1.0 this means that phagocytosis is complete. According to our data, ICP of staphylococci by macrophages from intact rabbits was 1.9 ± 0.2 and for micrococci ICP was 9.2 ± 1.1.

Parallel investigations of the function of digestion of the test microorganisms by AM by the two methods (microscopic and bacteriological) showed conclusively that the results were constantly uniform. Each method has it own advantages: Microscopic analysis gives some idea of both the ingestive and the digestive activity of the macrophages, whereas the bacteriological method reflects only the end result of the phagocytic reaction and characterizes the defensive function of the cell as a whole. Meanwhile the bacteriological method of determination of ICP, while completely reliable, is less tedious and laborious and can be recommended for use in research.

The technical improvements described above thus facilitate the work and save time, and the modified bacteriological method of determination of the completeness of phagocytosis can be recommended for assessment of the defensive function of macrophages, both parallel with microscopic investigation, making the results more reliable, and as an independent method.

LITERATURE CITED

1. E. I. Zhitova and K. I. Kudryashova, Tr. Gor'k. Med. Inst., 22, 53 (1967).
2. Z. E. Matusis and S. I. Pylaeva, Lab. Delo, No. 4, 237 (1972).
3. I. Ya. Uchitel', Macrophages in Immunity [in Russian], Moscow (1978).
4. Q. N. Myrvik, E. S. Leake, and B. Farris, J. Immunol., 86, 128 (1961).
5. V. V. Portugalov, G. N. Durnova, A. S. Kaplansky, et al., Acta Histochem., 46, 216 (1973).

A LUMINESCENCE METHOD FOR EXPERIMENTAL HEART RESEARCH

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KEY WORDS: heart, luminescence method.

A promising trend in diagnostic medicine is observation both of the luminescence of luminescent substances (LS) introduced into the body and selectively accumulating in certain organs and tissues, and also of intrinsic luminescence of the tissues. For example, measurement of intrinsic tissue luminescence was used in [1] to study oxidative metabolism of the dog heart in vivo during acute ischemia and hypoxia. Advances in fiberoptic technology, so that exciting luminescent radiation can be introduced inside the body and also led out, has greatly widened the scope for the use of luminescence methods and has stimulated their further development. For instance, in [2] a hematoporphyrin derivative was used as LS, enabling malignant tumors to be diagnosed in situ in the early stage by means of fiberoptic laser fluorescent bronchoscopy. The search for other LS suitable for use in the luminescence diagnosis of diseases of the internal organs or tissues, especially those suitable for investigations by fiberoptic techniques, is of much interest.

Pyrrole derivatives, which are widely used in the manufacture of chemotherapeutic preparations, are evidently noteworthy from this point of view. Compounds with spasmolytic and local-anesthetic properties [3], with an active effect on the central and autonomic nervous system [4] and capable of lowering blood pressure [5], are known. The antiarrhythmic activity of compounds of this type also has been described [6], which encourages the hope that they may accumulate preferentially in corresponding zones of the heart and, if they are in the LS category, that they can be used for luminescence diagnosis of these zones.

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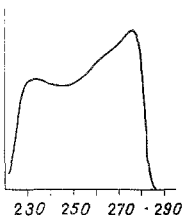

Fig. 1

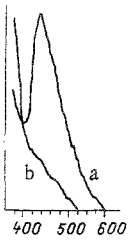

Fig. 2

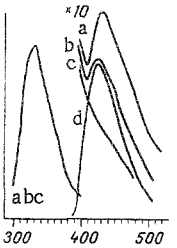

Fig. 3

Fig. 1. Absorption spectrum of aqueous solution of PI. Here and in Fig. 2: abscissa, wavelength (in nm); ordinate, intensity of luminescence (relative units).

Fig. 2. Luminescence of septal region of rabbit heart: a) immediately after intravenous injection of PI; b) 3 h after injection.

Fig. 3. Luminescence of septal region of right atrium (a) areas of heart muscle (b) of rabbit after intravenous injection of PI, of septal region of right atrium of control rabbit (c), and, for comparison, aqueous solution of PI (d). Abscissa, wavelength (in nm); ordinate, intensity of absorption.

The aim of this investigation was to study the possibility of using one of these pyrrole derivatives, namely 3, 6, 7, 8-tetramethyl-4-isobutyl-2-carboethoxy-6H-pyrrolo-3, 2, 5-indolyzine (pyrroloindolyzine – PI), for stimulating luminescence of individual areas of the heart in experimental animals. The choice of PI as LS is determined by its high solubility in water, high intensity of luminescence, and also its biological activity which was mentioned above.

EXPERIMENTAL METHOD

PI was obtained by the method in [7], recrystallized several times from glacial acetic acid and ether, and its physicochemical characteristics corresponded to those given in the literature.

The absorption spectrum of an aqueous solution of PI was recorded with the SF-26 spectrophotometer. Luminescence spectra were excited by the 4th harmonic of an LTI PCh-5 laser on YAG:Nd (~266 nm) and the spectra were recorded by means of an MDR-3 monochromator and FÉP-3 photoelectric attachment. With this method of excitation, luminescence spectra of both proteins and PI can be observed simultaneously in the heart tissues chosen for study, provided that PI accumulates in them.

