

# Surgical treatment of extrahepatic intraabdominal hydatid cysts: A single-centre retrospective analysis

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**Abstract.** Cystic echinococcosis is a zoonotic disease caused by *Echinococcus granulosus*. Although Echinococcal cysts are most frequently located in the liver (59-75%), in rare circumstances they may develop in extra-hepatic locations. Because extrahepatic cysts are rare and lack the characteristic appearance of hepatic cysts, diagnosis can be challenging. In the present retrospective study, the medical records of 41 patients surgically treated for intra-abdominal extrahepatic hydatid cyst disease were analysed to collect the following: Demographic data, cyst localization, serological test results, surgical findings and procedures, length of hospital stay, post-operative medical treatments and recurrence status. Based on this analysis, the female-to-male ratio was 27:14, with a mean age of 42.9±15.1 years (range, 19-75 years). Diagnosis was based on ultrasound, computed tomography or magnetic resonance imaging, and confirmed pre-operatively for 29 patients. Isolated kidney involvement was the most common finding (31.7%), whereas 12 patients had cysts in multiple locations. Isolated extrahepatic cysts were present in 30 patients (73.2%) and 11 (26.8%) had concurrent hepatic cysts. Surgery was performed on 34 patients for extrahepatic cysts alone, and on 7 (17%) for both hepatic and extrahepatic cysts; recurrence occurred in 4 patients (9.7%). Hepatic involvement (P=0.003), multiple cysts (P=0.033), multi-site involvement (P=0.033), history of surgery (P=0.002), concurrent liver surgery (P=0.019) and positive serology (P=0.030) were identified as risk factors for recurrence. The present results show that although imaging remains the cornerstone of extrahepatic cyst diagnosis, the disease was confirmed by radiology in only one-third of cases. Hydatid disease should be

suspected in endemic regions; and surgery remains the most effective and commonly used treatment.

## Introduction

Cystic echinococcosis is a zoonotic parasitic disease caused by *Echinococcus granulosus*, with humans serving as incidental hosts (1). The disease, endemic in specific geographic regions, most notably the Mediterranean and the Middle East, is a zoonosis caused by *Echinococcus granulosus* larvae in areas where there is a close link between sheep, dogs and humans (2). Echinococcal cysts are most commonly located in the liver (59-75%); whereas extrahepatic involvement has been reported less frequently, with the lungs representing the second most common site (27%). Isolated hydatid cysts in organs such as the spleen, heart, kidneys, bones, brain, pancreas and retroperitoneal space are rare (3).

*E. granulosus*, the causative agent of the disease, belongs to the Taeniidae family of the Cestoda class (1). In terms of genetic and biological characteristics, a total of six different types of *E. granulosus* have been identified (sheep, cattle, horse, camel, pig and deer). Of these, four are pathological for human health: *E. granulosus* (disease, cystic echinococcosis), *E. multilocularis* (disease, alveolar echinococcosis), *E. vogeli* and *E. oligarthrus* (disease, polycystic echinococcosis) (4).

Hydatid disease remains a notable public health issue in endemic regions, in large part due to insufficient preventive healthcare measures. In addition, extrahepatic hydatid cysts often do not present with clinical symptoms, and most cases are asymptomatic (5). At present, imaging studies serve as the cornerstone of diagnosis, where radiological findings may range from purely cystic to a more complex, solid appearance. Characteristic radiologic features include the 'floating membrane' sign, which is due to detachment of the endocyst from the pericyst, and is often accompanied by multiple daughter cysts; however, the rarity of extrahepatic involvement and the absence of typical imaging features can make diagnosis challenging (6).

The present study aimed to evaluate the diagnosis, clinical characteristics and treatment of isolated extrahepatic cysts, hydatid cysts and hepatic cysts occurring in various regions of the abdominal cavity, and report the cohort results.

