

Possibilities of application of fluorescence spectroscopy in minimally invasive surgery for analysis of abdominal cavity organs pathological processes

Ksenia Kandurova¹, Victor Dremine¹, Alexandr Alyanov^{1,2}, Andrian Mamoshin^{1,2} and Andrey Dunaev¹

¹ Scientific-Educational Center "Biomedical Engineering", Orel State University named after I.S. Turgenev, Orel, Russia

² Department of X-ray-surgical methods of diagnosis and treatment, Orel Regional Clinical Hospital, Orel, Russia

Introduction

Currently, the number of patients with malignant tumors of hepatopancreatoduodenal area is growing. This is one of the most important problems of surgery of the abdominal cavity due to the high level of complications and mortality. In the majority of cases patients are admitted to hospitals due to complications, while the frequency of early diagnosis of malignant tumors does not increase. There is a necessity to develop new diagnostic methods and criteria.

Optical non-invasive diagnostic methods are beginning to spread in clinical practice; one of them is fluorescence spectroscopy (FS). It is based on analyzing the endogenous fluorescence specters in biological tissues induced with optical radiation. It is known that one of consequences of cells functioning violation are changes in a respiratory chain of mitochondria resulting in changes in accumulation of NADH and FAD. Also, oncological processes can be accompanied by structural changes in collagen fibers in the stroma of hollow organs. Potentially, these changes can be assessed *in vivo* using the FS method.

The aim of research

To study the possibilities of fluorescence spectroscopy usage for analyzing and evaluating the state of the abdominal cavity organs in diseases of hepatopancreatoduodenal area.

Experimental study

19 patients of surgery department of Orel Regional Clinical Hospital aged 67±8 were engaged in the research. Areas of interest were distal and proximal points of common bile duct, 2 points of neck, body and fundus of gallbladder and 2 points of hepatic abscess.

Experimental equipment

Experimental measurements were conducted using the fluorescence channel of specially designed system with a laparoscopic optical probe (SPE "LAZMA" Ltd, Russia). A 365 nm and 450 nm radiation sources were used for fluorescence excitation.



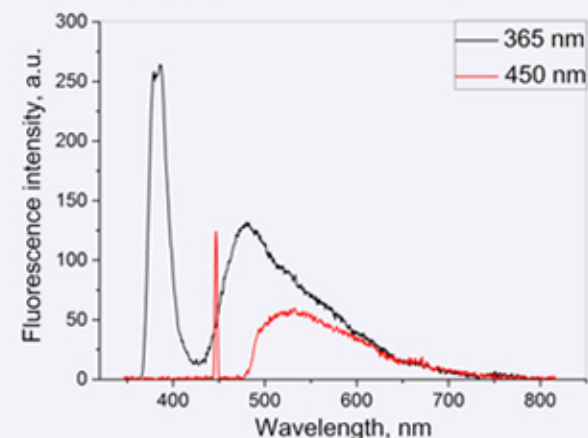
Prototype example of Lakk-M device



Laparoscopic optical probe

Results and Discussion

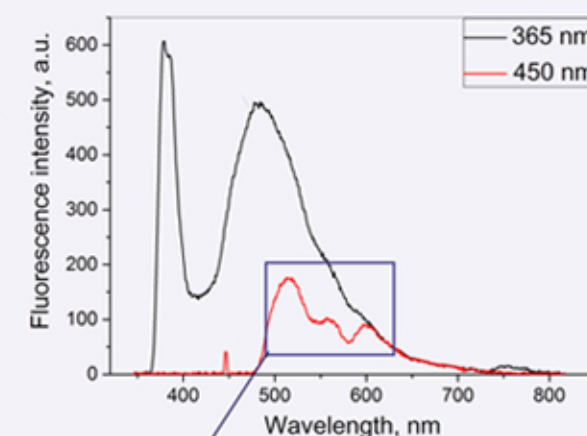
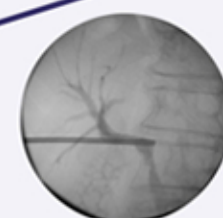
Fluorescence spectra were recorded during primary and repeated minimally invasive interventions. Typical fluorescence spectra for each area are shown below.



