Application of High-Energy Lasers in Surgical Treatment of Hepatic Hydatid Disease

Dr. Valentine I. KOREPANOV, Dr. Gregory D. LİTWİN,
Dr. Bakhtiar R. BABADZHANOV, Dr. Atabai R. ESCHANOV

Özet: *Karaciğer kist hidatik hastalığı olan 214 hastanın 10'inde konvansiyonel cerrahi tedavi (113 cerrahi girişim), 113'ünde laser tekniği ile cerrahi (138 girişim) tedavi uygulandı. Üç tip laser uygulandı: Karbondioksit (CO2), nd: YAG, ve He-Ne. Konvansiyonel cerrahi tedavide komplikasyon oranı %43 olup 3 olgu exitus oldu. Laser tedavide ise komplikasyon oranı %10, mortalite % 0 idi. Lokal morbidite konvansiyonel cerrahi grubunda %25, laser grubunda %1,8 bulundu. İlk grupta %13 nüks olurken ikincisinde nüks olmadı. Laser cerrahisindeki başarılı sonuçların laserin kanamayı durdurucu özelliği, biliyer fistülü kapatması, debrisi temizlenmesi, kistik kaviteyi sterilize etmesi ve yara iyileşmesini stimüle etmesine bağlı olduğu düşünüldü.*

Anahtar Kelimeler: Laser, cerrahi teknikler, sonuçlar, hidatik hastalık, karaciğer.

Summary: *214 patiens with hydatid disease of the liver were operated on: traditional surgical techniques were used in 101 patients (113 interventions) and laser techniques-in 113 (138 interventions). Three types of lasers were applied: CO_2, nd: YAG, and He-Ne. The rate of complications after traditional surgery came up to 43% with 3 lethal outcomes, and after laser surgery - 10% without mortality. The local morbidity in the control group constituted 25% and in the laser group-1.8%. The follow-up revealed 13% of reccurences in the first group and no relapses in the second. Beneficial results of the laser surgery are accounted for the properties of the lasers to arrest bleeding, close biliary fistulas, evaporate debries, sterilize the cystic cavity, stimulate the reparation of the operated tissues.*

Key Words: lasers, surgical techniques, results, hydatid disease, liver.

Surgical techniques of treatment for the hydatid disease of the liver can be roughly classified into the two categories: radical and conservative. Eradications include the hepatic and cystic resections, pericystectomy and hydatidectomy, conservative surgery-external drainage or marsupialization of the cyst (6,7,9,14). Demirci et al (3) divide surgical operations into two groups: those followed by the external cyst drainage and the others-without it.

The conservative surgery is commonly applied for advanced and complicated lesions and therefore they are more often accompanied by elevated postoperative morbidity (3,14) including biliary fistulae formation and recurrences (2,9).

Mastering the hand-on surgery and providing the surgeons with modern equipment, the percentage of the radical interventions could be increased. Thus, Rohner (12) had only 14% of radical operations prior to 1965, while 80%-during recent years.

The principal problems encountered by surgeon while performing management for hydatid disease of the liver are those of the careful hemostasis and biliostasis. For instance, using the electric scalpel for the pericystectomy in 183 patients, Mokhtari et al (10) had lost only three patients and discovered the relapse of the disease in the one (1.6 and 0.6%).

The lasers as the modern surgical. In 1981, Härb and Dinstl (4) have proved the carbon dioxide laser irradiation to be superior over other physical means of producing hemostasis on the liver. The emanation of the other high-energy laser nd: YAG is considered even more effective (5,8). Both lasers allow to destroy, vaporate and sterilize the tissues under the surgery, evidente-

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ly tissues of the parasite, and to seal the intrahepatic and paracystic vessels and biliary ducts. These properties of the lasers are referred to be the most perspective for surgery of the space and cystic liver lesions.

After having reviewed the special literature we collected only a few reports concerning the surgical treatment of the hepatic hydatid disease by CO_2 laser (1,2). The techniques used by these surgeons were similar: resection of the excess of the capsule of a cyst by a focused laser beam; evaporization of necrotic and granular tissues together with the cystic walls and sealing the blood vessels and biliary ducts by a defocused laser beam. The results of these trials were evaluated as encouraging. As far as the nd: YAG laser is concerned, we failed to find any information about its application for the hydatid cysts treatment.