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## Materials and methods

The medical records of patients, who were surgically treated for intra-abdominal extrahepatic hydatid disease at Erciyes University School of Medicine Hospital (Kayseri, Turkey) between January 2010 and April 2020, were retrospectively analysed. The present study was performed in accordance with the principles of the World Medical Association Declaration of Helsinki and was approved by the Local Ethics Committee of Erciyes University Faculty of Medicine (approval no. 279; date, June 2020). Although informed consent was not obtained due to the retrospective nature of the study, pre-operative informed consent was obtained for all interventional and surgical procedures performed. The study included patients >18 years of age who were diagnosed with extrahepatic hydatid cysts in the Department of Surgery, Erciyes University, and underwent surgical treatment. Patients with isolated liver cysts only, those lacking imaging or clinical-demographic data, those without postoperative follow-up data and those who did not undergo surgical treatment were excluded from the study. Among the 341 patients who underwent surgery for intra-abdominal hydatid disease, extrahepatic cysts were identified in 49 cases. Due to missing data or loss to follow-up, 8 patients were excluded from the present study, and the remaining 41 patients were included in the final analysis. Following ethics approval, patient charts, electronic records, pathology and operative reports and anaesthesia records were examined. Using this data, the following specific factors were retrospectively analysed: Demographic characteristics, cyst localization, serologic test results, intra-operative findings, surgical procedures, length of hospital stay, postoperative medical treatment and recurrence status.

For preoperative diagnostic evaluation, patients underwent ultrasound (US), computed tomography (CT) and/or magnetic resonance imaging (MRI), either individually or in combination. The choice of diagnostic modality was based on the clinician's experience and the diagnostic performance of the imaging method (e.g., CT was performed in some patients when US did not provide a definitive diagnosis). Regarding serological testing, a positive result was defined as a titre of  $\geq 1/320$  in the indirect haemagglutination assay (IHA). Western blot (WB) test analysis was performed using parasite-derived tissue protein extracts. Proteins were extracted using radioimmunoprecipitation assay buffer (50 mM Tris-HCl, 150 mM NaCl, 1% NP-40, 0.5% sodium deoxycholate and 0.1% SDS) supplemented with a protease inhibitor cocktail (MilliporeSigma). Protein concentrations were determined using the bicinchoninic acid assay. Equal amounts of protein (30  $\mu$ g per lane) were separated on 12% SDS-polyacrylamide gels and transferred onto polyvinylidene difluoride membranes. Membranes were blocked with 5% non-fat dry milk in Tris-buffered saline containing 0.1% Tween-20 (TBST; MilliporeSigma) for 1 h at room temperature. Membranes were incubated overnight at 4°C with patient sera diluted 1:200 as the primary antibody, followed by incubation with horseradish peroxidase (HRP)-conjugated anti-human IgG secondary antibody (1:5,000; MilliporeSigma) for 1 h at room temperature.  $\beta$ -actin was used as a reference protein. Immunoreactive bands were visualized using enhanced chemiluminescence substrate (MilliporeSigma), and the presence of a p7 band was considered a positive result.

Table I. Demographic data and clinical characteristics of patients (n=41).

Variable	Value
Age, years (range)	42.9 $\pm$ 15.1 (19-75)
Sex, n (%)	
Female	27 (65.9)
Male	14 (34.1)
Mean $\pm$ SD hospital stay, days	5.5 $\pm$ 2.2
Extrahepatic cyst rate, n/total n (%)	41/341 (12.0)
Isolated extrahepatic cyst	30 (73.2)
Hepatic + extrahepatic cyst	11 (26.8)
Radiological positivity, n/total n (%)	29/41 (70.7)
Average cyst diameter, mm	84.1 $\pm$ 36.8
IHA titre of positive patients (n=13)	640 (320-1,280)
WB positivity rate, n/total n (%)	18/34 (52.9)
Symptom, n (%)	
Abdominal pain	22 (53.6)
Flank pain	9 (21.0)
Inability to urinate	1 (2.4)
Vaginal bleeding	1 (2.4)
Lumbar pain	1 (2.4)
Malaise	1 (2.4)
No complaints	6 (14.5)

WB, western blot of p7; IHA, indirect haemagglutination assay.

