Percutaneous Treatment of Liver Hydatid Cysts: Comparison of Direct Injection of Albendazole and Hypertonic Saline Solution

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OBJECTIVE. The purpose of this study was to compare the effect of intracystic injection of albendazole and hypertonic saline in patients with liver hydatid disease.

MATERIALS AND METHODS. Fifty-nine patients with a total of 109 hydatid cysts were treated percutaneously. In all cases, local anesthesia was applied. Twenty percent hypertonic saline was used in 31 patients (40 cysts, group 1) as the scolicidal agent, and albendazole solution was used in 28 patients (69 cysts, group 2). The PAIR (percutaneous puncture, aspiration, injection, reaspiration) method was applied in group 1. In group 2, we used a different procedure that could be called the PAI (percutaneous aspiration and injection) method. After this procedure, routine sonography and CT examinations were conducted. The results of both groups were compared.

RESULTS. Follow-up examinations showed that liver hydatids expanded approximately to their original size after a significant reduction during the first month. In the follow-up period, fluid contents totally disappeared; thickening and irregularities were also observed in the cyst walls and a solid, hyperechogenic, heterogeneous pseudotumor appearance representing a degenerated membrane was seen in all patients. Hypertonic saline solution inactivated the scolices from the beginning of the treatment. However, scolices were inactive in the cysts aspirated 1 month after the procedure in group 2. A significant correlation was noted between elapsed time after the treatment and the cyst size using Wilcoxon's signed rank test ($p = 0.000$). No difference was seen between two groups in the amount of cyst size reduction using the Mann-Whitney test ($p = 0.521$).

CONCLUSION. In addition to its oral use, albendazole may be injected intracystically as we did in our study. It sterilizes the cyst cavity and affects scolices as well.

Hydatidosis (hydatid cystic disease) is a parasitic disease caused by *Echinococcus granulosus* [1]. The adult form of the parasite is not seen in humans. Its larvae induce the disease in humans, cows, sheep, and other domestic animals [2]. Hydatid cysts are mostly localized in the liver (50–80%). The second most common site for hydatid cyst is the lungs (5–30%) [3, 4]. Cysts have also been detected in the spleen, kidney, heart, bones, the central nervous system, and other organs, but with less frequency [4].

Hydatid cysts are observed endemically in Mediterranean, Middle Eastern, and South American countries and in New Zealand and Turkey, where people are in close contact with sheep and dogs. Hydatidosis is an important health problem in these countries [5, 6].

The primary treatment technique of hydatid cysts is surgery, which is unfortunately an invasive method with high rates of morbidity and mortality, a long hospital stay, high cost, and trauma. Although surgical treatment is the primary method, medical and percutaneous approaches have been used in recent years [3]. Currently, albendazole and mebendazole are used in medical treatment [7].

In this study, we compared the efficacy of 10% albendazole with 20% hypertonic saline as scolicidal agents with the guidance of sonography in the percutaneous treatment of liver hydatid cysts. Oral albendazole is absorbed through the gastrointestinal system and only a small ratio is transported to the cyst fluid. Therefore, we directly injected the albendazole solution into the cyst cavities. By doing this, we provided a high concentration of the drug in the cyst cavities. To our knowledge, ours is the first report describing the direct percutaneous injection of albendazole into the hydatid cyst cavity.

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Materials and Methods

Patients

Fifty-nine patients with a total of 109 liver hydatid cysts were treated percutaneously at the radiology and general surgery departments during a period of 3 years. Patients' consent was obtained. The data obtained from these patients are presented in Table 1. Previously, we used hypertonic saline as the scolicidal agent in the percutaneous treatment of hydatid disease at our hospital. After seeing the results of albendazole injection in animal and in vitro studies, however, we started to use only albendazole in our patients. The use of hypertonic saline was given up after the introduction of albendazole. The effect of hypertonic saline is well known, and we did not need a control group to compare the effects of hypertonic saline. Thus, we compared the results of the albendazole group with the hypertonic saline group.

Sonography and CT were performed in all patients before treatment. Hydatid cysts are classified according to their sonographic appearance as described by Gharbi et al. [8]. Ninety-six cysts (33 in group 1, 63 cyst in group 2) were of a pure cystic type (type 1), whereas in two cysts (one in each group) the laminar membrane of the cyst separated from the pericyst (type 2), and 11 (6 cysts in group 1 and 5 cysts in group 2) had a multivesicular form containing a few daughter vesicles (type 3). Infected and ruptured cysts presenting solid patterns (type 4–5) and type 3 cysts with innumerable daughter cysts were not included in this study.