CLINICAL MATERIALS AND FINDINGS

Between 1976 and 1990, 214 patients with hydatid cysts of the liver were studied at the regional hospital Nb. I of the Urgench city (Usb SSR). Sex distribution was 133 female and 81 male, ages ranged from 13 to 81 years (median 47). Primary lesions was stated in 193 (90%) patients, the recurrance-in 21 (10%), single cyst was found in 182 (85%), two or more cysts-in 32 (15%). Combined affections by parasite were in 30 (14%) patients, beween them the cysts located in lungs (11), abdominal cavity (9), spleen (8), in diaphragm (2). Uncomplicated cysts of the liver were in 128 (60%) patients and complicated-in 86 (40%), including cystic piogenic infections-in 66 patients, various ruptures-in 13 and calcification-in 7.

Pain and abdominal mass were the most typical symptoms. Clinical appearence of the disease are shown in Table I.

Diagnosis of the parasitic lesion of the liver was estimated by serologic tests, plain X-rays, radionuclide scans, ultrasonography, computer tomography, selective contrast angiography, laparoscopy, each examination according to demand and indication.

Table I: Clinical signs and findings

Symptoms	Number of patients	Incidence (%)
Pain	184	86
Hepatic enlargement	141	66
Weakness, lost of weight, hyperthermy	88	41
Abdominal tenderness	23	2
No symptoms	2	5

TECHNIQUES OF SURGICAL INTERVENTIONS

Access

The access to the cysts was dependent on the site of the foci: a median xyphoumbilical to the left lobe of the liver (25%), the right subcostal to the segments 4-6 (65%), and the thoracophrenolaparotomy to the segments 7 and 8 (10%).

Liver resection

We used both atypical and anatomical liver resections for hydatid liver disease. Regardless of the main hepatic vessels being ligated or not, we performed the laser dissection by laser alone (Fig. 1) of after liver stapling (Fig. 2).

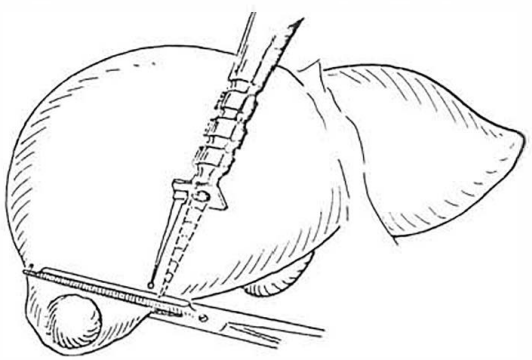

Figure 1. CO_2 laser liver wedged resection.

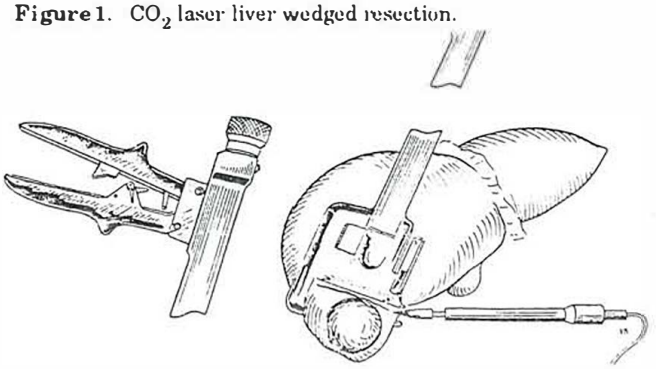

Figure 2. nd: YAG laser liver wedged resection after stapling.