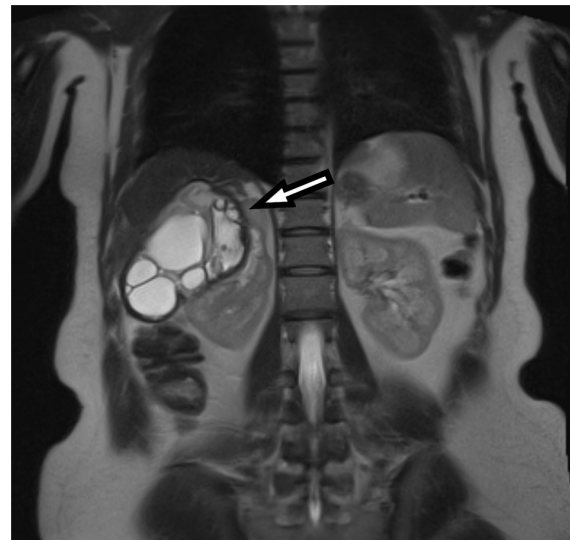


Figure 1. MRI image of a hydatid cyst in the right kidney. Daughter vesicles are seen within the cyst (arrow).

Statistical analyses were performed using IBM SPSS 22.0 (IBM Corp.). Normal distribution of data was analyzed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Continuous variables were presented as the mean  $\pm$  standard deviation, whereas nominal variables were expressed as frequencies (n) and percentages (%) and were compared using the Fisher's Exact (used to compare groups with sample

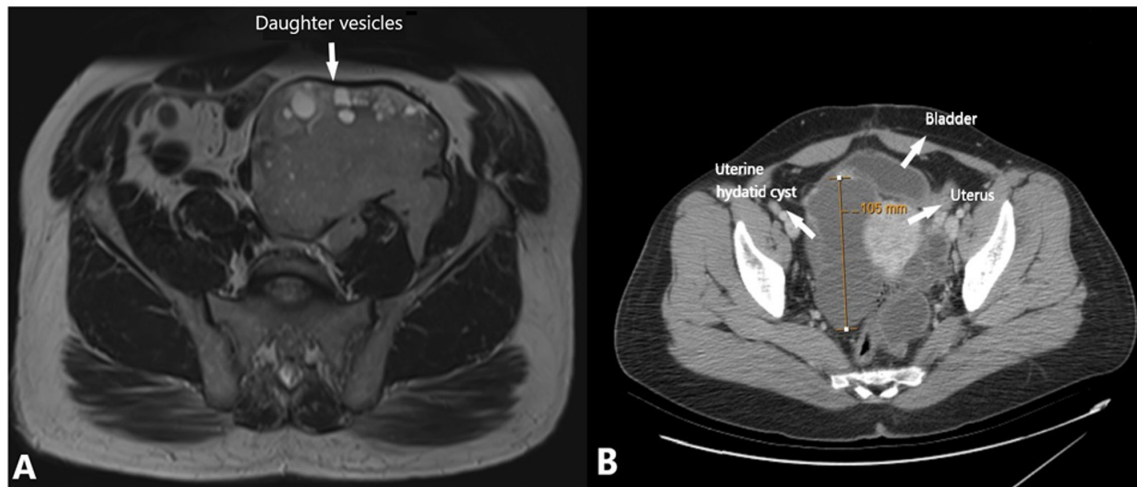


Figure 2. (A) MRI image of a hydatid cyst with daughter vesicles in the left retroperitoneum. (B) A 102 mm diameter multiseptate hydatid cyst was observed in the adnexal area in pelvic CT.

sizes <5).  $P < 0.05$  was considered to indicate a statistically significant difference.

## Results

Data from 41 patients who met the study inclusion criteria were analysed, revealing 30 cases of isolated extrahepatic hydatid disease and 11 cases of extrahepatic hydatid disease with concurrent hepatic involvement. Of these 41 patients, 14 (34.1%) were men and 27 (65.9%) were women, with a mean age of  $42.9 \pm 15.1$  years (range, 19-75 years). The most common presenting symptom was abdominal pain, reported by 22 (53.6%) patients, followed by flank pain in 9 (21%) patients. Less frequent symptoms included urinary retention ( $n=1$ , 2.4%), vaginal bleeding ( $n=1$ , 2.4%), lumbar pain ( $n=1$ , 2.4%) and general malaise ( $n=1$ , 2.4%); 6 patients (14.6%) were asymptomatic, and hydatid cysts were detected incidentally during imaging studies performed for other reasons in these patients. None of the patients showed any signs of acute abdominal pathology and findings from abdominal examinations were normal in all cases. Demographic and clinical characteristics of the 41 patients included in the present study are summarised in Table I.

