A Surgical Priority for Echinococcal Cysts in the Lung and Liver: One or Two-Stage?

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AIM: This study aimed to evaluate the surgical outcomes of liver and lung hydatid cysts treated either simultaneously or in separate stages. The main focus was to determine the impact of surgical timing on postoperative complications and overall patient recovery, with an emphasis on minimally invasive techniques.

METHODS: A retrospective analysis was conducted on 42 patients diagnosed with concomitant liver and lung hydatid cysts between March 2009 and July 2020. Surgical procedures included video-assisted thoracoscopic surgery (VATS), thoracotomy, laparoscopy, and laparotomy. Patient demographics, cyst characteristics, concomitant diseases, surgical procedures, postoperative complications, and recovery times were analyzed. The statistical significance of surgical outcomes between one-stage and two-stage procedures was assessed using appropriate statistical tests.

RESULTS: Demographic analysis revealed that 57.1% of the participants were female and 42.9% male, with an average age of 36 years. Comorbidities were present in 23.8% of patients, with chronic obstructive pulmonary disease (COPD) being the most common at 11.9% and asthma at 7.1%. The complication rate was 35.3% in patients who underwent lung hydatid cyst surgery and 30.8% in those who underwent liver and lung hydatid cyst surgery. Although there was no statistically significant difference among the three groups (p = 0.840), liver surgery was associated with a longer hospital stay (p = 0.013). Minimally invasive surgical techniques (VATS, laparoscopy) had a lower complication rate (20% versus 40.9%, p = 0.143). These results suggest that minimally invasive techniques can reduce the risk of complications.

CONCLUSIONS: The timing of the surgical procedure, whether performed in one or two stages, had no significant effect on the complication rate. Minimally invasive techniques are recommended due to their lower complication rate and shorter recovery time.

Keywords: hydatid cysts; coexistence of lung and liver; surgical priority

Introduction

Hydatid disease is a serious infection caused by the parasite Echinococcus granulosus and transmitted through the feces of carnivorous animals such as dogs. If it is not untreated, it can lead to serious complications or even death. The disease is widespread in regions such as South America, Australia, the Middle East, and the Mediterranean and most commonly affects the liver (60–70%) and lungs (20–25%). Cysts that affect both organs simultaneously are rare (4–25%) [1].

Hydatid cysts are more common in young people and are often asymptomatic, leading to delayed diagnosis and an increased risk of complications. Pulmonary hydatid cysts can occur as single cysts (51%), multiple cysts (25%), or ruptured/infected cysts (24%) and are usually located in the right lower lobe. Symptoms vary depending on the size and location of the cysts and usually include chest pain, coughing up blood, and coughing up cyst fluid. Ruptured cysts can cause dyspnea, severe chest pain, and potentially life-threatening anaphylactic shock. In addition, cysts that are in contact with the pleura or diaphragm can cause pain due to irritation [2,3].

The diagnosis of hydatid cysts is usually made by imaging. Serologic tests can also be used to diagnose the disease, however, a negative result is not sufficient to rule out the disease. Common diagnostic methods include chest X-ray, abdominal ultrasound, computed tomography (CT), and Magnetic Resonance Imaging (MRI) [4].

Surgical intervention is essential for pulmonary cysts, with the primary objective being the elimination of the disease and the preservation of the lung parenchyma. The most common surgical procedure is removal of the cyst (cystotomy) by thoracotomy, followed by closure of the cavity

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with a capitonnage. The determination of surgical priority for a liver or lung cyst is dependent on the patient's condition and the characteristics of the cyst. A multidisciplinary approach is often necessary to make this determination [5,6].

In single-stage surgery, both lung and liver hydatid cysts are treated in a single operation, reducing the need for multiple anesthesia sessions and shortening the hospital stay. However, treating multiple organs at the same time can increase the risk of complications and pose a greater challenge for the surgeon. The complexity of the procedure increases, particularly in cases involving large cysts or the presence of simultaneous complications [7]. In contrast, in two-stage surgery, liver and lung hydatid cysts are treated at different times, allowing a more targeted approach to each organ depending on the size and distribution of the cysts. However, this approach usually leads to a longer recovery time and involves a higher anesthetic risk [8].

Surgical procedures include video-assisted thoracoscopic surgery (VATS), thoracotomy, laparoscopy, and laparotomy techniques. Video-assisted thoracoscopic surgery (VATS) enables minimally invasive access to the chest cavity via small incisions, while thoracotomy enables direct access to the chest cavity via a large incision. Laparoscopy is a minimally invasive procedure in which a camera and instruments are inserted into the abdominal cavity through small incisions. At the same time, laparotomy is a traditional open surgical procedure that provides direct access to the abdominal structures through a large incision [9].

This study aims to provide guidelines for prioritizing surgical strategies in cases with concomitant pulmonary and hepatic hydatid cysts. Due to the limited number of studies in the literature on this topic, this study aims to determine the optimal surgical approach to improve patient outcomes.

