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Research Article

Bulbar Regulation of Contractile Function of the Bottom and Tubes of the Uterus

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Abstract

Aim of the Study: The goal is to identify the role of the bulbar departments of the cholinergic system in regulating contractions of the uterine floor and its tubes.

Materials and Methods: Experiments were conducted on 10 chinchilla rabbits, females weighing 3.5 - 4 kg. In sparing conditions of group 1 animals (n = 5), the peripheral segment of the right vagus nerve was stimulated at the C5-C6 level, and an electromyogram (EMG) of the smooth muscles of the uterine floor and the proximal part of the right fallopian tube was recorded. The nature of cholinergic innervation of the organ was determined by introducing toluidine blue into the peripheral part of the trunk of both vagus nerves, followed by morphological examination of biopsies.

Results: We found that intramural ganglia were stained, i.e., their synaptic contacts with preganglionic cholinergic fibers were present. The existence of cholinergic innervation from the bulbar part of the parasympathetic nervous system was shown for the first time on the example of the uterine floor of rabbits.

Conclusion: The cholinergic effect of increasing the contractile activity of the uterus and its tubes was confirmed.

Keywords: *Uterus; Tubes; Innervation; Vagus Nerve*

Introduction

The bulbar section of the parasympathetic nervous system, according to leading anatomists, does not Innervate the pelvic organs [1]. However, the results of physiological studies indicate that the vagus nerve is used for cholinergic innervation of the uterine floor and its tubes [2]. Cholinergic neurons form moderately dense plexuses in the myometrium, the microarterial system of the fallopian tubes. Acetylcholine is known to stimulate uterine contractions [3].

In studies of uterine innervation in mice, acetylcholine, histamine, serotonin, phenylepinephrine and oxytocin have been shown to cause uterine contractions that are inhibited by an ATP-Aza blocker [4]. Acetylcholine, norepinephrine, and serotonin dose-dependently regulate uterine motility and hormonal status. The blockade of the longitudinal muscle α -adrenoreceptors prevents a decrease in the contractile activity of the myometrium, while the blockade of the circular muscle fibers prevents-adrenoreceptors prevents a decrease in muscle tone caused by the action of norepinephrine.

Immunohistochemically, it has been shown that the myometrium of young mice contains P2x1 purinoreceptors [5], which play a role in the mechanisms of contractions of the smooth muscles of the uterus and its tubes. In particular, activation of P2 receptors leads to a reduction in the non-pregnant uterus of a Guinea pig [6].

Contractions of smooth muscles are also caused by the introduction of serotonin. Preincubation of the rat uterus with dichloromethane extract causes a dose-dependent inhibition of the contractile effect of serotonin [7]. In uterine smooth muscles, oxytocin slows down the uptake of serotonin by mast cells, having a potentiating effect on uterine contractions [8].

Acetylcholine, neurotensin and oxytocin stimulate the mobility of the fallopian tubes. Catecholamines have both a relaxing and reducing effect on the isolated fallopian tubes. In particular, the vasoconstrictor action of catecholamines is realized by activating α-adrenoreceptors [9]. During ovulation, the spontaneous contractile activity of the uterine tubes increases many times under the influence of acetylcholine, serotonin, prostaglandin Pgf2a. Serotonin regulates contractile activity of the rabbit uterus [10].

Peristalsis of the fallopian tube due to active contractions of its smooth muscles, along with the activity of the cells of the scintillating epithelium, plays an important role in ensuring the promotion of the egg through the tube to the uterus. The most pronounced peristalsis of the tube during ovulation. Since one of the main functions of the fallopian tube is the movement of the egg after ovulation, the funnel of the tube is in contact with the ovary at the time of ovulation, which is provided by contractions of the tube muscles.

The nature of the response of the uterus and tubes depends on the hormonal background, on the phase of estrus in which the animal is located. Cells of Cajal of the human myometrium Express receptors of estrogen and progesterone. In view of the need to conduct research on cholinergic mechanisms of regulating contractile activity of the uterine floor and its right tube on a tested hormonal background, the task of selecting an experimental animal was very relevant. The rabbit, as is known, is unique not only in that the vagus nerve and sympathetic trunk pass separately on its neck and do not form anastomoses, but also in that when animals are kept separately, females do not ovulate, and they have a natural stable background of the first phase of estrus.

In connection with the special role of the funnel of the tube and its adjacent proximal part in the reduction of the muscle layer, cholinergic regulation of the proximal part of the right tube and the bottom of the uterus was studied.

Aim of the Study

The goal is to identify the role of the bulbar departments of the cholinergic system in regulating contractions of the uterine floor and its tubes.

