

# The Influence of Transcranial Electrostimulation on Blood Pressure in Dogs with Modeled Hypertension

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**Abstract**—The present article describes the results of the transcranial electrostimulation (TES) for the correction of blood pressure (BP) in dogs. During the experiment, systolic blood pressure (BPs), diastolic blood pressure (Bpd), pulse pressure (PP), and mean blood pressure (MBP) were registered. It was established that TES mode that switched on the electrodes feeding that were fixed on the animal head at constant current (gradually increasing from 0 to 6 mA) with further switching to 75 Hz 4.0 mA square-wave pulse (impulse duration – 3.5 ms) for 30 minutes exerted corrective effect on blood pressure in dogs with pharmacologically modeled hypertension. The results of the performed tests showed that after the injection of mesatone, midodrine, and norepinephrine, the studied BP parameters elevated in all the dogs. In animals from the test groups that were injected drugs in combination with TES, the BP parameters increased insignificantly ( $p > 0.05$ ). In the dogs from the control groups, the increase in the BP parameters was significant in the majority of cases ( $p < 0.05$ ). The most significant differences between the studied parameters were observed in groups that received mesatone in combination with TES. It was revealed that after the injection of the drug and performance of TES in animals from the test group, BPs ranged within  $139.7 \pm 8.8 - 146.6 \pm 8.7$ ; Bpd ranged within  $78.8 \pm 6.8 - 80.0 \pm 5.0$ ; PP –  $60.0 \pm 5.8 - 67.8 \pm 5.7$ ; MBP –  $99.7 \pm 7.8 - 101.4 \pm 7.0$  mmHg. In animals from the control group that did not receive TES, the parameter values were higher and ranged within  $151.0 \pm 8.8 - 170.5 \pm 8.9$ ;  $80.3 \pm 6.4 - 98.9 \pm 7.3$ ;  $70.0 \pm 7.0 - 71.6 \pm 6.9$ ;  $103.9 \pm 8.0 - 122.8 \pm 8.1$  mmHg, respectively. It is recommended to use TES in practical veterinary to the correction of blood pressure in dogs.

**Keywords** - blood pressure, hypertension, hypotension, mesatone, midodrine, norepinephrine, pulse pressure, dogs, mean blood pressure, transcranial electrostimulation

## I. INTRODUCTION

One of the most acute issues in modern veterinary is the study of mechanisms of adaptation of animals to the influence of different extreme factors. During the

adaptation, there are changes in the functional systems of the animal organisms are observed that mobilize protective-adaptive reactions. The cardiovascular system plays an important role in these changes because it provides the organism's possibility to maintain homeostasis, in particular, to maintain blood pressure at the physiological level. It is known that hypertension is more often in dogs than hypotension. Blood pressure in dogs can get elevated in animals with kidney diseases associated with Sodium retention, hyperthyroidism, hyperadrenocorticism, cardiac diseases, and in senile animals [1, 2].

Presently, for the normalization of blood pressure in dogs, drugs are used that exert different pharmacological effects. At the same time, most of these drugs provoke adverse side effects. Thus, the search for new methods of the non-invasive mechanisms of the regulation of hemodynamics is acute in practical veterinary.

Such methods include transcranial stimulation (TES) that is widely used in medicine. In particular, it is used for the normalization of hemodynamics [3,4], treatment of vegetovascular dystonia [5], and arterial hypertension [2,6].

At the same time, TES is hardly used for the correction of blood pressure in the veterinary.

Taking into account the relevance of the specified problem, the present study aimed to evaluate the influence of TES on the blood pressure in dogs with hypertension that was modeled with pharmacological drugs (mesatone, midodrine, norepinephrine).

## II. EXPERIMENTAL

The study was performed at the facilities of the veterinary clinics of the Kursk State Agricultural Academy and included German shepherds and nonpedigree dogs that were used in different tests after a 10-day equalizing period. There were three series of experiments performed.

