Fiziologicheskii Zhurnal SSSR imeni I. M. Sechenova, vol. 48, no. 6, p. 735, 1962

Glaser (T-301 & T-305) Fed. Proc. 22 Trans. Supp 1 (1963)

Absorptive activity of stomach and intestine under the influence of a UHF electric field

V. R. FAITEL'BERG-BLANK

Ukrainian Research Institute of Spa Therapy and Physiotherapy, Odessa

Reports in the literature describe the effect of the UHF electric field on certain physiological processes in animals and man. The action of UHF fields has been studied on the systolic and minute volumes of the heart, the blood morphology, metabolism, and the activity of the central and autonomic nervous systems (Khrenov, 1939; Parin and Davydov, 1939; Militsyn, 1940, and others). The secretory and motor functions of the stomach and intestine during exposure to a UHF field have been studied (Vorob'ev and Oleinikov, 1940; Gogibedashvili, 1957; Kirichinskii, 1959, and others). UHF electric fields are now widely used in diseases of the gastrointestinal tract.

A. S. Ryvlin (1937), A. E. Uspenskii (1939), R. A. Chizhova and S. P. Shchipalin (1948), A. V. Seleznev and G. V. Bobrova (1948), and V. G. Gogibedashvili (1954) have reported good results from the use of the UHF electric field in the treatment of gastritis and gastric ulcer.

It is clear from the above that the effect of the UHF field on the activity of the gastrointestinal tract has already been investigated under both normal and pathologic conditions. However, not all its functions have yet been studied; the absorptive activity of the stomach and intestine in particular has been overlooked by researchers. We therefore decided to study the changes in the absorptive function of the stomach and intestine during the action of the UHF field on the body.

METHODS

Experiments were carried out on 6 dogs, 4 of which had a loop of intestine isolated by Thiry's method (the length of the isolated segment was 30 cm), and 2, a Pavlov's pouch. A 20% glucose solution was introduced into the stomach and a 7% solution, into the intestine. An amino acid (glycine) was introduced into the stomach and intestine in 0.1 M solution; chlorides were introduced into the stomach in a 2% sodium chloride solution and into the intestine in 1% solution. All these solutions were given in a volume of 20 ml.

The absorption of the solutes was determined by the difference between the amount of solute introduced into the gastric pouch and intestinal loop and the amount extracted from them. Water absorption was determined from the difference between the volume of water introduced and the volume extracted, with the volume of secretion taken into consideration. The glucose was determined quantitatively by means of a Zeiss-Volni refractometer and by the Hagedorn-Jensen method. The amino acids were estimated gasometrically by Tsuverkalov's method; chlorides by Rushnyak's modification of Volhard's method. All these substances were left in the stomach for 60 min and in the intestine for 30 min.

In each series of experiments, we studied the degree of absorption of the above substances under normal conditions, and then under the influence of a UHF electric field. In our experiments, we directed the UHF generator towards the skin projection zone of the stomach or intestine. A 60 w UHF generator with an electromagnetic wavelength of 7.3 m acted on the region of the stomach or intestine for 10 min. The distance of the electrodes from the skin surface was 0.5-1.0 cm, so that maximum heating of the gastric and intestinal mucosa could be obtained. Altogether, 356 experiments were carried out on 6 dogs.

EXPERIMENTAL RESULTS

The absorption of tap water was studied in dogs with a Pavlov's pouch. Under normal conditions, only a small amount of tap water was absorbed from the stomach. In the dog Dzhul'bars, for instance, the average amount of tap water absorbed was 7.4% (varying from 5 to 10%), and in the dog Dzhim, 15.4% (varying from 5 to 20%). Under the influence of the UHF electric field, the absorption of water from the gastric pouch was doubled. In Dzhul'bars, for instance, the average absorption of water was 17.1% (varying from 14 to 20%), and in Dzhim, 34.2% (varying from 20 to 60%).

The average absorption of glucose from the isolated gastric pouch in the dog Dzhul'bars under ordinary conditions was 15.9% (varying from 4 to 25%), and in the dog Dzhim, 26.8%. Under the influence of the UHF electric field, the absorption of glucose from the gastric pouch increased. In the dog Dzhul'bars, for instance, the average absorption of glucose was 19.1% (varying from 10.5 to 25%), and in Dzhim, 31.3% (varying from 7.2 to 47.5%) (Figs. 1 and 2).

