

Biliary fistula after treatment for hydatid disease of the liver: When to intervene

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Abstract

AIM: To determine the outcome of patients with biliary fistula (BF) after treatment for hydatid disease of the liver.

METHODS: Between January 2000 and December 2010, out of 301 patients with a diagnosis of hydatid cyst of the liver, 282 patients who underwent treatment [either surgery or puncture, aspiration, injection and reaspiration (PAIR) procedure] were analysed. Patients were grouped according to the presence or absence of postoperative biliary fistula (PBF) (PBF vs no-PBF groups, respectively). Preoperative clinical, radiological and laboratory characteristics, operative characteristics including type of surgery, peroperative detection of BF, postoperative drain output, morbidity, mortality and length of hospital stays of patients were compared amongst groups. Multivariate analysis was performed to detect factors predictive of PBF. Receiver operative characteristics (ROC) curve analysis were used to determine ideal cutoff values for those variables found to be significant. A comparison was also made between patients whose fistula closed spontaneously (CS) and those with intervention in order to find predictive fac-

tors associated with spontaneous closure.

RESULTS: Among 282 patients [median (range) age, 23 (16-78) years; 77.0% male]; 210 (74.5%) were treated with conservative surgery, 33 (11.7%) radical surgery and 39 (13.8%) underwent percutaneous drainage with PAIR procedure. A PBF developed in 46 (16.3%) patients, all within 5 d after operation. The maximum cyst diameter and preoperative alkaline phosphatase levels (U/L) were significantly higher in the PBF group than in the no-PBF group [10.5 ± 3.7 U/L vs 8.4 ± 3.5 U/L ($P < 0.001$) and 40.0 ± 235.1 U/L vs 190.0 ± 167.3 U/L ($P = 0.02$), respectively]. Hospitalization time was also significantly longer in the PBF group than in the no-PBF group [37.4 ± 18.0 d vs 22.4 ± 17.9 d ($P < 0.001$)]. A preoperative high alanine aminotransferase level (> 40 U/L) and a peroperative attempt for fistula closure were significant predictors of PBF development ($P = 0.02$, 95%CI: -0.03-0.5 and $P = 0.001$, 95%CI: 0.1-0.4), respectively. Comparison of patients whose PBF CS or with biliary intervention (BI) revealed that the mean diameter of the cyst was not significantly different between CS and BI groups however maximum drain output was significantly higher in the BI group (81.6 ± 118.1 cm vs 423.9 ± 298.4 cm, $P < 0.001$). Time for fistula closure was significantly higher in the BI group (10.1 ± 3.7 d vs 30.7 ± 15.1 d, $P < 0.001$). The ROC curve analysis revealed cut-off values of a maximum bilious drainage < 102 mL and a waiting period of 5.5 postoperative days for spontaneous closure with the sensitivity and specificity values of (83.3%-91.1%, AUC: 0.90) and (97%-91%, AUC: 0.95), respectively. The multivariate analysis demonstrated a PBF drainage volume < 102 mL to be the only statistically significant predictor of spontaneous closure ($P < 0.001$, 95%CI: 0.5-1.0).

CONCLUSION: Patients with PBF after hydatid surgery often have complicated postoperative course with serious morbidity. Patients who develop PBF with an output < 102 mL might be managed expectantly.

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Key words: Hydatid disease; Biliary fistula; Postoperative complications; Surgery

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INTRODUCTION

Hydatid disease, which is caused by the larval form of *Echinococcus granulosus*, is endemic in Mediterranean countries, the Middle East, Australia and South America and has a worldwide distribution^[1]. Despite a decreasing incidence, Turkey is an endemic country according to the Ministry of Health database with more than 14 000 cases recorded from 2001-2005^[2]. Although this zoonosis is rare in the United States and Europe, it is a gradually increasing cause of morbidity and mortality in these regions, largely due to travel and ongoing immigration^[3].