The serum blood indirect hemagglutination (IHA) test was performed for all patients before and after treatment and during the follow-up period. Ten milligrams a day per kilogram of body weight of albendazole (Andazol, Biofarma) was given to patients for 2 months after the procedure, starting 48 hr before the intervention.

In all cases, antiallergic prophylaxis (diphenhydramine, 10–50 mg/kg, and hydrocortisone sodium succinate, 100 mg IV) was applied IV for 15 min before the intervention. Only five patients who had anxiety received diazepam (0.5 mg/kg) before treatment. Before the procedure, liver function tests were performed and blood counts and coagulation functions were determined. Necessary medicines and equipment were kept ready in the procedure unit in case of anaphylaxis. Having ensured aseptic conditions in the intervention area, local anesthesia was applied with prilocaine (Citanest [AstraZeneca], 5 mg intradermal). We used 9- to 16-cm-long, 14- to 18-gauge polytetrafluoroethylene-sheathed needles (Secalon-T, Ohmeda).

As the scolicidal agent, 20% hypertonic saline was applied to 40 cysts in 31 patients (group 1), whereas albendazole solution was applied to 69 cysts in 28 patients (group 2). In group 1, cyst sizes ranged from 30 to 130 mm (14–1,150 cm^3; mean, 258 ± 208 [SD] cm^3); in group 2, cysts were 50–150 mm (65–1,210 cm^3; mean, 269 ± 246 cm^3).

Procedure

Hypertonic saline and albendazole solution were prepared as 20 mg of sodium chloride in 100 mL of water and as 10 μg/mL, respectively, and both solutions were sterilized by autoclave. Because it was difficult to dissolve the albendazole tablets in normal saline homogeneously, pure albendazole was obtained in powder form from Biofarma and dissolved in normal saline. Both solutions were prepared under laboratory conditions. The percutaneous puncture, aspiration, injection, reaspiration (PAIR) method was followed in group 1. This was performed in three steps as follows:

Step 1—A polytetrafluoroethylene-sheathed needle was used with sonographic guidance to aspire the cyst fluid (Fig. 1). Most of the cyst contents were aspirated. We did not aspirate completely, to keep the tip of the needle in the cavity.

Step 2—Twenty percent hypertonic saline in an amount equal to half of the aspired liquid was then injected into the cyst cavity, and a 20-min interval was allowed. A few irrigations (4–5 times back and forth) were made during this period to ensure complete contact of the scolicidal agent with all sides of the cyst.

Step 3—Almost all the contents of cyst were aspired and the cyst cavity was rinsed with normal saline.

To prevent a possible leak, the path through the liver parenchyma was selected for the puncture of the cyst.

In group 2, after the aspiration of almost all the cyst fluid, the solution was injected in the amount of one quarter of the cyst volume, and the procedure was terminated. However, in patients with a cyst volume greater than 700 mL, this rule was not applied, and 150 mL of albendazole solution was injected instead. Reaspiration was not performed in group 2. In group 2, we used the percutaneous aspiration and injection (PAI) procedure. All patients were kept under constant observation for 24 hr.

A month after the procedure, a 6-French pigtail catheter was inserted into 13 cysts (9 cysts in group 1, and 4 cysts in group 2) under sonographic guidance with a diameter greater than 100 mm to collapse the cyst cavity and evaluate the efficiency of scolicidal agent. Cysts were drained continuously for an average of 5–7 days until the fluid discharge from the catheter decreased to less than 5–10 mL/day and no fluid was apparent in the cavity as observed on sonographic follow-ups. Cystography (radiopaque imaging of the cyst cavity) was performed in each patient with a pigtail catheter to document the relation between the biliary system and the cyst cavity. Cystography did not show communication with the biliary system.

At the end of the third month, reaspiration was applied to 20 cysts (5 cysts in group 1, and 15 in group 2) to ensure the decrease in the size of the cyst cavities in a shorter time and to perform microbiologic and microscopic analysis of the cyst contents. These cysts are usually larger than 6 cm in diameter. The sonographic appearance of some cysts resembled an infected cavity.

In multivesicle cysts (type 3), daughter cysts were burst by the turbulent effects of scolicidal agent; however, in those with ineffective results, we punctured each daughter cyst in the same session.

