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RESEARCH

Risk factors indicating the need for surgical therapy in patients with pyogenic liver abscesses

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Abstract

Background Percutaneous drainage (PD) and antibiotics are the therapy of choice (non-surgical therapy [non-ST]) for pyogenic liver abscesses (PLA), reserving surgical therapy (ST) for PD failure. The aim of this retrospective study was to identify risk factors that indicate the need for ST.

Methods We reviewed the medical charts of all of our institution's adult patients with a diagnosis of PLA between January 2000 and November 2020. A series of 296 patients with PLA was divided into two groups according to the therapy used: ST ($n=41$ patients) and non-ST ($n=255$). A comparison between groups was performed.

Results The overall median age was 68 years. Demographics, clinical history, underlying pathology, and laboratory variables were similar in both groups, except for the duration of PLA symptoms < 10 days and leukocyte count which were significantly higher in the ST group. The in-hospital mortality rate in the ST group was 12.2% vs. 10.2% in the non-ST group ($p=0.783$), with biliary sepsis and tumor-related abscesses as the most frequent causes of death. Hospital stay and PLA recurrence were statistically insignificant between groups. One-year actuarial patient survival was 80.2% in the ST group vs. 84.6% in the non-ST ($p=0.625$) group. The presence of underlying biliary disease, intra-abdominal tumor, and duration of symptoms for less than 10 days on presentation comprised the risk factors that indicated the need to perform ST.

Conclusions There is little evidence regarding the decision to perform ST, but according to this study, the presence of underlying biliary disease or an intra-abdominal tumor and the duration of PLA symptoms < 10 days upon presentation are risk factors that should sway the surgeons to perform ST instead of PD.

Keywords Liver abscess · Abdominal infections · Liver transplantation · Hepatic artery thrombosis · *Klebsiella pneumoniae* infection

Introduction

Pyogenic liver abscesses (PLA) are a life-threatening infection consisting of solitary or multiple pus collections within the liver parenchyma secondary to invasion of microorganisms, adjacent infections, and hematogenous spread through hepatic artery occlusion or portal infections. The onset of PLA is most frequently due to biliary tree diseases [1], followed by surgical procedures for hepatopancreatobiliary tumors [2, 3] or colorectal tumors [4], hepaticojejunostomy procedures, liver transplantation (LT) [5–7], radiofrequency ablation, transarterial chemoembolization for hepatocarcinoma [8–10], and liver trauma [11]. *Klebsiella pneumoniae* and *E. coli* are the predominant pathogens isolated in PLA [12].

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The incidence of PLA has gradually increased in recent decades, ranging from 3.6 to 3.9 cases per 100,000 population per year in the USA [13], and from 15.4 to 17.6 cases per 100,000 population per year in Taiwan, where PLA is an endemic disease [14, 15]. Currently, antibiotics and percutaneous drainage (PD) are considered the primary therapy of choice, reserving surgery as a salvage treatment for patients with PD failure [8, 16–18] or patients who present concomitant biliary disease [8, 16, 19, 20]. The rate of PD failure has been reported to range between 9 and 34% [8, 17–20], and the overall hospital mortality rate is between 0 and 46%, considering all therapies [13, 15, 21–25]. Therefore, it is paramount to identify the risk factors associated with the need to perform surgical therapy (ST) in order to reduce the mortality in patients with persistent PLA due to non-ST failure. The aim of this retrospective and comparative study between patients with PLA who underwent ST vs. non-ST was to investigate the risk factors that indicate the need for surgical treatment.

Material and methods

Study design and patients

This is a retrospective cohort study performed at our HPB Surgery and Abdominal Organ Transplantation Unit. We reviewed all the medical charts of adult patients at our institution with a diagnosis of PLA at discharge between January 2000 and November 2020. During this period, 296 patients were diagnosed and treated for PLA. This series was divided into two groups according to the therapy used: ST ($n = 41$ patients) or non-ST ($n = 255$ patients). Patients who underwent antibiotic therapy and/or PD were included in the non-ST group.

PLA was defined as a parenchymal hepatic collection consistent with abscess as described by radiological procedures (ultrasonography, computed tomography [CT], or magnetic resonance imaging [MRI]), positive liver or concomitant blood cultures, or both, as well as compatible clinical findings. PLA was suspected based on clinical features and abnormal laboratory parameters and was confirmed through the cited imaging procedures and microbiological examination.