As a definitive treatment, surgery was considered to be relatively safe based on over 4 decades of accumulated experience^[4], but a recent meta-analysis of 14 studies analyzing the outcomes of surgery in endemic areas reported minor and major complication rates of 33.0% and 25.1%, respectively, with a mortality rate of 0.7%^[5]. Intrahepatic rupture (IBR), which involves a communication of the cyst cavity, which is under high pressure, with the biliary system, is the most common and troublesome complication^[6]. IBR was reported to occur at a relatively high rate of 5%-30% of the cases, and it has a wide range of complications, such as biliary obstruction, fistula, infection and secondary biliary cirrhosis^[7,8]. If not promptly diagnosed and treated, these biliary complications may result in serious postoperative morbidity and mortality^[9]. However, most IBRs are occult in nature, and patients may remain clinically silent in most cases, without any specific radiological or laboratory findings being observed in the preoperative work-up and with the IBRs only being discovered during or after surgery. The presence of a postoperative biliary fistula (PBF) is believed to determine the prognosis in these patients^[10].

In fact, there is limited information regarding the natural course and outcome of those patients who had an IBR that was not treated successfully and developed a PBF. We previously reported our experience with the treatment of liver hydatid disease^[11]. In this study, we aimed to report the clinical significance of PBF after treatment for hydatid disease in a separate cohort of patients and to identify clinical predictors associated with the closure of PBF.

MATERIALS AND METHODS

Between January 2000 and December 2010, 301 patients

with a diagnosis of hydatid cyst of the liver were admitted to the Gulhane Military Medical Academy Hospital, Ankara, Turkey. The data were gathered from a prospectively collected database and the electronic medical records of the patients, including age, gender, medical history of hydatid disease, main symptoms and findings, abdominal ultrasonographic cyst characteristics (number of cysts, single, or multiple; presence or absence of other organs involved with the disease), chest radiography, presence of preoperative complications (jaundice, dilation of the biliary tree, intrahepatic, peritoneal or intrathoracic rupture), type of surgical procedure performed, postoperative daily follow-up of complications, duration of stay after the operation and mortality.

All of the patients underwent a complete blood cell count and liver function test determinations. An abdominal ultrasonographic examination (USG) was performed in all of the patients, but computed tomography (CT) was not used routinely. An indirect hemagglutination test was used for the serological confirmation of the diagnosis.

The liver cysts were classified into 5 types according to their ultrasonographic appearance^[12]: type I, a simple hydatid cyst with pure fluid collection; type II, a cyst containing undulated hyperechogenic membranes that float in the cystic fluid (the detached germinative layer of the endocyst); type III, a cyst containing secondary vesicles (daughter cysts); type IV, a cyst with a heterogeneous echopattern and filled with a matrix or amorphous mass; and type V, a cyst with a thick and calcified wall. The presence of irregular linear echogenic structures without acoustic shadowing in the bile duct and/or the dilated biliary tract was accepted as a suggestive USG finding of IBR^[13]. All of the patients with these USG findings were further evaluated with either abdominal CT or magnetic resonance cholangiopancreatography (MRCP).

In total, 19 patients were excluded from the analysis. This group included patients discharged without treatment (5 patients), patients with a preoperative diagnosis of cholangitis (the presence of 2 out of the following 3 symptoms or findings: fever > 38 °C, right upper abdominal pain and jaundice) or patients with suggestive findings of IBR on USG (9 patients) who underwent further evaluation with endoscopic retrograde cholangiography (ERCP) preoperatively. Four additional patients with perioperative common bile duct exploration plus T-tube placement and a patient who died of anaphylactic shock after the operation due to free rupture of the hydatid cyst into the peritoneal cavity were excluded.

The technique of the procedure was mainly selected according to the World Health Organization guidelines on the management of the echinococcal disease, with criteria including the size, type and location of the cyst and the general medical condition of the patient^[14]. In patients with significant comorbidities who refused surgery and had cysts > 5 cm that were Gharbi Types 1-2 on USG were treated with the puncture, aspiration, injection and reaspiration (PAIR) procedure^[15]. Open surgical

Table 1 Preoperative characteristics of patients with hydatid disease of the liver (mean \pm SD)

	Bile fistula		P value
	Absent	Present	
Age, yr	32.0	31.5	0.8
Gender (M/F)	179/57	38/8	0.3
Cholangitis	6 (3%)	24 (52%)	< 0.001
Albendazol treatment	118 (50%)	23 (50%)	0.7
AST (U/L)	221.0 \pm 32.2	44.0 \pm 36.0	0.5
ALT (U/L)	223.0 \pm 41.2	44.0 \pm 38.4	0.8
ALP (U/L)	40.0 \pm 235.1	190.0 \pm 167.3	0.02
GGT (U/L)	25.0 \pm 71.7	151.0 \pm 64.3	0.08
Total bilirubin (mg/dL)	0.9 \pm 1.44	1.5 \pm 3.0	0.05
White blood cell	8077.3 \pm 2945.0	8802.2 \pm 3222.7	0.1

AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; ALP: Alkaline phosphatase; GGT: Gamma-glutamyltranspeptidase.

procedures were classified as radical for any type of liver resection and en-bloc cystectomy^[16]. A partial cystectomy with tube drainage, capitonnage or omentoplasty was considered to be a conservative procedure^[17]. In patients with multiple or communicating cysts, the same surgical procedures were used. The intraoperative detection of a biliary fistula (BF) was at the discretion of the attending surgeon. Uniformly, the cyst cavity was opened, explored for a BF or resection surface and carefully evaluated for a bile leak. Further measures included cholecystectomy and saline or methylene blue injection from the cystic duct stump. A PBF was defined as any drain output consistent with a biliary appearance and a bilirubin count higher than the synchronous serum bilirubin count within 5 d postoperatively.

The patients were grouped according to the presence or absence of PBF (PBF *vs* no-PBF groups, respectively). The preoperative clinical, radiological and laboratory characteristics, operative characteristics including the type of surgery, perioperative detection of BF, postoperative drain output, morbidity, mortality, and length of hospital stay of the patients were compared among the groups. A comparison was also performed between the patients whose fistula closed spontaneously and those who received intervention. The postoperative biliary interventions included ERCP with sphincterotomy and stent placement or nasobiliary tube drainage. Percutaneous drainage catheter insertions were performed under USG guidance.

The following variables were analyzed as potential predictors of PBF development: age, sex, findings on physical examination, leukocyte count, preoperative higher-than-normal liver function test results [alanine aminotransferase (ALT), aspartate aminotransferase, alkaline phosphatase (ALP), gamma-glutamyltranspeptidase, and total bilirubin levels], ultrasonographic cyst features (type, diameter, number, and localization), operation type and perioperative attempted fistula closure.

Statistical analysis

The quantitative data were compared using the *t* test, and

the categorical data were compared using the Pearson χ^2 test or Fisher's exact test for the presence of a PBF. Receiver operating characteristic (ROC) curve analysis with calculations of the area under the curve (AUC) was used to determine the ideal cutoff values for those variables that were found to be significant. Logistic regression analysis was used for the multivariate analysis, with a *P* < 0.20 being entered into the model, and a *P* < 0.05 was considered to be significant. All of the statistics were performed using the SPSS 18.0 software (SPSS, Inc., Chicago, IL, United States). The study was approved by the local Ethics Committee of the Gulhane Military Medical Academy.

RESULTS

Of the 282 patients, 217 (77%) were male, and 65 (23%) were female. The median age was 23 years (range 16-78 years). A preoperative diagnosis of cholangitis was found in 30 (10.6%) of the patients. The duration of the symptoms ranged from 1 mo to 7 years (median, 3 mo) (Table 1).

Overall, 178 patients (63.1%) had a single cyst, and 104 (36.9%) had multiple cysts. The cysts were localized only in the right lobe of the liver in 150 (53.2%) patients and in the left in 39 (13.8%), and bilobar involvement was observed in 93 (33%). A total of 484 hepatic cysts were treated in the 282 patients. Thirty-two patients (11.3%) had concomitant cysts in the lung, and 17(6%) had cysts elsewhere.

According to the largest cyst diameter in the USG evaluation, 79 (28%) were type I, 35 (12.4%) were type II, 127 (45%) were type III, 35 (12.4%) were type IV, and 3 (1.1%) were type V. The cyst diameter ranged from 2 cm to 20 cm (median, 8.0 cm) (Table 2).

Operations and perioperative interventions

Of the 282 patients, 210 (74.5%) were treated with conservative surgery, 33 (11.7%) were treated with radical surgery, and 39 (13.8%) underwent percutaneous drainage with the PAIR procedure (Table 2). Three patients (9%) treated with radical surgery, 6 (15%) treated with the PAIR procedure and 37 (17.6%) treated with conservative surgery developed a PBF (*P* = 0.44). An infected cyst cavity was found in 13 (4.6%) patients, with 1 developing a PBF. Perioperative suture ligation of the detected cyst-biliary communication was attempted in 39 (13.8%) patients, with 11 (4.2%) developing a PBF.