TABLE 1: Baseline Characteristics of Patients

Characteristic	Group 1 Hypertonic Saline	Group 2 Albendazole	*p*
Age (yr)			
Mean	45	42	0.254
Range	15–73	30–65	
Sex (female/male)	27/4	22/6	0.157
No. of patients	31	28	
History of hydatid cyst surgery	4	6	
No. of cysts	40	69	
Cyst location			0.163
Right lobe of liver	30	57	
Left lobe of liver	10	12	
Cyst volume (cm^3)			
Maximum	1,150	1,210	0.130
Minimum	14	65	
Mean ± SD	258 ± 208	269 ± 246	

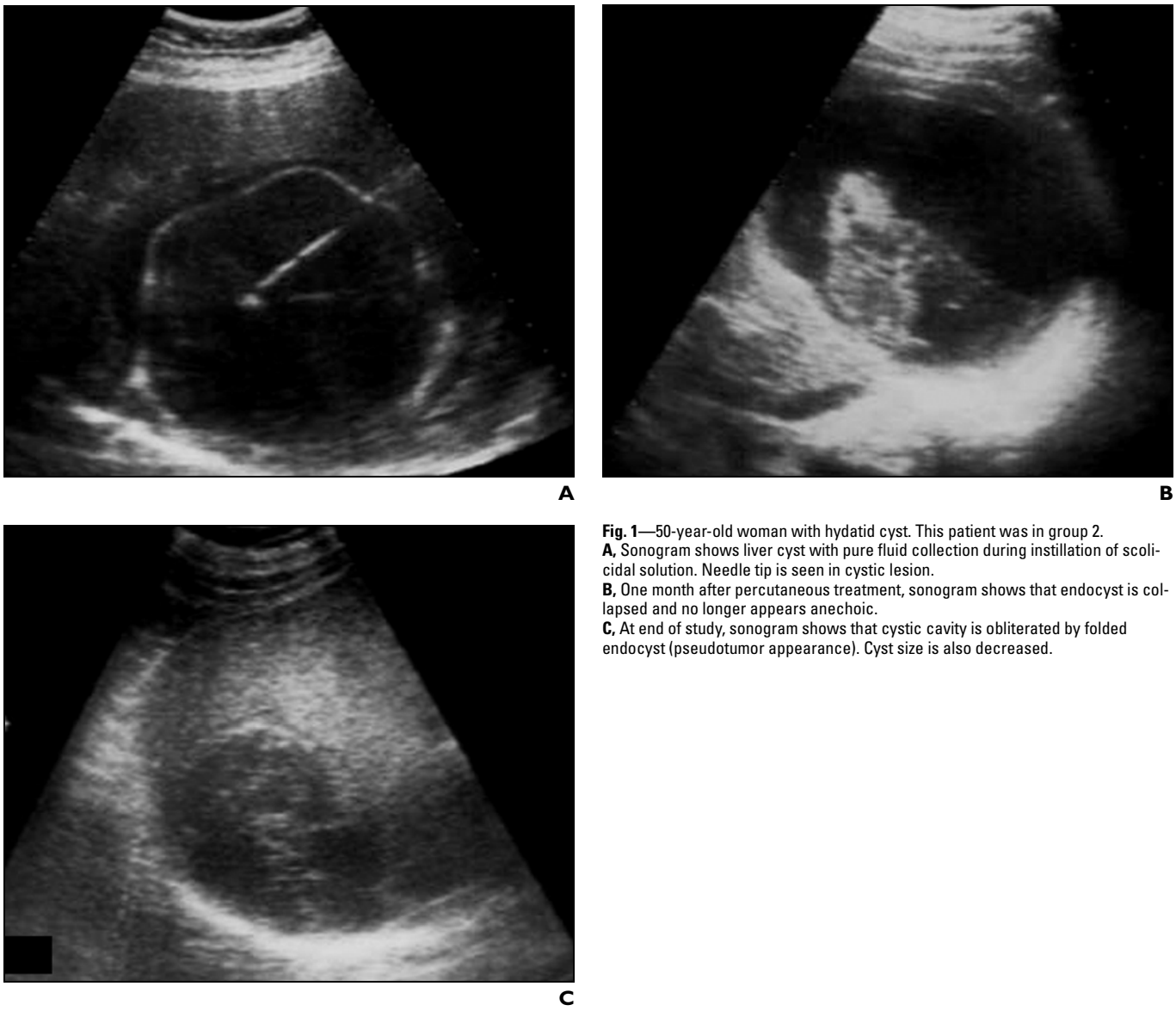


Fig. 1—50-year-old woman with hydatid cyst. This patient was in group 2.
A, Sonogram shows liver cyst with pure fluid collection during instillation of scolicidal solution. Needle tip is seen in cystic lesion.
B, One month after percutaneous treatment, sonogram shows that endocyst is collapsed and no longer appears anechoic.
C, At end of study, sonogram shows that cystic cavity is obliterated by folded endocyst (pseudotumor appearance). Cyst size is also decreased.

