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Vascular Physiology in Czechoslovakia (1945–1990)

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It is difficult to explain what is the inner binding energy which attracts a physiologist to life-long studies of the vascular system but, undoubtedly, it must be very strong. Perhaps, it is the intricate structure and function of this system which during a life-time enable the transfer of hundreds of million liters of blood ejected by the heart towards the individual organs – all this in a most flexible way, thanks namely to the smooth muscle which provides a wide range of changes of the calibre of the respective vascular bed.

What were the questions in vascular physiology that physiologists in Czechoslovakia have dealt with within the last four decades?

During World War II, in consequence of the well-known political conditions, the situation in Bohemia and Slovakia differed. The closing of Czech universities prevented any work in physiology. In Slovakia, the University in Bratislava continued working. J. Antal, Head of the Institute of Physiology at the Medical School, and since 1944 the first Slovak professor of physiology, was one of those physiologists for whom the cardiovascular system became a life-time passion. Having had an opportunity to work with H. Rein with "Thermostromuhr", he passed on his experience to his students.

After the end of war the great thirst for theoretical knowledge rapidly filled universities in the whole country by students who were probably even more enthusiastic than students at any other previous time.

It was an unusual historical paradox that in Czechoslovakia, in the period of social-political oppression in the fifties there were established institutes in which science could be professionally pursued. These institutes were provided with basic equipment, a huge body of literature from the whole world, and above all there were many young people enthusiastic for science. At that time there were established, among others, the Institute for Cardiovascular Diseases in Prague, the founders were K. Weber, J. Brod (returning from England), and Z. Fejfar, and the Institute of Physiology of the Czechoslovak Academy of Sciences in Prague (Z. Servít, E. Gutmann and O. Poupa).

In Slovakia various laboratories were gradually established by J. Antal, J. Čerňáček, L. Dérer, J. Stanek, K. Šiška and V. Mucha which became incorporated into the contemporary Institute of Normal and Pathological Physiology and the Institute for Heart Research of the Slovak Academy of Sciences in Bratislava.

The Institute for Cardiovascular Diseases in Prague became the center for cardiovascular research, oriented particularly on clinical physiology, but partly also on basic problems. Not only investigators from Czechoslovakia, but also a number from abroad worked for some time in this Institute. A natural necessity was felt at this time for international cooperation.

Basic Studies

Studies of the cardiovascular system in conscious dogs during normal physiological activities, and during stimuli signalizing the above activities, were started by J. Antal at the Institute Physiology, Medical School, Bratislava and by K. Froňková in Prague in the early fifties (Froňková *et al.* 1957). Antal opened a new research area, namely the cardiovascular and respiratory functions and their control in conscious animals during locomotion and other physiological activities. Relations in the time course of systemic blood pressure and blood flow in the femoral artery were described during hindleg flexion and during running on a treadmill (Antal 1962, 1966, 1970). A marked increase in systemic blood pressure was found during food intake, accompanied by an increase in blood flow in the carotid artery but no change in the femoral artery (Antal 1964). A pressor response elicited by clamping of the common carotid artery was shown to be significantly higher during food intake than during exercise (Antal 1967, 1974). Moreover, he studied the sinocarotid reflex during food intake from the comparative point of view and found it to be higher in carnivores than in the herbivores (Antal 1968). Antal proved in his studies, and later also together with Gantt, that stimuli which signalize either exercise or food intake (conditioning stimuli) elicit similar circulatory responses, however, the responses were always smaller than during the exercise or food intake itself (Antal 1962, 1968, 1976, Antal and Gantt 1970).

Antal and co-workers investigating the blood supply to salivary glands came to the conclusion that sialoresis and sialokinesis under certain stimuli (acetylcholine) are independent of the blood supply (Antal and Sedlák 1971).

J. Antal had to leave the Institute of Physiology after 1970. This was the reason why the studies on conscious animals were interrupted. In his new post he studied blood flow alterations in individual organs induced by vasoactive drugs (Antal 1978, Antal *et al.* 1980, Antal 1981, 1982, Antal and Holec 1986) and brought further evidence dealing with "the paradoxical" relation between pressure and blood flow in coronary circulation (Antal 1986), as well as with the relation of mean pressure and pulse amplitude along the arterial tree (Antal 1984, 1987).

