

PARTICIPATION OF AN INTEROCEPTIVE COMPONENT IN THE MECHANISM OF ALTERED KNEE JERK UPON INTRAVASCULAR ADMINISTRATION OF HYPERTONIC SOLUTION

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Substances administered intravenously inevitably come in contact with the tissues of the heart and lungs.

Numerous physiological [7, 8, 9] and morphological [1, 2, 3, 7] investigations show that the heart and lungs are a vast receptor field, extremely sensitive to chemical and mechanical stimuli.

We succeeded in showing earlier [5] that changes in the cortical motor response and the knee jerk reflex were much more pronounced on intravenous administration of hypertonic sodium chloride solution than when the latter was supplied directly to the brain by way of the common carotid artery. The same had been observed in other investigations [4].

The present work attempts to compare the changes in the knee jerk which arise upon administration of hypertonic NaCl solution into the heart with changes occurring when the solution is supplied to the spinal cord by way of the aorta in order to evaluate the role of the cardiac-pulmonary receptor field in the mechanism of action of the intravenously injected substance on the spinal reflex.

EXPERIMENTAL METHOD

The work was carried out in short-term experiments on cats under intravenous urethane anesthesia (1 g/kg). A fine, elastic chlorovinyl catheter was passed through the femoral or the external jugular vein into the right auricle and through the femoral or left carotid artery into the various parts of the aorta (arch, thoracic and abdominal). The knee jerk was elicited by automatic rhythmic strokes of a hammer of standard strength and frequency of once per 2 seconds, applied to the tendon of the quadriceps femoris muscle. The limb was fixed in a rack by means of a pin through the lower third of the femur.

During the experiments the following were recorded: blood pressure in the common carotid artery, respiration in the trachea, knee reflex (extension of the shin) with the help of two Marey's tambours.

Hypertonic (20%) NaCl solution was introduced through the catheter in amounts of 1-4 ml at a rate of 1 ml in 2-3 seconds. The catheters were first completely filled with hypertonic solution.

EXPERIMENTAL RESULTS

Preliminary experiments established that similar inhibition of the knee jerk reflex occurred in response to intravenous administration of hypertonic NaCl solution through a cannula in the femoral vein and through a catheter passed through the contralateral femoral or external jugular vein into the right auricle. Of 60 introductions of hypertonic saline solution into the right auricle through the catheter, in 51 cases inhibition of the knee jerk was elicited which was similar in intensity and duration to that elicited by injection into the femoral vein.

* Deceased.

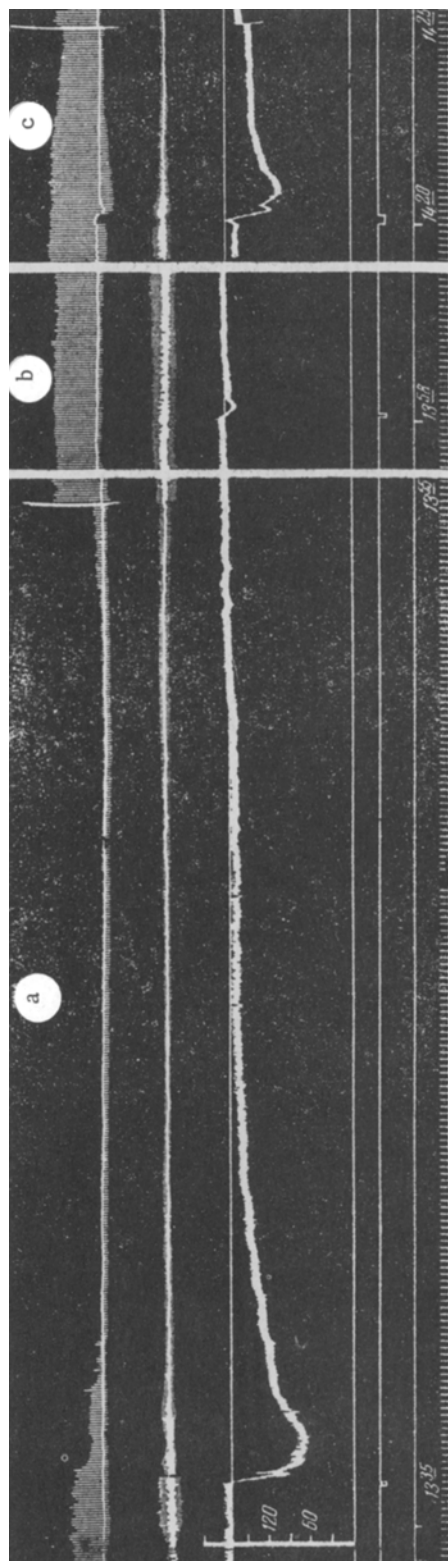


Fig. 1. Changes in knee jerk reflex in response to administration of 1 ml 20% NaCl solution into the right auricle (a) and arch of the aorta (b) and 4 ml 20% NaCl solution into the arch of the aorta (c) (cat under urethane anesthesia).