Materials and Methods

This study presents a retrospective analysis of 42 patients who were simultaneously diagnosed with hydatid cysts in the lungs and liver at Istanbul Training and Research Hospital between March 2009 and July 2020. Patient demographics, diagnostic methods, surgical procedures, and postoperative outcomes were analyzed using data from the hospital database.

Inclusion and Exclusion Criteria

Patients who were diagnosed with simultaneous hydatid cysts in the lung and liver required surgical treatment, and had complete clinical data were included in the study. Patients with permanent complications from previous surgery, patients with severe systemic diseases, and patients with incomplete clinical data were excluded from the study.

Diagnostic Criteria

The diagnosis of lung and liver hydatid cysts was confirmed by chest radiography, abdominal ultrasonography, CT, MRI, and serologic tests. CT was the most commonly used method to assess cyst size and spread. Serologic tests supported the diagnosis but did not rule out the disease if the results were negative.

Surgical Strategies and Methods

Both one-stage and two-stage surgical procedures have been used to treat hydatid cysts in the lungs and liver. In one-stage surgery, both organs were treated in one procedure, while in two-stage surgery, the cysts were removed in separate procedures. The choice of procedure depended on factors such as the size of the cyst, the rupture status, and the general health of the patient.

Minimally invasive techniques (VATS, laparoscopy) were preferred for smaller cysts, while open surgery (thoracotomy, laparotomy) was used for larger and more complex cysts. The choice was based on the size of the cyst, its location, and the general condition of the patient (Fig. 1).

Surgical Techniques

Cystotomy and capitonnage were the most common surgical techniques employed to spare the lung tissue and minimize damage in cases of pulmonary cysts. Depending on the size and location of the cyst, a cystectomy or lobectomy was performed if necessary. For liver cysts, a total pericystectomy was often performed to protect the surrounding tissue, while drainage omentoplasty without a roof was preferred for complicated cysts. In cases that required simultaneous treatment, combinations of these techniques were used to improve surgical success and reduce complications.

Statistical Analysis

Descriptive statistics such as mean, standard deviation, median, minimum and maximum values, frequency, and percentages were used to summarize the data. These methods were chosen to present the general characteristics and distribution of the data in a clear and understandable form. The distribution of the variables was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests to determine whether the data conformed to a normal distribution. If the data were normally distributed, parametric tests were used to analyze the data.

Parametric Tests

Analysis of Variance (ANOVA) (with Tukey post-hoc test) was used to compare independent quantitative data with normal distribution. ANOVA was also used to determine whether there were statistically significant differences between the means of several groups. Tukey's post-hoc test was then used to determine which groups showed significant differences.

Non-Parametric Tests

If the data were not normally distributed, non-parametric tests such as the Kruskal-Wallis test and the Mann-Whitney