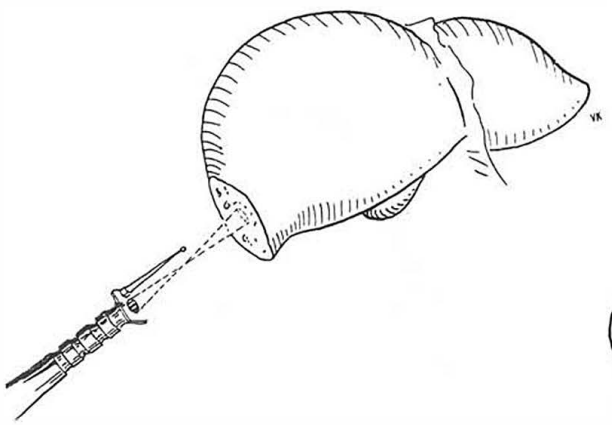

Figure 3. Final hemo- and cholestasis by a defocused CO_2 laser beam after CO_2 laser liver wetged resection.

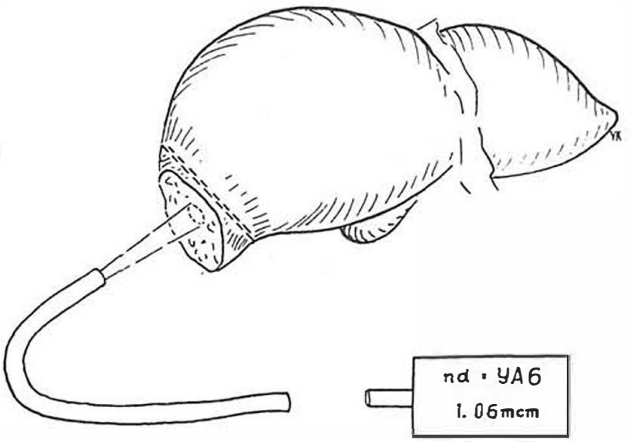

Figure 4. Final hemo- and cholestasis by a defocused nd: YAG laser beam after stapled liver wedged resection

For the final and finest hemostasis and biliostasis we used a defocused laser beam of either carbon dioxide (75-80 W) or nd: YAG (60-80 W) lasers (Fig. 3,4).

The laser-induced crust over the liver resected and lasered surface completely stopped any signs of bleeding and bile oozeing, and perfectly prevented the postoperative intraabdominal blood and bile collections.

Laser hydatidectomy

The first laser that we had used was the carbon dioxide one operating in continuous mode of 10.6 mcm wavelength and up to 80 W of power.

As generally adopted, the content of the cyst is evacuated through the closed needle-catheter aspiration system. Then, via the punction orifice, a lower branch of the special compressive clamp proposed by Skobelkin and co-workers (14) for laser abdominal surgery is inserted into the cyst's cavity. By unityng the branches, the narrow stripof the cistic capsule is compressed (Fig. 5). This gest leads to the arrest of blood circulation in the area of compression, without crushing, and results in a speedy and bloodless laser incision. Repeatedly, the hole into the cyst cavity is made (Fig. 6). The next step is to evacuate the bulk of the fixed debris of the cyst. The laser beam of the defocused mode (75-80 W, diameter

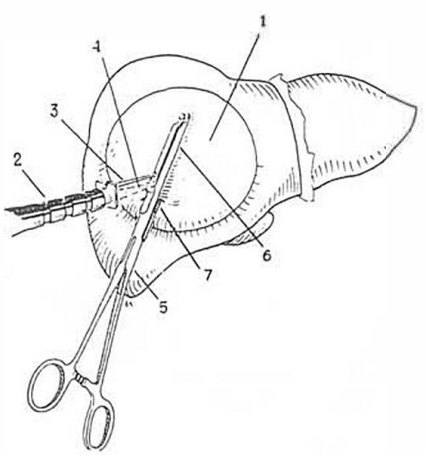

Figure 5. Positioning the compressive clamp: 1-cyst; 2-laser manipulator. 3- pointer of the laser focus beam distance; 4- CO_2 laser beam; 5- compressive clamp; 6- upper, and 7-lower branch of the clamp.