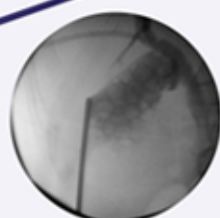
Liver
(hepatic abscess)



Common
bile duct



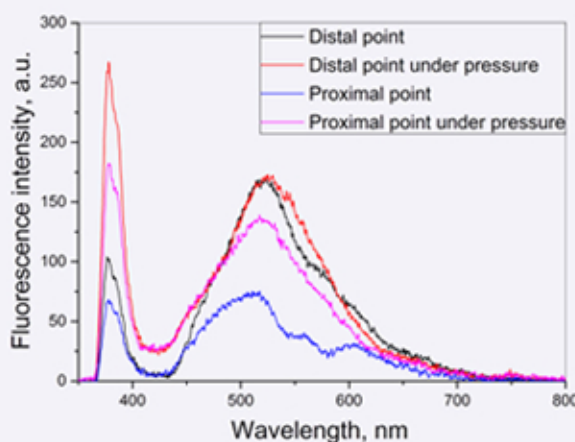
Gallbladder



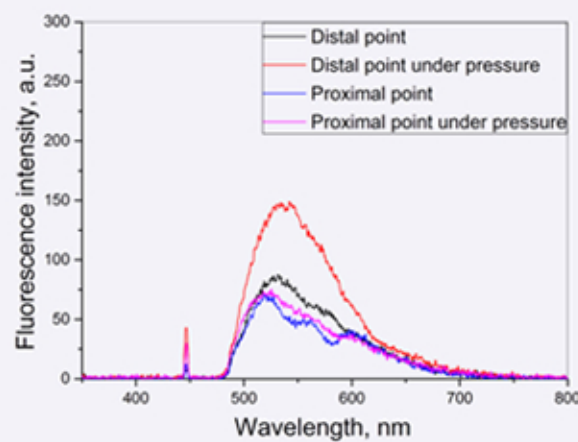
Fluorescence intensity decreases at wavelengths approx. 540 nm and 580 nm, which is associated with the absorption of laser radiation by hemoglobin fractions.

Fluorescence spectra of common bile duct under pressure at wavelengths 365 nm (a, c) and 450 nm (b, d): a, b - without the normalization, c, d - after the normalization to the backscattered source signal.

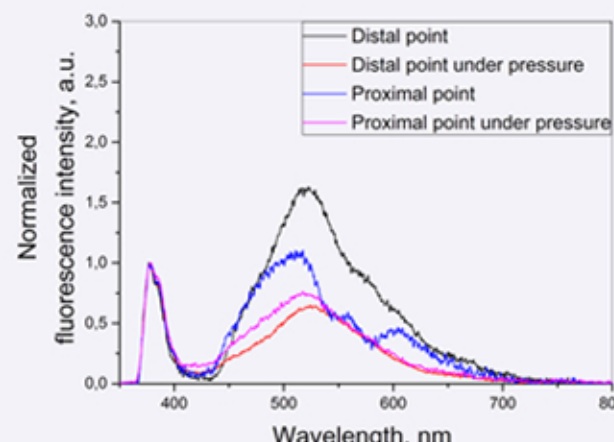
Fluorescence intensity increases while the visible influence of laser radiation absorption by blood decreases. Normalized spectra show opposite effect.



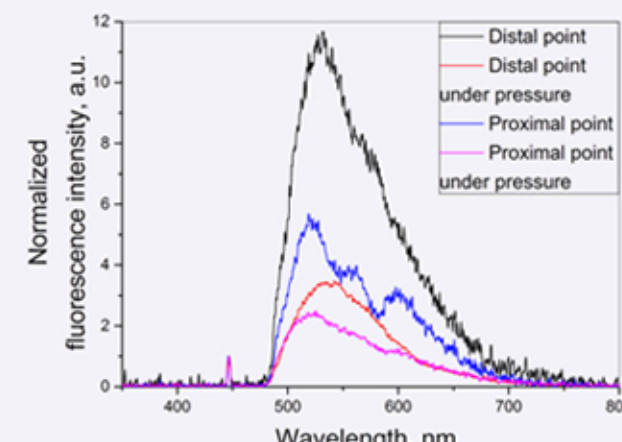
a



b



c



d

These graphs show that intensity of fluorescence and backscattered radiation can greatly vary in different areas of interest. It was observed in different points of one area as well. It is caused by a number of factors: the state and kind of changes in the tissues, the phase development of pathological processes, their behaviour in the setting of treatment. Blood perfusion also influences on the fluorescence spectra.

Conclusion

Thus, obtained results are of interest for further studies in a larger number of patients. It is also necessary to analyze the influence of the factors mentioned above, especially the influence of the stage of treatment on fluorescence spectra. It will allow to interpret the results more properly and to develop new diagnostic criteria for the study of hepatopancreatoduodenal organs pathologies.