

THE ROLE OF INTEROCEPTORS IN THE REGULATION OF BLOOD COAGULATION

COMMUNICATION 2. THE ROLE OF VASCULAR RECEPTOR ZONES OF THE CAROTID SINUS AND THE ARCH OF THE AORTA IN ACCELERATION OF BLOOD COAGULATION IN ACUTE BLOOD LOSS

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The phenomenon of accelerated coagulation of blood in acute blood loss, which is a protective measure, has been described by many authors [2, 3, 5, 6, 10 and others]. It has been established that secretion of adrenalin by the suprarenals [1, 9 and others] is of great importance in this reaction, but the mechanisms have not until now received adequate study. Taking into account the practical value of investigation of protective mechanisms in blood loss, which is one of the most widespread forms of pathology in wartime and peacetime trauma, we undertook to investigate the part played by the carotid sinus and arch of the aorta interoceptors in accelerating coagulation of the blood in acute blood loss.

EXPERIMENTAL METHODS

Twenty-nine experiments were performed on rabbits and 10 on dogs. The experiments on rabbits were done without anesthesia, while those on dogs were performed under morphine-pentothal analgesia. In experiments on dogs kymographic records were made of respiration and of blood pressure in the femoral artery, (by means of a mercury manometer). The method for taking blood samples for determination of coagulation time was described in a previous communication [4]. Coagulation time of the blood was determined in a Bazarov apparatus placed in a water bath with a mercury-toluene thermoregulator which maintained the temperature in the apparatus at 36.5°. The thrombin titer was determined by the dilution method.

EXPERIMENTAL RESULTS

In the first series of experiments the effect of local carotid sinus anemia on blood coagulation was studied on 7 rabbits. A ligature was passed under the common carotid artery, after which the animal was allowed to rest for 1-1½ hours. In several cases the superficial dissection was carried out under local infiltration anesthesia (0.25% solution of novocain). After the interval the initial level of blood coagulation time was determined until comparatively constant results were obtained; this took as long as 2 hours in some experiments. When this initial level had been established the common carotid artery was tied off on one side. Following the ligation, coagulation time was estimated after 5 and 30 minutes. Definite acceleration of coagulation time was noted after 5 minutes in 6 out of 7 cases, no change being discernible in the case of 1 animal only. The average value of blood coagulation time was about 60% of the initial value (Fig. 1), i. e., was almost halved. By the 30th minute coagulation time approached the initial value despite the fact that the ligature was not removed from the artery. Adaptation of the carotid sinus receptors had evidently taken place.

N. N. Popova [8] observed acceleration of blood coagulation in dogs when both the common carotid arteries were ligated. Drawing an analogy with acute blood loss, Popova explains this by cerebral anemia and completely disregards the possible role of interoceptors in the genesis of this phenomenon.

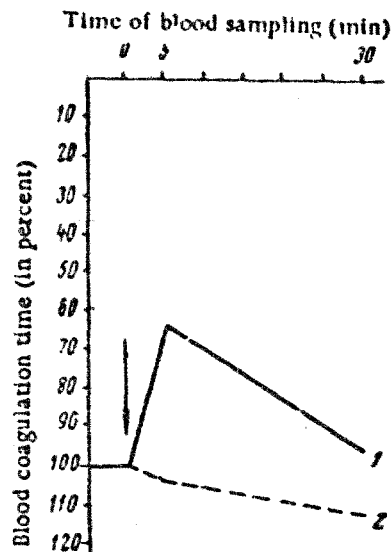


Fig. 1. Changes in blood coagulation time in rabbits following ligation of the carotid artery.

1) First series of experiments; 2) second series of experiments; | ligation of the carotid artery.

with preservation of carotid sinus receptor zones was, as a rule, accompanied by more marked acceleration of blood coagulation than in rabbits with transected sinus nerves. This difference was especially well marked 5 minutes after withdrawal of blood when the difference of the means exceeded its error more than 3-fold; this testifies to sufficiently high reliability of the difference between the mean values. The results of this series of experiments are presented in Fig. 2. Some acceleration of blood coagulation after withdrawal of blood was, however, also noted in animals with transected sinus nerves. It must be taken into account that the depressor nerves were left intact in these experiments.

Dogs (which are more resistant to acute blood loss) were used in further experiments in which the question was studied in greater detail. The experimental animals were again divided into two groups: the first group served as control and included 4 dogs, the second consisted of 6 dogs with denervated carotid sinuses and transected vagi, including the depressor fibers. Blood coagulation was determined prior to withdrawal of blood; immediately afterward, and then after 10, 20, 30, 45 and 60 minutes. The amount of blood withdrawn corresponded to 2% of body weight. According to literature data [2] such blood loss is accompanied by considerable shortening of coagulation time and increased thrombin titer; this was confirmed in the present experiments. The results of this series of experiments are presented in Fig. 3. There is a clear difference between the change in blood coagulation time following withdrawal of blood in normal dogs and in dogs with "elimination" of receptors in the carotid sinus and arch of the aorta. In the case of dogs with preserved innervation the shortening of coagulation time was considerable, averaging over 50%, and was most pronounced by the 20th-30th minute after withdrawal of blood. In the case of dogs with transected sinus and vagus nerves acceleration of blood coagulation time was considerably less marked and developed mainly directly after withdrawal of blood then disappeared and was replaced by slowing. In these animals there was no increase in thrombin titer either.