Duration of symptoms < 10 days was defined as the time elapsed from symptom onset to hospital admission. Antibiotic therapy was initiated promptly (before PD or surgical treatment) and was further adjusted according to blood/liver drainage cultures and susceptibility studies. All patients received a 2-week course of intravenous antibiotics followed by a variable course of oral antibiotics depending on the degree of success of the abscess drainage procedures (ranging from 1 week to 2 to 3 months). PD was performed under CT or ultrasonography guidance, placing an 8.5–12 French pigtail catheter inside the PLA cavity and draining the pus collection. The pigtail was removed when the daily drainage was less than 10–15 cc. The patients underwent ST in cases of non-ST failure and/or underlying intra-abdominal pathologies (colonic or biliary diseases). ST consisted of PLA debridement or segmental liver resection, as well as cholecystectomy and biliary tract exploration in the presence of biliary disease. Retransplantation was indicated in liver transplant patients with persistent abscesses and/or sepsis after PD. Cure was defined as complete resolution of the hepatic lesion confirmed through radiological imaging with associated clinical and liver function improvement after discontinuation of antibiotics and abscess drainage [6]. Persistent infection was defined as failure of antibiotic therapy or PD after 3 to 5 days of treatment, with clinical repercussion and altered laboratory parameters (leukocyte count and liver function tests). Mortality was defined as death during hospitalization, and PLA recurrence was defined as reappearance throughout the follow-up after cure of the abscess. The patients were followed for at least 1 year.

The data collected included patient demographics, comorbidities, etiology of the PLA, clinical presentation, laboratory values, radiological procedures, characteristics of the abscesses, types of therapies, rates of recurrence and mortality, 1-year actuarial patient survival, and blood and pus culture results. Multivariate analysis was conducted to investigate the risk factors associated with the need for ST of PLA. A comparison of such variables was performed between groups.

All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The need for local clinical research ethics committee approval was waived due to the retrospective nature of the research.

Informed consent for surgical therapy was obtained from all patients before surgery.

Statistical analysis

We analyzed quantitative variable normality with the Kolmogorov test. Because most of them were not normal, we expressed quantitative variables as median values with ranges (0–100). Qualitative variables were expressed as percentages. Differences in properties between qualitative variables were assessed using the chi-square test or Fisher's exact test, as appropriate. Comparisons of quantitative variables were made using the Mann–Whitney *U* test. Variables with statistical significance in the univariate analysis were subsequently investigated in a multivariate analysis using logistic binary regression to evaluate the risk of need for surgical therapy. All variables achieving p-values < 0.10 in the univariate analysis were included in the model. The results are expressed as odds ratios (ORs) and 95% confidence intervals (CIs). A p-value of < 0.05 was considered statistically significant. Analyses of these data were performed with SPSS Statistics, version 24 (IBM, Armonk, NY).

Results

From January 2000 to November 2020, a total of 296 patients were diagnosed and treated for PLA. The overall median age in this series was 68 years, whereas the median age of the ST patients was 65 years vs. 68 years in non-ST patients. In the comparative analysis between both groups of patients with PLA regarding demographics, relevant clinical history, and underlying pathology variables, only the duration of symptoms < 10 days from onset to hospital admission was significantly more frequent in the ST group than in the non-ST group (75.6% vs. 57.3%; $p = 0.023$). Of note, diabetes mellitus was present in 14 (34.1%) patients in the ST group and 75 (29.4%) in the non-ST group. Eight (19.5%) patients in the ST group and 25 (9.8%) in the non-ST group had a history of liver or kidney transplant. Concomitant tumoral disease was determined as the cause of PLA in 7 (17.1%) patients in the ST group and 28 (10.9%) in the non-ST group. An analysis of the laboratory parameters (serum glucose, creatinine, and albumin, liver function, and hematological tests) showed that only leukocyte count was significantly higher in the ST group than in the non-ST group (14.4×10^3/μL vs. 11.5×10^3/μL; $p = 0.002$) (Table 1).

