FUNCTIONAL PROPERTIES OF LASER EFFECTS ON MORPHOLOGY OF LIVER, GALL BLADDER AND BILE DUCTS IN CHOLELITHIASIS

In 85 patients with calculous cholecystitis the preoperative preparation before laparoscopic cholecystectomy included irradiation of the area of gall bladder and epigastric puncture with low power magneto-infrared laser. The performed investigations revealed significant reduction of the liver and gall bladder changes both on the light optic and electron microscopic levels due to effects of low power laser irradiation.

**Keywords:** Cholecystitis calculous, liver, gall bladder, laser.

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**Introduction**

Nowadays, there are many unresolved disputable questions in the treatment of liver and gall bladder. The high prevalence of cholelithiasis and appearance of new surgical technologies indicate the problem of treatment of the diseases of the gall bladder and bile ducts as very important in the current surgery (Ermolov et al., 1997; Yarosh and Romanov 2008).

The therapeutic effect of laser irradiation has been studied in many diseases and their models in experiment and on the clinical material with use of clinical, physiological, biochemical, histochemical, luminescent, electron-microscopic, biophotometric, mathematic and other methods of investigations.

The optimal diapasons, regimens, doses and points of laser effects have been clearly determined in different diseases. The therapeutic effects of laser irradiation are based on the following properties: stimulation of the cell synthetic function, stimulation of proliferative activity, enhancing microcirculation, phagocytic function and analgesic effect (Baybekov et al., 2008; Alexanratou et al., 2002; Baxter, 1994; Tuner and Hode, 1999).

These properties allow using laser therapy practically in all acute and chronic inflammatory processes, metabolic disorders, immune depressions, tissue regeneration disturbances.

Moskvin and Buylin (2006) suggest, that marked spasmolytic properties of the low power laser irradiation underlie in its use in the complex treatment of cholecystitis. On their opinion, the signal molecules of Ca2+ are responsible for the spasmolytic effect of laser therapy which being distributed among adjacent cells of smooth muscles provide coordination of myocyte contraction inducing positive effect of laser therapy.

According to the opinion of the majority of researchers engaged in the study of mechanisms of effect of low power laser irradiation in this aspect the identification of peripheral acceptor of the photo effect is the key question. There were found many these acceptors and a number of enzymes among them: catalase, superoxid dismutase, cytochroms (Geinits et al., 2006; Kary, 2001). Performing analysis of the literature data Moskvin and Buylin (2006) emphasize that any intracellular component having the site of absorption for this wave length, including water, may serve as acceptor. In this case the trigger mechanism of the biological effect of low power laser irradiation is, for the first turn, thermodynamic effect. Functioning of the majority of intracellular components is closely connected with their conformational mobility depending on the presence of water and its state.

Consequence of the photo-induced “behaviour” of macromolecules is, on the one side, change of the water structure, and, on the other side, excretion of Ca2+ ions from calcium depot (Moskvin and Buylin 2006; Carafoli et al., 2001). It was shown that concentration of
intracellular calcium was increased many times under effect of low power laser irradiation (Moskvin and Buylin 2006; Tuner and Hode 1999).

The regulatory mechanisms are very universal, this is a transport through membranes, processes of secretion, blood coagulation, activation of cellular metabolism and increase in their functional activity, stimulation of the reparative processes. These processes are related to increase in redox potential of mitochondria (Geinits et al., 2006; Kary, 2001; Schafer and Sroka, 1997).

Anti-inflammatory effect of low power laser irradiation and stimulation of microcirculation were also related to calcium dependent release of inflammation mediators cytokines, as well as calcium dependent discharge of vasodilator nitric oxide (NO) by endothelial cells (Moskvin and Buylin, 2006).

Thus, analysis of the current literature indicates that universality of the effect of low power laser irradiation, at present time, is connected with their effect of the discharge of Ca 2+ from calcium depot. The universality of the favorable effect of low power laser irradiation on many intracellular processes is connected with microcirculation stimulation again indirectly because of increase under the effect of Ca2+, NO content (Moskvin and Buylin, 2006).

It is difficult now to name organ or pathology, the exposure on which does not require laser therapy. However, the use of laser therapy in the complex endosurgical treatment of cholecystitis attracted the least attention of researchers. The changes of the gall bladder due to effect of low power laser irradiation, as well as liver changes in cholecystitis and effect of laser therapy on the reduction of these changes have not been studied yet. All this made performance of study presented in this article.

Materials and methods

In this investigation of 85 patients, including 55 with acute calculous cholecystitis and 30 with chronic calculous cholecystitis into the preoperative preparation before laparoscopic cholecystectomy (LCE), there was used irradiation on the area of the gall bladder and epigastric duct by low power magneto-infrared laser. At admission to the hospital the patients with acute cholecystitis received spasmolitics, analgetics and infusion solutions which had no effects on the laser activity. All the patients gave informed consent for their inclusion into the complex of preoperative treatment with laser therapy and for investigation of the biopsy samples after operation. For this purpose there were used magnetic laser apparatus “Milita” and “Sogdiana” (Russia), generating laser irradiation in the impulse regimen in the infrared spectrum with wavelength 0.89 µm in the constant magnate field with voltage 35 mT. The power in the impulse laser irradiation was 8-24 mVt, outlet average power was 4-7 mW. Frequency of impulse was 800-1000 Hz. The irradiation was performed percutaneously in 3-5 points by 60-120 sec. there were studied removal gall bladders and pieces of liver tissue which were dissected from the margins of the liver during laparoscopic surgeries.