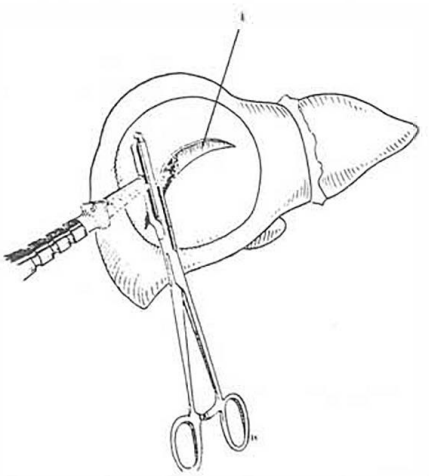

Figure 6. Laser excision of the cystic capsule: 1- previously laser - made hole into the cystic cavity.

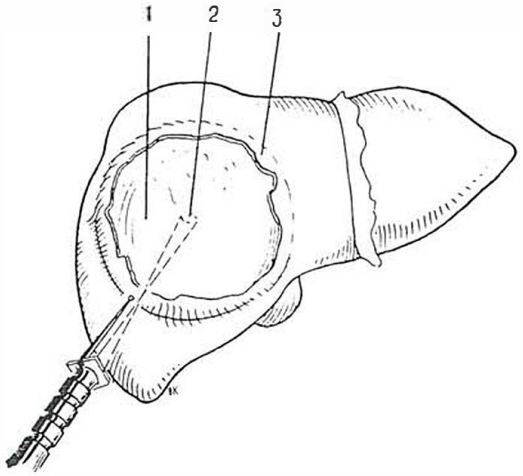

Figure 7. Laser necrectomy and sterilization of the cyst cavity by a defocused CO_2 laser beam: 1- cystic cavity; 2- spot of the laser beam; 3- border of the fibrous capsule after laser excision of its excess.

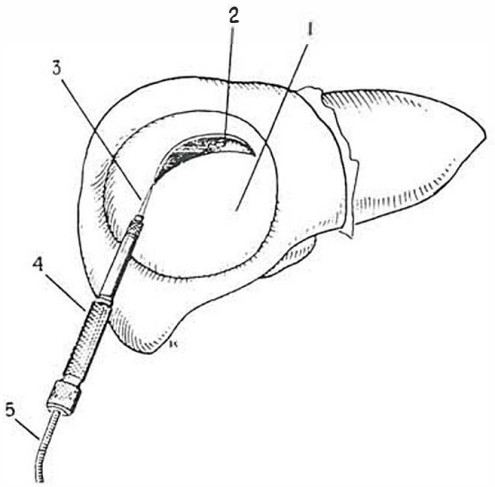

Figure 8. Excision of the parasitic cyst by a nd: YAG laser contact scalpel : 1- cyst; 2- cystic cavity; 3- contact laser probe; 4- holder of the contact laser probe; 5- flexible light-guide for laser energy delivery.

of the spot about 6 mm, superficial power density of some 2.7-2.9 W/mm^2) is then used to evaporate necrotic, granulation, and fibrous tissues, the rest of parasitic tissues and a thin layer of the fibrous capsule, as much as possible (Fig. 7). Simultaneously, the fine laser-assisted hemo- and-biliostasis is realized.

Recently, we have been equiped by a nd: YAG laser, operating in super-pulse or quasicontinuous mode (Wavelength of 1.06 mcm, output power of up 100 W).

The technique of YAG laser hydatidectomy is to some degree different than that of the CO_2 laser.

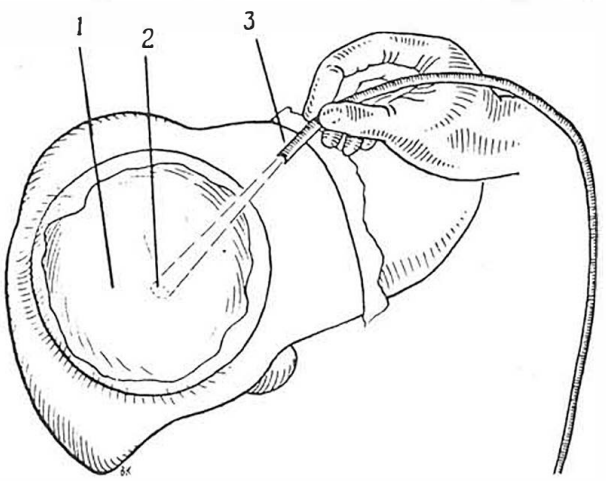

Figure 9. nd: YAG laser treatment of the cystic content: 1- cystic cavity; 2- spot of a defocused laser beam; 3- flexible light - guide for laser energy transportation.

