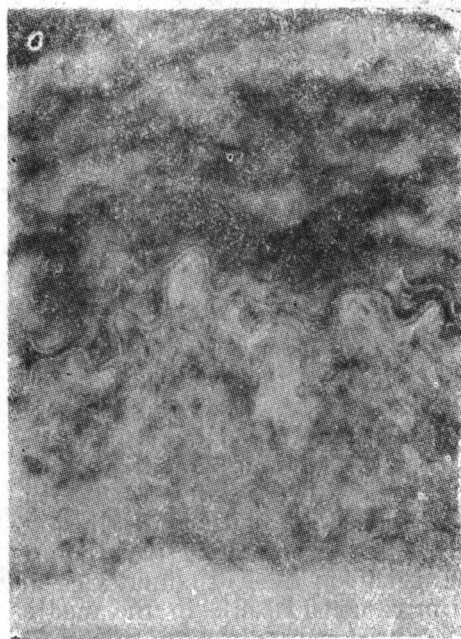


Fig. 3. Arteria femoralis. An adult individual. Reaction for myosin ATP-ase
Microphoto: project. 3.2, ob. 25.

dominantly longitudinal musculature development in the adventitia, e. g. the inferior caval and portal veins are concerned. During individual growth reaction intensity increases which is earlier and stronger expressed in the longitudinal adventitial muscular layer. Still at the age of 2 years a very intensive sedimentation of reaction product in the media of these vessels is observed. This tendency remains in adult individuals, too (fig. 4-a, b).¹

During the first months of life reactions are slightly positive in the circular muscular layer of the media, i. e. in the basic muscular layer when veins with predominantly circular musculature development in the media such as femoral and long saphenous veins are concerned. During growth media thickness increases. Parallely, reaction intensity in it increases, too, and still at the age of 5 years reactions show a significant intensity. However, despite the parallel intima thickness increase reactions remain reliably weaker there in comparison with those in the media (fig. 5-a, b).

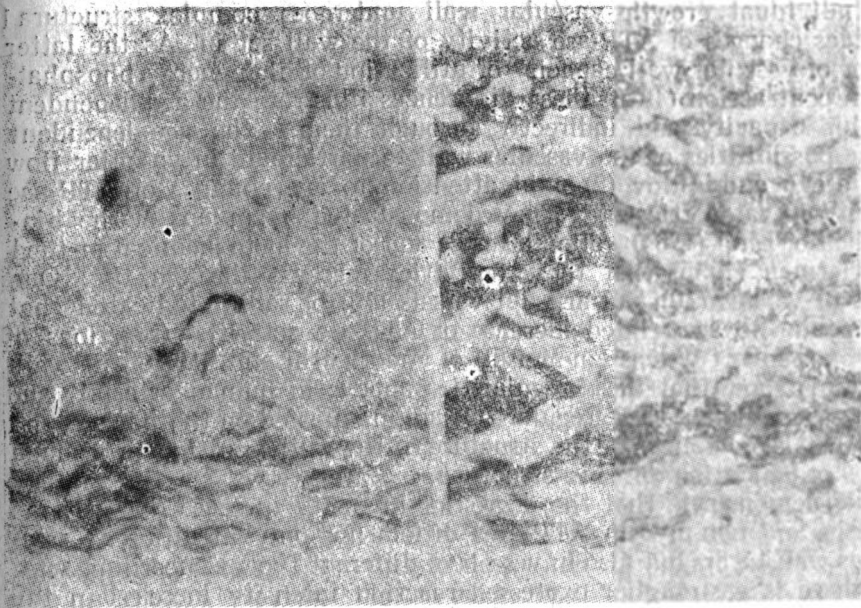


Fig. 4. Vena cava inferior. Reaction for myosin ATP-ase.

a) 45-day old infant. Microphoto: ob. 10, oc. 10.

b) 27-year old man. Microphoto: ob. 10, oc. 10.

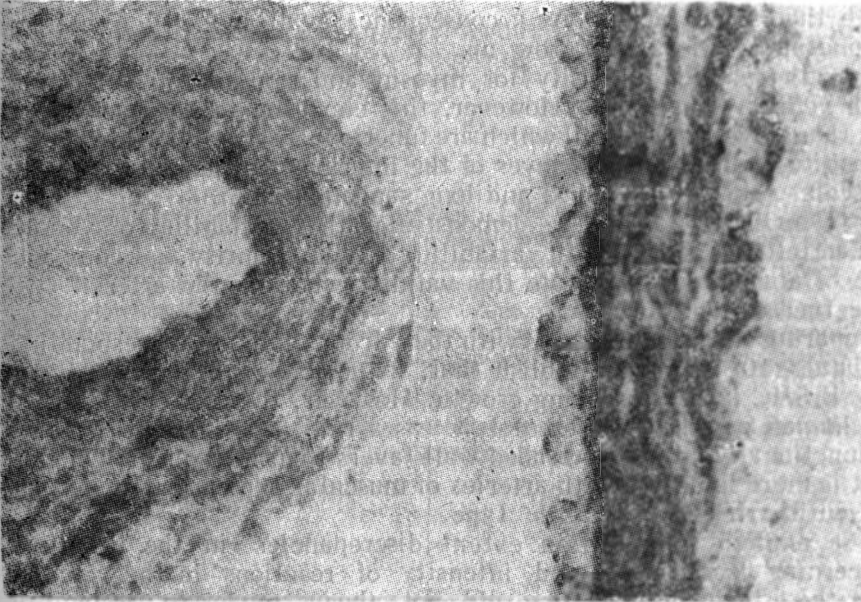


Fig. 5. Vena femoralis. Reaction for myosin ATP-ase.