During the 1<sup>st</sup> experiment, the authors studied the influence of TES on blood pressure in dogs with hypertension that was modeled with the injection of mesatone for 3 days in a row. The dogs from Group I (test) had i/v infusion of the drug at the dose of 5 µg/kg/min. The dose, the concentration of the drug in the infusion solution, the volume of the solution, and the rate of infusion were calculated for each animal individually. Punction and catheterization of v. cephalicalateralis/medialis with intravenous catheters 18G – 24G (depending on the dog size) were performed for the intravenous infusion. Along with mesatone infusion, the dogs received TES with “Transair-2” (“Center-TES” of the Institute of Physiology named after Pavlov I.P, Saint Petersburg) in the mode that switched on the electrode feeding of constant current that gradually increased from 0 to 6.0 mA. Further, the electrodes were switched to 75 Hz 4.0 mA square-wave pulse (impulse duration – 3.5 ms). The electrodes of the present construction (Patent RF No. 162193) were placed on animal’s head: cathode – in the area of the frontal bone, anode – in the area of the occipital bone.

The 2<sup>nd</sup> experiment included two groups of dogs with hypertension modeled with midodrine.

Dogs from Group I (test) received the drug for 3 days at the dose of 1.25-2.5 mg (depending on the body weight) per animal 30-40 minutes before the performance of TES. Electrostimulation was performed once a day in the mode described in the 1<sup>st</sup> experiment. Dogs from Group II (control) received midodrine without the performance of TES.

In the 3<sup>rd</sup> experiment, hypertension was modeled with norepinephrine. The dogs from Group (test) had the drug injected i/v at the dose of 0.1 µg/kg/min once a day for 3 days. Along with this, TES was performed once a day. The dogs from Group II (control) had norepinephrine injected without the performance of TES.

All the animals included in the study were monitored. The authors recorded their behavioral reactions and general clinical parameters. Blood pressure was measured with a tonometer PetMAP (USA). Such parameters as systolic blood pressure (BPs), diastolic blood pressure (BPd), pulse pressure (PP), and mean blood pressure (MPB) were recorded.

### III. RESULTS AND DISCUSSION

The results of the 1<sup>st</sup> experiment that included dogs with hypertension modeled with mesatone showed that before the experiment, the studied parameters in dogs from the test and the control groups were within similar range: BPs – 138.8±7.4 – 141.0±10.3; BPd – 73.7±6.2 – 76.4±9.0; PP – 64.6±8.7 – 65.1±6.9; MBP – 95.4±7.5 – 97.9±9.4 mmHg (Fig. 1).

On the 1<sup>st</sup> day of the experiment, the studied BP parameters in all the dogs elevated. However, in animals from Group I (test), they were lower (BPs – 148.4±9.8; BPd – 79.3±8.8; PP – 69.1±8.4; MBP – 102.3±8.7 mmHg) in

comparison with dogs from Group II (control) (BPs – 102.3±8.7 mmHg) in comparison with dogs from Group II (control) (BPs – 150.1±8.1; BPd – 89.4±7.6; PP – 60.7±7.0; MBP – 109.9±10.4 mmHg). In the following days of the experiment, test animals had a further elevation of the studied BP parameters. In dogs from Group I (test), BPs ranged within 148.4±9.8 – 154.0±7.0; BPd – 79.3±8.8 – 80.6±6.3; PP – 69.1±8.4 – 73.5±7.9; MBP – 102.3±8.8 – 105.0±9.4 mmHg, and in dogs from Group II (control): 150.1±8.1 – 189.0±7.9; 89.4±7.6 – 100.3±7.1; 60.7±7.0 – 88.7±7.7; 109.6±10.4 – 129.9±9.4 mmHg, respectively.

Biometric analysis of the revealed changes showed that in groups that received mesatone and TES, these changes were insignificant ( $p>0.05$ ). At the same time, in dogs that received methadone only, the established changes were statistically significant ( $p<0.05$ ).