The opening of the cyst hole is done without compression clamps, but by means of a sapphire scalpel (Fig. 8). The cleaning of the cyst walls, sterilization and hemo-biliostasis are performed by a defocused laser beam in diameter of about of 8 mm with the superficial power density of 2.9-3.6 W/mm^2 (Fig. 9).

Pericystectomy

This radical operation is rarely used for the danger of severe bleeding of the hepatic vessels richly surrounding the fibrous capsule of the parasitic focus. We found this procedure to be less dangerous using the contact scalpel of the nd:

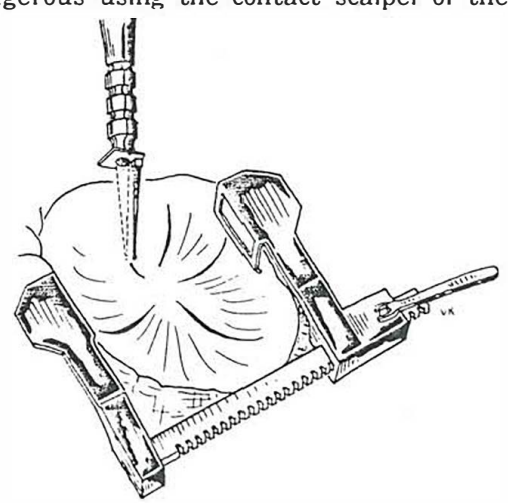

Figure 10. Decortication of the liver cyst's wall by a defocused CO_2 laser beam.

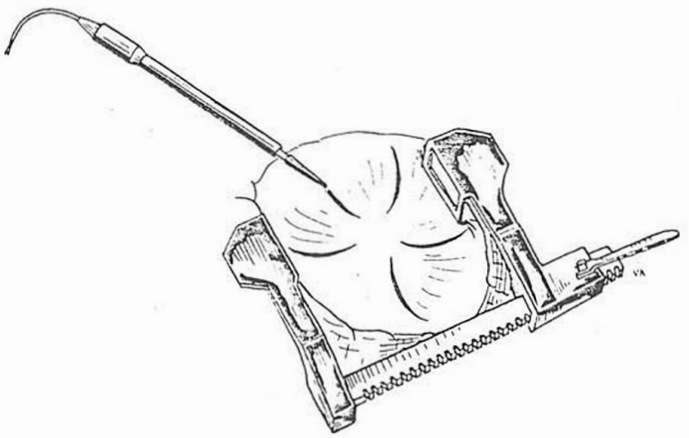

Figure11. Decortication of the liver cyst's wall by a defocused nd: YAG laser beam.

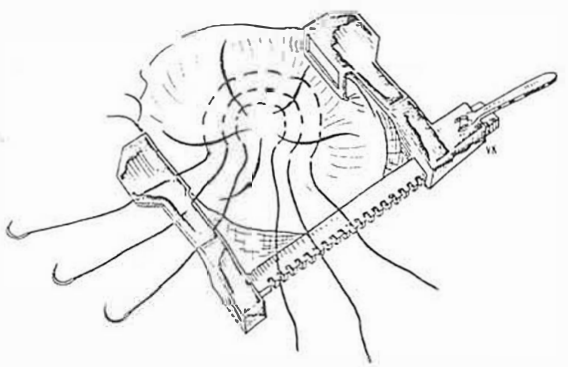

Figure 12. Circular sutures on the bottom of the cyst.

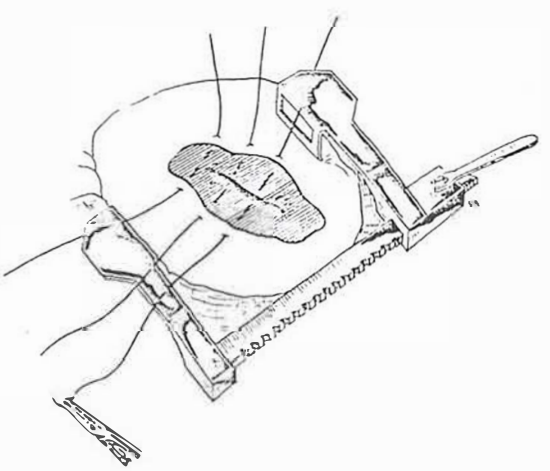

Figure 13. The second layer of the sutures covering the cystic cavity.