Records from above down: knee jerk, respiration in trachea, arterial blood pressure in common carotid artery in mm Hg; initial level of arterial blood pressure; manometer base line; marker denoting intravascular introduction of 20% NaCl solution; marker denoting insertion of syringe into catheter; time marker (5 seconds).

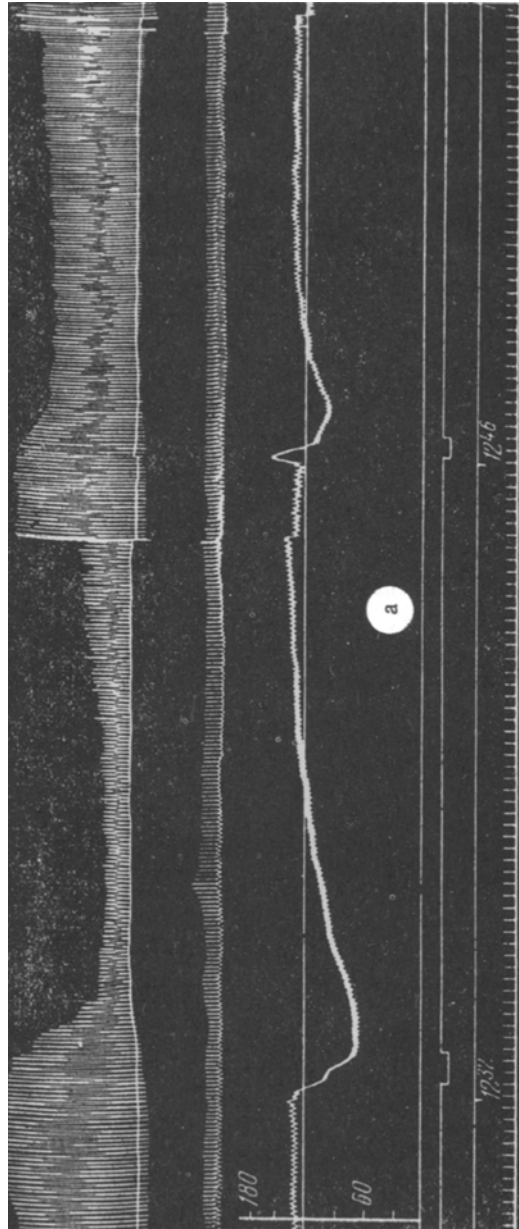


Fig. 2a. Changes in knee jerk reflex in response to introduction of 2 ml 20% NaCl solution into right auricle and thoracic aorta at T8 - T9 level (a) and 2 ml 20% NaCl solution into thoracic aorta at T8-T9 level and into right auricle (b) (cat under urethane anesthesia).

Records the same as in Fig. 1.

The results of the main series, consisting of 27 experiments, are shown in the Table.

Changes in the Knee Jerk Reflex on Intracardiac and Intra-Arterial Administration of Hypertonic (20%) NaCl Solution

Intensity of inhibition			Duration of inhibition		
Diminution of knee jerk (in % of initial amplitude)	Number of injections		Duration of inhibition of the knee jerk (in minutes)	Number of injections	
	Right auricle	Aorta		Right auricle	Aorta
76—100	25	9	Above 30	12	0
51—75	10	6	16—30	4	0
26—50	9	11	1—15	24	11
0—25	0	6	To 1	4	21
No change	6	18	No change	6	18
Total No. of injections	50	50	Total No. of injections	50	50

It is characteristic that in half of all the hypertonic saline injections into the right auricle the amplitude of the knee jerk decreased by more than $\frac{3}{4}$ of the initial magnitude, whereas on aortic administration this only occurred in 9 of the same number of injections. Moreover, intra-aortic administration was associated with absence of change in 3 times the number of cases as compared with intracardiac administration. The same is characteristic of the duration of reflex inhibition when the effects of hypertonic saline administration by the two routes are compared. Thus, intravenous injection led to inhibition lasting over 15 minutes in 16 of 50 cases, whereas intra-aortic administration did not elicit inhibition of similar duration in a single case; the effect of the latter was in most cases that of transient inhibition measurable in seconds.