The absorption of amino acids (glycine) in the gastric pouch was negligible. The average absorption of amino nitrogen from the glycine solution in the dog Dzhul'bars was 5.6% (varying from 0 to 30.9%). In most experiments of this series, no absorption of glycine from the stomach was observed. Similar results were also obtained in

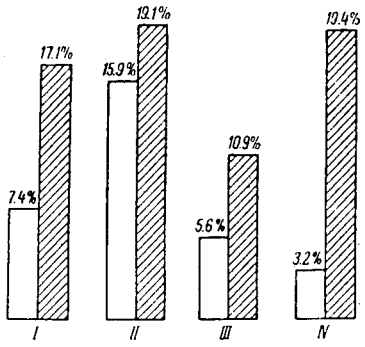

FIG. 1. Effect of UHF field on the absorptive activity of the stomach in the dog Dzhul'bars. In this and subsequent figures: I—absorption of water, II—of glucose, III—of amino acids, IV—of chlorides. White columns—initial figures, shaded columns—under the influence of UHF.

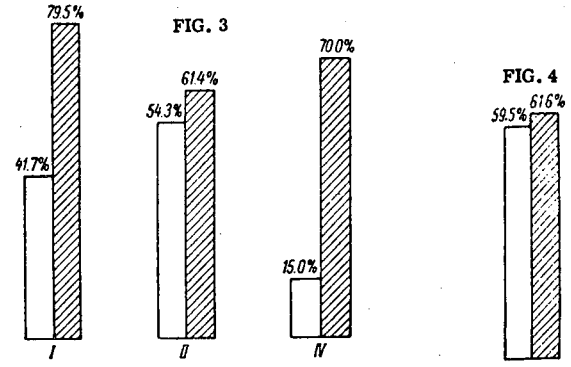

FIG. 3

FIG. 4

FIG. 3. Effect of UHF field on the absorptive activity of th intestine in the dog Zhuk.

FIG. 4. Effect of UHF field on the absorption of amino acic from the intestine in the dog Tungus.

the experiments on the dog Dzhim, in which the average absorption of amino nitrogen was 4.7% (varying from 0 to 23.7%). In many experiments, no absorption of glycine from the stomach was observed. Under the influence of the UHF electric field, the absorption of glycine was doubled or quadrupled by comparison with normal conditions. The average absorption of amino nitrogen from the stomach in the dog Dzhul'bars was 10.9% (varying from 4.7 to 30.9%), i.e., twice that found under normal conditions. The absorption of glycine in the dog Dzhim also increased under the influence of the UHF field. The average absorption of amino acid from the Pavlov's pouch in the dog Dzhim was 21.9% (varying from 16.5 to 38.1%), i.e., it was increased fourfold. In some experiments on Dzhul'bars and Dzhim, no absorption of glycine was observed under normal conditions. Under the influence of the UHF electric field, absorption of this amino acid from the gastric pouch invariably occurred.

Absorption of chlorides from the gastric pouch was increased by exposure to an UHF field. In the dog Dzhul'bars, the normal absorption of chlorides from the NaCl solution averaged 3.2% (varying from 2.4 to 6.1%). Under the influence of the UHF electric field, the average absorption of chlorides was 19.4% (varying from 7.2 to 36.0%), i.e., much greater than normally. The same relationship was observed in the dog Dzhim, in which the average absorption of chlorides was 15.8%

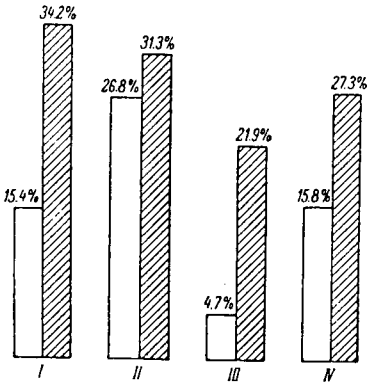

FIG. 2. Effect of UHF field on the absorptive activity of the stomach in the dog Dzhim.