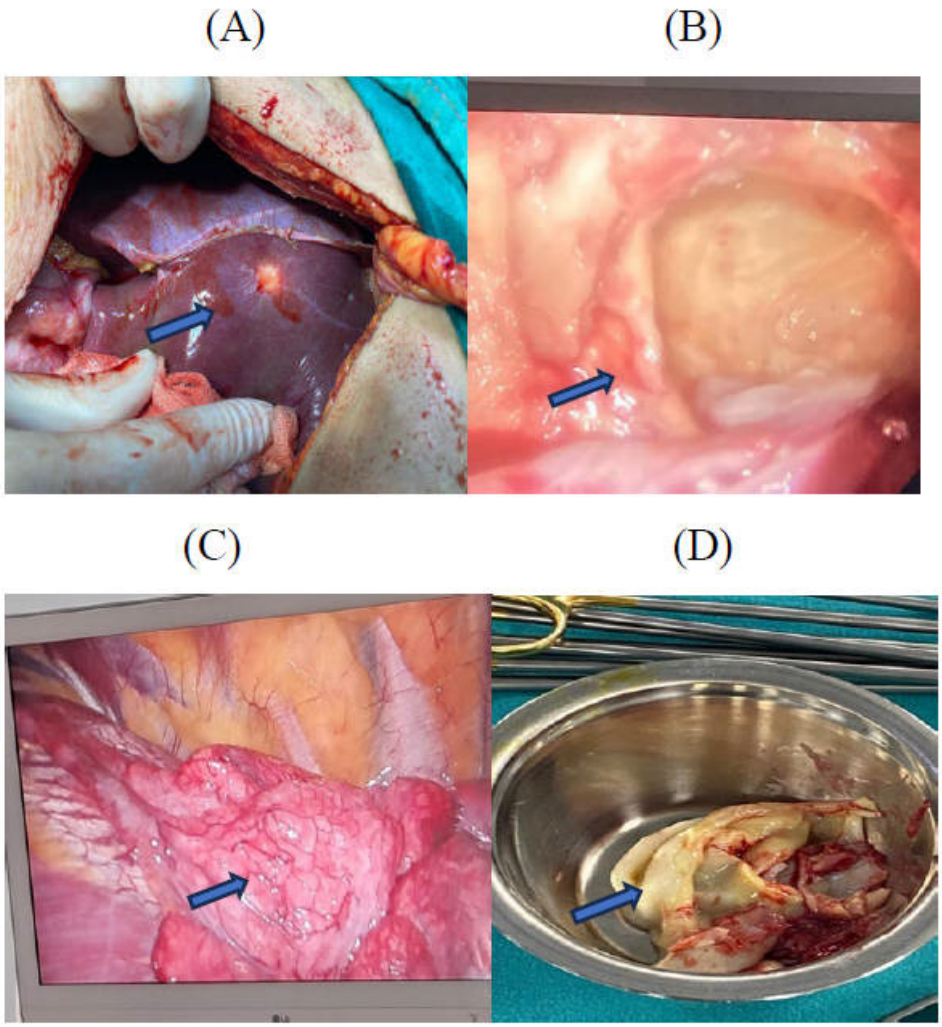

Fig. 1. Surgical views of hydatid cysts. (A) View of a hepatic hydatid cyst during laparotomy (the arrow indicates the location of the cyst). (B) Intracavitary view after laparoscopic removal of a hepatic hydatid cyst (the arrow indicates the cavity remaining after cyst removal). (C) View of a hydatid cyst in the right lower lobe of the lung during video-assisted thoracoscopic surgery (VATS) (the arrow indicates the location of the cyst). (D) Excised hydatid cyst membrane (the arrow highlights the excised cyst membrane).

U test were used. The Kruskal-Wallis test was used to compare medians between three or more groups, while the Mann-Whitney U test was used to analyze median differences between two groups. These tests provided reliable results regardless of the data distribution.

Analysis of Qualitative Data

The chi-square test was used to analyze the independent qualitative data. If the conditions for the chi-square test were not met (e.g., if the expected frequencies were too low), Fisher's exact test was used to obtain more accurate results.

In this study, a p-value of less than 0.05 ($p < 0.05$) was considered to indicate statistical significance. This threshold is widely recognized in statistical analysis as an indicator of sufficient evidence to reject the null hypothesis. This suggests that the observed differences or relationships are unlikely to have arisen by chance.

All statistical analyses were performed using SPSS 27.0 software (IBM Corp., Armonk, NY, USA). This software ensures the accuracy and reliability of the data analysis.

Results

Eighteen of the patients included in the study were male (42.9%), and 24 were female (57.1%). The average age of the patients was 36 years (36 $\pm$ 9.7), with an age range of 22 to 67 years.

Comorbidities

While 76.2% of patients had no comorbidities, 23.8% had at least one. The most frequently identified comorbidities were chronic obstructive pulmonary disease (COPD) (11.9%), asthma (7.1%), hypertension (2.4%), and diabetes (2.4%).