a) 45-day old infant. Microphoto: ob. 10, oc. 10.

b) 5-year old child. Microphoto: ob. 10, oc. 10.

During individual growth vascular wall undergoes complex structural changes. Besides changes of ATP-ase activity of the wall set in. As the latter is an indicator of vascular wall capacity of utilization of high-energy phosphates for its own contraction (4—6) these differences illustrate the age-dependent changes of this capacity and indirectly through them — the age-dependent changes of the possibilities of the vascular wall to participate in vascular flow regulation. Zlateva and Antov (2) paid attention to age changes of ATP-ase enzyme activity in rat aortic wall. They demonstrated by means of the biochemical method of Lind (1964) (cited after 2) and of the histochemical method of Padycula-Herman (1955) that these activities increase through life. Our investigations of venous (10) and arterial vessels (13) of rabbit indicated that in fact, it pertains to age-related increase of ATP-ase activities (reactions of Padycula-Herman and of Wachstein-Meisel) of endothelial and SMC of the wall.

Present results show that these regularities appear in human arterial and venous vessels, too. In man, these regularities are manifested on the background of very significant age changes of the structure of the wall resulting in a much more complex organization of this structure.

Our results demonstrate that the degree of intensity increase of reactions for both myosin and non-myosin ATP-ases differs not only in different arterial and venous wall layers but also in vessels of different type. Concerning arterial vessels, there is a stronger expressed reaction intensity increase in the media than in the intima. Reaction intensity varies in arteries of muscular and elastic type being stronger in vessels of muscular type. It is probably due to greater SMC loading in arteries of muscular type because SMC are the main component compensating wall tension. Concerning the intima, its thickness increase is not accompanied by a similar ATP-ase activity elevation in it as compared with that in the media. As a consequence, wall capacity to utilize high-energy phosphates does not grow up.

During growth reaction intensity for myosin and non-myosin ATP-ases increases with venous vessels, too. However, this elevation takes place more intensively in those layers of the wall which are functionally stronger loaded — i. e. in the longitudinal adventitial layer of the inferior caval and portal vein and in the circular one of the femoral and long saphenous vein.

In our previous investigations we demonstrated that variability of venous wall ATP-ase activity correlated with variability of SMC quantity and compactness in it (12). Data obtained indicate this validity when human arterial vessels are concerned, too.

When comparing the present results with these from studies of corresponding vessels in animals (10) one can establish that, in principle, ATP-ase activity in vascular wall SMC increases during growth. However, there are certain peculiarities in human vessels of different type: as a rule, this increase is more intensive in functionally stronger loaded wall layers than in the rest. On the other hand, it is more intensive with arteries of muscular type and with venous vessels than with arteries of elastic type.

These data explain to a certain extent discrepancies in the literature available concerning localization and intensity of reactions in the vascular wall as during these investigations one did not always render an account of local and age variability of the vascular wall. Simultaneously, strongly expressed intima thickness increase with arterial and venous vessels setting in at a mature age and in adulthood is not accompanied by an ATP-ase activity in-

crease which results in alterations of the contractile capacity of the wall. This statement correlates with the results obtained from investigations of venous vessels with obliterating diseases of the lower limb (11).

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ВОЗРАСТНЫЕ ИЗМЕНЕНИЯ АДЕНОТРИФОСФАТАЗНОЙ АКТИВНОСТИ В СТЕНКАХ АРТЕРИАЛЬНЫХ И ВЕНОЗНЫХ СОСУДОВ ЧЕЛОВЕКА

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РЕЗЮМЕ

Исследованы гистохимически возрастные изменения активности миозиновой и немиезиновой аденотрифосфатазы в стенках брюшной аорты, бедренной артерии, воротной, нижней полой, бедренной и большой подкожной вен. Исследование проведено на материале одиннадцати трупов людей, умерших внезапно в возрасте 45—50 лет.

Установлено, что позитивирование реакций в отдельных оболочках сосудистой стенки различных по виду и строению сосудов связано с наличием, количеством, компактностью и распределением основных клеточных компонентов в ней — гладкомышечных и эндотелиальных клеток. И при артериях, и при венах, наблюдается сходная возрастная динамика, выражающаяся повышением интенсивности реакции клеток гладкой мускулатуры в процессе роста организма. Этот процесс протекает с различной интенсивностью в артериальных и венозных сосудах разного конструкционного типа, а также в различных слоях их стенки.