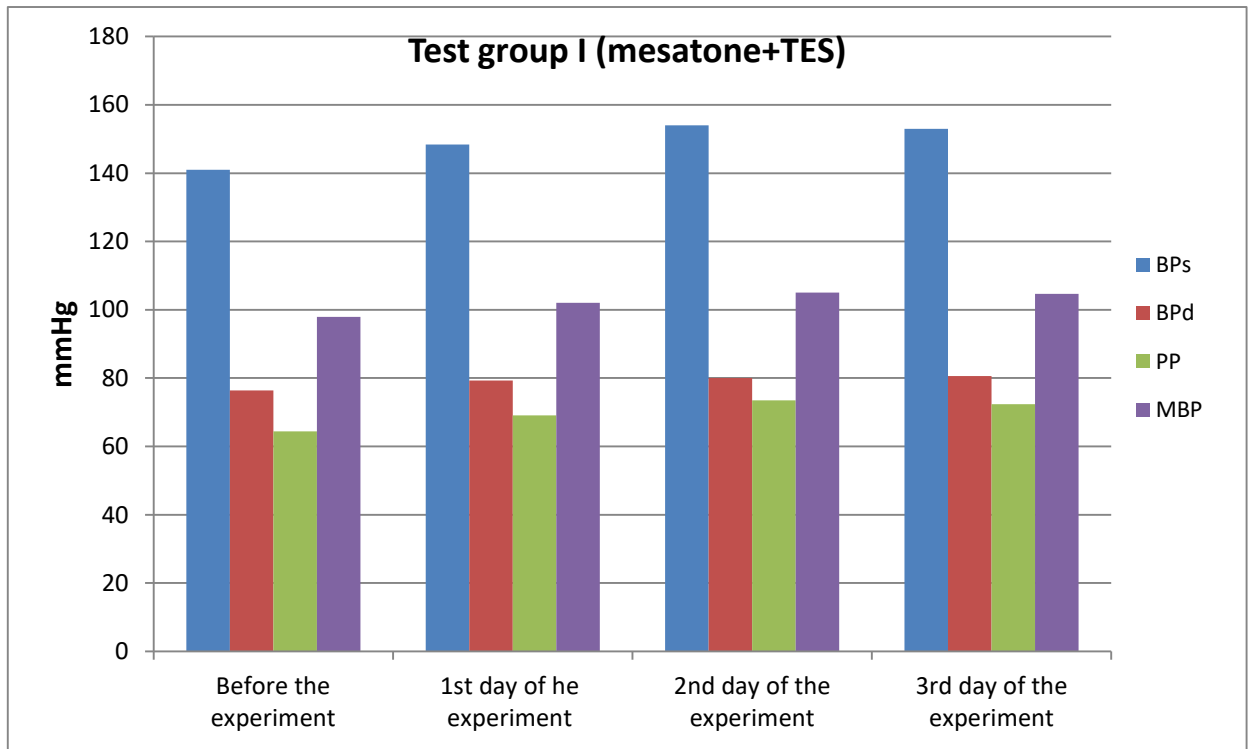
During the 2<sup>nd</sup> experiment, it was established that after the administration of midodrine, BP in dogs from both groups elevated. Thus, before the experiment, the studied parameters ranged within the following values: BPs – 135.0±9.1 – 136.9±7.5; BPd – 74.0±6.0 – 76.3±6.3; PP – 58.7±5.0 – 62.9±6.8; MBP – 95.0±7.3 – 95.9±7.7 mmHg and, during the experiment, they elevated (Fig. 2).

In dogs that received midodrine in combination with TES, the studied parameters were relatively low and ranged within the following values: BPs – 139.7±8.8 – 146.9±8.7; BPd – 78.8±6.8 – 80.0±5.0; PP – 60.0±5.8 – 67.8±5.7; MBP – 99.7±7.8 – 101.4±7.0 mmHg. In dogs from the control group, these parameters were higher and ranged within the following values: 151.0±8.8 – 170.5±8.9; 80.3±6.4 – 98.9±7.3; 70.0±7.0 – 71.6±6.9; 103.9±8.0 – 122.8±8.1 mmHg.

