THE EFFECT OF THE SYMPATHETIC SYSTEM AND ADRENALS ON SPERMATURIA IN THE FROG

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In 1947 Galli-Mainini [8] described a simple diagnostic test for pregnancy. The reaction consists of the effect on male frogs of hypophyseal or chorionic gonadotropin, contained in the urine of pregnant women; this induces a spermaturia which is readily detected by microscopic examination of a drop of urine taken from the cloaca.

Various investigations of this reaction have been made. V. P. Veis [3] found in frogs that after Sechenov inhibition, the spermaturia induced by injection of urine from pregnant females was considerably delayed. He supposed that the nervous center for the regulation of spermaturia was located in the spinal cord.

Galli-Mainini showed that in spinal frogs after removal of the brain, lungs, gut, spleen and hypophysis, the action of chorionic gonadotropin is preserved. He concluded that this reaction is due to the direct effect of the chorionic gonadotropin on the vesicula seminalis.

E. I. Kvator and I. F. Sokolova [5] consider that spermaturia in the frog is a reflex action. V. I. Babukhadiya [2] thinks that spermaturia may result from the direct action of the chorionic gonadotropin on the vesicula seminalis. Neither author gives any factual foundation for these views.

Since this reaction is so poorly understood, we decided to investigate the parts played by the sympathetic system and adrenals. Our starting point was the data of A. V. Tonkikh [7], who demonstrated the involvement of the sympathetic system in Sechenov inhibition, a result which was confirmed by I. V. Senkevich [6].

A. A. Atabek [1] induced spermaturia in the frog by injection of 0.3-1 ml of 1:1,000 adrenalin. We confirmed this in ten frogs; after injection of 1 ml of 1:1,000 adrenalin, spermaturia was obtained.

EXPERIMENTAL METHODS

Altogether 205 experiments were performed on lake and pond frogs (Rana ridibunda, R. esculenta).

In all frogs we first determined the rate and amount of spermaturia after injection of 3 ml of the urine from pregnant females into the dorsal lymph sac, and we recorded the room temperature. According to the number of spermatozoa in the urine, we were able to distinguish three degrees of spermaturia (the examination of the urine was carried out with the low power): reaction strongly positive – in each field of view more than 40-50 spermatozoa; positive reaction – more than 15-20 spermatozoa in a single field; weak positive reaction – occasional spermatozoa seen.

Three to four days after the strengths of these reactions had been determined, one of two operations was performed. At a definite time interval after the operation, the time of onset and the intensity of the reaction were again determined.

The first five experiments were designed to show the effect of Sechenov inhibition (Table 1).

TABLE 1

Sechenov Inhibition and the Spermaturia Reaction in Frogs

Experiment No. and Frog No.	No. of Frogs	Operation	Time Between operation and Injection of Pregnant Urine	No. Frogs in whom Cut Brain Surface was not Stim. by Crystal of NaCl	No. of Frogs in whom Brain Surface was Stim. by Crystal of NaCl			Results of reaction	
					once for 1-2 min	once for 3 min	three times for 3 min at 25-min intervals	no. of frogs without delay in reaction	no. of frogs with delay in reaction
Exper. 1 1-34	34	Section through optic lobes and removal of brain anterior to this	After 24 hr	34	–	–	–	34	–
Exper. 2 35-42	8	Ditto	After 2 hr	8	–	–	–	8	–
Exper. 3 43-75	33	Ditto	After 24 hr	–	33	–	–	33	–
Exper. 4 76-95	20	Cut anterior to optic lobes through diencephalon and removal of brain anterior to this	After 1-2 hr	–	–	20	–	20	–
Exper. 5 96-115	20	Ditto	After 1-2 hr	–	–	–	20	4	16
Всего	115			42	33	20	20	99	16

EXPERIMENTAL RESULTS

Experiment 1. – 34 frogs; operation – section through optic lobes and removal of brain anterior to this.

Injection of pregnant urine 24 hrs. after operation.

Results – rate of reaction the same before and after operation.

Experiment 2. – 8 frogs; same operation.

Pregnant urine injected two hrs after operation.

Results – rate of onset of reaction the same before and after operation.

Experiment 3. – 33 frogs; same operation.