The following criteria were used to assess the demise of the parasitic cyst: reduction of the cyst dimensions, the absence of a living scolex in the aspiration contents, and irregularities in the cyst wall [3, 6]. Recurrence was defined as an increase in the cyst dimensions or fluid contents, appearance of daughter cysts, persistence and increase in the IHA titration, and observation of a living scolex in reaspirations.

Routine sonographic examinations were conducted the first week after the procedure. Sonography was repeated at 1 month, 3 months, and every 6 months thereafter. IHA titration was measured during the same periods for all patients. CT was repeated at the end of the first and second years in all patients. Liver functions were tested. The invasion of the cysts to other organs and recurrence were investigated with the help of lung radiography, sonography, and CT.

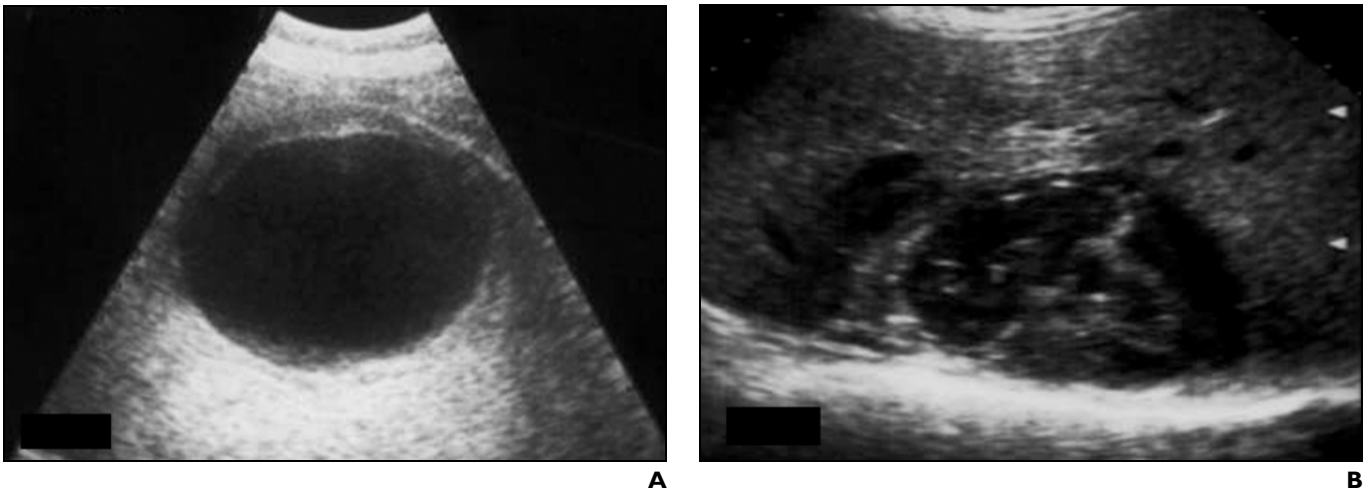
The presence of a living protoscolex was tested with the eosin Y stain in reaspirations after the intervention in group 1 and the follow-up in group 2 [9]. We compared the second year's results in two groups. The relation between the time lapse and the decrease in size of the cyst in both groups was tested using the Wilcoxon's signed rank test. The differences in the cyst size reduction between two groups were compared using the Mann-Whitney test.

Results

At the first entrance inside cysts, pressurized clear fluid gushed out except for type 2 cysts (2 cysts). Living scolices were present in the aspiration fluid of all cysts.

Follow-up sonography revealed that liver hydatid cysts expanded to approximately their initial sizes in both groups (Figs. 1 and 2), with a progressive reduction in the size observed after the first month. A significant correlation was seen between elapsed time after the treatment and cyst size using Wilcoxon's signed rank test ($p = 0.000$). No significant difference was seen between the two groups at the end of the second year in the amount of cyst size reduction according to the Mann-Whitney test ($p = 0.521$). In follow-up sonography during the first month, we observed endocysts breaking off from pericysts floating in the cyst cavity (Figs. 1 and 2).