J. Gero and M. Gerová (Institute of Normal and Pathological Physiology, Slovak Academy of Sciences, Bratislava) described the fundamental factors involved in stimulation of baroreceptors: *(i)* the biomechanical properties of the sinocarotid wall including dynamics of distensibility of this area due to smooth muscle activity of myogenic origin or induced by vasoactive drugs (Gero and Gerová 1959, 1960, 1961, 1962, Gerová and Gero 1960) and *(ii)* the role of the intravascular pulsating pressure. They found that changes of each individual parameter of pulsating pressure (mean pressure, pulse amplitude and frequency of pulsations) affect the response of baroreceptors (afferent firing in the sinocarotid nerve) with a subsequent reflex response of systemic pressure. It was concluded that both "dynamic" and "static" components are operating in the stimulation of baroreceptors. The "dynamic" component, the rate of blood pressure change ($\Delta P/\Delta t$), is indirectly related to the "static" component, i.e. mean blood pressure (Fig. 1), (Gero *et al.* 1962, 1963, 1965, Filistovich *et al.* 1966).

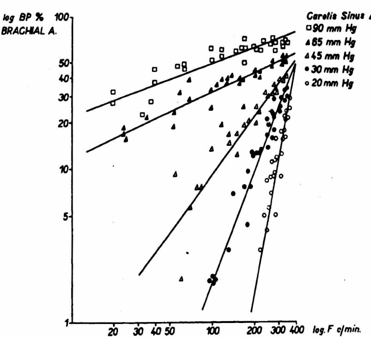

Fig. 1
Logarithmic relationship of the frequency (c/min) of pulsating intracarotid pressure and the reflexly induced change of systemic blood pressure (brachial artery); mean intracarotid pressure was maintained constant (120 ± 10 mm Hg).

Another field of investigation in this Institute were the peculiarities of the nervous control of the consecutive portions of vascular system: conduit, resistant and capacitive vessels. Very early after Falck had published his method, an almost complete mapping of adrenergic nerve terminals in the vascular system (both localization and density) was performed in various species, during the ontogenesis and in various functional situations (Doležel 1973, Doležel *et al.* 1975, 1978, 1980, 1984, 1986, Kristek 1987, Klasová 1990). At the same time the functional significance of sympathetic control in individual segments of the vascular tree was described: *(i)* differences in maximum constriction during stimulation of the respective sympathetic outflow (resistant vessels > dorsal pedal artery > femoral artery = femoral vein = brachial artery > aorta close to the bifurcation > caudal caval vein > left descending coronary artery > carotid artery > aorta close to renal artery) and *(ii)* differences in the velocity of contraction (resistant artery > femoral artery > femoral vein). Velocity of contraction was shown to change during ontogenesis; in puppy femoral artery the velocity was found to be larger than in adult femoral artery (Gero *et al.* 1968, Gerová *et al.* 1964, 1965, 1967, 1968a,b, 1969, 1973, 1974, 1975, 1979, 1981, Gerová 1982). A remarkable peculiarity of sympathetic control was disclosed in conduit coronary arteries. A weak contraction of conduit coronary arteries was found during stimulation of postganglionic fibres from the stellate, vertebral and thoracic ganglia. However, sympathetic stimulation increased the metabolism of the heart muscle, dilated the nutritive coronary bed and consequently raised blood flow through the conduit coronary artery. The experimental evidence was brought that the increase in blood flow induced a conduit coronary dilation. The above two findings have been taken as experimental evidence for the dual control of conduit coronary diameter (Gerová *et al.* 1979, 1981, Levický *et al.* 1981, Gerová 1983).

A relationship was also found between the volume of either ventricle and the geometry (length and diameter) of conduit coronary arteries and the role of this phenomenon in evaluating vasomotion (Gerová *et al.* 1989). The deformation of the coronary artery, concomitant long-lasting cardiac volume overload compromise the contractile ability of the coronary smooth muscles (Holécyová *et al.* 1987).