The present experiments fully confirmed the data on the predominant role of carotid sinus and aortal nerves in the adaptation reaction of the cardio-vascular system to blood loss [11, 12 and others]. Compensatory cardio-vascular changes are absent in animals with denervated carotid sinus and aortal zones: their blood pressure drops and does not recover following blood loss, whereas similar blood loss in control animals is associated with much less marked hypotension which is transient.

In order to determine whether the observed acceleration of blood coagulation was a reflex act or resulted from cerebral anemia, we staged a second series of experiments for control, in which rabbits were subjected to unilateral ligation of the internal carotid artery. The carotid sinus on the appropriate side was first denervated by section of the sinus nerve in order to prevent possible irritation of the sino-carotid zone. This excluded stimulation of the powerful vascular receptor zone while maintaining the same disturbances of cerebral hemodynamics as in the first series of experiments.

In this series of experiments, no reflex acceleration of blood coagulation was obtained (Fig. 1), and in 4 of the 7 experiments there was even some slowing of coagulation. These data agree with investigations [5] which had shown that anemia of various degrees could not be regarded as a physiologic regulator of autonomic centers and their activity and that cerebral anemia with preservation of normal carotid sinus reflexes led to a gradual diminution of activity in brain stem centers.

In the third series of experiments, 2 groups of rabbits had 6-10% of their total blood withdrawn; in the first group the sinus nerves were transected bilaterally. In the second group of animals the sinus nerves were left intact but incisions were made in the neck similar to those made in the first group. Withdrawal of blood

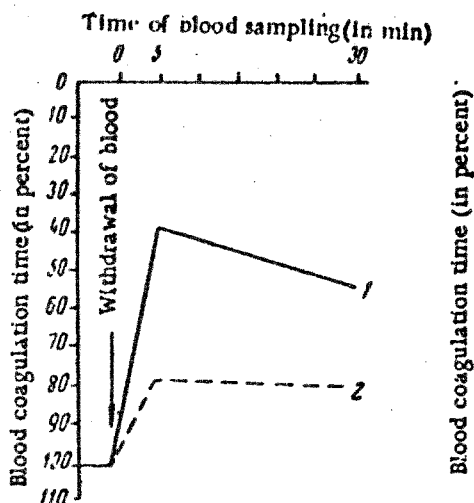


Fig. 2. Changes in blood coagulation time in rabbits following withdrawal of blood.

1) Experiments on normal rabbits; 2) experiments on rabbits with denervated carotid sinuses.

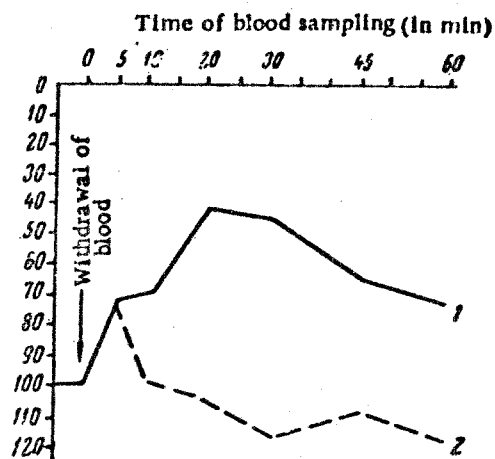


Fig. 3. Changes in blood coagulation time in dogs following withdrawal of blood.

1) Experiments on normal dogs; 2) experiments on dogs with denervated carotid sinus and aortal zones.

Acceleration of blood coagulation associated with excitation of the sympathetic-adrenalin system during acute blood loss is thus predominantly a reflex phenomenon dependent chiefly on the receptors on the carotid sinus and arch of the aorta. Together with hyperadrenalinemia, hyperglycemia, vasopressor reaction, tachycardia, hyperhydremia and other reactions accompanying acute blood loss, acceleration of blood coagulation is of great protective significance for the organism since it promotes cessation of hemorrhage.

Local anemia of carotid sinus zone elicits reflex acceleration of blood coagulation, while denervation of the carotid sinus and aortal zones impairs severely the protective acceleration of coagulation and rise of thrombin titer associated with acute blood loss.

SUMMARY

The role of interoceptors of carotid sinus and of the arch of aorta in acceleration of blood coagulation in acute blood loss was investigated. It was revealed by 29 experiments on rabbits and 10 on dogs that local anemia of sinocarotid zones causes reflex acceleration of blood coagulation. Blood loss in rabbits with denervated carotid sinuses is associated with the weaker response of acceleration of blood coagulation, than in normal animals. With exclusion of the sinus, depressor and vagus nerves the acceleration of the blood coagulation and increase of thrombin titer is not as considerable as following blood loss in the intact animals.

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