The diagnosis of PLA was performed based on clinical features and using ultrasonography, CT, and MRI. The frequency of these diagnostic procedures was similar in both groups of patients. The locations of the abscesses in the ST group were the right lobe in 58.5% of patients, left lobe in 14.6%, and both lobes in 26.8%, whereas in the non-ST group, 54.1% were in the right lobe, 22.4% were in the left lobe, and 23.5% were in both lobes; no significant differences between groups were found ($p = 0.581$). No significant differences in median size diameter ($p = 0.356$) or number of abscesses ($p = 0.768$) were found between groups. The rate of portal thrombosis was similar in both groups, but arterial thrombosis was significantly more frequent in the ST group (12.2%) than in the non-ST group (3.9%) ($p = 0.041$).

Twenty-six (63.4%) patients in the ST group were initially treated with antibiotics, as were 127 (49.8%) patients in the non-ST group ($p = 0.091$), whereas 15 (36.6%) patients in the ST group were treated with antibiotics and PD, as were 128 (50.2%) patients in the non-ST group ($p = 0.152$). On the other hand, 41 patients underwent ST due to failure of antibiotic and/or PD therapies or the presence of hepatobiliary or colonic diseases. Cholecystectomy and ST of PLA were performed in 17 (41.5%) patients, ST was performed alone in 11 (26.8%), Roux-en-Y-hepaticojejunostomy and ST were performed in 5 (12.2%), liver retransplantation was performed in 4 (9.7%), hepatectomy was performed in 3 ([7.3%], 2 left lateral segmentectomies and one atypical segment V resection), and an ileocecal resection was performed due to an incidental tumor, alongside ST in one case (2.4%).

The mortality rate in the ST group was 12.2% (5 patients) and 10.2% (26 patients) in the non-ST group ($p = 0.783$), with biliary sepsis and the presence of tumors being the most frequent causes of mortality. The median hospital stay of the ST group was 18 days (range, 3–90), and it was 15 days (range, 1–87) for the non-ST group ($p = 0.268$).

Eight (19.5%) patients in the ST group and 41 (16.1%) in the non-ST group ($p = 0.496$) developed PLA recurrence during a median follow-up period of 54 months (0–227) (Table 2). The median follow-up of the series was 54 months (range, 0–227). One-, 6-, and 12-month actuarial patient survival rates did not show significant differences between groups: 95.1%, 85.1%, and 80.2%, respectively, in the ST group and 98.0%, 91.4%, and 84.6%, respectively, in the non-ST group ($p = 0.625$) (Fig. 1).

Microbiological characteristics

PLA cultures showed monobacterial cultures in 23 (56.1%) patients in the ST group and 142 (55.7%) patients in the non-ST group and multibacterial growth in 5 (12.2%) patients in the ST group and 23 (9.0%) patients in the non-ST group, whereas negative cultures were found in 13 (31.7%) patients in the ST group and in 39 (15.3%) patients in the non-ST group. No significant differences were found regarding these characteristics between groups ($p = 0.567$). Regarding the blood cultures, gram-positive bacteria were more frequent in the ST group (31.7%), and gram-negative bacteria were more frequent in the non-ST group (43.1%) ($p = 0.014$). The most frequently isolated microorganisms were *Klebsiella pneumoniae*, *Escherichia coli*, *Enterococcus* spp., *Streptococcus* spp., and *Staphylococci* spp., without significant differences between groups (Table 3).

Risk factors for the need of surgical management

Multivariate analysis revealed that duration of symptoms < 10 days from onset to admission and underlying biliary or tumoral diseases were risk factors indicating the need for surgical treatment in patients with PLA (Table 4).

Discussion

The overall median age of our patients was 68 years, which is higher than that of other reported large series that showed a mean age between 52 and 62 years [1, 15, 24–27].

Table 1 Clinical and demographic characteristics of patients with pyogenic liver abscess