YAG laser. The laser acute dissection is bloodless in case of the vessels of up to 1 mm in diameter. More larger vessels, up to 2 mm in diameter are coagulated by a defocused laser beam of the same apparatus. Anyhow, this techniques is advocated for a relatively small cysts to not more than of 5 cm in diameter.

Decortication

We proposed and elaborated a new technique of the laser treatment of the cystic cavity called as decortication of the cavity wall. Using a moderately defocused beam of the CO_2 or nd: YAG laser (spot diameter of about 3-4 mm, output power of 70-80 W, superficial density of power of 6.0-2.4 W/mm^2), the surgeon evaporates the tissues of both cuticular and fibrous capsules in form of the strips traying to spare the vessels and biliary ducts from the laser beam contact (Fig. 10,11). This procedure makes the frame-work of the cyst less rigid and resistant to the collapsable action of the suturing in order to abolish the cystic lumen (Fig. 12,13).

Treatment of cystic cavity

In cases where the cystic cavity remains open it needs be diminished as much as possible in volume and for that we prefer the Delbet-procedure, invagination of filling the cavity in with a pediculated omental graft and suturing over the drain tube, when the other techniques are not suitable.

The external drainage and marsupialization we have used only in 8 patients of 101 operated by traditional surgery and in none of 113 operated by laser. More generally we have applied so called half-closed technique (38 of 214 patients). It means that the remnant of the fibrous capsule is hermetically sutured over the drain tube, and the latter is passed out of the abdominal cavity through the separate stab-wound and serves for active aspiration during the postoperative period. This technique is especially suitable for patients being operated by decortication of the cevity wall.

The other surgical techniques include the interventions for hydatid cysts of lungs, spleen, pancreas, mesenterium, and ovaries. Most of these organs were also operated by laser, as an addi-

Table II: Surgical management of hydatid disease (number of patients, percentage)

Group	Total	Lesion primary recurrence	Cysts solitary multiple	Combined lesions	Complicated lesions
Study 1 (CO2 laser)	78 (37%)	71 (32%) 7 (3%)	66 (31%) 12 (6%)	8 (4%)	42 (20%)
Study 2 (CO_2 laser)	35 (16%)	29 (14%) 6 (3%)	28 (13%) 7 (3%)	11 (5%)	24 (11%)
Control	101 (47%)	93 (44%) 8 (4%)	88 (41%) 13 (6%)	11 (5%)	20 (9%)
Total	214 (100%)	193 (90%) 21 (10%)	182 (85%) 32 (15%)	30 (14%)	86 (40%)

tional surgery to the main on the liver simultaneously as a rule.

SURGICAL MANAGEMENT

Detailed information of 214 patients who have undergone the surgery is listed in Table 2.

The lasers (carbondioxide, nd: YAG) were used in 113 patients (53%). The rest (101 patients or 47%) were operated with traditional cutting (metallic scalpel, scissors) and hemostatic (electrocautery) instrumentation.

The findings in all three groups were comparable exluding the study 2 (YAG laser) group where the incidence of unfavourable satellites of the disease (recurrence, multiple, combined, and complicated lesions) proved to be higher.

Lasers were applied both for hepatic and other hydatid lesions in patients with multiorgans parasitic location (Table 3).

Between 86 patients patients treated for complicated cysts, 66 were operated by lasers and 20-by traditional techniques (Table 4).

Traditional techniques of surgery were applied to 101 patients who have underwent 113 operations. In 113 patients being operated with lasers, 138 interventions have been undertaken. Allto

gether 48 (48%) complications were registered in the control group, and 14 or 12%-in the study group, as the ratio of the complications to the number of patients.