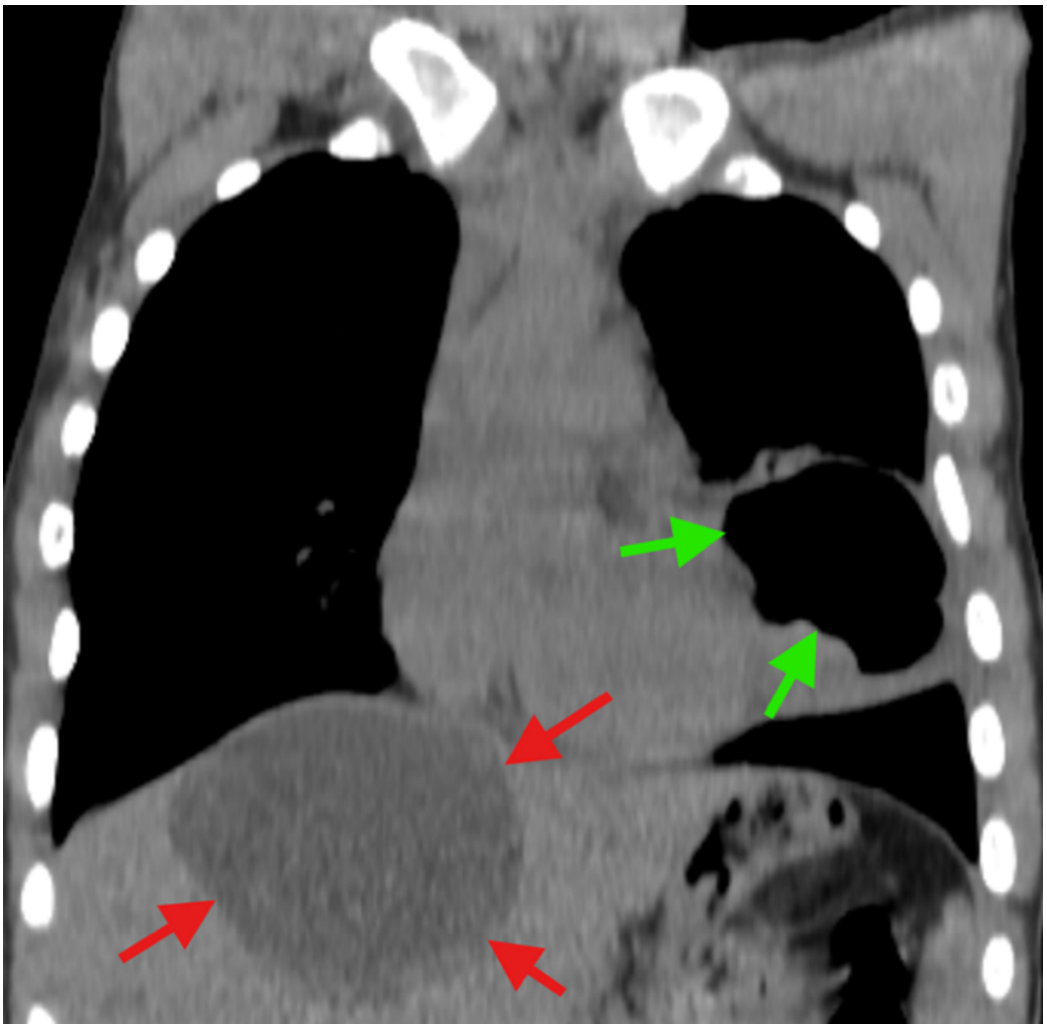

Fig. 2. Coronal thoracic computed tomography (CT) image of hydatid cysts in lung and liver. In the coronal section of the thoracic CT, a hydatid cyst opening into the bronchus and containing air in the lingular segment is shown with green arrows, while a fluid-filled hydatid cyst extending from segment 8 to segment 7 of the liver is indicated by red arrows.

Method for Measuring Cyst Diameter

In patients with multiple cysts, the diameter of the largest cyst was used as the measurement for each patient. This approach was chosen best to address the surgical challenges and risk of complications.

Characteristics of the Cysts

When analyzing cyst size, it was found that 31% of patients had cysts 5–10 cm in size, while 69% had cysts 10–15 cm in diameter. In particular, cysts larger than 10 cm tend to exert greater pressure on the surrounding tissue, making surgery more difficult and increasing the risk of rupture. This risk is particularly high if liver and lung hydatid cysts are present at the same time, which can lead to serious complications.

For cysts larger than 10 cm, the open surgical approach is generally preferred, as complete removal using minimally invasive methods can be difficult, and these techniques carry a higher risk of complications. In addition, open surgery is considered more suitable for cysts located in anatomically difficult areas, such as deep liver tissue or near the diaphragm [10,11].

Study by Aghajanzadeh *et al*. [12] emphasize that laparoscopic surgery is suitable for cysts less than 10 cm, while open surgery is recommended for larger cysts. These results emphasize the importance of carefully considering the size, location, and relationship of the cysts to the surrounding tissues when choosing the surgical approach.

Surgical Procedures

The most commonly performed surgical procedures were VATS (23.8%), thoracotomy (16.7%), laparoscopy (11.9%) and laparotomy (16.7%). The choice of surgical technique depended on factors such as cyst size, location, and the overall condition of the patient. In cases of small, simple cysts, the preferred surgical approach involves the use of minimally invasive techniques, such as VATS and laparoscopy. These techniques have been shown to result in a reduction in recovery time and an increase in patient

Table 1. Surgical outcomes of concomitant hydatid cysts in the lung and liver: analysis of clinical factors.

		Min–max	Median	Mean ± sd/n-%
Age		22.0 – 67.0	35.0	36.0 ± 9.7
Gender	Female			24 57.1
	Male			18 42.9
Comorbidity	(-)			32 76.2
	(+)			10 23.8
COPD				5 11.9
Asthma				3 7.1
Hypertension				1 2.4
Diabetes mellitus				1 2.4
Postoperative complication	(-)			29 69.0
	(+)			13 31.0
Pneumothorax				2 4.8
Pleural Effusion				2 4.8
Empyema				1 2.4
Bleeding (Liver)				1 2.4
Intraabdominal Infection				1 2.4
Bile Fistula				1 2.4
Surgical Site Infection (Liver)				1 2.4
Bronchopleural Fistula				1 2.4
Atelectasis				3 7.1
Surgical approach	VATS			10 23.8
	Thoracotomy			7 16.7
	Laparoscopy			5 11.9
	laparotomy			7 16.7
	Thoracotomy+Laparoscoyy			6 14.3
	VATS+Laparoscopy			5 11.9
	VATS+Laparotomy			2 4.8
Cyst diameter	5–10 cm			13 31.0
	10–15 cm			29 69.0
Hospital stay duration/day		4.0 – 14.0	7.0	6.9 ± 2.1
Length of stay in ICU/day		0.0 – 6.0	1.0	1.9 ± 1.4
Thorax tube termination time/day		3.0 – 11.0	5.0	5.2 ± 1.7
Abdominal drain termination time/day		3.0 – 15.0	5.0	5.8 ± 2.5
Relapse	(-)			38 90.5
	(+)			4 9.5
Mortality	(-)			41 97.6
	(+)			1 2.4

COPD, chronic obstructive pulmonary disease; ICU, Intensive Care Unit.

safety, as evidenced by a lower incidence of complications (20%). In contrast, for large and complex cysts, open surgical methods such as thoracotomy and laparotomy were associated with a higher complication rate (40.9%).