For light microscopy the tissue samples were fixed in 10-12% of formalin solution on the phosphate buffer by Lilli. Paraffin slices were stained by hematoxylin-eosin.

For transmission electronic microscopy (TEM) the tissue samples were fixed in the 2.5% solution of glutaraldehyde on the phosphate or cacodylate buffer, after dehydration in the ethanol aceton they were immersed into epon-araldite mix. The ultra-thin slices obtained at the ultratom “Ultracut” were contrasted in the apparatus “Ultrostainer” and were studied in the electron microscope Hitachi HB600.

For scanning electron microscopy (SEM) after the above described fixation were dehydrated in the ethanol acetone, then were dried by method of critical point in the apparatus HCP-2 and were covered by nebulized aurum in the apparatus IB-2. They were studied in the electron microscope Hitachi S405A.
The pictures were made on the color film Kodak Professional Pro Foto100 or Fijicolor superia 100, as well as with use of digital mirror camera from microscope monitor. Microphotographs were scanned on the scanner Scan Prisa 640P (Acer) and they were undergone to computed processing on the computer using Windows 2003.
The semi-thin epoxide slices stained with methylene blue - fuxin were studied with use of light optic apparatus. The light-optic microphotographs were obtained on the microscope “Axioscope” (Zeizz) with digital camera “Sony”.

**Results and discussion**

The effect of low power laser irradiation on the morphology of liver and bile ducts in cholecystitis were studied in patients who underwent laser therapy in the prepared period to laparoscopic cholecystectomy.

The investigations showed that the course of laser therapy had marked positive effect on the normalization of the liver structure. The number of hepatocytes decreased after balloon and fat dystrophy in chronic calculous cholecystitis. The lumens of sinusoids decreased with reduction in number of erythrocytes in them (Figures 1, 2).

In the portal tracts the lymphoid infiltration reduced. The lumens of the central veins remained to be dilated, but there were no formal blood elements there. The general architectonics of the hepatic beams was normalized and also nearer to the central vein. The nuclei became more homogenous both in form and sizes (Figure 3).

Electronic microscopic investigations showed restoration of the intracellular structures of the hepatocytes. Mitochondria acquired the specific ultrastructure and electron density of the matrix. The number of profiles of granular endoplasmic net increased. Glycogen distributed evenly in the cytoplasm. Heterochromatin dominated in the nuclei, and in the nuclear membrane there was found great number of pores.

The significant reduction of inflammatory destructive changes was noted in the wall of gall bladders. This was expressed in the decrease in inflammatory infiltration, edema and stasis as well as in occurrence of thrombi in the vessel lumens.

The integrity of the epithelial layers in the mucosa was restored (Figure 5). However, in the wall of the gall bladders the fibroblasts continued to dominate in chronic cholecystitis. Scanning electronic microscopy showed decrease in number and sizes of micro-erosion on the apical surface of endotheliocyte. The restoration of the closed adhesion of the epithelial cells to each other and decrease in number of inclusions on the lumen surface were found too (Figure 6).

Laser therapy performed in the preoperative period induced significant qualitative changes in the bile sediments. The number of crystalloid structures sharply decreased. The formation of detritus amorphous masses and various desquamated and migrated into the cell lumen continued to dominate (Figures 7, 8).

Morphological examinations showed specific changes in the liver, wall of the gall bladder and bile in the patients with acute and chronic calculous cholecystitis.

In different forms of the acute cholecystitis the pathological changes were less expressed. They were manifested in the changes of circulatory character. There were no found changes showing types of dystrophy.

The liver changes were more intensified in chronic cholecystitis. Additionally to the circulatory disorders there was revealed fat and balloon dystrophy of the hepatocytes. The general liver architectonics was damaged too.

In conclusion it should be noted that investigations performed showed significant reduction of changes in liver and gall bladder both at the light-optical and electron-microscopic level due to effect of low-power laser irradiation. And this, in its turn, allows recommendation of laser therapy as effective part in the preparation of the patients with cholecystitis for performance of endovisual cholecystectomy for obtaining of good
immediate and long-term postoperative results. This method of treatment may be widely used in the clinical practice.

**Figure 5. Reduction of inflammatory changes, restoration of the integrity of epithelial layers of the gall bladder after laser therapy.**

**Figure 6. Restoration of integrity of the epithelial layers of gall bladder after laser therapy.** SEM x 1000

This investigation is important because it may be continued on the other organs of the gastrointestinal tract surrounding the gall bladder participating in the acute and chronic inflammatory process.
Conclusion

The course of laser therapy in chronic calculous cholecystitis results in decrease of the hepatocytes in the hepatic tissue which underwent to balloon and fat dystrophy, reduction of lymphoid infiltration in the portal tracts, normalization of the general architectonics of the hepatic beams.

The significant reduction of inflammatory-destructive changes takes place in the wall of gall bladders: the inflammatory infiltration, edema and stasis reduced as well as formation of thrombi in the vessel lumens, the integrity of the epithelial layers in the mucosa were restored too.

The course of laser therapy in different forms of acute cholecystitis resulted in decrease in intensity of pathological changes: the vascular circulatory character was normalized; the changes in the liver and gall bladder were no found showing types of dystrophy.

The laser therapy is recommended as effective integral part in the process of preparation of the patients with cholecystitis for performance of cholecystectomy.

References


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