For diagnostic purposes, 16 patients were evaluated by CT, 8 by US and 3 by MRI imaging. An additional 7 patients were evaluated by both US and CT, whereas 4 were evaluated using CT and MRI, 2 using US and MRI and 1 patient using US, CT and MRI imaging. Based on these data, the mean cyst diameter was calculated to be  $84.12 \pm 36.78$  mm. Imaging findings were suggestive of hydatid cyst in 29 (70.7%) patients, whereas no radiological indication of hydatid disease was observed for the remaining 12 (29.3%) patients.

Analysis of cyst locations revealed isolated kidney involvement in 13 patients (31.7%) (Fig. 1); isolated splenic involvement in 5 patients (12.1%); isolated retroperitoneal involvement in 5 patients (12.1%) (Fig. 2A); isolated intraperitoneal involvement in 5 patients (12.1%); and isolated ovarian involvement in 1 patient (Fig. 2B); cyst localization data are summarised in Fig. 3. For the remaining 11 patients, cysts were identified in multiple locations. Out of the 41 patients

included in the present study, 30 (73.2%) had isolated extrahepatic hydatid cysts, whereas 11 (26.8%) also had concurrent hepatic involvement.

Serological testing, including an IHA test and WB analyses, were performed on 34 patients. The IHA test was positive for 13 patients (38.2%); whereas the WB test was positive for 18 (52.9%) patients. Of the 30 patients diagnosed with isolated extrahepatic disease, 26 underwent serological testing, with 9 (34.6%) yielding positive results (both IHA and WB). Of the 11 patients with concurrent hepatic hydatid disease, 8 underwent serological testing and 6 (75%) tested positive for both IHA and WB. In addition, 7 out of 10 patients with a history of previous hydatid surgery had positive serological test results.

Out of the 41 patients included in the present study, 31 (75.6%) had no prior history of surgery for hydatid disease; whereas 5 patients (12%) had previously undergone surgical and puncture, aspiration, injection, re-aspiration (PAIR) treatments for hepatic hydatid cysts in the liver and spleen; 3 patients (7%) had surgery for pulmonary hydatid cysts; and 1 patient (2%) had surgery for both hepatic and pulmonary hydatid cysts. In addition, 1 patient (2%) received only PAIR treatment for hepatic hydatid cysts.

Based on analysis of the surgical procedures used for patient treatments, 7 patients (17%) underwent simultaneous surgery for hepatic hydatid cysts; whereas 34 patients (83%) underwent surgery solely for extrahepatic hydatid disease. With respect to surgical treatment procedures used, partial or total cyst excision was performed on 28 patients (68%), a splenectomy on 5 patients (12%), a combined splenectomy and cyst excision was performed on 4 out of these 5 patients (10%), a partial nephrectomy on 2 patients (5%) and a total abdominal hysterectomy with bilateral salpingo-oophorectomy was used to treat 2 patients (5%). The mean hospital stay was  $5.5 \pm 2.2$  days (range, 2-12 days). Post-operatively, 10 patients received medical therapy (albendazole treatment was administered for varying durations depending on the patient's clinical condition); and recurrence was observed in 4 patients (9.7%), all of whom were receiving post-operative medical treatment. Out of the 4 patients with recurrence, 3 had undergone concurrent surgery for intra-abdominal and hepatic hydatid cysts.

Table II. Risk factors for recurrence in operated extrahepatic hydatid cysts.

Variable	Recurrence, n	Non-recurrence, n	P-value
Sex			0.107
Male	3	11	
Female	1	26	
Cyst location			0.003
Isolated extrahepatic cyst	0	30	
Hepatic + extrahepatic cyst	4	7	
Number of cysts			0.001
One	0	28	
Multiple	4	9	
Number of regions in which the cyst is found			0.033
Single	1	29	
Multiple	3	8	
IHA/WB			0.030
Negative	0	14	
Only one positive	0	5	
Both positive	4	25	
Previous cyst surgery			0.002
Negative	0	31	
Positive	4	6	
Concurrent liver surgery			0.019
No	1	32	
Yes	3	5	

Fisher's Exact test was used to compare groups with sample <5. WB, western blot of p7; IHA, indirect haemagglutination assay.

