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SPECTRAL STUDY OF THE LUMINESCENCE OF THE TISSUES
OF THE OTORHINOLARYNGOLOGICAL ORGANS
by Yu. N. Yefuni, et al.
USSR

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SPECTRAL STUDY OF THE LUMINESCENCE OF THE TISSUES OF THE OTORHINOLARYNGOLOGICAL ORGANS

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[Following is a translation of an article by Yu. N. Yefuni and V. V. Maryakin, State Scientific Research Institute of Ear, Nose, and Throat of the 12 RSFSR, Moscow Order of Lenin Clinical Hospital imeni S. P. Botkin, in the Russian-language journal Biofizika (Biophysics), Vol VII, No 4, Moscow, 1962, pages 480-483.]

As is known (1-7), tumor tissue of the stomach, rectum, breast and lungs possesses fluorescence upon the introduction of dye into the human or animal organism. This property aids in the diagnosis of malignant tumors and helps to define more precisely their limits, which is very important for the postoperative prognosis. On the basis of studies of the luminescence of different tissues of the ear, nose and throat, it has been shown (8), that upon injection into the organism of fluorescein, certain pathologically involved tissues of these organs possess a characteristic yellowish green luminescence which is characteristic of the injected dye upon exposure to filtered ultraviolet light. Such tissues include nasal polyps in which there is edema and fibrous tissue and certain non-epithelial tumors such as reticulosarcoma, reticulosis, the Shmink tumor, angioendothelioma, and juvenile fibroma of the nasopharynx.

As to tumors localized in the ear, nose and throat (squamous-cell keratinizing and nonkeratinizing tumors, adenocarcinoma and epidermoidcarcinoma, as well as the so-called Shneyderov form), as well as papillomas, fibroma and angina, upon examination in filtered ultraviolet light, following the injection into the organism of fluorescein, in no case was luminescence of the tumor observed. At the same time, preparations of these tumors in filtered ultraviolet light produced a secondary luminescence in certain cases.

For the objective conformation of the data of visual observations of fluorescence in pathologic tissues received in the clinic, we used in the present work a spectrophotometric method which has been used for the study of the luminescence of lung tissue (2).
We obtained the tissues which we studied from the surgical department. Spectral studies were performed on the luminescence of tissues removed from patients to whom had been given, prior to operation, technically pure fluorescein (8), or whose tissues had been subjected to ordinary laboratory staining (2) following their removal. In addition, spectral studies were also made of the luminescence of removed tissues in order to determine the level of natural, primary luminescence, without the addition of a fluorochrome.

In all, we performed spectrophotometric studies on more than 30 samples of tissues from the ear, nose and throat. The results of the studies (Figures 1-4) are shown in the table, in which are given the spectra of primary and secondary fluorescence of the tissues of the ear, nose and throat, and in which the relations are shown between the intensity in the maxima of the spectra of fluorescence of dye absorbed to the intensity of the maxima of primary, that is natural, fluorescence of a given tissue (see Columns 7 and 10 of the table).

A comparison of the visual observations of the luminescence of different tissues of the ear, nose and throat with the calculated ratio of intensities of maxima of secondary fluorescence to primary fluorescence, enable us to demonstrate certain definite laws. The luminescence of the organic dye - technically pure fluorescein - in ear, nose and throat tissues upon examination of patients in filtered ultraviolet light is not observed in cases in which the ratio of intensity of the maxima of the luminescence has a value from 1.0-2.0. When the ratio of intensities of maxima of fluorescence is greater than 3, as occurs, for example, in nasal polyps, then examination of the ear, nose and throat, as well as of the slides of removed tissues, in filtered ultraviolet light shows a contrasting yellowish green luminescence.

As can be seen from the Table and from Figures 1-4, there is a complete identity of the spectra of secondary luminescence of tissues both in the case of intravital staining (that is, when the fluorescein is given to the patient before operation), and in cases of laboratory staining.