Outcome of patients with PBF

In total, PBF developed in 46 (16.3%) patients, all of whom were diagnosed within 5 d after the operation. The maximum cyst diameter (cm) and preoperative ALP levels (U/L) were significantly higher in the PBF group than in the no PBF group (10.5 \pm 3.7 U/L *vs* 8.4 \pm 3.5 U/L, *P* < 0.001; and 40.0 \pm 235.1 U/L *vs* 190.0 \pm 167.3 U/L, *P* = 0.02, respectively). The hospitalization time was also significantly longer in the PBF group (37.4 \pm 18.0 d *vs* 22.4 \pm 17.9 d, *P* < 0.001) (Table 3).

The multivariate analysis revealed that high preopera-

Table 2 Characteristics of hydatid cysts in patients with hydatid disease of the liver (mean \pm SD)

Cyst	Bile fistula		P value
	Absent n = 236	Present n = 46	
Size localisation (cm)			
Diameter	8.46 \pm 3.52	10.59 \pm 3.74	0.0001
Right lobe	127 \pm 45.9	23 \pm 8.2	0.2
Left lobe	36 \pm 12.8	3 \pm 1.1	
Bilobar	73 \pm 25.9	20 \pm 7.1	
Type			
I	68 \pm 24.4	11 \pm 3.9	0.7
II	30 \pm 10.8	5 \pm 1.8	
III	102 \pm 36.6	102 \pm 36.6	
IV	30 \pm 10.8	5 \pm 1.8	
V	3 \pm 1.1	0	
Operation type, n (%)			
Conservative surgery	173 (61.3)	37 (13.1)	0.4
Radical surgery	30 (10.6)	3 (1.1)	
PAIR	33 (11.7)	6 (2.1)	

PAIR: Puncture, aspiration, injection and reaspiration.

tive ALT levels (> 40 U/L) and a perioperative attempted fistula closure were significant predictors of PBF development ($P = 0.02$, 95%CI: -0.03-0.5 and $P = 0.001$, 95%CI: 0.1-0.4, respectively).

Factors related to spontaneous fistula closure

The patients with PBF were further divided into 2 groups regarding fistula closure-either spontaneous (CS group, 12 patients, 4.6%) or with biliary intervention (BI group, 34 patients, 12.1%). The mean diameter of the cyst was not significantly different between the CS and BI groups (9.9 ± 4.1 cm *vs* 10.8 ± 3.6 cm). The maximum drain output was significantly higher in the BI group (81.6 ± 118.1 mL *vs* 423.9 ± 298.4 mL, $P < 0.001$). The time for the fistula closure was significantly higher in the BI group (10.1 ± 3.7 d *vs* 30.7 ± 15.1 d, $P < 0.001$).

The ROC curve analysis revealed cut-off values of a maximum bilious drainage < 102 mL and a waiting period of 5.5 postoperative days for spontaneous closure with sensitivity and specificity values of 83.3%-91.1% (AUC: 0.90) and 91%-97% (AUC: 0.95), respectively.

The multivariate analysis demonstrated a postoperative biliary drainage volume < 102 mL to be the only significant predictor of spontaneous closure ($P < 0.001$, 95%CI: 0.5-1.0), and the presence of multiple cysts on preoperative imaging approached significance ($P = 0.06$, 95%CI: 0.2-0.5).

In the BI group, 15 (5.3%) patients had an ERCP with sphincterotomy, and 19 (6.7%) had an ERCP and NBD. Two patients required repeated ERCPs and plastic stent placement. In addition, 5 (10.8%) patients required catheter placement with USG guidance to control the biliary collections that were not adequately drained.

There were 3 (1.1%) deaths in our series: 2 due to spontaneous rupture of the cyst with subsequent anaphylactic shock and 1 who underwent multiple biliary inter-

Table 3 Postoperative characteristics of patients with postoperative biliary fistula (mean \pm SD)

	Biliary fistula closed		P value
	Spontaneous n = 12	Intervention n = 34	
Maximum output (mL)	81.6 \pm 118.1	423.9 \pm 298.4	< 0.001
Drain removal (d)	13.0 \pm 6.0	27.1 \pm 12.8	0.001
Maximum cyst diameter (cm)	9.9 \pm 4.1	10.8 \pm 3.6	0.4
Time to fistula closure (d)	10.1 \pm 3.7	30.7 \pm 15.1	< 0.001
Time to intervention (d)	10.1 \pm 3.7	11.4 \pm 6.7	0.5
Hospitalization (d)	22.4 \pm 17.9	11.4 \pm 6.7	< 0.001

ventions due to PBF and died due to myocardial infarction.