The adrenergic nerve terminals have been found in most conduit arteries to be remote (tens and even hundreds nm) from effector smooth muscle cells (Doležel 1973, Doležel *et al.* 1978, Gerová *et al.* 1982, Kristek *et al.* 1987, Klasová 1990). It thus seemed logical to suggest that the of transmitter diffuses through the vessel wall. This mechanism was ultimately proved (Gerová *et al.* 1967, Bevan and Török 1970, Török *et al.* 1971a,b, Doležel *et al.* 1975). The low velocity of contraction of conduit arteries during sympathetic stimulation *in vivo* was in good agreement with the process of diffusion (Fig. 2) (Gerová *et al.* 1969, 1973).

However, neuro-effector transmission in the vessel wall was shown to be mediated by a whole series of factors. First of all, the intrinsic processes in the neuro-effector system, namely the dynamics of reuptake of the transmitter, were shown to be important for the smooth muscle contraction. The generally acknowledged hyperboloid frequency-response characteristics (F-R) were proved to be valid only for prolonged sympathetic stimulation. By lowering the number of impulses applied, the F-R characteristic even becomes inverted. The following rules operating the reuptake process were revealed: *(i)* The number of stimulating impulses being constant, the rate of reuptake is directly (exponentially) related to the frequency of stimulation (i.e. to the rate of change of transmitter level within the neuromuscular cleft). *(ii)* The stimulation frequency being constant, by increasing the number of impulses applied, the activity of reuptake mechanism declines, i.e. by increasing the total amount of transmitter released, the activity of reuptake mechanism decays (Gero *et al.* 1978, 1980, 1981).

Török in Burnstock's lab found an inhibitory effect of adenine nucleotides and nucleosides on neuro-effector transmission, very probably operating *via* prejunctional purinergic receptors (Burnstock *et al.* 1984). Glycoside antibiotics also act as inhibitors (Török *et al.* 1986). Carbamate local anaesthetics inhibit vascular smooth muscle contractions to nerve stimulation by affecting the pre- and postjunctional component (Török *et al.* 1986). The facilitating effect was shown for serotonin (Török 1989).

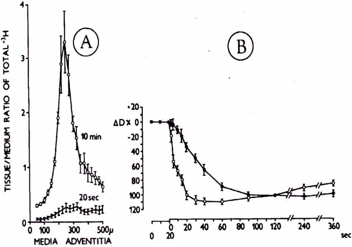

Fig. 2
A. Distribution of ^3H in rabbit aortic wall (due to diffusion) after the adventitial surface of the vessel was exposed to ^3H-norepinephrine (7.5×10^{-7} M) for 20 seconds and 10 minutes; B. Time course of diameter decrease of femoral artery (full dots) and consecutive arterioles (open dots) during stimulation of postganglionic fibers leaving L G3 – L G4 (rectangular impulses, supramaximal amplitude, 15 Hz).

V. Smieško and J. Török gathered basal data how the biomechanical parameters of blood flow affect the tone of vascular smooth musculature. Contraction of resistant vessels in the small intestine, in response to increased intravascular pressure was shown to be significantly greater, if the rise in blood pressure was induced from the venous portion; it becomes, however, smaller with increased extravascular pressure (Török 1975, 1980).

Smieško, using a detailed analysis of the time course of arteriolar response to ultrashort (one second) bidirectional intravascular pressure change found that it is always the ascendant component of the pressure change which induces the relaxation of the respective arterioles and an increase in blood flow. This response is distinctly different from the Bayliss phenomenon (Smieško 1971).

Convincing evidence was provided that besides blood pressure, the blood flow, inducing the alterations in shear stress, is an important determinant of vessel diameter and/or smooth muscle tone in all consecutive segments of the vascular tree including the microcirculatory area (Smieško *et al.* 1987, 1989). The crucial role of the endothelium in this regulating mechanism (Fig. 3) was demonstrated by Smieško *et al.* (1985). To maintain a stabilized pressure gradient in a given circulatory area and, consequently, to economize cardiac work, is the haemodynamic role of this phenomenon.