Postoperative Complications

The overall postoperative complication rate was 31%. The most frequently observed complications were pneumothorax (4.8%), pleural effusion (4.8%), empyema (2.4%), liver hemorrhage (2.4%), intra-abdominal infection (2.4%), biliary fistula (2.4%), surgical site infection (2.4 %) and bronchopleural fistula (2.4%).

Postoperative complications are classified according to their severity into three categories: mild, moderate, and severe. Mild complications can usually be treated with minimal medical intervention, while moderate complications can prolong hospitalization. Severe complications often require intensive care or additional surgery and can increase the risk of death. In this study, postoperative complications were observed in 13 of 42 patients (31%). Mild complications occurred in seven patients (16.7%), moderate complications in four patients (9.5%) and severe complications in two patients (4.8%). The classification of complications was based on the need for surgical surgery and their impact on the course of the disease.

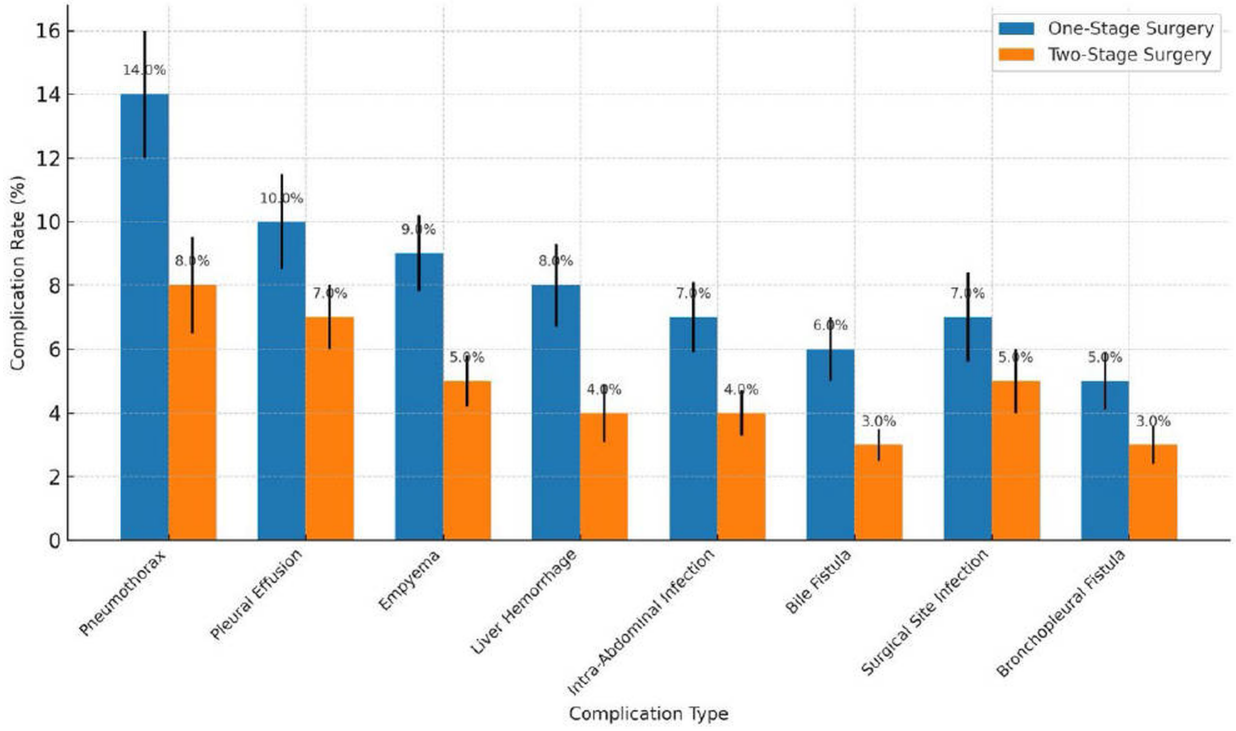

Fig. 3. Complication rates in one-stage vs. two-stage surgery.

Hospital Stay and Recovery Time

The median length of stay of the patients in hospital was seven days, the stay in the Intensive Care Unit (ICU) was one day. The median time for the removal of thoracic and abdominal drains was five days.

Follow-up Time and Evaluation of Recurrence Rate

Patients were followed for an average of 12 months after surgery. Patients were examined at regular intervals to ensure standardization of the postoperative follow-up process, particularly in the first, third, sixth, and twelfth months after surgery. During these follow-up examinations, imaging techniques such as ultrasound (USG) and computed tomography (CT) were used to detect possible recurrences of hydatid cysts in the liver and lungs. In certain cases, serologic tests were also performed to confirm the diagnosis further. Each follow-up included a comprehensive physical examination, an assessment of vital signs, and an evaluation of patient-reported symptoms. This structured follow-up protocol was developed to increase the accuracy of recurrence detection and to ensure consistency in follow-up procedures for patients. In addition, this follow-up approach contributed to the overall monitoring of patients' health and facilitated the early detection of potential postoperative complications. Similar recurrence rates were observed for both surgical procedures (9.5%), with no significant difference between the two groups. The mortality rate was low, with only one patient (2.4%) dying after open surgery. Recurrences were detected by ultrasound and CT scans (Fig. 2) (Table 1).