	ST ($n=41$)	Non-ST ($n=255$)	*p*-value
Sex (male/female)	27/14 (65.9%/34.1%)	163/92 (63.9%/36.1%)	0.811
Age	65 (27–94)	68 (18–91)	0.594
Age > 65 years	22 (53%)	146 (57%)	0.864
Comorbidities			
Diabetes mellitus	14 (34.1%)	75 (29.4%)	0.539
Synchronous/metachronous tumor	12 (29.3%)	68 (26.7%)	0.670
Alcoholism	5 (12.5%)	56 (21.9%)	0.160
Chemotherapy	5 (12.2%)	46 (18.0%)	0.577
Liver transplant	7 (17.1%)	19 (7.5%)	0.236
Kidney transplant	1 (2.4%)	6 (2.3%)	0.973
Etiology			0.207
Biliary	26 (63.4%)	132 (51.8%)	
Tumoral	7 (17.1%)	28 (10.9%)	
Vascular	4 (9.8%)	24 (9.4%)	
Diverticular disease	0 (0%)	10 (3.9%)	
Appendicitis	1 (2.4%)	4 (1.6%)	
Cryptogenic	3 (7.3%)	57 (22.4%)	
Clinical presentation			
Duration of symptoms (< 10 d)	31 (75.6%)	146 (57.3%)	0.023
Abdominal pain	30 (73.2%)	169 (66.3%)	0.365
Fever	29 (70.7%)	206 (80.8%)	0.208
Nausea	16 (39.0%)	98 (38.4%)	0.859
Weight loss	14 (34.1%)	82 (32.1%)	0.716
Hepatomegaly	13 (31.7%)	58 (22.7%)	0.230
Anorexia	12 (29.3%)	88 (52.1%)	0.716
Pleural effusion/pneumonia	8 (19.5%)	76 (29.8%)	0.258
Jaundice	8 (19.5%)	72 (28.2%)	0.514
Laboratory values			
Serum glucose (mg/dL)	113 (50–263)	124 (45–565)	0.115
Serum creatinine (mg/dL)	0.9 (0.22–3.62)	0.95 (0.35–9.1)	0.697
Serum albumin (g/dL)	3.3 (2–4.3)	3.5 (2.3–5.1)	0.382
Total serum bilirubin (mg/dL)	0.8 (0.39–20.2)	1.1 (0.1–12.2)	0.551
AST (IU/L)	35 (12–11,011)	42 (7–2051)	0.880
ALT (IU/L)	37 (14–1314)	52 (5–3560)	0.241
GGT (IU/L)	139 (11–977)	148 (10–2351)	0.602
Alkaline phosphatase (IU/L)	254 (75–1304)	184 (39–2412)	0.384
Lactate dehidrogenase (U/L)	283 (140–14,918)	234 (93–7353)	0.634
Prothrombin rate (%)	87 (50–123)	80 (9–128)	0.540
Platelets $\times 10^3$/μL	247 (64–517)	225 (8–740)	0.302
Leukocytes $\times 10^3$/μL	14.4 (4.3–29.1)	11.5 (0.4–45.6)	0.002
Neutrophils (%)	84.2 (44.8–97.9)	84.6 (26.7–98.1)	0.861
Hemoglobin (g/dL)	12.2 (7.2–16.6)	12.2 (6.9–16.7)	0.697

ALT, alanine aminotransferase; *AST*, aspartate aminotransferase; *GGT*, gamma-glutamyl-transpeptidase; *ST*, surgical therapy

Concerning the comorbidities of patients with PLA, several series have reported a rate of diabetes mellitus between 26.9 and 36.9%, of malignancy between 6.7 and 15.3%, and of liver cirrhosis between 3.5 and 6.5% [1, 15, 26, 28]. The presence of diabetes, immunosuppression, and malnutrition constitute risk factors for developing PLA [5, 13, 15, 20, 29]. There were no significant differences in comorbidities between our patient groups. However, although statistically insignificant, our patients in the ST group showed a higher rate of diabetes, presence of tumors or biliary disease, and

Table 2 Diagnosis, treatment, and outcomes of patients with pyogenic liver abscesses