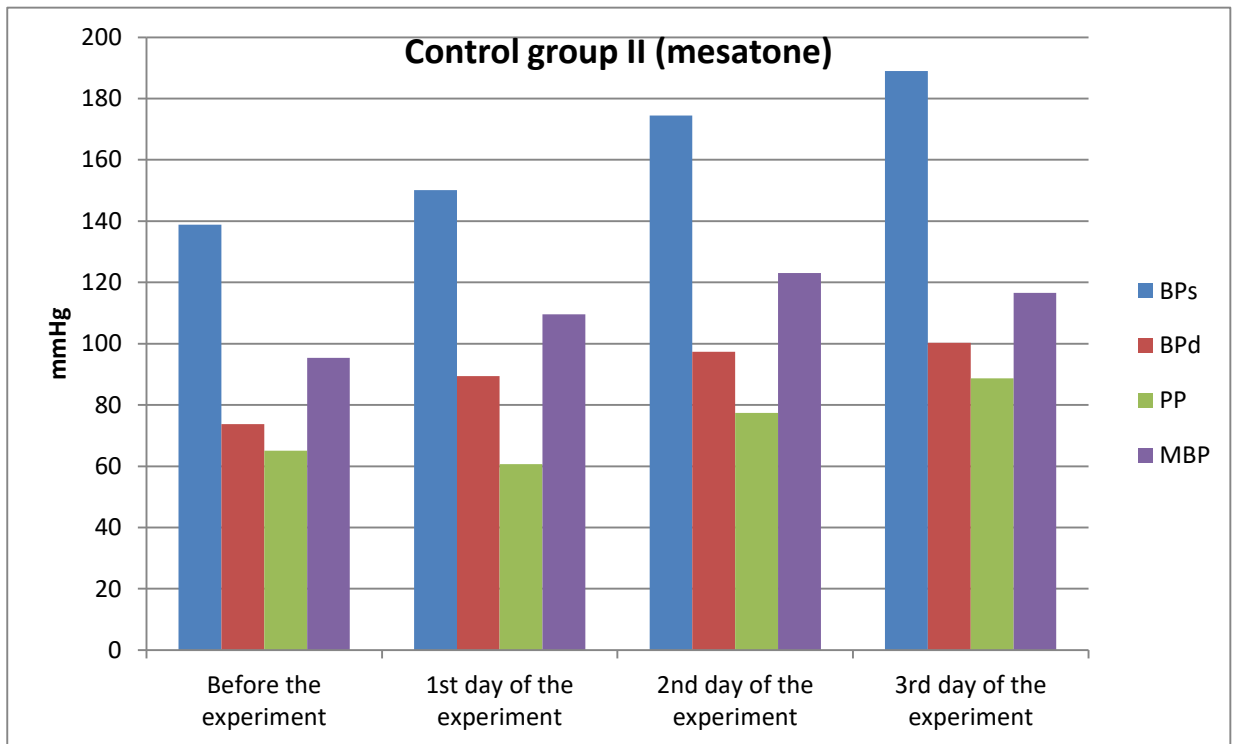
Biometric processing of the obtained data showed that the increase in BPs and BPd in dogs that received midodrine without TES was significant ( $p<0.05$ ), and the changes in these parameters in dogs from Group I (test) were insignificant ( $p>0.05$ ).

The results of the 3<sup>rd</sup> experiment showed that after the administration of norepinephrine in combination with TES, the BP parameters in dogs from Group I (test) decreased in comparison with dogs from group II (control) that did not receive TES (Fig. 3).

Thus, during the experiment, the dogs from the test group had BPs 148.5±9.8 – 155.8±10.3; BPd – 78.0±7.9 – 81.4±7.7; PP – 69.3±6.8 – 74.9±7.4; MBP – 101.5±7.9 – 105.9±8.5 mmHg, and the dogs from the control group had the parameters ranging within the values 156.7±12.3 – 174.1±9.8; 79.9±7.7 – 97.7±7.3; 76.4±7.0 – 80.2±7.3; 105.5±8.3 – 123.2±8.9 mmHg, respectively. It should be mentioned that the changed in BP in animals from the control group were more expressed in comparison with other parameters and were statistically significant ( $p<0.05$ ).