Comparison of One- and Two-Sided Operations

When comparing the surgical outcomes of the different surgical strategies, the mean age of patients who underwent Lung Hydatid Cyst Surgery first (group 1) was 39.4 ± 12.4 years, the mean age of patients who underwent liver and lung surgery (group 2) was 34.1 ± 6.5 years, and the mean age of patients who underwent Liver Hydatid Cyst Surgery first (group 3) was 33.3 ± 7.3 years ($F = 1.\ 860$, $p = 0.169$). There was no significant difference in the gender distribution among the groups; the proportion of women was 52.9% in group 1, 69.2% in group 2, and 50% in group 3 ($\chi^2 = 1.148$, $p = 0.563$).

No statistically significant difference was found among the groups with regard to comorbidities ($\chi^2 = 5.150$, $p = 0.076$). No significant difference was found for postoperative complications either ($\chi^2 = 0.349$, $p = 0.840$), although liver surgery was associated with a longer hospital stay compared to lung surgery ($H = 8.626$, $p = 0.013$) (Table 2) (Fig. 3). Single-stage procedures had higher rates of pneumothorax and pleural effusion, although these differences were not statistically significant.

Fig. 3 presents a comparison of postoperative complication rates among the groups. The analysis revealed that patients who underwent single-stage surgery exhibited higher incidences of complications, including pneumothorax and pleural effusion. However, these differences were not found to be statistically significant ($p > 0.05$). Nevertheless, the one-stage surgical approach requires careful planning as it potentially involves greater surgical complexity and a higher risk of complications. Compared to two-stage proce-

Table 2. Comparison of surgical outcomes and clinical factors between groups with lung surgery alone, liver and lung surgery, and liver surgery alone.

			[1]Lung Hydatid Cyst Surgery			[2]Liver + Lung Hydatid Cyst Surgery			[3]Liver Hydatid Cyst Surgery			*p*	F/χ^2 /*H*
Age	Mean ± sd		39.4	±	12.4	34.1	±	6.5	33.3	±	7.3	0.169	1.860 ^{F}
	Median			39.0			35.0			30.5			
Gender	Female	n-%	9		52.9%	9		69.2%	6		50.0%	0.563	1.148 $^{\chi^2}$
	Male	n-%	8		47.1%	4		30.8%	6		50.0%		
Comorbidity	(-)	n-%	16		94.1%	8		61.5%	8		66.7%	0.076	5.150 $^{\chi^2}$
	(+)	n-%	1		5.9%	5		38.5%	4		33.3%		
Postoperative Complication	(-)	n-%	11		64.7%	9		69.2%	9		75.0%	0.840	0.349 $^{\chi^2}$
	(+)	n-%	6		35.3%	4		30.8%	3		25.0%		
Surgical Approach													
Closed		n-%	10		58.8%	5		38.5%	5		41.7%	0.481	1.463 $^{\chi^2}$
Open		n-%	7		41.2%	0		0.0%	7		58.3%		
On+off		n-%	0		0.0%	8		61.5%	0		0.0%		
Cyst diameter													
5–10 Cm		n-%	8		47.1%	3		23.1%	2		16.7%	0.166	3.587 $^{\chi^2}$
10–15 Cm		n-%	9		52.9%	10		76.9%	10		83.3%		
Length of hospital stay/day	Mean ± sd		6.0	±	1.3	6.8	±	2.1	8.3	±	2.5	0.013	8.626 $^{\chi^2}$
	Median			6.0[3]			7.0			8.0			
Length of stay in intensive care/day	Mean ± sd		1.5	±	1.1	2.0	±	1.5	2.3	±	1.8	0.633	0.916 $^{\chi^2}$
	Median			1.0			1.0			1.5			
Thorax tube termination time/day	Mean ± sd		5.5	±	1.8	5.3	±	1.9	4.7	±	1.4	0.453	1.586 $^{\chi^2}$
	Median			5.0			5.0			4.5			
Time to end abdominal drain/day	Mean ± sd		5.1	±	1.4	6.9	±	3.0	5.8	±	3.0	0.094	4.723 $^{\chi^2}$
	Median			5.0			6.0			5.0			
Relapse	(-)	n-%	16		94.1%	11		84.6%	11		91.7%	0.667	0.811 $^{\chi^2}$
	(+)	n-%	1		5.9%	2		15.4%	1		8.3%		
Mortality	(-)	n-%	16		94.1%	13		100.0%	12		100.0%	0.464	1.536 $^{\chi^2}$
	(+)	n-%	1		5.9%	0		0.0%	0		0.0%		

n, number of patients; SD, standard deviation; ICU, Intensive Care Unit; *p*, probability value indicating the significance level; χ^2, Chi-square test (Fischer test); H, Kruskal-Wallis (Mann-Whitney u test); F, ANOVA (Analysis of Variance) test. [1]Lung Hydatid Cyst Surgery: surgery performed only on the lung hydatid cyst. [2] Liver + Lung Hydatid Cyst Surgery: surgery performed on both liver and lung hydatid cysts. [3] Liver Hydatid Cyst Surgery: surgery performed only on the liver hydatid cyst.