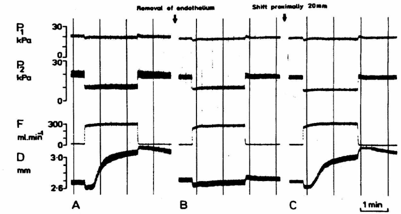

Fig. 3
Key role of endothelium in the control of arterial diameter (dog femoral artery, FA) by blood flow. Traces from top to bottom: inflow pressure (P_1), outflow pressure (P_2), blood flow (F) and diameter (D). A before, B after removal of endothelium, C with intact endothelium 20 mm proximally of site B.

Valuable data on the special type of smooth muscle in the ductus arteriosus Botalli (DA) were provided by the investigators at the Institute of Pharmacology, Medical School in Bratislava. A special oxygen induced constriction of the DA smooth muscle was described (Kovalčík 1963). Kriška and Kovalčík (1976) detected oxygen constrictor sensitivity during a short period before birth, although the DA smooth muscle responds well to vasoactive drugs in the second half of pregnancy. Together with Smieško (1978) they described significant constriction of DA as a response to the increase of blood pressure just before birth (Bayliss phenomenon).

The influence of kinins and of hormones on the reactivity of coronary and other vascular smooth muscles were studied in this department (Kovalčík 1962, Blašková *et al.* 1970, Krajčovičová *et al.* 1975, Mosnárová *et al.* 1989). Pharmacological influences on the developing atherosclerosis were also investigated (Kovalčík *et al.* 1989, Czirfusz *et al.* 1989).

At the Institute of Experimental Pharmacology (Slovak Academy of Sciences, Bratislava) the properties of smooth muscle of coronary artery, namely the receptors, were studied systematically. Dřímal (1968) and Dřímal *et al.* (1969) described a three-way effect of angiotensin: *(i)* a direct affect on coronary smooth muscle as well as an indirect one *via* the increased release of catecholamines which stimulate both the receptors *(ii)* in the coronaries and *(iii)* in the myocardium. The participation of $alpha_2$ receptors was shown in the blood flow response to ultrashort coronary occlusion (Dřímal 1983). The dynamics of changes of alpha- and beta-receptors after exposure of coronary arteries to ischaemia and histamine were described (Dřímal *et al.* 1988). A long-lasting constriction of coronary arteries causes a shift in H_1 : H_2 receptor ratio, so that histamine induces a constant constrictory response of the coronary artery (Sotníková *et al.* 1988). No alterations in coronary blood flow after beta blocker oxprenolol could be explained by simultaneous changes in its chronotropic effect (Dřímal and Aviado 1971). Dřímal (1988) found that coronary smooth muscle contains both high- and low-affinity calcium channel binding sites in a ratio 1:5.

A higher sensitivity to vasoactive drugs was shown in the mesenteric microvascular area of animals immobilized for 24 h (Nosáľová *et al.* 1975). A shock-like haemodynamic response was described after administering the polysaccharide-protein complex from Candida albicans (Nosál *et al.* 1979).

Circulation in skeletal muscle was studied by O. Hudlická at the Institute of Physiology (Czechoslovak Academy of Sciences in Prague). Blood flow and the metabolism of striated muscles during differentiation into slow and fast muscle types were described. The increase of oxidative metabolism is accompanied by an increase in blood flow, however, an increase in glycolytic metabolism is associated with a decrease in blood flow. During development of muscle atrophy due to tenotomy, denervation or immobilization, blood flow changes were small. It seemed that the blood supply for a weight unit might even be increased; possible vasodilating factors are apparently involved (Hudlická 1962a,b, Hudlická *et al.* 1964, 1967, Štulcová and Hudlická 1967) Hudlická left the country after 1968 but she has successfully continued to study skeletal muscle circulation abroad.

Hník with co-workers (1973, 1976) were searching for the factors which participate in hyperaemia in contracting skeletal muscles. Using liquid ion-exchanger microelectrodes they found an increase in potassium in the extracellular space ($[K^+]_e$) during muscle contractions and also in venous effluent blood. They concluded that the increase in $[K^+]_e$ influences the efficacy of all three components: vascular smooth muscle, striated muscle itself as well as afferent nerve endings.