	ST ($n = 41$)	Non-ST ($n = 255$)	p-value
Ultrasonography	33 (80.5%)	203 (79.6%)	0.832
CT scan	32 (78%)	222 (87%)	0.216
MRI	11 (26.8%)	102 (50%)	0.162
Location of the abscess			0.581
Right lobe	24 (58.5%)	138 (54.1%)	
Left lobe	6 (14.6%)		
Both lobes	11 (26.8%)	57 (22.4%) 60 (23.5%)	
Abscess size; maximum diameter (cm)	5 (0.8–10)	4.5 (0.1–18)	0.356
Number of abscesses	1 (1–6)	2 (1–6)	0.768
Portal thrombosis	4 (9.8%)	27 (10.6%)	0.872
Right portal vein	1 (2.4%)	11 (4.3%)	
Left portal vein	2 (4.9%)	7 (2.7%)	
Main portal vein	1 (2.4%)	9 (3.5%)	
Hepatic artery thrombosis	5 (12.2%)	10 (3.9%)	0.041
Initial treatment			
Antibiotics	26 (63.4%)	127 (49.8%)	
Antibiotics + percutaneous drainage	15 (36.6%)	128 (50.2%)	
Surgical treatment			
Cholecystectomy + ST	17 (41.5%)	–	0.091
ST alone	11 (26.8%)	–	0.152
Roux-en-Y-hepaticojejunostomy + ST	5 (12.2%)	–	
Liver retransplantation	4 (9.7%)	–	
Left liver lateral segmentectomy	2 (4.9%)	–	
Atypical liver segmentectomy V	1 (2.4%)	–	
Ileocecal resection (tumor) + ST	1 (2.4%)	–	
In-hospital mortality (causes)	5 (12.2%)	26 (10.2%)	0.783
Biliary sepsis	2 (4.9%)	19 (7.4%)	
Liver failure	1 (2.4%)	–	
COVID-19 infection	1 (2.4%)	–	
Metastatic liver disease (colonic origin)	1 (2.4%)	1 (0.4%)	
Gallbladder tumor	–	1 (0.4%)	
Klatskin tumor	–	1 (0.4%)	
Lymphoma	–	1 (0.4%)	
Cirrhosis	–	1 (0.4%)	
Heart failure	–	1 (0.4%)	
Stroke	–	1 (0.4%)	
Hospital stay (d)	18 (3–90)	15 (1–87)	0.268
Abscess recurrence	8 (19.5%)	41 (16.1%)	0.496

CT, computed tomography; *MRI*, magnetic resonance imaging; *ST*, surgical therapy

history of transplantation, as compared to the non-ST group. Furthermore, several previous reports showed that benign and malignant hepatobiliary and pancreatic diseases, colorectal malignancies, and vascular diseases (hepatic artery or portal thrombosis after LT) were the most frequent causes of PLA [1, 3, 5, 15, 17, 20, 27, 28]. Of note, a duration of symptoms < 10 days from onset to admission was significantly more frequent in the ST group, a setting that usually reflects a rapid development of PLA and overall worse clinical condition that could justify an early and more aggressive therapy. The presence of significantly higher leukocyte count in ST group also indicates a higher inflammatory reaction in the ST group. As described by previous literature, the diagnosis of PLA was suspected based on clinical findings and laboratory parameters and confirmed through CT scan or MRI, with abscesses more frequently located in the right lobe [26, 27, 30, 31]. Hepatic artery thrombosis, or less frequently stenosis, is the most important risk factor associated

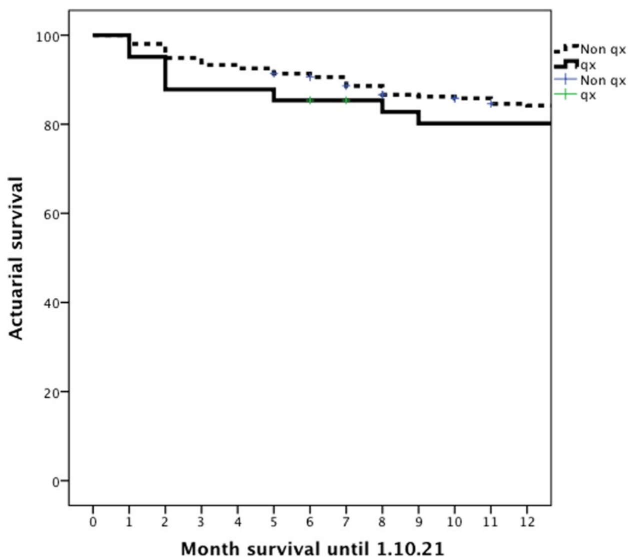

Fig. 1 A comparison of 1-, 6-, and 12-month actuarial patient survival, using Kaplan Meier curves, between patients who underwent ST (95.1%, 85.4%, and 80.2%, respectively) and patients who underwent non-ST (98.0%, 91.4%, and 84.6%, respectively) did not show significant differences ($p=0.625$)