Table 3. Surgical procedures in the operation of hydatid cysts in the lung and liver and their distribution.

	Lung Hydatid Cyst Surgery		Liver + Lung Cyst Hydatid Surgery		Liver Hydatid Cyst Surgery		Total	
	n	%	n	%	n	%	n	%
Surgical Procedure								
Cystotomy-capitonnage	11	64.7%	0	0.0%	0	0.0%	11	26.2%
Cystectomy	4	23.5%	0	0.0%	0	0.0%	4	9.5%
Lobectomy (lung)	2	11.8%	0	0.0%	1	8.3%	3	7.1%
Total pericystectomy	0	0.0%	0	0.0%	6	50.0%	6	14.3%
Partial hepatectomy	0	0.0%	0	0.0%	1	8.3%	1	2.4%
Unroofing drainage-omentoplasty	0	0.0%	0	0.0%	4	33.3%	4	9.5%
Cystotomy-capitonnage + unroofing drainage-omentoplasty	0	0.0%	8	61.5%	0	0.0%	8	19.0%
Cystectomy + total pericystectomy	0	0.0%	1	7.7%	0	0.0%	1	2.4%
Cystotomy-capitonnage + total pericystectomy	0	0.0%	1	7.7%	0	0.0%	1	2.4%
Cystectomy + partial hepatectomy	0	0.0%	1	7.7%	0	0.0%	1	2.4%
Cystotomy-capitonnage + partial hepatectomy	0	0.0%	1	7.7%	0	0.0%	1	2.4%
Cystectomy + unroofing drainage-omentoplasty	0	0.0%	1	7.7%	0	0.0%	1	2.4%

n, number of patients; Cystotomy-capitonnage, surgical removal of the cyst followed by the collapse and suturing of the residual cavity; Cystectomy, surgical removal of the entire cyst; Lobectomy (lung), surgical removal of a lobe of the lung; Total pericystectomy, complete removal of the cyst wall (pericyst) while preserving the surrounding tissue; Partial hepatectomy, partial removal of the liver tissue, typically to excise a cyst; Unroofing drainage-omentoplasty, surgical unroofing of a cyst followed by the drainage of its contents and the use of omentum (fatty tissue) to cover the exposed area.

dures, one-stage procedures are surgically more complex but offer the advantage of a shorter recovery time.

Surgical Outcomes by Method

In the context of surgical intervention for pulmonary hydatid cysts, cystotomy-capitonnage emerged as the prevailing procedure, accounting for 64.7% of surgical interventions. A cystectomy was utilized in 23.5% of cases, while a lobectomy was employed in 11.8% of cases. In cases involving both liver and lung hydatid cysts, the most prevalent surgical technique involved a combination of cystotomy-capitonnage and exposure drainage-momentoplasty, accounting for 61.5% of procedures. This combination allowed complete evacuation of the cyst contents and optimal drainage, minimizing the risk of infection and promoting postoperative healing.

When operating on liver hydatid cysts alone, total pericystectomy was the preferred surgical method, used in 50.0% of cases. This technique focused on the complete removal of the cyst while sparing the surrounding tissue, thereby reducing the risk of recurrence (Table 3).

No complications occurred in 80% of patients in the closed surgery group, compared with 59.1% in the open surgery group. The complication rate was 20% in the closed group and 40.9% in the open group. However, this difference was not statistically significant ($p = 0.143$, $\chi^2 = 2.143$). These results suggest that closed surgery may have a lower risk of complications; however, it should be kept in mind that the observed difference could be due to chance (Table 4).

Discussion

The success rates and complication risks of surgical techniques vary depending on the general condition of the patient and the characteristics of the cyst. VATS technique, which is used for pulmonary hydatid cysts, can reduce the risk of complications by up to 20% and shorten the hospital stay. However, VATS requires one-lung ventilation, which limits its use in patients with limited respiratory capacity, particularly those with respiratory insufficiency or COPD. Thoracotomy may be required for large or deep cysts. Thoracotomy is preferred for infected or ruptured cysts as it allows wider surgical exposure; however, the complication rate with this procedure can be as high as 40% [13,14]. These results are consistent with the conclusions of Alharbi [15]. and Lone *et al*. [16], who reported that minimally invasive procedures reduce complications.

Treatment options for hepatic hydatid cysts include open surgery, laparoscopy, and percutaneous aspiration injection (PAIR). Laparoscopic surgery offers advantages in terms of a shorter hospital stay and a lower recurrence rate. However, the risk of complications may increase in cases where the cyst is connected to the bile ducts [17,18]. Aghajanzadeh *et al*. [12] also point out these risks and, at the same time, emphasize the reliability of laparoscopy.