Reaspiration revealed that the cyst cavity contents became denser, with a dark yellowish color. The macroscopic appearance of the aspirated material was similar to that of



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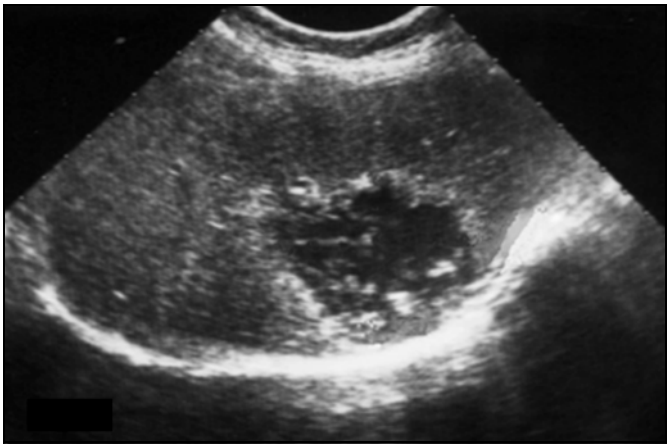

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Fig. 2—Serial sonograms of liver hydatid cyst in 45-year-old woman in group 1.
A, Before percutaneous treatment.
B, One year after percutaneous treatment, sonogram shows that cyst cavity is obliterated by folded endocyst.
C, Three years after percutaneous treatment, cyst cavity is almost obliterated and decreased. Fluid content has totally disappeared, and solid, heterogeneous pseudotumor appearance representing degenerated endocyst is seen. Thickening and irregularities are observed in cyst wall during follow-up period.

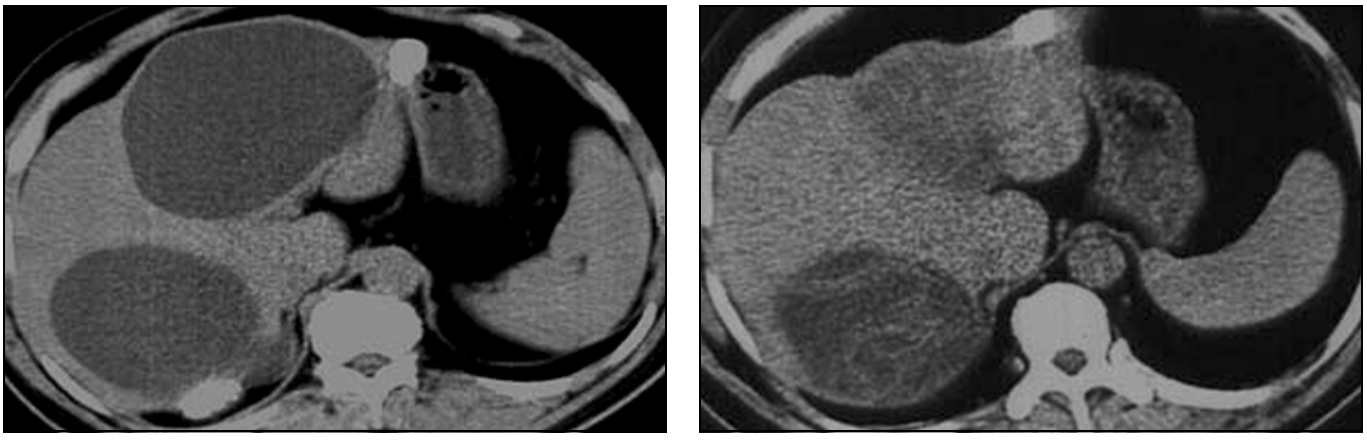

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Fig. 3—54-year-old woman in group 2 with hydatid cysts.
A, CT scan shows pure cystic liver hydatid cysts before treatment.
B, After treatment, CT scan shows increased cavity density.

purulent fluid, but with no apparent smell. However, no reproduction was observed in cultures and no living scolices were observed under the microscope. The contents of the cysts consisted of dead scolices, necrotic material, laminar membrane pieces, and leukocytes. A significant reduction was seen in the amount of cyst fluid 6 months after the treatment. In patients with a follow-up period of 2 years or more, fluid contents totally disappeared, and a solid, hyperechogenic, heterogeneous pseudotumor appearance representing a degenerated membrane was formed. Thickening and irregularities were also observed in the cyst walls in all patients during the follow-up period (Figs. 1 and 2). The pure cystic appearance disappeared on sonographic examinations, and CT examinations revealed an increased cavity density (Fig. 3). No abnormalities were observed in liver function tests performed after the procedure. The total follow-up periods for group 1 and group 2 were 36 and 24 months, respectively.