L. Vacek in the Laboratory of Pathological Physiology, (Medical School in Brno) studied the relation between central haemodynamics and microcirculation (arterioles of 200 μm diameter up to venules of 200 μm diameter) in three vascular beds: skeletal muscle, skin and mesentery. The authors concluded that neither these vascular beds nor their consecutive portions actively contribute to the general pressure responses to noradrenaline, adrenaline, angiotensin, acetylcholine, bradykinin and serotonin. In contrast, it seems that the vasomotion in the respective vascular beds antagonizes the systemic blood pressure changes. In Goldblatt hypertensive rats a higher basal tone in the three above mentioned vascular beds was found. However, a paradoxical dilating ability in these areas was higher as compared to the controls (Vacek 1983, Vacek *et al.* 1989).

The main goals at the Department of Physiology (Medical School in Košice) was to ascertain the relations between circulation and respiration. Particular attention was paid to the haemodynamics during the cough. During normal breathing, blood pressure and the outflow from sinus coronarius decreases within the inspirium, peripheral resistance in the pulmonary artery region also diminishes. During expirium all the above parameters increase. The cough significantly decreases the coronary blood flow; the tracheobronchial cough induces significantly greater systemic blood pressure changes and coronary blood flow changes which are more prolonged than during the laryngo-pharyngeal cough (Ivančo and Vereš 1958, Ivančo *et al.* 1973, Samseli *et al.* 1976). The hypothalamic regulatory mechanism of cardiovascular and respiratory system are under study (Petriľák *et al.* 1967, 1975, Bračoková *et al.* 1983, 1984, 1988).

The respiratory and accompanying cardiovascular phenomena during stimulation of the upper airways, particularly nasal mucosa, were the object of studies at the Department of Physiology (Medical School in Martin). Javorka and Tomori (1976, 1977) detected a decrease in resistance in pulmonary circulation parallel to an increase of systemic peripheral resistance during chemical stimulation of nasal mucosa. They also described the role of the autonomic nervous system in eliciting the above cardiovascular changes.

Human Cardiovascular Research

Czechoslovakia has a prominent position in Europe with its long tradition in modern cardiovascular research. As our clinicians and scientists very soon became aware of the importance of multidisciplinary investigation of the multitude of cardiovascular problems seen in clinical practice, they established virtually the second Cardiological Society in Europe in 1929. This was intended "to study the physiology and pathology of the cardiovascular system " and organized the First International Congress of Cardiology in Prague in 1933.

Very early after the 2nd World War a true interdisciplinary center, the Institute for Cardiovascular Research, was founded in Prague in 1951. As a matter of fact, after Mexico (1944) and Bethesda, USA (1948) it was the third institution of this type in the world.

Besides this, human vascular physiology and blood pressure research were performed at the clinics of the Faculty of Medicine, Charles University in Prague and in other laboratories in Bratislava (Institute of Normal and Pathological Physiology, Slovak Academy of Sciences and the Medical Faculty of the Commenius University) and in Brno (Department of Physiology, Faculty of Medicine of the Purkyně University).

Research activities in Czechoslovakia moved forward the knowledge in the field of the regulation of central and peripheral haemodynamics, underlying physiological blood pressure changes as well as in the research of hypertension development. Among the older studies in this field, outstanding contributions concerned the classification of hypertension according to its clinical course (Vančura 1942) and various conditions changing the arterial elasticity and distensibility in man (Ipser 1953).

Based on the simultaneous determination of regional vascular resistances in as many important vascular areas in man as possible, Brod with his co-workers (1962) reported elevated renal, visceral and skin vascular resistances in human hypertension. The muscle blood flow – measured in the forearm – was, however, greater than normal and the haemodynamic pattern was similar to that found in normal subjects after an unpleasant emotional stimulus, during mmuscular exercise, or during the preparatory phase (Brod *et al.* 1959). From earlier work the authors had some evidence that – at least in the early stages of essential hypertension – this haemodynamic pattern is replaced by normal circulation at night during complete relaxation (Brod and Fencl 1957). These studies, which contributed to the evaluation of neurogenic mechanisms in the regulation of peripheral blood flow in man and revealed in early human hypertension a cardiovascular pattern so closely mimicking the hypothalamic defense reaction in animals, are still referred to in the literature and deserve particular mention. However, in these early studies the blood flow to other muscle groups during emotional load or in essential hypertension was not measured and the haemodynamics in the forearm muscles were considered to be representative of the conditions in other muscles.