Table III: Surgery for combined lesions

Second location	Total	Surgery	
		traditional	laser
Lung	11	5	6
One of the abdominal organs (omentum, mesentery, pancreas, ovaries)	9	3	6
Spleen	8	3	5
Diaphragm	2	-	2
Total	30	2	19

Table IV: Surgery for complicated hydatid cysts

Complication	Total	Surgery	
		traditional	laser
Infection of cyst	66	17	49
Calcification	7	1	6
Rupture into pleural cavity	5	1	4
Intrabronchial rupture	2	-	2
Intraperitoneal rupture	3	-	3
Rupture into biliary tract	3	1	2
Total	86	20	66

TableV: Surgical management and immediate complications

Surgery	Techniques of surgery			
	Traditional		Laser	
	No of operations	No of complications	No of operations	No of complications
Liver resection	-	-	6	-
Pericystectomy	-	-	3	-
Suture obliteration techniques	76	29	83	8
Halfclosed technique	17	11(1)	21	3
External drainage	5	3(1)	-	-
Marsupialization	3	2(1)	-	-
Others	12	3	25	3
Total	113	48	138	14
Total of patients	101 (3)		113	

In parentheses: number of lethal outcomes

The list of techniques and the number of the postoperative complications are presented in Table 5.

Considerable fall in the postoperative complication rate is remarked in the laser group, that is at least three times.

All complications were divided into the two large categories: general (pulmonary, cardiovascular, intraabdominal and wound infection) and local (bleeding, fistulas, cholangiohepatitis). The Table 6 shows the incidence of complications in the both.

The difference in the local complication rates between the two groups of patients is very significante and constitutes the figure of 12. This fact could not be assessed as astonishing because the lasers that we have been using are capable to arrest bleedings and seal the biliary ducts and capillaries. In order to force the cystic cavity obliteration, we have added the intracystic laser irradiation to the cyst lavage.

For this purpose we used the He-Ne laser (0.63 mcm of wavelength and 50 mW of power), and its energy was delivered through the flexible quartz fiber. The latter has been introduced via a drain tube to perform laser treatment two-three times a week with 60 min exposition. The grade of the cystic volume regression under influence of the various surgical and medical motalities is presented in Table 7.

In spite of the fact, that the first measurements of the cystic volumes in the three groups have given the equal figures, the following data have shown the divergence between the patients of the control group and those of the laser ones, approximately of 2.8-3.0 times. As a result, the time needed for the spontaneous closure of the cystic (biliary) fistulas proved to be in the laser groups half as much as that in a control group, so was the treatment duration (Table 8).

The assambled data concerning the hospital stay after the surgery are presented in Table 9.

Remote results of the surgery were estimated in 96 persons, whos follow-up constitutes three or more than three years after the intervention (Table 10).

The remote results proved to be superior in patients of the laser group over those of a control

TableVI: Immediate postoperative complications

Complications	Number of patients	Techniques of surgery	
		Traditional	Laser
Local :	27	25	2
- bleeding	5	5	-
- residual cyst cavity	4	4	-
- fistula of cyst cavity	7	7	-
- occlusion of biliary ways	2	2	-
- Hepatic fistula to other abdominal organ	1	1	-
- nonparasitic cysts formation	4	4	-
- cholangio-hepatitis	2	-	2
- others	2	2	-
General	35	23	12
Total	62	48	14

group. We account it due to more radical interventions in patients collected in the laser group.

DISCUSSION

The principal goals of our investigations were:

1) to elaborate the laser techniques of surgery in patients with hydatid disease of the liver, and 2) to compare results of the currently used (traditional) techniques and the laser ones.