IHA tests were negative for the initial attempts in eight (25.8%) of 31 patients in group 1. Although the titration showed a decline in five patients (16.1%) during the follow-up period, it was found to be negative at the end of 18–24 months in 18 cases (58%) that had positive results initially. In group 2, IHA tests were negative in four patients (14.3%). Although 14 patients (50%) presented significant decreases in titration at the 6- to 10-month follow-ups, the test was negative in 10 patients (35.7%). A total of 11 patients in both groups presented a significant titration increase in the first month. However, this decreased progressively during the following months. An IgG titration value of less than 1/160 was accepted as a negative test result [3].

Anaphylaxis or death was not observed in this series. Postprocedure infection developed in two patients in group 1 at the end of the first year. A 73-year-old patient lost to follow up needed surgery. Percutaneous drainage and antibiotics treated the other patient, who developed an abscess after the procedure.

Minor complications such as fever and hypotension developed in six patients (three patients in group 1 and three in group 2) during the procedure. Fever was managed with symptomatic treatment. Two subjects developed urticaria approximately 6 hr after the procedure, and the symptoms were remedied within 48 hr with antihistaminic treatment.

During the follow-up at the end of 12th month, in one patient of group 1, a daughter cyst of 2 cm in diameter was identified in the treated cyst pouch (Fig. 4). Oral albendazole treatment was started again for this patient. The daughter cyst disappeared at the end of the second month of treatment. No recurrence was observed in the other patients. In group 2, 24-month follow-ups did not show any recurrence. We did not observe any secondary dissemination in our study. The recurrence rate was 1.7% (1/59 patients).

The volumes of cysts at the end of the 24th month were 1.5–128 cm^3 (mean, 58 ± 31 cm^3) in group 1 and 7–302 cm^3 (mean, 63 ± 40 cm^3) in group 2. Treatment outcomes are summarized in Table 2.

Discussion

To date, surgery has been the primary treatment for hydatid cyst disease [10]. Mortality rates of patients undergoing a surgical intervention are reported to be 0–6.3%, depending on the method applied. This rate may increase to 8.0% in complicated cases. Recurrence after surgery has been reported to be 2.2–22% [10–12]. The complication rate varies between 12.5% and 80%, depending on the applied surgical techniques and cyst types and location.

In recent years, medical and percutaneous drainage methods have been developed as alternatives to surgery for the treatment of hydatid cyst disease. Albendazole and me-

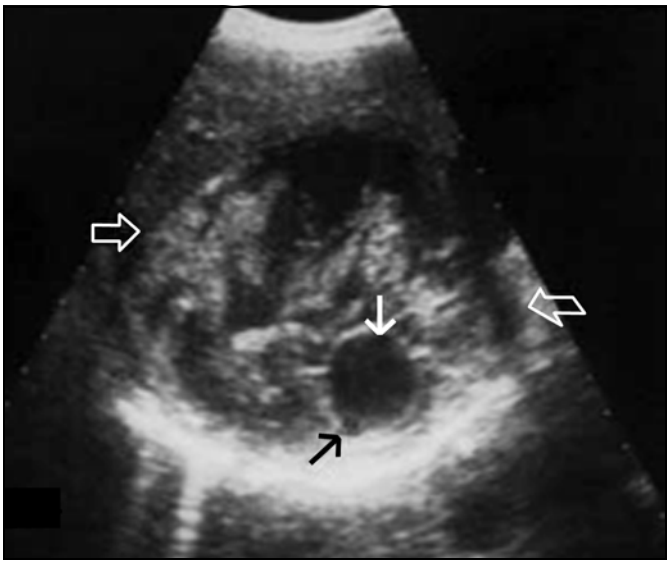

Fig. 4—28-year-old woman in group 1 with hydatid cysts. Daughter cyst (*solid arrows*) of approximately 2 cm in diameter is seen in treated cyst pouch (*open arrows*) at end of 12th month. Oral albendazole treatment was started and daughter cyst disappeared at end of second month of treatment (not shown).