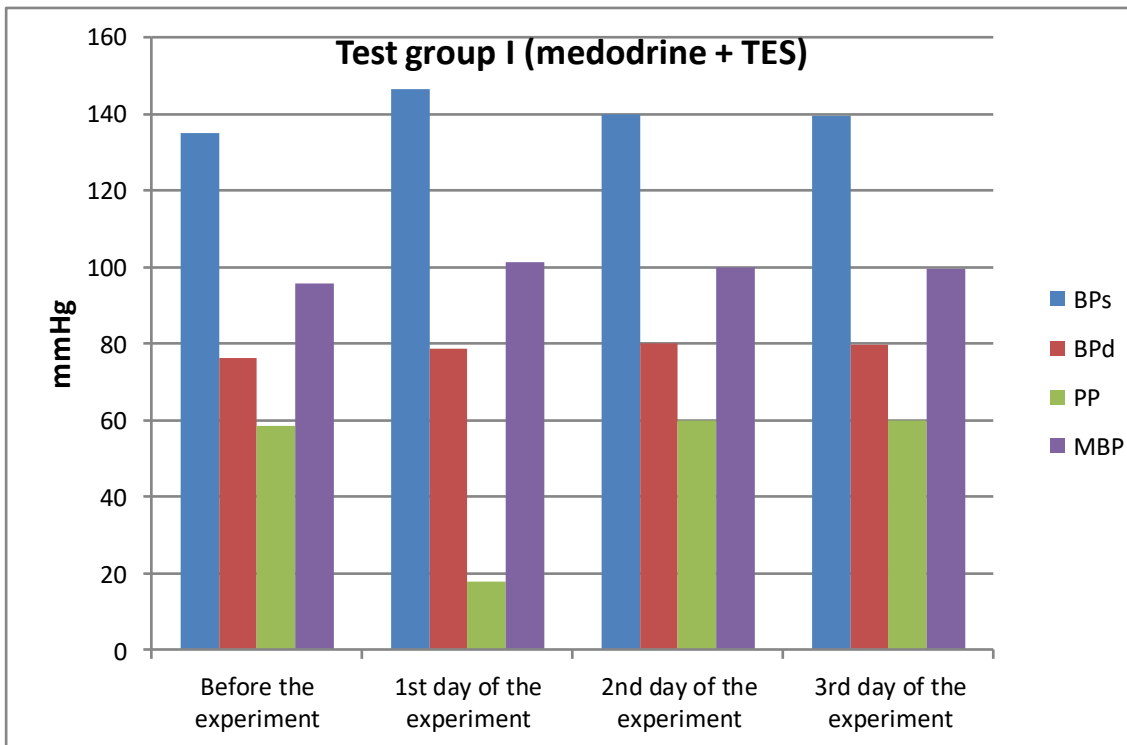


A

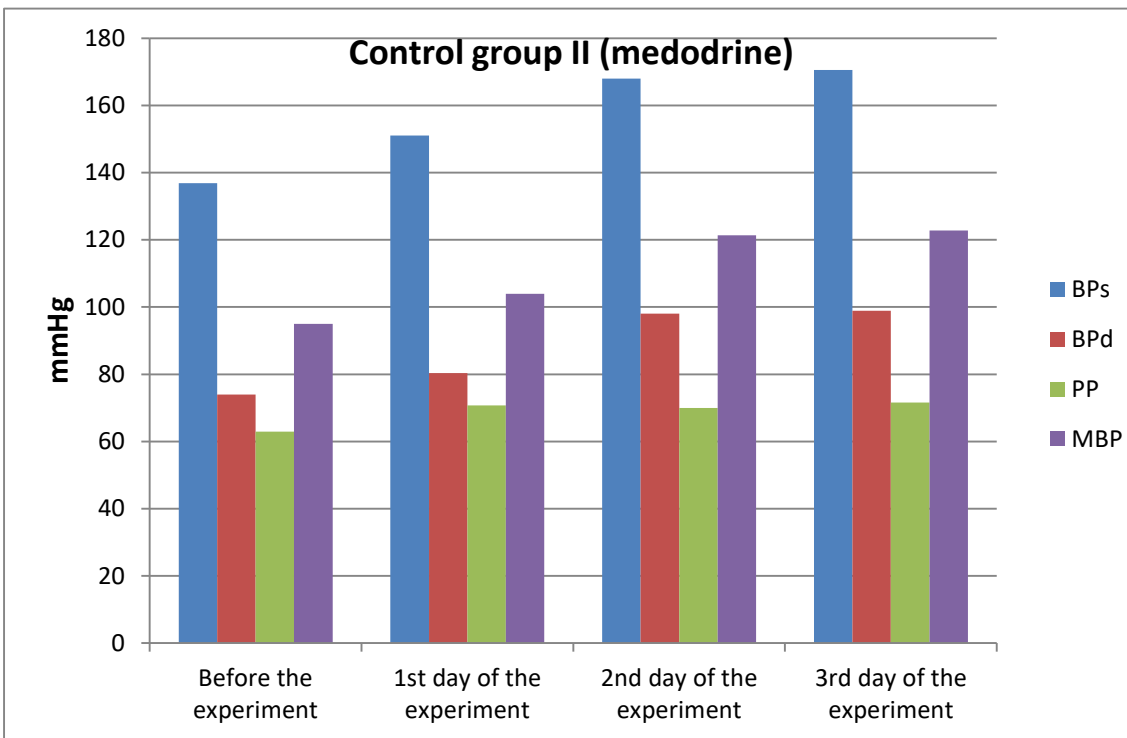


B

Fig. 1. Dynamics of the parameters of blood pressure in dogs after the performance of mesatone +TES (A) and injection of mesatone (B)