As has been shown by Kellerová and Delius (1969) in simultaneous measurements in healthy men, the reactive changes in the skin and muscle blood flow in the extremities during psychoemotional stress were not uniform, showing lower skin as well as muscle vasomotor reactivity in the lower limbs, with significantly smaller calf blood flow increases as compared to the forearm. The same nonuniformity was also reflected in the muscle vasodilatation in hypertensive subjects at rest, with significantly increased total as well as capillary blood flows in forearm muscles. However, blood flow levels were almost unchanged or even decreased in the calf muscles (Kellerová *et al.* 1989, Ondrejička *et al.* 1974). This disbalance in vasomotor tone in hypertensive subjects can be levelled out by blocking adrenergic transmission (by guanethidine) and thus decreasing the blood flow in the forearm and increasing it partly in the calf muscle and skin (Fig. 4) (Pecháň *et al.* 1974).

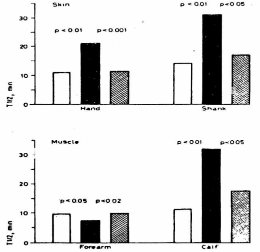

Fig. 4
^{131}I clearance-rate-inversed value of the capillary blood flow in subcutaneous tissue and muscle in hypertensive subjects before (black columns) and after (hatched columns) guanethidine application in comparison to clearance values in normotensive controls.

Findings about the higher values of minimal vascular resistance in muscles of hypertensive subjects (Romanovská *et al.* 1977) in the upper as well as the lower extremities showed that not only neurogenic but also structural alterations of the arteriolar wall are involved but again with a higher resistance in the lower extremity (Fig. 5) (Kellerová *et al.* 1989).

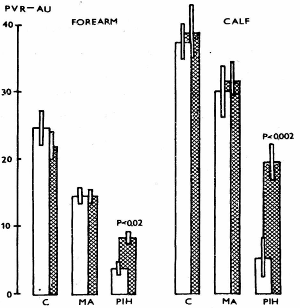

Fig. 5
Values of peripheral vascular resistance in the forearm and calf of normotensive subjects (white columns) and hypertensive patients (hatched columns) at rest (C), during vasodilatatory reaction to mental arithmetic (MA) and during postischemic hyperemia (PIH) after 3 min of arterial occlusion.

The increase in vasomotor tone in hypertensive subjects concerns not only the resistance (arteriolar), but also the capacitance (venous) system, as has been proved by decreased venous compliance (Ulrych 1979). This is also present after nitroglycerine administration, documented by decreased local blood volume (Přerovský *et al.* 1985, Roztočil *et al.* 1985) as well as by more pronounced increase of venous pressure in essential hypertension after a rapid hypertonic sodium chloride infusion (Hejl *et al.* 1963).

Original findings documented also the disturbances of microcirculation in essential hypertension. Clearance studies showed that the level of capillary blood flow in the skin of hands and in calf muscles was decreased in contrast to that in the forearm (Kellerová 1967, Ondrejička *et al.* 1974, Pecháň *et al.* 1974). Decreased values of the capillary filtration coefficient which were found in hypertensives by Roztočil *et al.* (1982) as well as the slowed down lymphatic outflow from the skin regions of the lower extremities described by Pecháň and Janotka (1974) could be normalized by guanethidine administration.

Studies of microcirculation by the isotope clearance technique, performed at the Faculty of Medicine in Bratislava stimulated original and systematic investigations of gingival circulation (Kovář and Pecháň 1968). Substantial reduction in gingival capillary blood flow was observed in emotional stress situations and under the influence of different stimuli (Kovář *et al.* 1989) during raised plasma oestrogen levels for contraception (Kovář *et al.* 1987) and, of course, in parodontopathies.