TABLE 2: Outcomes After Treatment

Outcome	Group 1 (*n* = 31)	Group 2 (*n* = 28)
Follow-up (mo)	36	24
Hospital stay (hr)	24	24
Serum IgG antibody titer		
Increase in the 1st month	6	5
Negative initially	8	4
Negative during follow-up	18	10
Progressive decrease	5	14
Complications	1.9%	1.1%
Abscess	2	0
Fever	2	1
Hypotension	1	2
Recurrence	1	0
Range (mean ± SD) in cyst diameter after 24 months[a]	1.5–128 cm^3 (58 ± 31 cm^3)	7–302 cm^3 (63 ± 40 cm^3)
No. of patients undergoing catheterization	9	4

[a] $p = 0.521$, $z = -0.641$.

bendazole have been used extensively in the treatment of hydatid cyst since 1977 [7]. Medical treatment with benzimidazole compounds (i.e., albendazole and mebendazole) is controversial. These medications have not seemed to be highly curative [13, 14]. It has been proposed that these agents be used for prophylactic purposes to prevent the spread and recurrence [15, 16]. Wilson et al. [17] argued that albendazole is an effective and reliable method for the treatment of recurrent hydatid cysts and that its scolicidal effect can be seen mostly at the second and third months. It has been reported that benzimidazole compounds may be injected locally during percutaneous drainage [5], or albendazole may be used as a scolicidal agent inside the cyst [6, 18]; however, there is a lack of scientific publications to support this promising methodology [19].

Oral albendazole is one of the most commonly used agents in the treatment of hydatid disease [20]. It causes the reduction of adenosine triphosphatase, pyruvate kinase, and phosphoenol pyruvate carboxylase in the cyst wall and blocks glucose intake, which causes the death of scolices [7]. However, the efficacy of the systemic effect of this agent in treatment has been limited because of its oral administration [21, 22]. A small proportion of the drug is transported to the cyst fluid through the gastrointestinal system [7]. Moreover, side effects such as hepatotoxicity, jaundice, and granulocytopenia often occur [23]. Long-term albendazole therapy is teratogenic and embryotoxic in some animal species [24]. De Rosa and Teggi [25] reported mebendazole levels of 20.6–160.3 ng/mL in the plasma and 0.0–17.8 ng/mL in the cyst fluid 4 hr after a 30 mg/kg oral dose [25]. Therefore, in our study, we directly injected the albendazole solution into the cyst cavity under sonographic guidance. By this method, we obtained a higher dose than the plasma and cyst concentrations reported in the literature. To our knowledge, Erzurumlu at al. [7] injected mebendazole at a concentration of only 2.4 μg/mL into the cyst cavity. With a percutaneous injection, high scolicidal activity can be obtained and the systemic side effects can be avoided or reduced. We hope that pharmaceutical companies can produce commercially available sterile intracystic forms of these agents.

As compared with the PAIR method, the PAI technique requires less time; scolicidal agents in the PAIR method need approximately 10–20 min or more to destroy viable scolices. This condition prolongs the procedure and is uncomfortable for the patient. However, in the PAI procedure, as soon as the scolicidal agent injection is completed the needle may be removed, which perhaps lessens the risk of infection. The effects of scolicidal agents are limited to 10–20 min in the PAIR method, whereas the scolicidal effects continue for a longer time in the PAI procedure.

Khuroo et al. [3] reported that efficacy of simple cystectomy (cyst resection) and percutaneous treatment was similar in respect to the reduction in size of the cyst pouch. The advantage of percutaneous treatment was shorter hospitalization times and fewer complications.

Recently, it has been suggested that the intracavitary injection of benzimidazole compounds may be used in the treatment of hydatid cysts [7]. The in vitro scolicidal effect of albendazole has been investigated and was found to be effective [9]. In a study of sheep, we previously concluded that the intracavitary injection of albendazole is an effective treatment [26]. We compared the results of an albendazole group with a hypertonic saline group because the effect of hypertonic saline is well known [6, 18].

Clinical and experimental studies have shown that the intracystic injection of scolicidal agents may cause sclerosis and chemical cholangitis [27]. Moreover, one report stated that fatal cholangitis might occur when scolicidal solutions are introduced into the biliary system [28]. However, this was not observed in any case studied by Livraghi et al. [29]. If communication exists between the hydatid cyst and the biliary system, chemical cholangitis may cause sclerosing cholangitis. The highest frequency and greatest severity of inflammatory reaction or late stricture formation of bile ducts was seen with formalin and the lowest with silver nitrate solutions. Hypertonic saline and cetrimide solutions were also irritating to the bile ducts but have moderate severity [28]. In our study, after cystic aspiration under sonographic guidance, we injected the albendazole solution into the cyst cavity. Because of its well-known scolicidal activity, which has been confirmed through previous in vivo and in vitro studies, the scolicidal concentration of albendazole is well established. Ten micrograms per milliliter of albendazole solution is enough to completely kill scolices in vitro [7, 9, 30–34]. In contrast to other scolicidal agents, albendazole is not toxic to the liver and biliary structures at the applied concentration, decreasing the possibility of chemical sclerosing cholangitis, which is a well-known complication of chemical scolicidal agents [5]. Erzurumlu et al. [30] reported that the direct application of 10 μg/mL albendazole and 50 μg/mL mebendazole solutions to the biliary system of a rabbit intraoperatively did not cause any side effects (i.e., ductal epithelial proliferation, ductal dilatation or fibrosis) in the liver and biliary system.

