

CHANGES IN ARTERIAL PRESSURE OF DOGS IN ONTOGENESIS

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Arterial pressure of dogs at different age periods starting from the first days of life was recorded with an electromanometer. During the first days the diastolic pressure was 48 ± 8.2 and the systolic 83 ± 3.49 mm Hg. In adult dogs the diastolic pressure increases slightly to 55.6 ± 2.17 mm Hg but the systolic pressure rises far more (147.4 ± 5.55 mm Hg). The increase in systolic and pulse pressure takes place at the time when the first signs of tonic excitation of the vagus centers of the heart appear, and it becomes particularly marked in dogs at the age of 2.5-3 months or more. From the time of appearance of tonic excitation of the vagus centers of the heart and slowing of the heart rate, the duration of the systolic portion of the pulse wave decreases relative to the total duration of the wave. The working efficiency of the heart increases with age.

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During postnatal ontogenesis in dogs the heart rate (HR) falls on the average from 220 to 90-60/min while the arterial pressure rises [1, 3-7, 9].

In the present investigation the arterial pressure was studied during ontogenesis by means of an electromanometer.

EXPERIMENTAL METHOD

By means of electromanometric recording accurate determinations can be made of the systolic (SP) and diastolic (DP) pressures in puppies of different ages, the duration of the pulse wave, and also the durations of its systolic and diastolic portions. The pressure in the femoral artery was recorded under acute experimental conditions by an "Orion" electromanometer. In very young puppies (under 1.5-2 months) the measurements were made without anesthesia, and only data obtained on puppies whose heart rate during the experiment corresponded to the natural rate under normal waking and resting conditions were used for analysis. Older puppies (2.5 months and above) and adult dogs were anesthetized with morphine during the experiment, and their heart rate coincided almost completely with that in a state of complete rest. Experiments were carried out on 30 puppies of various ages (from one day to three months) and seven adult dogs.

EXPERIMENTAL RESULTS

The first group of puppies included those up to the age of 16-18 days, whose cardiac activity is under the control of centers of sympathetic innervation [3-5, 7]. The duration of the pulse wave, equal to the duration of the cardiac cycle [10], was 0.3 ± 0.03 sec. The duration of the systolic component was 0.085 ± 0.0065 sec ($28.5 \pm 1.16\%$ of the duration of the waves), and the duration of the diastolic component was 0.22 ± 0.08 sec ($71.5 \pm 1.11\%$). The mean HR was 180-220/min, the mean SP 83 ± 3.49 mm Hg, the mean DP 48 ± 8.2 mm Hg, and the pulse pressure (PP) 35 ± 2.66 mm Hg. The mean arterial pressure of these puppies was 65.4 ± 2.77 mm Hg. The PP at this age was $55 \pm 3.48\%$ of the mean. No catacrotic waves were seen on the arterial pressure curve (Fig. 1a).

The first signs of tonic excitation of the vagus center of the heart appear in puppies at the age of 16-18 days [5-9], when the HR begins to fall and the duration of the pulse wave increases. In the puppies of the second age group (from 18-20 days to 2-2.5 months) the duration of the pulse wave was 0.36 ± 0.008 sec,

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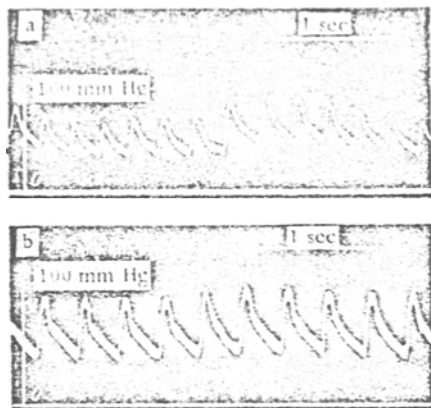


Fig. 1. Curves of blood pressure in femoral artery of puppies aged 4 days (a) and 20 days (b). The rise of the curve corresponds to a respiratory fluctuation in blood pressure.