An aqueous solution of PI was injected intravenously into rabbits. Experiments were carried out on 20 rabbits weighing 1.5-3 kg, seven of which constituted the control group, which did not receive PI. The quantity of PI injected into the blood stream varied from 5 to 30 mg/kg body weight. The time intervals from injection of PI until sacrifice of the animals and resection of the heart, and comparison with pieces of pectoralis muscle, lungs, and liver, varied from a few minutes to 3 h.

EXPERIMENTAL RESULTS

The absorption spectrum of an aqueous solution of PI is illustrated in Fig. 1. The main peak of absorption lay in the ultraviolet region and overlapped quite well with the 266 nm laser line used to excite luminescence. The luminescence spectrum of this same solution is shown in Fig. 3d. Its peak lay in the initial short-wave region of the visible spectrum (430 nm), i.e., it was appreciably shifted relative to the ultraviolet protein luminescence [8].

After injection of PI, luminescence of the resected heart tissues was observed in the blue region of the spectrum (peak 430 nm), characteristic of aqueous solutions of PI. Luminescence was not observed in other tissues taken for investigation. The greatest effect was achieved when the rabbit was killed within a few minutes after injection of PI (Fig. 2). The most intensive luminescence in this region of the spectrum was characteristic of structures of the atrial septum (Fig. 3). Figure 3 shows luminescence curves of these structures and areas of myocardium of the rabbit after injection of PI (Fig. 3a, b) and of the same structures of a control rabbit heart (Fig. 3c), normalized relative to the peak of luminescence in the ultraviolet region of the spectrum, corresponding to luminescence of proteins contained in them. In this way the intensity of luminescence in other regions of the spectrum in different parts of the heart of the same or different rabbits could be compared directly. It will be clear from Fig. 3 that luminescence observed in the 430 nm region on the ultraviolet luminescence curve of proteins was due to PI injected via the blood stream.

These results thus indicate that intravenous injection of PI promotes its rapid absorption in the heart of experimental animals (rabbits), and that luminescence of PI on ultraviolet excitation (λ = 266 nm) is observed mainly in the septal region of the right atrium. This encourages the hope that PI will be used as LS in the future for luminescence probing of the heart as an aid to the solution of medical diagnostic problems.

LITERATURE CITED

1. S. A. Mills, F. F. Jöbsis, and A. V. Scaber, Ann. Surg., 186, 193 (1977).
2. D. R. Doiron and A. E. Profio, Springer Ser. Opt. Sci., 22, 92 (1980).
3. French Patent 1541593 (1970), Chem. Abst., 72, 12558 (1970).
4. U. S. Patent 3636042 (1972), Ref. Zh. Khim., 18N, 188 (1972).
5. U. S. Patent 3809753 (1974), Ref. Zh. Khim., 50, 243 (1975).
6. Author's Certificate No. 978566 USSR (1982).
7. N. A. Chernogryazskaya, Yu. M. Rozanov, M. S. Bogdanova, et al., Ultraviolet Fluorescence of Cells [in Russian], Leningrad (1978).

REVERSIBLE FUNCTIONAL BLOCKING OF THE OPTIC TRACT BY FOCUSED ULTRASOUND

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The use of focused ultrasound (FUS) to obtain reversible changes in the CNS is useful both in experimental physiology and in medical practice. For example, during ultrasonic neurosurgical operations reversible (temporary) blocking of an area of brain tissue could serve as a function test for settling the issue of whether final (irreversible) destruction of a given structure is acceptable depending on the result obtained.

It has been shown that reversible blocking of some brain formations by FUS is possible in principle [4, 5]. The doses required for functional blocking of nerve structures were found to be so close to destructive doses that the use of this procedure in practice seemed to be contraindicated.

The writers have studied the possibility of using irradiation with FUS under conditions known to be nondestructive in order to produce changes leading to the temporary, reversible, blocking of conduction of information along the optic tract. Evoked potentials (EPs) of the brain centers of the visual system were used as the indicator of functional changes.

To verify the functional character of the action of the chosen doses of FUS, an electron-microscopic investigation was made of endings of the optic tract (OT) fibers in the superior colliculus (SC).

EXPERIMENTAL METHOD

The experimental apparatus enabled FUS to be applied to the optic tract and, at the same time, electrical activity from different parts of the visual system to be recorded [1–3].

Experiments were carried out on 40 adult cats anesthetized with pentobarbital. Ultrasound was applied through a burr-hole above the part of the brain to be irradiated, and the uninjured dura mater. A cannula, consisting of a hollow cylinder made of transparent plastic (Fig. 1), filled with physiological saline 2 heated to 37°C, was fixed hermetically to the animal's head above the burr-hole. The center of the focal region of the generator 3 was made to coincide with the test structure 4 by means of a coordinate system. The coordinates

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