(varying from 10.6 to 32.4%) under normal condition and 27.3% (varying from 11.2 to 45.6%) under tl influence of the UHF electric field (Figs. 1 and 2

Under normal conditions, the absorptive activity the intestine is far greater than that of the stomac In the dog Zhuk (Fig. 3), the average absorption of ta water normally was 41.7% (varying from 26 to 56% Under the influence of the UHF field, the absorptiv activity of the intestine increased: the average absorp tion of tap water was 79.5% (varying from 57.5 to 88.5%

The average absorption of water in control exper ments on the dog Seryi was 51.6% (varying from 30-65% while under the influence of the UHF electric fie (Table 1), it rose to an average value of 76% (varyir from 67.5 to 85%). These results were statistical significant ($t = 3.1$; $p < 0.02$).

Under the influence of the UHF field, the absorptic of glucose from the isolated loop of small intestir of the dogs increased. Whereas in the control experi ments on the dog Zhuk, the average absorption glucose was 54.3% (varying from 34.2 to 60.0%), rose to 61.4% (varying from 52.9 to 73.5%) under th influence of the UHF field. In the dog Seryi, the averag absorption of glucose under normal conditions was 63.9 (varying from 46.4 to 65.7%); under the influence of th UHF field, it rose to 66.9% (varying from 57.8 to 79.3% i.e., became slightly higher than in the control experi ments.

Fairly intense absorption of amino acids (glycine took place in the intestine of the dogs. Under norma conditions, for instance, the average absorption c amino nitrogen from a 0.1 M glycine solution in th dog Tungus (Fig. 4) was 59.5% (varying from 49.4 t 70.2%); under the influence of the UHF electric field the absorption of glycine was only very slightly highe than the control values, the average figure being 61.6 (varying from 60.3 to 79.1%). In some experiments o this series, the glycine absorption increased 5-8% Similar results were obtained in the dog Kromulya Whereas in the control experiments the average absorp tion of amino nitrogen was 39.5% (varying from 29.3 t 52.3%), under the influence of the UHF field (Table 2) it rose to 56.5% (varying from 38.9 to 70.2%). Th results of these experiments were statistically signifi cant ($t = 2.8$, $p < 0.02$).

The absorption of chlorides from the isolated loo of intestine was on a fairly considerable scale in th dogs. The average absorption of chlorides in the do

TABLE 1. Absorption of water from the isolated loop of small intestine in the dog Seryi

Introduced	Extracted	Absorbed		Introduced	Extracted	Absorbed	
		in ml	in %			in ml	in %
Initial values				Under the influence of UHF			
20	10.0	10.0	50.0	20	4.0	16.0	80.0
20	10.0	10.0	50.0	20	6.5	13.5	67.5
20	14.0	6.0	30.0	20	5.5	14.5	72.5
20	7.3	12.7	63.5	20	3.6	15.4	82.0
20	8.1	11.9	59.5	20	6.0	14.0	70.0
20	9.4	10.6	53.0	20	3.0	17.0	85.0
20	7.0	13.0	65.0	20	5.0	15.0	75.0
Average 51.6				Average 76.0			

NOTE: $t = 3.1$, $p < 0.02$.

Khromulya was 38.8% (varying from 23.8 to 53.5%). Under the influence of the UHF electric field, this rose to 60.3% (varying from 40.6 to 86.5%) in the same animal (Table 3), i.e., to a level appreciably higher than in the control experiments. The results of this series of experiments were statistically significant ($t = 4.4$, $p < 0.02$). In the control experiments on the dog Zhuk, the average absorption of chlorides was 15% (varying from 4.0 to 29.1%); under the influence of the UHF field, it rose to 70.0% (varying from 43 to 80%), i.e., showed a sharp increase by comparison with the normal value (Fig. 3).