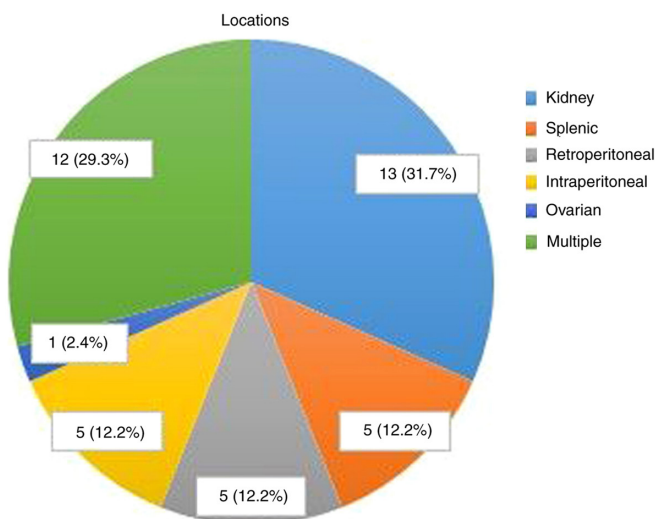


Figure 3. Lesion locations.

Statistical analysis identified the following as significant risk factors for post-operative recurrence in extrahepatic cystic echinococcosis: Hepatic involvement ( $P=0.003$ ), the presence of cysts at multiple sites ( $P=0.033$ ), the presence of multiple cysts ( $P=0.001$ ), a prior surgical history ( $P=0.002$ ), concurrent liver surgery ( $P=0.019$ ) and positive results from both

serological tests ( $P=0.030$ ). Factors affecting postoperative recurrence are detailed in Table II.

## Discussion

Hydatid disease is common in endemic regions, where it predominantly affects the liver and lungs; extrahepatic and extrapulmonary involvement is relatively rare and can present specific diagnostic challenges. Reported rates of extrahepatic hydatid disease in general vary between 6.9-20.3% (7-9); primary extrahepatic involvement without hepatic or pulmonary disease is rare, with an incidence rate ranging from 2.1 to 11.1% (7,10,11). Akcam *et al* (8) reported an extrahepatic involvement rate of 20.3% in the authors' cohort and noted extra-abdominal sites, such as the central nervous system, bones, thyroid, breasts, muscles and the heart; while the most common intra-abdominal sites included the peritoneal cavity, kidneys and spleen. Lianos *et al* (12) observed pulmonary involvement with concurrent extrahepatic disease in 7.8% of patients, with peritoneal and splenic involvement most frequently reported. Another study reported a 16.3% rate of extrahepatic involvement, predominantly in the peritoneum and spleen (9). Tsaroucha *et al* (11) found extrahepatic involvement in 17.8% of patients, including concurrent hepatic involvement in 6.7% and isolated extrahepatic involvement in 11.1%, with peritoneal and splenic sites most commonly affected. In the present study, the rate

of extrahepatic intraperitoneal involvement was 14.3%, with the kidneys and spleen being the most frequently identified sites. Balik *et al* (7) reported that 70.4% of the patients were diagnosed with concurrent hepatic hydatid disease, while 29.6% were found to have isolated extrahepatic disease. By contrast, in the present study, concurrent hepatic involvement was found in 24.3% of the patients, with isolated extrahepatic disease observed in 75.6%. Nonetheless, while malignant mechanisms, such as hepatic cancer, have been well-investigated, the mechanisms governing development of extrahepatic hydatid cysts remain to be fully clarified (13).

Similar to hepatic hydatid disease, some patients with extrahepatic involvement also remain asymptomatic, whereas others develop symptoms related to complications or compression of adjacent structures by the cystic mass. In the present study, 22 patients (53.6%) presented with abdominal pain and 11 patients (22%) reported flank pain, whereas 6 patients (12%) were asymptomatic. In agreement with this, Gündeş *et al* (14) also reported abdominal and flank pain as the predominantly reported symptoms in their cohort, whereas Makni *et al* (15) identified abdominal pain as the most common presenting complaint (80%), while 18% of the patients were asymptomatic.

The diagnosis of hydatid disease primarily relies on imaging studies, with serological testing used to support radiological findings. However, diagnoses involving extrahepatic hydatid cysts are more challenging because of their relatively lower occurrence rate and lack of typical radiological features. US is the preferred imaging method for the evaluation and diagnosis of hepatic hydatid disease. A staging system consisting of five grades has been established based on the ultrasonographic characteristics of the cysts and the US findings (6,16). In addition, it is also useful for diagnosing extrahepatic hydatid disease in US-accessible regions, enabling visualisation of daughter cysts and the germinal layer and providing diagnostic support (6). In the present study, out of 14 patients evaluated by US, hydatid disease was diagnosed in 4 cases with splenic involvement and 2 with renal involvement; however, due to the narrowness of the pelvic area and the bony structures, US failed to diagnose cysts located in the pelvic region.