In pioneering haemodynamic studies on young hypertensives, Widimský *et al.* (1957,1958) documented an increased cardiac output at rest at early stages of hypertension that was associated (for the given cardiac output) with an inappropriately high vascular resistance. This early somewhat hyperkinetic stage of human primary hypertension has been an object of numerous further investigations of these and other authors.

Recently, Kellerová and Andrásyová (1990) published representative normal blood pressure values for neonates and factors concerning their physiological variability. The postnatal development of blood pressure during the first days of life, the gradual differentiation of blood pressure values in relation to wakefulness and sleep, its reactive changes in food intake (Kellerová, 1981) and specific influences of upright and prone body posture on neonatal blood pressure were described (Kellerová and Andrásyová 1990).

The haemodynamic readjustment during ontogenesis under various environmental influences have been elucidated in different models of experimental hypertension in rats at the Institute of Physiology of the Academy of Sciences in Prague (Albrecht, Dlouhá, Jelínek, Křeček, Kuneš, Zicha). Significant contribution of their studies to this field is reviewed in papers of Dlouhá *et al.* (1979, 1981), Křeček *et al.* (1987) and Zicha *et al.* (1982a,b).

Several studies have dealt with the chronobiological aspects of peripheral circulation and blood pressure in man, Peňáz (1958) analysed the spontaneous regulatory oscillations of blood pressure – the so-called waves of the third order – in relation to the dynamic properties of the vasomotor system, heart rate and respiration in man. With his co-workers he developed a detailed spectral analysis of spontaneous fluctuations of the above mentioned functions and their mutual relationships in the frequency band from 1–30 c/min (Fišer *et al.* 1978, Peňáz *et al.* 1978, Honzíková *et al.* 1990). Kellerová (1966, 1971) described spontaneous oscillations in vasomotor excitability with periodicities in the range of minutes. She also demonstrated the existence of circadian rhythms in blood pressure in neonates (Kellerová 1985) and the effect of synchronization of circadian rhythms in vasomotor activity in the skin and muscle on the resulting circadian oscillations of blood pressure (Kellerová and Kittová 1980).

The various groups working in the field of clinical physiology of peripheral circulation and blood pressure, contributed significantly to the development, evaluation and application of new diagnostic methods such as radioactive tissue clearance (Přerovský *et al.* 1967), rheoplethysmography (Sova and Vokoun 1952, Cachovan *et al.* 1968), measurement of blood flow by thermodilution (Froňek and Ganz 1960, Ganz *et al.* 1964) and others. Figar (1959) developed an original electrocapacitance plethysmograph and used it for measurement of blood supply to different parts of the body in various physiological situations and under psychological influences.

Due to the invention of the volume-clamp method, using photoelectric measurement in the finger, Peňáz (1973, 1989) introduced a continuous non-invasive beat-to-beat blood pressure measurement in man. Based on his results the devices FINAPRES and PORTAPRES are manufactured in the Netherlands.

Kellerová with co-workers (1977, 1978) significantly improved the noninvasive ultrasonic method for systolic as well as diastolic blood pressure measurement in neonates. According to the authors proposal the device is made by TESLA in Czechoslovakia.

Linhart and Přerovský with their co-workers from the Institute for Cardiovascular Research in Prague as well Prusík, Puchmayer, Reiniš and others from the Faculty of Medicine, Charles University in Prague, investigated for years another group of projects, connected with the topics of this review, but more clinically oriented. Results of these studies on diseased arteries and varicose veins were presented mainly at the platform of clinical angiology.

Concluding this review it has to be marked out, that practically all included studies have an high impact factor, several of them – as they represent advance in knowledge progressed into monographs and handbooks – were presented with success at many international meetings and some of the research groups organized in our country special international workshops to the topics.

The authors are aware of the fact, that this review by far has not met their own claims to give a complete picture of what was going on in the vascular physiology in our country during the last five decades. They therefore apologize for this both to their colleagues as well as to the readers.

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