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Treatment Method of Hydatid Disease in Children, which is A Problem in Developing Countries

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ABSTRACT

Objective: Hydatid disease (HD) is a parasitic disease caused by ingesting *Echinococcus granulosus* parasite eggs. HD is a common disease in developing countries. We aimed to evaluate the effectiveness and outcomes of medical, percutaneous, and surgical treatments in pediatric HD cases.

Methods: A retrospective review was conducted on pediatric patients diagnosed with HD between January 2013 and January 2023. Data on patients were analyzed. The files of 93 patients who had treatment of 112 hydatid cysts were reviewed.

Results: In the study, hydatid cysts were most frequently seen in the liver (65,6%), followed by multiple organ involvement (28.9%) and isolated lung involvement (13%). All patients received medical treatment. The mean hospital stay was 6.86 days, Percutaneous treatment by puncture-aspiration-injection-re-aspiration (PAIR) of liver cysts was associated with a shorter stay than surgical cases. The recurrence rates were similar in the PAIR- and surgical-treated groups, and the procedure time was shorter in the PAIR group. However, the complication rate was higher in the PAIR group.

Conclusion: *E. granulosus* can cause hydatid cysts in more than one organ at the same time, and the most common sites are the liver, lung and spleen. To achieve the highest success rate, with fewest complications, treatment selection should be made according to the localization of the cyst, its size, and the patient's condition.

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Introduction

Hydatid disease (HD) is a parasitic disease caused by ingesting *Echinococcus granulosus* parasite eggs. It has been reported to be endemic in East Africa, South America, Australia, New Zealand, the Middle East, Central Asia, the Mediterranean region, China, Tunisia and Türkiye. The incidence in Türkiye is reported as 3.4/100,000.[1,2]

Two main *Echinococcus* species infect humans, *E. granulosus* and *E. multilocularis*. These species cause cystic echinococcosis and alveolar echinococcosis, respectively. The adult form of the *E. granulosus* parasite is found in the intestines of domestic dogs and other wild carnivores. Its larvae are found in herbivores such as cattle, sheep goats, and various human organs (intermediate hosts). Eggs taken orally pass through the mucosa of the upper intestinal tract into the portal venous system. They then develop into larval forms in the terminal organ where the eggs are retained.[3] The most common site is the liver (35-45%), followed by the lungs (25-30%) and, to a lesser extent, the spleen, kidney, omentum, peritoneum, urachus, genitourinary system, bone, muscles, heart, eye, and brain are also involved.[1,4-6] There are three main methods in the treatment of HD: medical treatment, percutaneous treatment, and surgery (laparoscopic or open surgery). Percutaneous treatment is performed using the puncture-aspiration-injection-re-aspiration (PAIR) technique. This is the preferred treatment method because it is minimally invasive. Open surgery or laparoscopy is performed in surgery. Albendazole is used in medical treatment. Medical treatment is applied alone to some patients or added to percutaneous and surgical treatment.[7-9] With this study, we aimed to evaluate the effectiveness and outcomes of medical, percutaneous, and surgical treatments in pediatric HD cases.

Materials and Methods

The files of patients diagnosed with HD and treated between January 2013 and January 2023 were retrospectively reviewed. Ethical approval was obtained from the local ethics committee of our institution (No: 2023/441 and date: September 26, 2023). Inclusion criteria were children under 18 years of age who underwent percutaneous treatment, surgical treatment, and concurrent medical treatment for HD. Patients over 18 years of age at the time of diagnosis were excluded from the study. Gender, age, presenting complaint, location, number of cysts, size of cysts, treatments used, length of hospital stay, follow-up period and postoperative complications of the patients were examined.

Liver hydatid cysts were classified according to the World Health Organization Informal Working Group on Echinococcosis (WHO-IWGE) classification according to their ultrasonographic images. HD diagnosis was made by radiological examination. In patients with cysts seen on chest X-ray or abdominal ultrasonography, brain thorax abdomen scans were performed with computed tomography. PAIR treatment was generally preferred for liver cysts of types CE1 and CE3A, and surgical treatment was preferred for liver cysts of types CE2 and CE3B.

In patients with both liver and lung cysts, lung cysts were treated first and then surgery was performed. Hypertonic saline 3% and baticon solution were used as scolicidal agents in all patients. During the operation, the surrounding tissues were protected with gauze moistened with a scolicidal agent.

In patients with pulmonary HD, cyst contents were aspirated via posterolateral thoracotomy and treated with a scolicidal agent. A cystostomy was performed and the germinative membrane was removed. The dilated and airway patency was sutured and the lung tissue was capitonized. Tube thoracostomy was performed in all patients during thoracotomy. After the drainage from the chest tube stopped, the chest radiograph was evaluated and a decision was made whether to remove the tube.