A careful analysis of the spectra of luminescence of tissues of the ear, nose and throat shows that unmodified tissue of these areas almost fails to absorb the fluorescein (Figure 1). The demonstration of a new maximum in the area of 510 mmc must be attributed to the luminescence of the dye, which is absorbed by the tissue in small amounts.

It should be noted that the tonsillar tissue in cases of chronic tonsillitis absorbs the fluorescein as poorly as does the natural tissue (Figure 2).
Figure 1. Spectrum of luminescence of unchanged tissue (true vocal cord).

a - Primary luminescence;
b - Secondary luminescence following laboratory staining

Figure 2. Spectrum of luminescence of the tonsil in a case of chronic tonsillitis.

a - Primary luminescence;
b - Secondary luminescence upon intravital staining

Figure 3. Spectrum of luminescence of tumor tissue.

a - Primary luminescence;
b - Luminescence upon laboratory staining;
c - Secondary luminescence upon intravital staining

Figure 4. Spectrum of luminescence of fibrous and edematous polyp.

a - Primary luminescence;
b - Secondary luminescence upon intravital staining
<table>
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<td>Широкая полоса с плохо выраженным максимумом; имеет меньшую интенсивность, чем 1, 2 и 4 (по вертикали)</td>
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<td>4</td>
<td>Остно-фиброзная полоса носа</td>
<td>Широкая полоса с плохо выраженным максимумом</td>
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Key to Table on page 4

1. Number of patient;
2. Primary luminescence;
3. Type of tissue and histologic characteristics of it;
4. Type of spectrum;
5. Maximum in mmc;
6. Secondary luminescence;
7. Upon laboratory staining;
8. Type of spectrum upon laboratory staining;
9. Ratio of intensities of maxima of fluorescence of the dye to maxima of primary fluorescence of tissues;
10. Upon intravital staining;
11. Type of spectrum upon staining tissues intravitaly;
12. Unmodified true vocal cord;
13. Wide band with poorly demonstrated maximum;
14. Wide band with two maxima;
15. Tonsil in chronic tonsillitis;
16. Tumor tissue;
17. Wide band with poorly demonstrated maxima; has less intensity than 1, 2 and 4 (with respect to its vertical dimension);
18. Edematofibrous polyp of the nose;
19. Narrow band of high intensity with a single maximum due to the dye.

Tumor tissue absorbs fluorescein poorly, but nonetheless slightly better than normal tissue, especially with intravital staining (Figure 3). The spectra of cancer tissue show a basic maximum at 515 mmc and a secondary maximum at 470 mmc, which is attributable to primary luminescence.

Nasal polyps, as compared with the above mentioned tissues, absorb fluorescein very readily (Figure 4). The spectrum of a polyp, either with intravital or with laboratory staining, has a very sharp narrow band of high intensity with a single maximum in the area of 515 mmc, which is attributable to the dye.

Despite the considerable amount of experimental data on the luminescence of tumors, in none of the above mentioned works has any serious attempt made to explain this phenomenon on a theoretical basis.

According to the data of I. A. Oyvin and V. I. Oyvin (9), a definite part of the fluorescein injected into the body is bound to the albumin of the blood and, with changes in the permeability of vessels, is extravasated together with the albumin into the tissues.

It is possible that the absorption of fluorescein by certain tumors is due to disturbances in the permeability of the vessel walls of vessels supplying these tumors.
CONCLUSIONS

1) Tissues of the ear, nose and throat (both normal and pathologic) absorb fluorescein to differing degrees.

2) A correlation has been discovered between visually observed luminescence upon examination of the ear, nose and throat and the amount of luminescing dye in the tissues.

3) Laboratory staining of pieces of tissue produces the same spectral characteristics as does intravital staining, which also permits studies of the secondary luminescence of tissues under laboratory conditions for the purpose of determining specific dyes for one or another type of pathologically altered tissue.

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