Table 3 Blood and pus cultures in patients with pyogenic liver abscesses

	ST ($n=41$)	Non-ST ($n=255$)	p-value
Abscess cultures			0.567
Monobacterial	23 (56.1%)	142 (55.7%)	
Multibacterial	5 (12.2%)	23 (9.0%)	
Negative	13 (31.7%)	39 (15.3%)	
Not performed	0 (0%)	51 (20%)	
Blood cultures			0.014
Gram-positive	13 (31.7%)	43 (16.9%)	
Gram-negative	10 (24.4%)	110 (43.1%)	
Negative	5 (12.2%)	68 (26.7%)	
Pathogen			
Klebsiella pneumoniae	8 (19.5%)	53 (20.8%)	> 0.999
Escherichia coli	3 (7.3%)	47 (18.4%)	0.094
Enterococcus spp.	5 (12.2%)	26 (10.2%)	0.577
Streptococcus spp.	5 (12.2%)	24 (9.4%)	0.556
Staphylococci spp.	4 (9.7%)	16 (6.3%)	0.319
Pseudomonas spp.	0 (0%)	7 (2.7%)	0.597
Others	4 (9.7%)	20 (7.8%)	0.822

ST, surgical therapy

with PLA after LT [6]. Thus, the incidence of HAT after LT is between 3.1 and 25% [6], leading to liver graft ischemia that predisposes patients to hepatobiliary infection and subsequent abscess formation [6, 32]. Portal vein thrombosis is a recognized complication of severe cholangitis with similar incidence between our groups, but without repercussion over the chosen PLA therapy [33]. Only one series reported a rate of 3.2% of portal vein thrombosis associated with PLA [31].

Table 4 Multivariate analysis. Risk factors indicating the need for surgical therapy

	OR	p-value	IC 95%
Previous organ transplant	1.835	0.343	0.571–4.988
Biliary etiology	2.516	0.045	1.020–6.207
Vascular thrombosis	2.030	0.134	0.804–5.126
Tumoral etiology	3.726	0.027	1.158–11.992
Duration of symptoms (< 10 days)	3.050	0.010	1.307–7.117
Leukocyte count > 15,000	1.895	0.094	0.898–4.000

CI, confidence interval; *OR*, odds ratio

All authors report *Klebsiella pneumoniae* and *E. coli* as the most common bacteria cultured in pus from PLA [1, 24, 27, 28, 31, 34], with *E. coli* being more frequently associated with biliary diseases [1, 23, 31] and diabetes mellitus [35, 36].

In our study, the most isolated species were *Klebsiella pneumoniae*, *E. coli*, *Enterococcus*, and *Streptococcus*, which did not display significant differences between groups. In this study gram-positive bacteria were more frequent in the ST group, while gram-negative bacteria were more frequent in the non-ST group. The negativity of the PLA pus or blood cultures performed upon admission is likely attributed to cultures inadvertently taken after antibiotic therapy [24].

