Abstract—The method and apparatus are designed allowing fluorescent diagnostics of preliminarily photosensitized inflamed tissues of major human joints (shoulder and knee joints). The method is unique because the system provides registration of two kinds of images, fluorescent and color, which are displayed simultaneously as superposition of them. The concentration of photosensitizer is determined at any desired point of the image in digital form in monitoring mode before, during and after the procedure. Excitation of fluorescence is initiated by a laser light source with wavelength of 635 nm. Control of a therapeutic dose of laser irradiation is monitored by photo bleaching in the red wavelength range, which allows providing diagnostics even when thin layers of the blood over analyzed tissue screen the fluorescence signal.

Keywords—fluorescence; diagnostics; imaging; arthroscopy

I. INTRODUCTION

Photodynamic therapy (PDT) in the arthroscopy is a new direction in the treatment of arthritis and other inflammatory processes in large human joints. The uniqueness of PDT is caused by the induction of biological structures damage under the action of the natural regulators such as cell proliferation, metabolism and apoptosis regulators. Under the conditions of inflammatory processes in the large joints of humans PDT allows enhancing of local and general blood circulation, helps to relieve swelling, inflammation and pain, facilitates the development of joint movement. To increase the effectiveness of PDT there is a need to monitor and control the accumulation of photosensitizer (PS) and laser irradiation dose. For this purpose, fluorescent diagnostic methods are used which monitors the level of PS fluorescence in tissue. We have developed a fluorescence endoscope system that allows to define the boundaries of inflammatory processes in tissue due to accumulation of PS molecules in inflamed cells.

The uniqueness of the developed imaging system is, in comparison with similar systems in the world, that there is no need to switch between the color navigation and fluorescence diagnostic modes. The optical probing depth is also managed to increase during fluorescence diagnosis, due to the use of the red wavelength range for fluorescence excitation, because in this range of visible spectrum the window of biological tissue transparency have a place. Using the 635nm wavelength, it is possible to diagnose the tissue state through the thin layer of blood, which can be formed in the surgical wound after a small surgery.

II. MATERIALS AND METHODS

As a photosensitizer Photoditazine (chlorine E6 derivative) was used. The PS was administered intravenously calculated as 0.05 mg per 1 kg of the patient body weight. All patients underwent fluorescence spectroscopy diagnosis and video fluorescence analysis before, during and after surgery. In all cases, the PS content in tissue was determined by fluorescence index and boundaries of inflammatory processes were visualized. The research is based on the results of examination and treatment of 8 patients with deforming arthrosis, synovitis and meniscal injuries of the knee, and 3 patients with deforming arthrosis, subacromial bursitis and impingement syndrome of the shoulder joint.

III. RESULTS

Fluorescent diagnostics with both spectral and imaging methods was conducted before, during and after surgery adjustments for foci of inflammatory processes in which the photosensitizer is accumulated. Before the analysis of spectral data, all the spectra were normalized to the intensity of back scattered laser light. Spectroscopic analysis of the top of bloated knee showed that PS was mostly accumulated in the medial and lower section in comparison with cartilage, which was later accepted as the normal tissue because of the negligible accumulation of the PS in it.

IV. CONCLUSIONS

Quantitative video fluorescent analysis and fluorescence spectroscopy of tissues of the knee and shoulder joints allowed to develop the diagnostic criteria for control of laser radiation doses.

Analysis of clinical results of PDT with "Photoditazin" showed that the optimal dose of laser irradiation at which a photo bleaching is reached equals 50-100 J/cm².

Thus quantitative video fluorescence arthroscopic navigation improves the efficiency of photodynamic therapy of large joints arthritis.