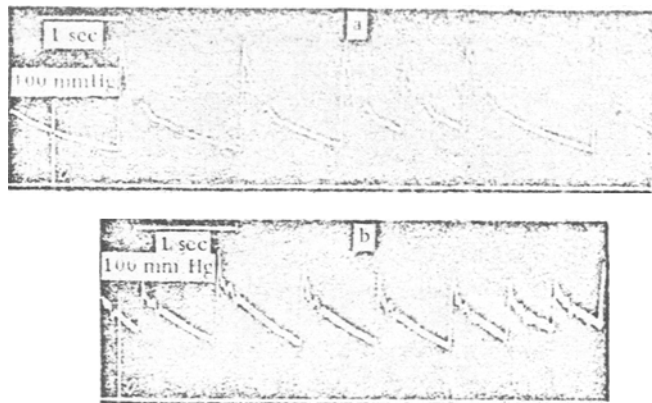


Fig. 2. Curves of blood pressure in femoral artery of a puppy aged 2.5-3 months (b) and an adult dog (a).

the duration of the systolic component 0.072 ± 0.0062 sec ($19.8 \pm 2.3\%$ of the whole pulse wave), and the diastolic 0.29 ± 0.008 sec ($80 \pm 2.22\%$). The value of HR was 140-160/min, SP 96 ± 3.62 mm Hg, DP 51 ± 3.88 mm Hg, PP 44 ± 1.66 mm Hg, and the mean arterial pressure 73.4 ± 3.65 mm Hg. At this age, PP was $60.8 \pm 4.35\%$ of the mean pressure. A catacrotic wave could only just be distinguished on the arterial pressure curve of the puppy aged 20 days (Fig. 1b). Well marked catacrotic waves were seen on the curves for puppies aged 1.5-2 months.

The constant tonic excitation of the vagus center of the heart becomes established after the age of 2.5-3 months [5, 7-9]. In our experiment the HR of the puppies of the third age group (2.5-3 months) fell to 90/min. Because of sinus arrhythmia, the duration of the pulse wave varied from 0.5 (during inspiration) to 0.9 sec (during expiration, with a mean value of 0.7 ± 0.038 sec). The duration of the systolic component was 0.052 ± 0.0031 sec ($9.2 \pm 1.34\%$ of the total duration of the pulse wave), while the duration of the diastolic component was 0.65 ± 0.045 sec ($90.8 \pm 1.35\%$). Well-marked catacrotic waves were present, giving the curve a polycrotic character (Fig. 2b). The arterial pressure of the puppies of this age group was much higher than in the animals of the preceding groups: SP 122 ± 1.47 mm Hg, DP 53 ± 4.2 mm Hg, PP 69 ± 3.25 mm Hg, mean arterial pressure 87 ± 2.6 mm Hg. At this age, PP was $79.7 \pm 5.94\%$ of the mean pressure.

Age group 4 included adult dogs in which the level of tonic excitation of the vagus center of the heart is highest [3, 5, 8-10]. Accordingly their HR fell to 60, or even slightly below, and this was accompanied by an increase in the severity of the sinus arrhythmia. Their pulse wave duration increased to a mean value of 1.11 ± 0.055 sec (with fluctuations from 0.7 sec in the phase of inspiration to 1.4 sec during expiration). The duration of the systolic component was 0.06 ± 0.0057 sec, or $6 \pm 0.68\%$ of the pulse wave duration, the diastolic component being 1.05 ± 0.062 sec ($94 \pm 0.686\%$). Only one, but a clearly defined dicrotic wave, was present on the diastolic component (Fig. 2a). SP 147.4 ± 5.55 mm Hg, DP 55.6 ± 2.17 mm Hg, PP 91.8 ± 5.46 mm Hg, mean arterial pressure 101.5 ± 5.46 mm Hg. In adult dogs with well marked vagal tone, PP was $90 \pm 4.56\%$ of the mean pressure.

Hence, during postnatal ontogenesis the arterial pressure of the dogs rose mainly because of an increase in SP and PP, the value of DP increasing only slightly. The increase in SP and PP was mainly attributable to an increase in the stroke volume of the heart [10], which is observed during ontogenesis. The fact that DP remains at a comparatively low level in adult dogs evidently ensures economy in the work of the left ventricle. In addition, the decrease in duration of the systolic component relative to the duration of the whole pulse wave, which we found in dogs from the time that they acquire vagal tone demonstrates shortening of the relative duration of cardiac systole, suggesting a further increase in working efficiency of the myocardium. It is important to note that with the appearance of tonic excitation of the vagus centers of the heart, the systolic index (i.e., ratio between the duration of electrical systole and the duration of the cardiac cycle [2, 8]) falls, affording further evidence of increased working efficiency of the myocardium.

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