Comorbidities such as respiratory insufficiency, COPD, and cardiovascular disease are important factors that increase the risk of complications during surgery for hydatid cysts in the lungs and liver. Respiratory diseases increase the risk of complications in lung cyst surgery, while diabetes, hypertension, and chronic liver disease increase this risk in liver cyst surgery [19,20]. These results are consistent with the study by Aydin *et al*. [21].

Table 4. Comparison of postoperative complication rates between open and closed surgery groups.

		Closed surgery		Open surgery		*p*	χ^2
		n	%	n	%		
Postoperative complication	(-)	16	80.0%	13	59.1%	0.143	2.143 $^{\chi^2}$
	(+)	4	20.0%	9	40.9%		

n, number of patients; *p*, probability value (significance level); χ^2, Chi-square test; Closed surgery, refers to minimally invasive surgical techniques, including VATS and laparoscopy; Open surgery, refers to traditional open surgical techniques, including thoracotomy and laparotomy.

In our study, comorbidities such as COPD (11.9%), asthma (7.1%), hypertension (2.4%), and diabetes (2.4%) were found in 23.8% of patients.

The study by Kanojia and Bawa [22] showed that large lung and liver hydatid cysts could be successfully removed using VATS. In our study, minimally invasive procedures such as VATS were also preferred for pulmonary hydatid cysts, while thoracotomy was performed for more complex cases.

Synchronous surgery of lung and hepatic hydatid cysts can be performed either sequentially (laparotomy/laparoscopy followed by thoracotomy/VATS) or in a single combined session. Although it may increase the risk of complications, single-stage surgery is preferred in young, healthy patients as it offers the advantage of a shorter recovery time. Two-stage surgery is a safer option for older patients or those with high comorbidity [23,24]. The results of Kabiri *et al*. [25] which show that two-stage surgery is associated with a longer hospital stay are consistent with our results. Our study found that both single-stage and two-stage surgery for lung and hepatic hydatid cysts had similar postoperative complication rates, but liver surgery required a longer hospital stay.

In patients with simultaneous hepatic and lung hydatid cysts, the combination of cystotomy-capitonnage and uncovered drainage-omentoplasty was the most commonly used surgical technique (61.5%), reducing the risk of infection and promoting recovery. In liver cyst surgery, complete pericystectomy (50.0%) was preferred, as this method is associated with a lower risk of recurrence.

Postoperative complications following liver surgery can range from mild to severe, including bile leakage, bronchobiliary fistulas, and biliary-cutaneous fistulas. Thoracic complications may include atelectasis, persistent air leaks, empyema, postoperative hemoptysis, and wound infections [26]. Aghajanzadeh *et al*. [12] reported a complication rate of 30%, and the study by Kabiri *et al*. [25] and Toktogaziev *et al*. [27] emphasized the advantages of minimally invasive surgery. Patients who underwent liver surgery were observed to require longer intensive care and hospitalization. Minor complications could be treated with minimal intervention, while moderate complications required additional treatment. Complications such as pleural effusion and bronchopleural fistulas prolonged the recovery process, while pneumothorax, empyema, and intra-abdominal infections required intensive care or additional surgery.

Follow-up is required for 12 to 24 months after hydatid cyst surgery to reduce the risk of cyst recurrence, and this period can be extended up to five years in high-risk patients [26, 27]. In our study, patients were followed up for an average of 12 to 18 months after surgery, with recurrences detected by ultrasound and CT scans. Occasionally, serologic tests were also used to assess recurrence.

Limitations of the Study

Limitations of this study include the retrospective design, single-center structure, sample size, and variation in surgical experience that may have influenced the results. These factors should be considered when interpreting the results.

Suggestions for Future Research

Large-scale, multicenter, prospective studies will improve the reliability and generalizability of surgical techniques. Data on the long-term efficacy and complication rates of minimally invasive surgery should be evaluated, and the impact of multidisciplinary approaches should be investigated. A follow-up period of at least three to five years would allow an accurate assessment of recurrence rates. In addition, the potential of innovative techniques, such as robotic surgery, in the treatment of hydatid cysts should be explored.

Conclusions

This study found no significant difference in complication rates between one-stage and two-stage procedures for hepatic and pulmonary hydatid cysts. The choice of surgical approach should be based on factors such as cyst size, location, and patient characteristics. Minimally invasive surgery, which is generally used for smaller cysts, offers faster recovery and lower complication rates but it requires careful evaluation for larger cysts.

The longer recovery time of liver surgery emphasizes the need for thorough planning and long-term follow-up. The comparable outcomes of one-stage and two-stage procedures emphasize the importance of a multidisciplinary approach to surgical treatment.

Availability of Data and Materials

The data supporting the results of this study are available upon reasonable request to the corresponding author.

Author Contributions

TD conceived the study and wrote, supervised, and revised the manuscript. KB, TR, GC, and AA were responsible for data collection and contributed to data analysis and interpretation. All authors have been involved in revising it critically for important intellectual content. All authors gave final approval of the version to be published. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

This study was conducted with the approval of the relevant ethics committee (Istanbul Training and Research Hospital, 24 July 2020, Decision No. 2483), and all participating patients gave their informed consent. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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