DISCUSSION

This study investigated the outcome of patients with PBF due to the IBR of a hepatic hydatid cyst. Whether minimally invasive techniques, conservative surgery or radical surgery were used, the goal of treatment was to eliminate the parasite completely and prevent complications, including pressure on adjacent structures, secondary infection or rupture of the cyst into the biliary system that results in PBF. In our series, PBF occurred in 46 (16%) patients, despite preoperative and operative efforts to prevent this complication. The fistula closed spontaneously in only 12 (26%) of the patients with PBF without further intervention, confirming that patients with PBF often have a complicated postoperative course, requiring multiple endoscopic and other interventional procedures with serious morbidity and mortality^[18,19].

Although there are several surgical techniques described to control cyst-biliary communications intraoperatively, 10%-32% of cases eventually develop a PBF^[20]. A cyst-biliary communication complicates the natural history of the disease and the treatment processes. Aktan *et al*^[21] previously reported a median intracystic pressure of 25 mmHg (range 5-55 mmHg) and a positive correlation between cyst size and pressure in viable cysts. Manometric studies indicate that the sphincter of Oddi pressure (basal 10 mmHg, peak 124 mmHg) is higher than the normal common bile duct pressure (10 mmHg). According to the LaPlace Law, the expansion of the cyst due to increased intracystic pressure results in increased cyst diameter, which causes increased tension on the cyst wall that serves as the pericyst containing the neighboring bile ducts. The pressure dynamics arising from higher intracystic pressures than the resting bile duct pressure may explain how the cyst communicates with the biliary system as the pericyst becomes thinner and thinner, eventually eroding into the bile ducts and leading to the development of an IBR^[22].

Several studies reported a history of cholangitis, high bilirubin, high ALP levels, a cyst larger than 10 cm and the presence of suggestive USG findings as clinical predictors of IBR, and an ERCP was suggested to delineate the presence of cyst-biliary communication in these cas-

es^[8,13]. Our analysis also showed that a high preoperative ALP, history of cholangitis and larger cyst diameter (> 10 cm) were significantly more common in patients that developed PBF. However, the multivariate analysis revealed that a perioperative attempt at suture ligation and a high preoperative ALT level were significant predictors of PBF. Perioperative suture ligation was performed in 39 patients in this cohort, and 11 (28%) patients developed a PBF. We have not encountered any reports on the success rate of perioperative suture ligation attempts in the literature. Our data indicate that there might be a significant failure rate for an attempt to control a detected BF intraoperatively if that was used as the only method to control the cyst-biliary communication.

Our analysis showed no significant difference in the development of PBF based on the type of procedure. During the hydatid surgery in a given patient with a cyst-biliary communication, regardless of whether a conservative or radical approach (total pericystectomy) is taken, the same biliary pedicles will be encountered, and the fistula risk should be the same unless each communicating pedicle is individually detected and effectively controlled. In our experience, PBF developed in 3 patients [3 (9%) out of 33 patients in the radical surgery group] despite at least 1 attempt to control the fistula with suture ligation, suggesting that controlling all of the detected fistulae with suture ligation may not even be possible, especially when the fistula orifices are deeply located in the cyst cavity and liver. Furthermore, our data indicate that certain fistulae may not even be detected intraoperatively. Other than technical failure, such misses may be partially explained by the abovementioned fluctuating pressure dynamics in the biliary system arising from intermittent Oddi sphincter contractions, which may cause a cyst-biliary communication that is not visible at the time of the surgery unless further manipulation is performed. We agree with others that all interventions on liver hydatidosis should be considered to be potentially major operations and that further intraoperative intervention searching for a cyst-biliary communication is warranted in patients with preoperative risk factors^[23]. Our results underline the importance of preoperative detection and effective treatment of the cyst-biliary communication. A preoperative MRCP for patients with clinical and laboratory risk factors could detect biliary complications, and an intervention with ERCP and sphincterotomy could decrease the pressure in the biliary tract, with the further benefit of providing useful anatomical information for the surgeon to select the best therapeutic approach^[24]. This information may enable the surgeon to safely perform a conservative approach and avoid a possible cholecystectomy and/or biliary exploration procedure that potentially confers further morbidity, especially in patients with previous symptoms or a history of cholangitis. These patients have a cyst that communicates with the biliary system, resulting in an ascendant infection of the cyst contents. Although bacterial superinfection may kill the parasite, this phenomenon

causes extensive inflammation with the subsequent adhesion of the duodenum and colon to the cyst, which renders biliary exploration potentially dangerous. There is a growing body of literature suggesting that it is not the type of surgery but rather the preoperative determination of cyst-biliary communication that is more important in avoiding PBF^[25,26].