DISCUSSION OF RESULTS

These findings showed that the absorptive activity of the stomach and intestine was modified by exposure to the UHF electric field. The increase in the absorptive activity of the stomach and intestine under the

TABLE 2. Absorption of glycine from the isolated loop of small intestine in the dog Khromulya

Amount of amino nitrogen introduced		Amount of amino nitrogen extracted		Amino nitrogen content of wash water		Amount of amino nitrogen absorbed	
in ml	in mg	in ml	in mg	in ml	in mg	in mg	in %
Initial values							
16	6.72	12.0	3.6	16	1.15	1.97	29.3
16	0.72	10.0	2.72	16	0.96	3.04	45.0
16	6.72	10.5	3.9	16	0.85	1.97	29.3
16	6.72	9.5	2.4	16	1.4	2.92	43.4
16	6.72	8.0	2.4	15	0.8	3.52	52.3
16	6.72	10.5	2.3	16	1.9	2.56	38.0
						Average . . .	39.5
Under the influence of UHF							
16	6.72	4.0	0.76	15.5	1.3	4.66	67.7
16	6.72	7.0	2.8	16.0	0.8	3.12	46.4
16	6.72	6.5	2.9	16.0	1.2	2.62	38.9
16	6.72	2.5	0.5	16.0	1.5	4.72	70.2
16	6.72	5.5	1.4	16.0	1.1	4.22	52.7
16	6.72	7.5	0.7	16.0	1.4	4.62	68.7
16	6.72	8.5	1.78	16.0	1.49	3.45	51.3
						Average . . .	56.5

NOTE: $t = 2.8$, $p < 0.02$.

TABLE 3. Absorption of chlorides from an isolated loop of small intestine in the dog Khromulya

Amount of chloride solution given		Amount of chloride solution extracted		Chloride content of wash water		Amount of sodium and chlorine absorbed	
in ml	in mg	in ml	in mg	in ml	in mg	in mg	in %
Initial values							
16	88.6	8.2	38.0	15.0	3.1	47.5	53.5
16	88.6	8.0	38.0	16.0	13.0	37.6	41.3
16	88.6	9.8	50.0	13.0	15.0	23.6	26.6
16	88.6	13.0	40.5	16.0	12.4	35.7	40.3
16	88.6	12.5	48.7	16.0	7.8	41.5	38.3
16	88.6	11.0	48.4	16.0	2.2	38.9	49.9
16	94.4	14.2	61.0	16.0	2.2	31.2	33.0
16	94.4	14.5	44.9	16.0	0	49.5	52.3
16	94.4	16.0	65.6	16.0	5.6	32.0	23.8
					Average		39.8
Under the influence of UHF							
16	88.6	6.0	24.3	12.0	0	63.7	71.8
16	88.6	4.0	17.0	16.0	0	71.0	80.5
16	88.6	8.0	32.9	16.0	19.2	36.0	40.6
16	88.6	11.0	39.6	16.0	0	49.0	55.0
16	88.6	10.0	43.3	16.0	7.2	58.5	53.6
16	88.6	14.0	33.6	16.0	0	66.2	65.0
16	94.4	10.0	33.0	16.0	3.3	58.1	61.2
16	94.4	9.8	33.3	16.0	0	61.1	64.5
16	94.4	12.0	39.6	16.0	6.8	48.0	50.8
					Average		60.3

NOTE: $t = 4.4$, $p < 0.02$.

influence of the UHF field may be explained by changes in the functional state of the cells of the gastric and intestinal mucosa, by activation of their functions and by an increase in the blood supply to these organs. Various writers (Schliephake, 1929; Veshchezorov, 1935; Militsyn and Plemyannikova, 1940) have shown that under the influence of UHF, electrical energy is converted into thermal energy, which is absorbed by the body during the action of the UHF and causes an influx of blood into the internal organs.

The influence of UHF on the absorptive function of the stomach and intestine is exerted through a reflex mechanism. This view is supported by the observations of S. N. Finogenov (1949) and A. R. Kirichinskii (1959), who demonstrated the reflex influence of UHF on certain functions of the body.

V. G. Gogibedashvili believes that UHF affects the gastric glands through the central nervous system (CNS). He concludes from his experimental investigations that the UHF field acts on the processes taking place in the interneuronal and neuro-effector synapses of the reflex arc, as a result of which impulses pass to the gastric glands and to adrenergic structures. Under conditions of 5-10-min exposure, he observed facilitation of the conduction of impulses to the gastric glands.

According to the observations of N. A. Popov (1938) and of A. V. Tonkikh (1939), UHF exerts an influence on the CNS, including the hypothalamic region, which leads to changes in the metabolism of the body. In some cases, a change in one of the functions of the gastrointestinal tract is known to be accompanied by parallel changes in other functions of the alimentary canal.