CT can effectively detect calcified cyst walls and provides valuable information regarding cyst size and its relationship with adjacent organs (6). In the present study, 31 patients underwent CT evaluation, which was used to facilitate diagnosis of cases with intraperitoneal, retroperitoneal and renal involvement. Inan *et al* (17) reported that in addition to conventional MRI imaging, diffusion-weighted MRI may be helpful for the diagnosis of extrahepatic hydatid cysts. DWI images provide rapid and effective imaging, particularly in differentiating between benign and malignant lesions, and between simple cysts and hydatid cysts. In a 2021 study, Guo *et al* (18) found that CT and MRI demonstrated similar efficacy for the diagnosis of extrahepatic hydatid cysts. In the present study, conventional MRI images were evaluated, and, to the best of our knowledge, the number of patients previously diagnosed by this MRI-based method is limited (17). Moreover, 4 of the present patients were evaluated using MRI, which was used to effectively visualise internal cysts and enabled diagnosis of 2 patients with splenic and retroperitoneal cysts. Beside this, although a definitive preoperative radiological diagnosis could not be made in 12 of the patients included in the present study,

numerous had suspected hydatid cysts on imaging (mostly US). However, these patients were diagnosed by perioperative imaging or histopathological diagnosis. Furthermore, because the Interventional Radiology Unit at Erciyes University School of Medicine Hospital is the leading hydatid cyst diagnosis and treatment centre in the Middle Anatolian region, US was used for most of the diagnoses, eliminating the need to use World Health Organization Informal Working Group on Echinococcosis classification of cystic echinococcosis (CE), such as CE1, CE3c and CE4 (16). In addition, since the present study was retrospective, it was not possible to apply all three imaging methods (US, MRI or CT) to all patients; diagnosis was made using one or more of the appropriate imaging methods.

Although serological tests using IHA and WB are commonly used for the diagnosis of hydatid disease; their diagnostic accuracy is reduced in patients with extrahepatic involvement vs. those with hepatic disease (19). In the present study, of the 29 patients evaluated by serological testing, 10 patients (34.4%) were found to be positive by IHA and 15 patients (51.7%) by WB. In the literature, serological positivity rates range from 50-77% (8,13,14,20). Among these tests, WB generally demonstrates a higher positivity rate than IHA, whereas overall serological positivity is lower in extrahepatic vs. hepatic hydatid disease (19). Similarly, in the present study, 42.8% of patients with extrahepatic hydatid cysts tested positive in serological assays, compared with a 75% positivity rate for those with hepatic involvement.

Albendazole-based therapy has been shown to have limited efficacy for the treatment of hydatid disease and is generally only recommended for smaller (<5 cm) asymptomatic cysts. Percutaneous treatments such as PAIR have been proposed as first-line therapy for eligible patients with hepatic hydatid disease (21). However, surgery remains the preferred approach for more complicated cases, such as those designated CE4 or CE5, as well as for patients deemed to be unsuitable for PAIR. Experience with percutaneous treatment of extrahepatic hydatid cysts is limited, and thus surgery is considered the primary treatment modality for such cases (22). When pre-operative diagnosis is uncertain, exploratory surgery may become necessary and can be used to both eradicate the disease and prevent recurrence, while minimising morbidity and mortality.

For surgical treatment of hepatic hydatid cysts, complete cyst resection is associated with a low recurrence rate and total cyst excision is preferred (1); however, when this is not feasible, partial excision should still be considered. Organ-preserving resections are recommended for lesions involving specific organs, such as the kidneys, spleen or ovaries, although organ removal may be required in cases of extensive damage. Due to technical challenges and the high complication risks associated with partial splenectomy, total splenectomy is recommended for splenic involvement (23); in the present cohort, 9 patients underwent splenectomy. For renal hydatid cysts, kidney-preserving total or partial cyst excision is preferred. Out of the 11 patients with kidney involvement in the present cohort, 2 patients underwent partial nephrectomy whereas 9 underwent cyst excision.