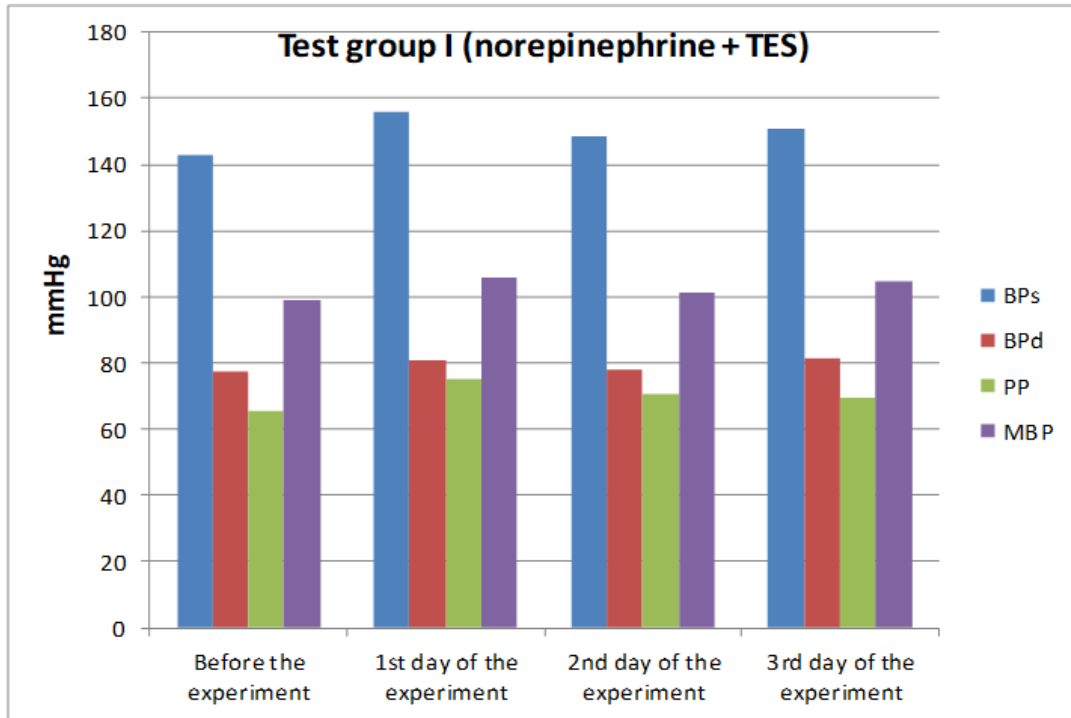


A

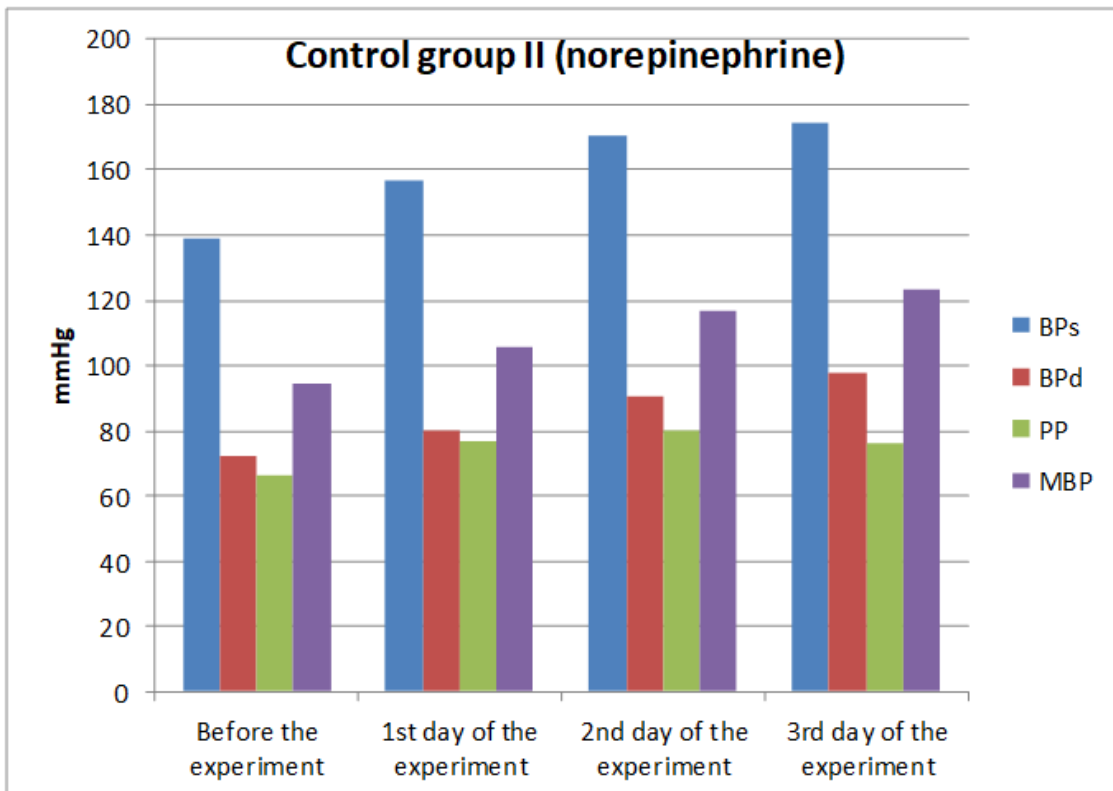


B

Fig. 2. Dynamics of the parameters of blood pressure in dogs after the performance of midodrine +TES (A) and injection of midodrine (B)



A



B

Fig. 3. Dynamics of the parameters of blood pressure in dogs after the performance of norepinephrine + TES (A) and injection of norepinephrine (B)

#### IV. CONCLUSION

The conducted series of experiments showed that TES in animals in the specified mode activated opioidergic mechanisms associated with the emission of endogenous opioids into the bloodstream and cerebrospinal fluid, which exerts the corrective effect on BP. Taking into account the obtained data, it can be concluded that TES in the specified mode can be recommended for the application in veterinary practice for dogs with hypertension.

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