Materials and Methods

Experiments were conducted on 10 chinchilla rabbits, females weighing 3.5 - 4 kg. In sparing conditions of group 1 animals (n = 5), the peripheral segment of the right vagus nerve was stimulated at the level of C5-C6, and an electromyogram (EMG) of the smooth muscles of the uterine floor and the proximal part of the right fallopian tube was recorded using bipolar silver electrodes with a contact surface area of 1.5 - 2 mm^2 placed on the surface of the organs. EMG registration was performed on a Nichon-Cohden polygraph under pre-amplification conditions. In the second group of rabbits (n = 5), toluidine blue was injected into the peripheral part of the trunk of both vagus nerves at the level of the neck. Axoplasmic current dye is transferred to the organs and tissues innervated by the vagus nerve for 9 - 10 hours. Then the tissues of the uterine floor and the right tube were taken. Biopsies were fixed in 9% neutral formalin, dehydrated in alcohols of increasing concentration of 70 - 90°, enclosed in paraffin and prepared histological sections. The resulting sections were stained with hematoxylin and eosin and visualized at the light-optical level at a magnification of 240 - 600. The uterus and the right tube of the uterus of intact rabbits served as a control.

Statistical data processing was performed on a personal computer using the computer program "SPSS-Statistics 17". When analyzing distributions of quantitative data, measures of the Central trend - the median (Me) and measures of dispersion - the interquartile range in the form of 25 and 75% percentiles were determined. The nonparametric Mann-Whitney test was used to calculate the reliability of differences in small samples. The criterion of statistical significance was the level $p \leq 0.05$.

Results and Discussion

Irritation of the right vagus nerve increases the amplitude and frequency of slow waves of electromotor activity of the smooth muscles of the uterine floor (Table 1).

Background EMA		Stimulation vagus nerve	
Frequency, /min	**Amplitude, mV**	**Frequency, /min**	**Amplitude, mV**
8,6 ± 1,1	0,16 ± 0,04	11,2 ± 1,5	0,26 ± 0,09
P < 0,05		P < 0,05	

Table 1: *Electromotor activity of the uterine floor when the vagus nerve is irritated. The value of the studied stimulatory effect is 30.2% in frequency and 62.5 % in amplitude.*

It should be noted that the vagal stimulatory effect on the uterine floor EMA is detected with intact α - and β-adrenoreceptors. Isolated stimulation of the sympathetic trunk in none of the experiments on rabbits weighing 3.5 - 4 kg did not lead to an increase in the motility of smooth muscle cells of the uterine floor. Thus, using a physiological method, the presence of a vagal stimulatory effect on the EMMA of the smooth muscles of the uterine floor was established.

Irritation of the right vagus nerve leads to an increase in the motor function of the proximal part of the right uterine tube. Thus, the wave frequency of the slow waves of the right tube is 17.0 ± 1.1/min, the amplitude is 0.17 ± 0.03 mV. The reduction capacity was 2.89. Irritation of the vagus nerve leads to an increase in the frequency of slow waves of the right tube to 19.5 ± 2.4/min (14.7% $p < 0.05$), the amplitude to 0.27 ± 0.05 mV (58.8% $W < 0.05$) and the power of reduction to 4,265 (47.8% $p < 0.05$). That is, physiologically shown the possibility of regulating the right vagus nerve of the proximal part of the right uterine tube.

Anatomical evidence of the presence of vagal innervation of the uterine floor was provided by experiments with the *in vivo* endoneural introduction of toluidine blue under the myelin sheath of the right and left vagus nerves and the detection of subsequent staining of the neural structures of the uterine floor, its right tube.

Vessels of fundus enlarged, full-blooded, muscular tissue in the subserous layer are defined nerve trunks. There is a transition of bundles of smooth muscles from the tube to the uterine tissue with a slight defibration of muscle fibers. Bundles of smooth muscle cells go in different directions. In the thickness of the muscle tissue, the nerve ganglia, colored with toluidine blue, surrounded by the perineum and containing a different number of neurons - from 3 - 4 to 15 - 20 cells.

The muscle layer of the uterus floor of the control group of animals contains only smooth muscle cells that go in different directions. Intramural ganglia were not detected. Connective tissue layers are located between the bundles of smooth muscle cells.

Thus, intramural ganglia that have synaptic contacts with preganglionic cholinergic fibers of the vagus nerve are visualized when the vagus trunks are colored. Staining of intramural ganglia confirms their presynaptic regulation by cholinergic fibers of the vagus nerve - bulbar regulation of the uterine floor and its tube. Studies have confirmed the functional role of the vagus nerve in regulating the electromotor activity of the uterine floor.

Conclusion

Irritation of the vagus nerve leads to increased contraction of the smooth muscles of both the uterus and the proximal end of the right fallopian tube. Consequently, the cholinergic fibers of the vagus nerve are involved in the nervous regulation of the female sexual system. In the analysis of chronoinotropic relationships in the systems of the right tube, the vagus nerve has a predominantly inotropic effect, whereas in the uterus it has a chronotropic effect. As for the effect of right vagus nerve stimulation on the power of contractions, it should be noted that the effect prevails on the smooth muscles of the uterine floor, which is probably due to a more powerful muscle layer in this part of the sexual system.

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