

## CONCLUSIONS

1. AN consists of afferent fibers belonging to the A-delta group.
2. Electrical stimulation of AN fibers, with an intensity equivalent to non-noxious stimulation, is sufficient to activate fibers of the dorsal and ventral trigeminal tracts and also neurons of the caudal trigeminal nucleus at a level 3 mm caudally to the obex.
3. Neuronal units of the paramedian and lateral reticular nuclei can be excited by electrical stimulation of AN fibers equivalent in intensity to both noxious and non-noxious stimulation.

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## AGE DIFFERENCES IN FUNCTIONAL PROPERTIES OF VASCULAR SMOOTH-MUSCLE CELLS

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KEY WORDS: Vascular smooth-muscle cells; age changes; membrane potential; spontaneous electrical and contractile activity.

An important role in the formation of vascular tone is played by the state of the smooth-muscle cells (SMC) of the blood-vessel wall. Consequently, to understand mechanisms of age changes in vascular tone, it is essential to study the basic properties of SMC of the vascular wall at different stages of individual development. Considerable progress has been made in the study of the function of vascular SMC of adult animals [2, 7, 11, 12], but as yet age differences in the physiological properties of these effector formations have received little study.

The object of the present investigation was to study the electrical and contractile properties of vascular SMC in animals of different ages.

## EXPERIMENTAL METHOD

Experiments were carried out on isolated segments of the portal vein of rats of three age groups: 3-4 weeks (young), 6-8 months (adult), 26-28 months (old). The level of the membrane potential (MP) and the spontaneous electrical activity possessed by the SMC of this vessel were recorded by intracellular microelectrodes. Spontaneous contractile activity was studied by means of a mechanical to electrical transducer. The levels of MP and electrical

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TABLE 1. Some Electrophysiological Characteristics of SMC of the Portal Vein in Rats of Different Ages

Index, mV	Age of animals								
	3-4 weeks		6-8 months			26-28 months			
	M ± m	n	M ± m	n	P <sub>1</sub>	M ± m	n	P <sub>2</sub>	P <sub>3</sub>
MP of "silent" cells	41±6	15	40,3±3,6	28	>0,5	54±5,5	43	<0,05	<0,05
MP of active cells	41,7±7,6	41	28,7±4,1	25	<0,05	39±4,7	23	<0,05	>0,01
Amplitude of action potentials	15±4,6	102	18,3±3,2	90	>0,5	28±3,9	217	<0,05	<0,05

**Legend.** Here and in Table 2: P<sub>1</sub>) significance of differences between groups of animals aged 3-4 weeks and 6-8 months; P<sub>2</sub>) aged 26-28 months and 6-8 months; P<sub>3</sub>) aged 26-28 months and 3-4 weeks; m) number of measurements.

TABLE 2. Principal Parameters of Spontaneous Fast Contractions of GMC of Portal Vein in Animals of Different Ages

Index	Age of animals								
	3-4 weeks		6-8 months			26-28 months			
	M ± m	n	M ± m	n	P <sub>1</sub>	M ± m	n	P <sub>2</sub>	P <sub>3</sub>
Strength of contraction, mg	90±25	162	249±38	169	<0,001	600±60	168	<0,001	<0,001
Duration of contractions, sec	1,97±0,2	140	1,63±0,15	127	<0,05	5,3±2	135	<0,001	<0,001
Duration of increase in contraction, sec	0,89±0,05	140	0,81±0,1	127	>0,2	2,85±1,5	135	<0,01	<0,01
Duration of relaxation, sec	1,26±0,1	140	0,82±0,07	127	<0,001	2,46±1,2	135	<0,001	<0,001
K, units	0,77±0,09	140	0,98±0,1	127	<0,05	1,2±0,09	135	<0,05	>0,05
Maximal rate of contraction, mg/sec	166±5	120	328±24	120	<0,01	220±12	114	<0,001	<0,05
Maximal rate of relaxation, mg/sec	102±4	116	264±23	112	<0,01	200±25	114	<0,05	<0,02

and contractile activity were recorded synchronously by means of a two-channel electronic automatic writer, and photographically from the oscilloscope screen.

#### EXPERIMENTAL RESULTS

The experimental results showed that spontaneous electrical activity is not observed in all SMC of the portal vein. With age there was a decrease in the relative number of active cells from  $75.3 \pm 9.3\%$  in young animals to  $45.6 \pm 12\%$  in adult and to  $32.3 \pm 7\%$  in old animals. The relative number of cells without spontaneous electrical activity (silent cells) increased correspondingly with age.

An essential indicator of the state of the cell is the level of MP. As Table 1 shows, during individual development this indicator changes its value, and it differs in active and "silent" cells. The mean value of MP in the latter is less in young and adult animals and greater in old animals. In active cells, on the other hand, MP is lower in adult than in young animals, and in old age it increases again. Several workers have shown that the MP level in cells of different tissues changes variously [5, 8]. The reason is evidently that with age ionic asymmetry changes significantly, and changes also take place in glycolysis and oxidative phosphorylation [1, 4].

The study of spontaneous electrical activity of SMC showed that the amplitude of action potentials of SMC differ only a little in young and adult animals (Table 1), but in old animals this amplitude rises significantly.

The smooth-muscle layer of the portal vein possesses marked spontaneous contractile activity, which undergoes significant changes during age development. In the present investigation the strength of spontaneous fast contractions and their time course were determined. Table 2 shows that the duration of the contractions and time relationships between their in-

dividual phases changed with age. The longest spontaneous contractions were observed in segments of blood vessels from old animals. In this age group the rise time of contraction and the relaxation time were increased. The coefficient K (the ratio of the rise time of contraction to the relaxation time) also increased with age. An increase also was observed with age in the strength of fast contractions (Table 2), and the increase was greater than that of the weight of the segments of the vessels studied. When these results are discussed, it must be recalled that hypertrophy and hyperplasia of SMC of the portal vein take place with age [9, 10].

The maximal rate of rise of contraction and the maximal rate of relaxation of SMC of the portal vein also were investigated. These parameters are less dependent on the number of cells taking part in contraction, and they characterize their functional capacity to some degree [6]. Although the mean indices of the strength of fast contractions of the segments of the portal vein were highest in old animals (Table 2), the maximal rate of rise of contraction and relaxation were less in these animals than in the adults. In young animals these indices also were lower than in adults. It can thus be tentatively suggested that SMC of the portal vein of adult animals differ functionally from SMC of both young and old animals.

During age development considerable changes take place in the electrical and contractile properties of SMC of the portal vein. These changes play an essential role in the mechanism of the change in function of vascular SMC during individual developments.

Changes in tone of the portal vein may be of great importance for the portal hemodynamics. Some workers interpret the appearance of spontaneous activity in SMC of the portal vein as an adaptation to new conditions of the circulation [12]. With age, the conditions arise for obstruction to the blood flow of this region [3]. Changes in the electrical and contractile activity of SMC of this vessel in individual development and, in particular, in old age may play an important role in maintenance of the normal hemodynamics of the portal system through their participation in the mechanism of regulatory influences on tone and contractile activity of the portal vein.

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