Liver HD was treated by PAIR or open surgery. During open surgery, the cyst content was aspirated and treated with a scolicidal agent, and the germinative membrane was removed. The relationship between the cyst cavity and the biliary system was analyzed. If the bile duct was seen to be open, the open channels were sutured and the cavity was closed by capitonnage. In suitable patients, the cavity was capitonnaged or omentopexy was applied by placing a part of the omentum. Capitonnage was not performed on patients whose cyst content was infected, but a drainage catheter was placed

The PAIR procedure began with positioning the patient either in a supine or lateral decubitus position on a fluoroscopy table with C-arm equipment. Sterility was achieved by shaving the abdominal wall over the liver area, then applying povidone-iodine and draping the site. Local anesthesia

(prilocaine hydrochloride) was administered before the cyst puncture. An 8F trocar-type multi-purpose drainage catheter (Flexima™, Boston Scientific) was inserted into the cyst using ultrasound guidance. A stopcock was fitted to the catheter to prevent air entering during aspiration and injection. The contents of the cyst were fully aspirated, and the cyst was then filled with a solution composed of nonionic contrast medium and saline (equal parts contrast medium and 0.09% saline), matching the volume of the aspirate. Cystography was performed in both anteroposterior and lateral views to detect any connection between the cyst and the biliary tract. If a connection was observed, alcohol was not used due to the risk of secondary sclerosing cholangitis. If no connection was found, the cyst was aspirated again, and absolute alcohol (98% ethyl alcohol) was injected, with a volume equivalent to two-thirds of the aspirated fluid. After 10 minutes, the alcohol was aspirated, and the catheter was secured to the skin. Patients underwent a follow-up evaluation 24 hours later. If their vital signs and lab results were stable, they were discharged from the hospital following the catheter removal.

Splenic cysts were managed by cystotomy, performed carefully to avoid damaging the retroperitoneal and retrovesical cysts, surrounding cavity walls, and adjacent main vessels; capitonnage was not performed. An indirect hemagglutination test was performed on suspicious patients.

Albendazole treatment (10-15 mg/kg/day) was started three weeks before the operation and continued for 3-6-9-12 months in four-week periods, each with three weeks of drug treatment and then one week off the drug in the postoperative period. Patients were followed up monthly. Recurrence was diagnosed radiologically.

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software version 21 (SPSS Inc., Chicago, IL, USA). Numerical variables such as age, length of hospital stay, number of cysts, and cyst size were investigated to determine whether they were normally distributed using visual methods (histograms and probability plots) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests). Student t-test was used in descriptive statistics of these variables. $\chi 2$ test was used to compare categorical variables. $P<0.05$ was considered statistically significant for all variables.

Results

A total of 93 patients were included in the study. Fifty (53.7%) were female; fourtythree (46.3%) were male. The mean age was 11.02 years (range 3-17 years, standard deviation 3.6 years). A total of 112 hydatid cysts were treated in 93 patients. The most common organs affected by hydatid cysts were the liver alone (65.6%), more than one organ (28.9%) and the lung alone (13%), as seen in **Table 1**.

Table 1. Anatomic locations of hydatid cysts in 93 paediatric hydatid disease cases

Anatomic Location	No. (%) of cases
Liver	61 (65.6)
Lung	12 (13.0)
Spleen	2 (2.1)
Liver+ lung	13 (13.9)
Liver+ lung+ spleen	2 (2.1)
Lung+ spleen	1 (1.1)
Spleen+ posterior of bladder	1 (1.1)
Renal	1 (1.1)

The most common presentations in patients with liver or pulmonary hydatid cysts were abdominal pain and cough, respectively. Three patients with liver hydatid cysts presented with cyst rupture and widespready peritonitis, requiring emergency surgery (**Figure 1A**). Three patients with lung hydatd cysts underwent surgery after tube thoracostomy because they presented with cyst rupture and pneumothorax (**Table 2**).

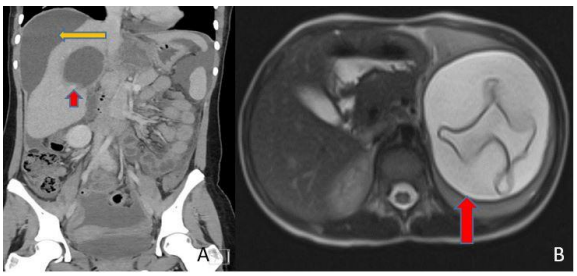

Figure 1A. A tomography image of a ruptured liver hydatid cyst. The red arrow shows the ruptured cyst. The yellow arrow shows the free fluid leaking around the liver as a result of the rupture of the cyst.