Almost all patients with PLA will require some type of therapy, and PLA between 3 and 5 cm in size can be managed with more conservative therapy, such as antibiotic therapy alone [33]. The early and adequate administration of antibiotics is of primary importance in PLA therapy. On the other hand, PD has been indicated in PLA greater than 10 cm, with subcapsular location, high risk for rupture and superinfection, or poor response to medical therapy [37]. Clinical success using PD has been achieved in 66% to 90% of patients with single or multiple multiloculated abscesses [18, 19, 38, 39]. All our patients were initially treated with antibiotics alone or antibiotics + PD, without a significant difference between groups. However, failure of this non-ST was observed in 41 (13.5%) patients, and as other authors have reported, subsequent ST must be indicated in these cases because of the presence of multiple and multiloculated abscesses, PLA > 5 cm, concomitant biliary disease, communication of PLA with the biliary tree, abscess rupture, patients with hepatobiliary-pancreatic cancer, elevated creatinine, preexisting hypertension, or hyperbilirubinemia [8, 17, 19, 24, 30, 38, 40]. In this way, ST has also been indicated in 3.6% to 55% as a second option for salvage therapy in patients with PLA due to PD failure [8, 16–21, 27, 30], patients presenting with large multiloculated abscesses or in the presence of an underlying disease requiring surgery [16]. Surgical drainage and debridement of PLA was performed in 29 patients in our series due to PD failure, together with other surgical procedures such as cholecystectomy, hepaticojejunostomy, hepatectomy, or ileocecal resection. Liver retransplantation was indicated in four LT patients with persistent PLA and severe sepsis after PD. Other authors have even advocated ST as the first-line indication for septic patients with multiloculated abscesses, as the perceived risk of failure of PD is high and any delay is highly likely to lead to death [41]. Patients with PLA and underlying malignant disease, especially of hepatobiliary and pancreatic origin, have poor outcomes [2, 8]; hence, ST should also be considered in these cases. There is great variability regarding overall hospital mortality, ranging from 0 to 46% [16, 19, 21, 25, 26, 28, 30, 31, 38]. However, the overall outcomes of ST are worse than those of percutaneous drainage, probably related to a selection bias of severe and complicated abscesses requiring surgery [31]. According to 6 series of STs, the mortality rate ranged between 17.9 and 46% [19, 21, 42–45]. Our hospital mortality rate was similar in both groups, with biliary sepsis being the most common cause of death. Several risk factors have been associated with therapy failure or mortality, such as older age, septic shock, poor physiological state, anemia, acute renal failure, hyperbilirubinemia, APACHE score ≥ 15, PLA-containing yeast, communication of the PLA with the biliary tree, underlying hepatobiliary-pancreatic malignancy, liver cirrhosis, and septic encephalopathy [8, 13, 17, 24, 31]. Patients who underwent ST had a longer hospital stay and a higher morbidity rate and cost [8, 16, 18], and the median hospital stay is reported between 11 and 26 days in several studies [17, 20, 28].

Currently, the indication for ST is not clearly established, but it is very important to determine the optimal timing to change the treatment from a less aggressive non-ST to a more aggressive ST because non-ST patients can evolve to severe sepsis in cases with persistent PLA. Surgical therapy provided better clinical outcomes in a series of abscesses > 5 cm, concluding that larger, loculated abscesses should be primarily treated with surgical drainage [30], but we have found few studies reflecting the failure of non-ST, ranging between 9 and 34% [8, 17–20, 23] in patients with these characteristics. However, we have not seen any study that analyzes the predictive factors indicating the need to perform ST. We consider it of paramount importance to investigate these factors when performing a change to ST, knowing that the prolonged, inefficient non-ST of PLA can lead to severe sepsis and patient death. In our multivariate analysis, underlying biliary disease, the presence or history of a malignant tumor, and the duration of symptoms < 10 days from onset to admission comprised the risk factors that indicate the need to perform ST to avoid subsequent risk of death. We consider that, in the future, the presence of the aforementioned risk factors could sway the decision towards the need for ST before the patient's clinical condition deteriorates, while bearing in mind that PLA therapy should be individually tailored to the patient's specific clinical setting [46].

In our cohort, the 12-month actuarial patient survival did not reveal significant differences between groups (80.2% in ST vs. 84.6% in non-ST), despite the fact that the ST patients had an overall worse clinical condition. Some authors report an overall mortality rate of 17% at 6 months [47] and of 23.8% at 1 year [25].

Our rate of PLA recurrence was not significantly different between groups (19.5% in the ST group vs. 16.1% in the non-ST group). Several series report a recurrence rate between 5 and 24% [1, 3, 17, 26], reaching a rate of 37% in patients with recurrent pyogenic cholangitis [48].

There are some limitations of this study because the data was collected retrospectively over a long period of time and is consequently subject to the biases typical of such studies.

Conclusion

PD is still considered the primary choice of therapy for most patients with PLA, reserving ST as a second therapy for patients with concomitant intra-abdominal diseases and/or failure of non-ST. There is little evidence in the literature regarding the decision to perform ST, but according to our multivariate analysis, the presence of underlying biliary disease or an intra-abdominal tumor and the duration of symptoms < 10 days from onset to hospital admission are risk factors that should convince the surgeons to perform ST. Despite the worse clinical conditions of ST patients, the in-hospital mortality and 12-month patient survival did not show significant differences between the ST and non-ST groups.

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Data availability The datasets analyzed in this study are available from the corresponding author on reasonable request.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in this study.

Conflict of interest The authors declare no competing interests.

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