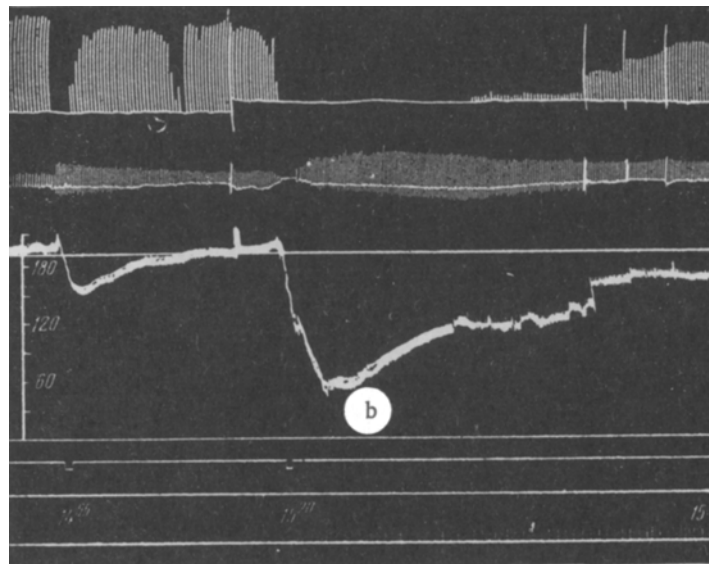


Fig. 2b. For legend see Fig. 2a.

Analysis of the table indicates that the inhibitory reaction is considerably more marked, both with respect to intensity and duration, in response to introduction of hypertonic NaCl solution into the right auricle than by the intra-aortal supply to the spinal cord (Figs. 1 and 2). The sequence of injections did not affect the character and magnitude of the response.

The experiments described show that changes elicited by intravenous injection of hypertonic NaCl solution are explained chiefly by reflex influences from cardiac and pulmonary receptors rather than by direct action of

the substance on the appropriate segments of the spinal cord. Professor V. S. Galkin had voiced suppositions of the existence of such influences on many occasions. It is not very clear yet which particular cardiac and pulmonary receptors are the most sensitive to this chemical agent. However, it is evident that when the substance by-passes the heart and lungs, passing into the arch of the aorta and then along the descending aorta to the spinal cord, it cannot elicit such marked changes. It must be taken into account that when the solution is given intra-aortically it reaches the spinal cord in higher concentration than when it is given by the intracardiac route, and especially by the intravenous route, but the reaction is nonetheless weaker. This fact further emphasizes the role of the reflex, interoceptive component in the mechanism of the described changes.

With respect to inhibition which is to some extent observed when the substance is supplied to the spinal cord by way of the aorta, it is necessary to take into account the existence of reflexogenic zones in the aorta itself [1, 6] on which the substance may act. This suggestion appears very probable because in special experiments in which the catheter was introduced into the abdominal aorta below the point from which the lumbar arteries arise (at the site where the aorta divides into the iliac arteries) inhibition of the knee jerk also took place in response to introduction of hypertonic NaCl solution.

The data presented indicate the need for considering the interoceptive component when analyzing the effects produced by intravascular administration of substances.

SUMMARY

The author compared the changes in the knee jerk occurring as a result of injection of hypertonic NaCl solution into the femoral vein, right auricle and various portions of aorta. Injection of hypertonic NaCl solution into the right auricle caused a more pronounced inhibition of the knee jerk than when it was injected into the aorta to supply the spinal cord. This suggested that the changes in the knee jerk caused by intravenous and intracardiac injection of the above substance was explained mainly by the reflex effect from the receptors of the lungs and heart, rather than by the direct action of this substance on the motor centers of the spinal cord.

LITERATURE CITED

- [1] T. A. Grigor'eva, *Innervation of Blood Vessels*,* Moscow, 1954.
- [2] B. A. Dolgo-Saburov, *Biull. Eksptl. Biol. i Med.* 28, No. 2, 146-151 (1949).
- [3] A. F. Kiseleva, *Voprosy Fiziologii* No. 5, 122-127 (1953).
- [4] O. S. Merkulova, *Doklady Akad. Nauk SSSR* 112, No. 5, 968-971 (1957).**
- [5] L. I. Osadchii, *Biull. Eksptl. Biol. i Med* 45, No. 2, 33-37 (1958).***
- [6] I. I. Fedorov, *Arkh. Patol.* No. 1, 15-22 (1950).
- [7] J. C. Coleridge, A. Hemingway, R. L. Homes and R. J. Linden, *J. Physiol.* v. 136, p. 174-197 (1957);
- [8] G. S. Dawes and J. H. Comroe, *Physiol. rev.* v. 34, p. 167-201 (1954).
- [9] A. S. Paintal, *J. Physiol.* v. 135, p. 486-510 (1957).

* In Russian.

** See English translation.

*** Original Russian pagination. See C. B. translation.