Pregnant urine injected 24 hours after operation.

Immediately after the operation the cut surface of the brain was stimulated for 1 to 2 min with a crystal of sodium chloride.

Results – rate of onset of the reaction before and after operation the same.

Experiment 4. – 20 frogs; operation – section anterior to the optic lobes through the diencephalon and removal of parts anterior to cut.

Pregnant urine injected 1-2hrs after operation. Immediately after the injection the cut brain surface was stimulated for 3 min. with a crystal of sodium chloride.

Results – Rate of onset the same before and after operation.

Experiment 5. – 20 frogs; operation – section through diencephalon anterior to optic lobes and removal of brain anterior to cut.

Pregnant urine injected 1-2 hours after operation with simultaneous stimulation of cut surface of brain with crystal of sodium chloride 3 times for 3 min at intervals of 25 mins. (These experiments were carried out in the same way as by V. P. Vets.) The pregnant urine was injected after the first stimulation.

Results – in 4 frogs the rate of onset of the reaction was the same as before operation; in 16 frogs the reaction was delayed from 30 min to 1 hr, i. e., we confirmed the results of V. P. Vets.

Experiments 3 and 4 showed that, as regards Sechenov inhibition, a single stimulation of the cut brain surface does not change the time of onset of the reaction. Sechenov inhibition of the spermaturia reaction occurs only on stimulating the cut brain surface three times for 3 min at 25-min intervals with a crystal of sodium chloride; out of the 20 frogs of experiment 5, in 16 there was a delay of 30-60 minutes. This indicates a reflex regulation of the spermaturia reaction. We may suppose that there are nerve centers in the cord which regulate this reaction, and that their suppression in the Sechenov inhibition experiment causes a delay in the spermaturia reaction.

In 24-48 hr observations on frogs operated by Sechenov's method, we found spontaneous spermaturia to occur in 25 animals. This took place 2-24 and even 48 hrs after the operation and was observed most frequently in summer and winter frogs. In our view, the spontaneous spermaturia is due to the release of the centers in the cord from the inhibitory influence of the higher nervous centers.

Sixty-five experiments were performed to investigate the reaction of the sympathetic and adrenal system.

The adrenal glands were cauterized with an electric thermo-cautery, using A. V. Kibyakov's method. On the fifth day after the operation the rate of onset and the strength of the reaction to the injection of pregnant urine was determined. According to A. V. Kibyakov [4] and his co-workers, it is at this time that the sympathetic adrenal system is at its lowest functional level.

The results of the experiment are shown in Table 2.

TABLE 2

The Sympathetico-Adrenal System and the Spermaturia Reaction

Experiment No.	No. of frogs	Type of operation	Time between experiment and operation	Results of the spermaturia reaction		
				No. of frogs in which the rate and strength of the reaction were the same before and after operation	No. of frogs in which there was no delay of onset, but a reduced intensity	No. of frogs with delayed and reduced reaction
141-205	65	Cauterization of adrenal glands with electric thermo-cautery	On the fifth day	16	8	41

In 41 of the 65 frogs, the spermaturia was reduced in amount and there was a delay of from 40 min to 2 hrs. The delay was most clearly shown in the spring and summer frogs.

In 8 animals the reaction was less in amount, but the time of onset was the same.

In 16 frogs the rate and amount were the same before and after operation.

Thus, in most frogs removal of the adrenal glands (essentially the adrenal medulla) had an effect on the spermaturia reaction. The absence of this effect in some of the frogs may be due to incomplete cauterization of the medulla of the gland, or to the presence of additional chromaffin tissue.

Our experiments showed that the sympathetico-adrenal system is concerned in the regulation of the spermaturia reaction.

The physiological mechanism of this reaction is therefore basically reflex, and includes centers in the diencephalon and cord, as well as the sympathetico-adrenal system.

SUMMARY

205 experiments were conducted to elucidate the role of Sechenov's inhibition and the sympathetico-adrenal system in the mechanism of spermaturia. This reaction was stimulated by urine of pregnant women.

It was established that the physiological mechanism of spermaturia in frogs is of a reflex nature. It includes the transitional and spinal centers and those of the sympathetico-adrenal system.

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