Figure 1B. A tomography image of a splenic hydatid cyst with vesicles inside (shown with the red arrow).

The liver was the most common anatomical site for cysts in all age groups. In 61 patients the liver was the only site of cysts, but a further 16 patients with liver cysts also had cysts in other organs. Four patients had more than one liver cyst. The average

Table 2. The clinical presentations of 93 patients with hydatid disease according to the anatomic locations of the hydatid cysts

Anatomic Location of Cysts	No. Of Cases with A Clinical Presentation of:						
	Symptoms caused by cyst rupture in liver	Symptoms caused by cyst rupture in lung	Chest pain	Cough	Abdominal pain	Incidental finding	Anaphylaxis
Liver	3	0	0	0	45	5	0
Lung	0	3	8	5	0	1	0
Spleen	0	0	0	0	2	0	0
Liver+ lung	0	0	3	6	3	3	0
Liver +lung +spleen	0	0	0	3	0	0	0
Lung+ spleen	0	0	0	2	0	0	0
Spleen+ posterior of bladder	0	0	0	0	0	0	0
Renal	0	0	0	0	1	0	0
Total	3	3	11	16	51	9	0

size of the liver cysts was 78.28 mm. PAIR treatment was applied to 38 patients with liver cysts and surgical treatment was applied to the remaining 39.

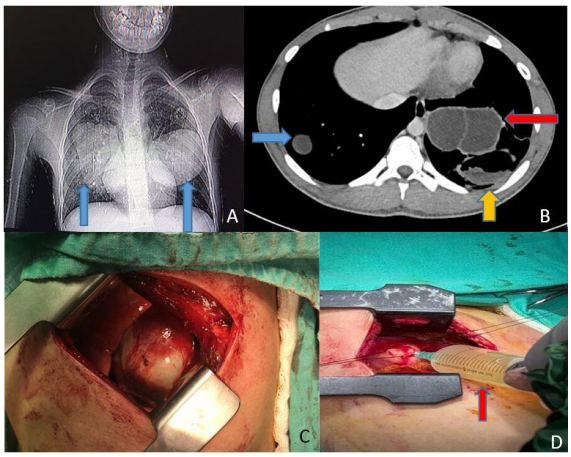

Figure 2A. A direct radiography of bilateral lung hydatid cysts. Blue arrows show the right and left lung cysts.

Figure 2B. A tomography image of bilateral lung hydatid cysts. The right lung cyst is shown with the blue arrow. The red arrow shows a lobulated cyst in the parenchyma of the left lung. The yellow arrow shows a ruptured hydatid cyst with air-fluid leveling because it is filled with air.

Figure 2C. Image of a hydatid cyst in posterolateral thoracotomy performed during open surgery for treatment of pulmonary hydatid cyst

Figure 2D. Cyst fluid drained during open surgery: rock water image is shown with red arrow

The average size of the 28 pulmonary cysts was 68.92 mm; 18 cysts were located in the right hemithorax. Posterolateral thoracotomy was performed for 28 pulmonary cysts. Bronchial orifices were closed with sutures in all patients (**Figure 2**).

Of the six patients with splenic cysts, two each underwent partial splenectomy, transabdominal total splenectomy and PAIR (**Figure 1B**).

The one patient with a renal cyst underwent opensurgery because the cyst diameter was 150.8 mm and it impacted on the surrounding anatomy. More than one daughter vesicle was seen in a single cyst (**Figure 3**).

The mean hospital stay for all patients was 6.86 days. The hospital stay for liver HD was 3.82 days in patients treated with PAIR and 7.92 days in patients treated surgically. The hospital stay for pulmonary HD was 6.81 days. The mean follow-up period for all patients after treatment was 21.5 months. The most common postoperative complications were cystobiliary fistula in liver HD patients and atelectasis in pulmonary HD patients. Endoscopic retrograde cholangiopancreatography (ERCP) was performed in one patient with a cystobiliary fistula. Only sphincterotomy was performed during ERCP and there were no complications.

While the cyst diameter in patients without cystobiliary fistula was 58.69 mm, the mean cyst size in patients with cystobiliary fistula was 108.28 mm. Thus, it is seen that the cyst size in patients with cystobiliary fistula wass larger than the cyst size in patients without cystobiliary fistula (P=0.04).