Wani *et al* (24) reported a 0% recurrence rate during follow-up in their study of 12 patients with extrahepatic

intra-abdominal hydatid cysts, and Gündeş *et al* (14) observed no recurrence in 22 patients diagnosed with primary intra-abdominal hydatid cysts. In this study, the mean follow-up period of the patients was 40 months (range, 6-68 months). In addition, in a 2025 study involving 31 patients with extrahepatic hydatid cysts, a 0% recurrence rate was reported after a 36-month follow-up period in patients treated percutaneously (25). However, contrary to these results, recurrence rates in other studies have reached as high as 22% (11,26,27). In the present study, a recurrence rate of 9.7% was found during the follow-up period, which is consistent with recurrence rates reported in the literature.

To the best of our knowledge, in the literature a limited number of studies have been published that investigated factors influencing recurrence rates. A study by Gollackner *et al* (28) suggested that radical surgery reduces the risk of recurrence; whereas another study, published in 2015, identified a laparoscopic approach as the only factor influencing recurrence and reported a higher recurrence rate in patients that underwent laparoscopic surgery (29). The present study represents a detailed investigation on this topic, and identified the following factors associated with increased risk of recurrence: Hepatic involvement, cysts located in multiple sites, multiple cysts, a history of previous surgery, concurrent liver surgery and positive results by both serologic tests. Due to the limited number of patients and recurrence cases reported in the literature for extrahepatic hydatid cysts, factors associated with recurrence may have not been thoroughly investigated. In the present study, extensive disease was associated both with recurrence and treatment challenges, as evidenced by the development of recurrent disease despite post-operative medical therapy.

Total cyst excision should be performed whenever possible in cases with intraperitoneal and retroperitoneal lesions; however, if total excision is not feasible, evacuation of the cyst contents followed by partial resection should be carried out, with careful attention to avoid contamination of the surrounding tissues. Hamamci *et al* (9) reported performing a partial cystectomy on 4 patients with retroperitoneal hydatid cysts; one of these four patients reported a recurrence in the same area 1 year after surgery. In the present study, cyst excision was performed on 11 patients with peritoneal cysts, and of these, 6 patients had retroperitoneal cysts. A total of 4 out of these 11 patients underwent total cyst excision whereas 2 patients underwent partial cyst excision.

The present study has limitations similar to those frequently encountered in other studies addressing this topic; these include retrospective design, a single-centre study and a small sample size. In addition, due to the retrospective nature of the present study, the inability to access CT, MRI and US images of some patients is another limitation. Moreover, diagnosis of extrahepatic hydatid cysts is complicated by their lack of a characteristic radiological appearance; therefore, hydatid disease should be considered in patients presenting with cystic lesions in atypical locations, particularly in endemic regions. Due to the limited experience with medical and percutaneous treatments for these cases, surgery remains the primary and most effective treatment modality.

In conclusion, the demographic and clinical data collected from patients included in this study and followed throughout the study period are consistent with those reported in the

literature. Furthermore, the present results contribute to the literature, as the present study is one of the rare studies investigating and analyzing factors influencing recurrence. Nevertheless, there is a need for larger-scale, multicenter clinical trials that analyze factors affecting disease recurrence.

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### Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

### Authors' contributions

FD and MA were responsible for the conceptualization of the present study and TT, UT and GS were responsible for the study design. DGI, FD and MA contributed to the analysis using statistical software. FD, EMS and HYA checked the accuracy of the data and analyses; FD, SC and MK conducted the formal analysis; FD and MA were the primary investigators; FD and DGI provided the resources; FD and TT wrote the original draft of the manuscript and; FD, MA and TT reviewed and edited the manuscript; and FD and UT supervised the study. All authors have read and agreed to the final version of the manuscript. TT and FD confirm the authenticity of all the raw data.

### Ethics approval and consent to participate

The present research was conducted ethically following The Code of Ethics of the World Medical Association (Declaration of Helsinki). The responsible authorities approved the study (Local Ethics Committee of Erciyes University Faculty of Medicine; approval no. 279/June 2020). Although informed consent could not be obtained from patients for the study due to its retrospective nature, pre-operative informed consent was obtained for all interventional and surgical procedures performed.

### Patient consent for publication

Not applicable.

### Competing interests

The authors declared that they have no competing interests.

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