In contrast to post-cholecystectomy fistulae, which close rapidly after ERCP and sphincterotomy, hydatid fistulae were reported to be more resistant and rarely closed spontaneously without decompression of the biliary tract^[27]. Endoscopic treatment has been advocated in high-output fistulae with a duration of more than 1 wk and no signs of reduction and in low-output fistulae with a duration of more than 3 wk and no signs of reduction^[28]. The ROC curve analysis enabled the detection of a maximum biliary drainage < 102 mL and a waiting period of 5.5 postoperative days for spontaneous closure (sensitivity and specificity values of 83.3%-91.1%, AUC: 0.90 and 91%-97%, AUC: 0.95, respectively) as significant cut-off levels, and multivariate analysis demonstrated a postoperative biliary drainage volume < 102 mL to be the only significant predictor of spontaneous closure ($P < 0.001$, 95%CI: 0.5-1.0). This information might help with the decision of when to attempt further intervention in a patient with PBF to prevent delays in treatment.

There are several limitations of this study. In addition to the study's retrospective nature and the lack of a uniform treatment protocol, our results may also be influenced by patient selection bias for each type of surgical or PAIR procedure. Furthermore, there was intersurgeon variability in terms of technical experience, which might have an effect on operative outcomes.

This study showed that an aggressive approach to the detection of cyst-biliary communications, both preoperatively and intraoperatively, is warranted to prevent the development of PBF and thus to avoid serious morbidity and mortality in patients with hydatid disease of the liver. Patients who develop PBF with a fistula output < 102 mL may be managed expectantly, but timely endoscopic intervention and aggressive monitoring is necessary to prevent further complications.

COMMENTS

Background

Hydatid disease, which is caused by *Echinococcus granulosus*, has a worldwide distribution, resulting with tissues developing cysts containing the parasite located mainly in the liver in humans. There are several treatment options including, medical, interventional and surgical modalities. Intrahepatic rupture (IBR), which involves a communication of the cyst cavity with the biliary system is the most common and troublesome complication resulting with a biliary fistula (BF). Development of BF complicates the natural history and outcomes of the disease treatment.

Research frontiers

To date, there is limited information regarding to the development of BF after hydatid disease treatment and its outcomes. Several risk factors including the size and location of the cyst in the liver have been documented however, very few groups reported the outcome of the patients with BF. Furthermore, treat-

ment of BF after treatment of hydatid disease is seldom reported. In order to prevent BF complication; developing multimodality approaches for detecting patients with risk factors preoperatively and developing guidelines for selecting the most suitable surgical or conservative management for these patients as well as best postoperative treatment for this complication is an active field of research.

Innovations and breakthroughs

The authors found certain risk factors in preoperative radiology and biochemistry tests of patients for development of a BF. However, this study is different from others in two aspects. The authors' analysis revealed that certain amount of patients undergoing treatment for hydatid disease of the liver would eventually develop a BF regardless of the method chosen to control the disease. Secondly, the authors documented that detecting a BF intraoperatively and attempting to control by the current standard surgical means may not be enough to control the development of BF hence emphasizing the importance of preoperative detection and aggressive intervention. The authors were also able to find a cut-off value for postoperative BF drainage output in order to choose between expectant or interventional treatment.

Applications

The study results suggest that an aggressive approach to the detection of IBR both preoperatively and intraoperatively is warranted to prevent the development of a postoperative BF and thus to avoid serious morbidity and mortality in patients with hydatid disease of the liver. Patients who develop postoperative BF with a fistula output < 102 mL may be managed expectantly.

Peer review

The manuscript is well designed, with clear objective. The manuscript aim to determine the outcome of patients with BF after treatment for hydatid disease of the liver. The authors found certain risk factors in preoperative radiology and biochemistry tests of patients for development of a BF.

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