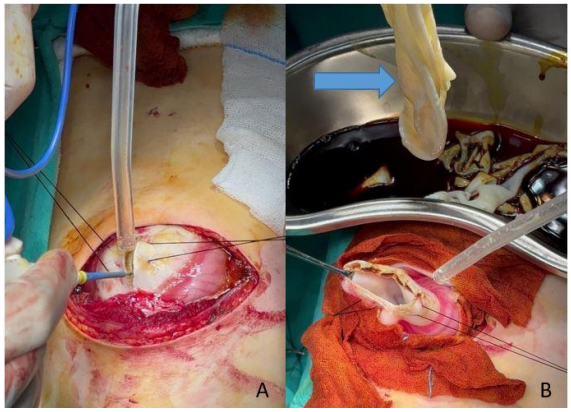

Figure 3A. Image of a kidney hydatid cyst during surgery

Figure 3B. Vesicle removed from a kidney hydatid cyst (shown with the blue arrow).

7 of the 8 patients with recurrence were in the liver and 1 in the lung. All recurrences were detected in patients who received postoperative albendazole treatment for only 3 months. Two of the patients with liver HD recurrence were treated with PAIR; all other cases were treated surgically. The mean cyst diameter in patients with liver HD recurrence was 58.50 (40-86; 28.34) mm, and the cyst diameter in the patient with lung HD recurrence was 51 mm. The recurrence rate was higher in patients with a treatment period of 3 months or less (P<0.05). Pure alcohol was used as a scolocidal agent during PAIR treatment in 3 of the patients with recurrence; this did not increase the recurrence rate (P>0.05).

Table 3. Comparions of open surgery and PAIR treatment of hydatid disease in terms of complications, duration of surgery, and recurrence

	Surgery group (n=30)	PAIR Group (n=36)	*P* - value
Size of the largest cysts (mm)	6.63 ±(2.22) (SD)	6.56 ±(2.65) (SD)	0.899
Recurrence	3 (10%)	4 (11.1%)	>0.999
Complications	1(2.6%)	9 (23.1%)	0.008*
Surgery Time (min.)	47.77± (6.59)(SD)	29.89± (5.31) (SD)	<0.001*

* Statistically significant

We did not find a statistically significant difference in the mean size of cysts between patients undergoing PAIR and open surgery (6.63 ± [2.22] [SD] mm vs. 6.56 ± [2.65] [SD] mm, P=0.899). The recurrence rates of the two groups were comparable (10% vs. 11.1%, P>0.999). The mean surgery time in the PAIR group was significantly shorter than the surgery group (29.89± [5.31] [SD] min. vs. 47.77 ± [6.59] [SD] min., P<0.001). However, the complication rate in the PAIR group was significantly higher than in the surgery group (23.1% vs. 2.6%, P=0.008), as seen in **Table 3**.

Discussion

This study retrospectively analyzed the medical records of pediatric patients diagnosed with HD and treated at our institution between January 2013 and January 2023. Our findings were compared with existing literature to understand better the outcomes of different treatment modalities for pediatric HD and their complications

Treatment modalities and outcomes

PAIR technique

The PAIR (Puncture, Aspiration, Injection, Re-aspiration) technique was employed for CE1 and CE3A type liver cysts. PAIR must be the first choice for treating uncomplicated cysts, with minimal complications, and good clinical outcomes.[10-12] In particular, the use of hypertonic saline and ethanol as scolicidal agents is well-supported in the literature for their efficacy in inactivating protoscoleces[13,14] In our study, although the recurrence rate was higher in those using alcohol as a scolicidal agent, the difference was not statistically significant. In addition, PAIR was not performed for cystss larger than 6 cm due to the high complication rate. However, the complication rate was higher than in patients who underwent surgical treatment.

Surgical intervention

Surgical intervention was indicated for CE2 and CE3B type liver cysts and cases where PAIR was unsuitable. The literature supports the use of surgical approaches for complex cysts, with procedures like cystectomy and pericystectomy being standard practice. In ruptured liver hydatid cysts, urgent surgery is performed. The patient has acute abdomen symptoms in his/her clinic and the cyst content spreading into the abdomen causes contamination. The risk of anaphylaxis is high.[15,16] The results of our study are consistent with these findings and show that surgical treatment is necessary for some types of cysts with a high complication rate, that is those that are larger than 7 cm or have ruptured.