Our experimental findings are in agreement with the observations of writers who describe an increase in secretion in man and experimental animals under the influence of an UHF electric field when the duration of experimental exposure is 10 min (Gogibedashvili, 1957; Vorob'ev and Oleinikov, 1940; Zavadovskii, 1948, and others). Our results, demonstrating an increase in the absorptive activity of the stomach and intestine under the influence of UHF are in accord with our previous observations (Faitel'berg-Blank, 1959) that UHF increases the absorptive function of the pleura. Moreover, M. I. Yatsenko (1961) has shown that UHF increases the absorption of radioactive phosphorus from the cavity of the knee joint.

CONCLUSIONS

1. Under normal conditions, intense absorption of glucose takes place from the intestine. Under the influence of the UHF electric field, intestinal absorption of glucose increases 7-8% on the average and 15-20% in individual cases.

2. The intensity of glucose absorption from a Pavlov's gastric pouch is much less than in the intestine. Under the influence of the UHF field, the absorption of glucose from the stomach increases by 4-5% and, in individual experiments, to 10-12% above its normal level.

3. The average absorption of water from the intestine varies in different dogs from 63.6 to 66.6%, and from the stomach from 5 to 10%. Under the influence of the UHF electric field, the average absorption of water from the intestine increases 10-12%, and 15-20% in some experiments. Absorption of water from the stomach increases 15-20%.

4. Under the influence of the UHF electric field, the absorption of amino acids from the stomach and intestine is increased by an average of 3-5%, and in individual experiments, by 8-10%.

5. Under the influence of the UHF electric field, the absorption of chlorides from the stomach increases 5-6%, and from the intestine, 12-15%.

Received March 29, 1961

REFERENCES

Bratkovskii, R. E. and N. A. Fishchenko. Fizioterapiya. (1):68, 1939.
Chizhova, R. A. and S. P. Shchipalin. Collected Transactions of the Maritime Province Research Institute of Physiotherapy. (3):55, Khabarovsk, 1948.
Faitel'berg-Blank, V. R. Abstracts of the First All-Ukrainian Conference of Physiotherapists and Spa Therapists. Kiev, 1959.
Finogenov, S. N. Fizioterapiya. (1):23, 1949.
Gogibedashvili, V. G. Refer. Sb. Tr. N.-Issl. Inst. Kurortol. Gruzii. 21:176, 1954; The Treatment of Chronic Gastritis by the UHF Electromagnetic Field (Clinico-Experimental Research). Gruzmedgiz, Tbilisi, 1957.
Khrenov, I. I. Fizioterapiya. (5): 30, 1939.
Kirichinskii, A. R. Reflex Physiotherapy. Ukrainian SSR Medgiz, Kiev, 1959.
Militsyn, V. A. In: The Use of Short and Ultra-Short Waves in Medicine. Moscow, 1940, p. 175.
Militsyn, V. A. and N. N. Plemyannikova. Tr. Gos. N.-Issl. Inst. Fizioterap. (6):139, 1940.
Parin, V. V. and I. N. Davydov. Fizioterapiya. (5):35, 1939.
Popov, N. A. Fizioterapiya. (2):5, 1938.
Ryvlin, A. S. Therapeutic Use of UHF. Leningrad, 1937, p. 386.
Seleznev, A. V. and G. V. Bobrova. The Biological and Therapeutic Action of a Magnetic Field in Strictly Periodic Vibration. Perm', 1948, p. 135.
Tonkikh, A. V. Cited by Bratkovskii and Fishchenko, 1939.
Uspenskii, A. E. Fizioterapiya. (6):81, 1939.
Veshchezorov, N. I. Transactions of the All-Union Conference of Pathologists. Moscow, 1935, p. 15.
Vorob'ev, A. M. and S. N. Oleinikov. In: The Use of Short and Ultra-Short Waves in Medicine. Moscow, 1940, p. 139.
Yatsenko, M. I. Fiziol. zhurn. (Ukrain.). 7(5):701, 1961.
Zavadovskii, K. N. Essays on Special Physiotherapy. Tomsk, 1948.
Schliephake, E. Zs. ges. exper. Med. 66:212, 1929.