Two types of lasers are commonly used for general surgery and for liver surgery, too. The carbon dioxide laser, which energy is nearly completely absorbed by water of biologic tissue, possesses the property to cut tissues in focused mode of the beam simultaneously weldingand closing the blood vessels and bile ducts. While using the defocused mode, the laser beam produces more profound hemo- and biliostatic actions, and evaporization and sterilization. The laser crust being formed during the laser treatment serves as a shield protecting both the liver tissue against the enzymes of the cystic cavity content and the cystic wall from the bile oozing. The nd: YAG laser produces energy that is large-

TableVII: Regressing of cystic cavity volume

Management	Number of patients	Mean volume of cavity (ml)			
		Days after surgery			
		One	Six	Twelve	Twenty
Traditional + lavage of cyst	17	890	523	421	356
CO_2 laser surgery + lavage of cyst + laser irradiation	14	870	445	222	127
YAGlaser surgery + lavage of cyst + laser irradiation	7	820	426	212	115

TableVIII: Mean range of cavity fistula closure and length of postoperative treatment

Surgery	No of patients	Days needed to :	
		fistule closure	treatment
Traditional + lavage of cyst	17	48 ± 1.5	49 ± 1.6
CO_2 laser surgery + lavage of cyst + laser irradiation	14	23 ± 2.7	26 ± 1.4
YAGlaser surgery + lavage of cyst + laser irradiation	7	24 ± 2.3	25 ± 2.0

ly adopted by hemoglobin and therefore is accompanied by a deep tissue destruction and an pronounced hemo- and biliostasis. When a light-guide fiber is charged with a sapphire probe (scalpel), the laser energy gains the properties to dissect tissues, close blood vessels bile ducts. The main attribute of the CO_2 laser is the property to evaporate tissues, the main defect- the limited manoeuvrebility of the hand-piece. The main attribute of the nd: YAG laser is the flexibility of the light-guide and the property to destroy tissues and produce stable and reliable hemo- and biliostasis.

The traditional surgical techniques were applied in 101 patients (control group), the laser techniques - in 113 patients (study group), the latter being divided into two subgroups: those operated with the CO_2 laser (78 patients) and the rest - with the nd: YAG laser (35 patients).

Patients of both groups were stated as highly compared in age more patients with recurrences after previous surgery, with multiple, combined and complicated lesions. In spite of these unfourable circumstances, the percentage of postoperative complications in the laser group was found as 14 against 48 in the control group, the ratio was 3.5.

Most complications are referred to hydatidectomies followed by various techniques of obliteration of the cystic cavity (51 of 197 operations). The most frequent and marsupialization (5 of 8 operations with two lethal outcomes).

The advantages of the laser surgery proved to be attractive according to analysis of the list of complications. The principal properties of the laser surgery to arrest bleeding and bile leakage explain the absence of specific complications. Two cases of cholangiohepatitis existing before the operation were not induced but impared by surgical intervention on the background of the severe hepatic and biliary tract lesion. Laser application could no be appraised as a cause of the aggravation.

In patients where the operation was completed by placing the drain into the cystic cavity we have used the laser therapy by He-Ne low energy generator. Our previous experience based on the treatment of several thousands of patients with various inflammative and septic diseases has shown the stimulation of the reparation in affected tissues. The combination of the highen-

Table IX : Length of postoperative hospital management

Surgery	No of patients	General data (days)	Complicated disease	
			No of patients	Length of treatment (days)
Traditional + lavage of cyst	101	28 ± 2	19	44 ± 5
CO_2 laser surgery + lavage of cyst + laser irradiation	78	17 ± 1	43	30 ± 2
YAGlaser surgery + lavage of cyst + laser irradiation	35	16 ± 1	24	25 ± 3

Table X : Remote results of surgery

Results	No of patients	Techniques of surgery	
		Traditional	Laser
Recovery	72	42	30
Recurrence	8	8	-
Residual cavity or fistula	3	3	-
Other disorders (hernias, abdominal adhesions)	5	4	1
Dead	8 (2)	7 (2)	1
Total	96	64	32

In parentheses : Number of patients expired with disease progressing

ergy and soft lasers resulted in the more accelerated regressing of the cystic cavity space and, what is more, in accelerating the spontaneous closure of fistulae and in shortening the laps of recovery.

In summary, the lasers can be considered as instruments supplying the surgeon by an effective tool to improve the results of the surgery for hydatid disease of the liver and other organs affected by echinococcosis. That is realized by increasing a list of indications for more radical interventions even in multilocal and complicated lesions and by decreasing the number of postoperative complications and the rate of reccurences in late follow-up.

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