Pulmonary HD

For pulmonary cysts, posterolateral thoracotomy is the surgical approach of choice. This method aligns with existing literature, which suggests

thoracotomy is effective for preventing cyst rupture and ensuring complete cyst removal[2,17-22] If dyspnea and massive hydrothorax accompany ruptured pulmonary cysts, urgent thoracotomy should be performed.[18] Our study confirmed the efficacy of thoracotomy combined with scolicidal treatment and meticulous surgical techniques to minimize postoperative complications and recurrence rates.

Combined liver and lung HD

Our protocol prioritized treating lung cysts first in patients with both liver and lung cysts. The literature supports this approach, emphasizing the need to address pulmonary involvement before liver surgery to prevent complications such as cyst rupture and dissemination during liver surgery.[1] In cases with cysts in the lungs and liver, we primarily intervened for lung cysts.

Splenic and retroperitoneal HD

For splenic and retroperitoneal cysts, complete excision without cyst drainage or capitonnage was performed according to the localization of the cyst. The literature supports drainage or surgical excision of splenic cysts to ensure drainage and complete cyst excision in retroperitoneal cysts to avoid damage to surrounding structures.[1,23] There may be serious complications during cyst excision due to splenic blood supply. Therefore, while we treated cysts within the parenchyma with splenectomy, we treated cysts with exophytic extension with drainage. A patient with renal HD was treated with open surgery. Considering the bleeding in the renal parenchyma, drainage was found to be risky. After cystotomy with open surgery, capitonnage was performed.

Multiorgan-disseminated HD

Hydatid cysts grow slowly and can affect multiple organs. Cysts in this setting require repeated surgical treatment and long-term medical treatment.[4] Disseminated HD was not seen in our study.

Medical therapy

Preoperative and postoperative albendazole therapy was administered in our study, following a regimen that aligns with existing guidelines and recommendations. Studies indicate that albendazole effectively reduces cyst size and recurrence rates when used in conjunction with surgical or PAIR treatments.[7,24,25] All our cases received medical treatment. It is understood that the recurrence rate is high in patients who received short medical treatment, and it is statistically significant. Therefore, we gave medical therapy for at least 6 months to hydatid cysts larger than 5 cm and cases with two organ involvement.

Complications and follow-up

Postoperative complications, including biliary fistula, infection, and recurrence, are well documented in the literature and emphasize the importance of careful surgical technique and comprehensive postoperative management.[1,15] The follow-up period in our study was crucial for early detection and management of recurrences, consistent with recommendations for long-term follow-up of HD patients. The duration of postoperative medical therapy also affected the complication rate of surgical techniques. Determining treatment options according to the patient, the cyst and the location of the cyst will be effective in reducing the complication rate.

In conclusion, our ten-year retrospective analysis of pediatric HD treatment highlights the effectiveness of treatment modalities including PAIR, surgical intervention, and medical therapy. The results are consistent with the existing literature and reinforce the importance of personalized treatment plans based on cyst classification, location, and patient-specific factors. Further prospective studies are needed to improve treatment protocols and outcomes for pediatric HD patients. Based on the literature results and our study, we can summarize the following; the most common infesting pathogen is *E. granulosus* which usually causes a single cyst. *E. alveolaris*, which is associated with multiple organ/widespread involvement, is very rare in childhood. *E. granulosus* can cause hydatid cysts in more than one organ at the same time and is most common in the liver, lung, and spleen. During diagnosis, a whole body scan should be performed using the necessary imaging tests.The most preferred medical treatment agent is albendazole. The duration of medical treatment after percutaneous or surgical treatment varies according to organ involvement, the diameter of the hydatid cyst, and the treatment method. Surgical and percutaneous treatment and medical treatment are used to provide a cure. Percutaneous treatment is not suitable for cyst hydatid cysts that are 6 cm or larger in diameter and are found in the liver, and the possibility of biliary fistula and recurrence is high.

Declarations

Author contributions

Conceptualization, methodology, software; validation, formal analysis, investigation, data curation writing; — original draft preparation, writing—review and editing; F. Ö. SIKI, M. SARIKAYA, M. GÜNDÜZ, T. SEKMENLİ, A. NAYMAN, N KILIÇLI, İ ÇİFTCİ visualization; supervision, project administration; F. Ö. SIKI and İ. ÇİFTCİ; All authors have read and agreed to the published version of the manuscript.

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Institutional review board statement

The study was conducted by the Declaration of Helsinki and was approved by the Selçuk University Institutional Review Board (No: 2023/441 and date: September 26, 2023)

All subjects agreed on written informed consent before their participation.

Data availability statement

The datasets analyzed during the current study are not publicly available due to privacy and ethical considerations. However, they are available from the corresponding author upon reasonable request.

Conflicts of interest

The authors declare no conflicts of interest.

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