The presence of daughter vesicles does not create a contraindication for percutaneous treatment. Investigations [3, 35] have shown that percutaneous treatment might be used in multivesicle cysts as well. A decrease in the size of cyst cavities in the liver is slow, requiring 6 months; however, this period could be shortened to 2 weeks for peritoneal cysts.

Recurrence has been reported after percutaneous treatment. However, the rate of recurrence was much lower than with surgery. In the series by Gargouri et al. [35], the ratio was reported to be 5 (4%) of 120 cysts during a follow-up period of 12–24 months. In our study, recurrence was observed in the form of a daughter vesicle within the cyst cavity in one patient. Secondary dissemination was not detected. In the early period after percutaneous treatment, complications such as urticaria, pain, fever, and anaphylaxis may be observed, whereas fistulas and suppurations can be encountered in the later period. However, these abscess formations may also be treated percutaneously [18]. Although minor complications, such as fever, urticaria, and pain, and rare major complications, such as infection, were observed in our study groups, no anaphylaxis was detected. Whatever the preferred treatment method, precautions should be taken to treat a possible anaphylactic reaction.

The aim in surgical treatment is to inactivate the parasite, evacuate the cyst cavity, remove the germinal membrane, and obliterate the residual cyst cavity. The residual cyst cavity does not collapse because of its rigid wall and various techniques applied [36]. Khuroo et al. [3], in their study comparing surgery and percutaneous treatment, reported no statistically significant difference with respect to the decrease of the cyst cavity. They applied simple cystectomy and drainage as a surgical technique. The aim of percutaneous treatment is the same except for removal of the germinal layer [11]. Saremi and McNamara [37], in their series, emptied membranes, as is done in the surgical method, in addition to the PAIR method. They did this by passing a thick dilator and a sharp tool over the needle. They reported that the method was more effective than the PAIR method, the cyst cavity shrank

in a shorter period, and the deposition of reactionary fluid was less. They presented the procedure as an alternative to surgery, emphasizing the similarities with surgery [37].

It has been reported that the aspirated cyst cavity filled with reactionary fluid 24 hr after the percutaneous intervention and returned to its original size [1, 19]. It was emphasized that during 3–8 months in the follow-up period the cyst contents turned yellow and that the aspirated material contained necrotic debris, leukocytes, and no living scolices [1, 6].

The efficacy of the procedure has been shown in the literature primarily with sonographic follow-ups and serologic tests. Several months after the treatment, the lesion size became smaller, its contours became irregular, fluid contents disappeared, and a solid sonographic appearance was finally obtained, with these findings being accepted as signs of healing [6, 38]. Some references even state that the cyst cavity disappears completely and is not differentiated from liver parenchyma [1, 18]. In our study, we did not observe a cyst cavity that disappeared totally. Sonography may be used in the interpretation of the response to the percutaneous treatment because sonographic findings correlate with pathologic findings [6].

The scolicidal effect of albendazole, which we used in our study, is very well known. Its efficacy in intracavitary injection has been applied in humans in vitro [9] and in vivo [7], and albendazole was also used by us previously in sheep and was regarded as an efficient scolicidal agent [26]. Albendazole solution kills all scolices in vitro within 48 hr [17]. Albendazole solution is reported to have fewer toxic effects on the biliary system than other agents [29]. Because it is not reaspirated from within the cyst cavity, all the scolices not affected by scolicidal agents in short contact periods may be influenced in a longer period.

In conclusion, we think that percutaneous treatment is a profitable and reliable method that can be used in symptomatic and asymptomatic hydatid disease patients. Although the literature describes open surgical drainage as the first choice of treatment, percutaneous treatment has become an alternative to the surgery because of successful results obtained in recent studies. In addition to oral use, albendazole may be injected intracystically as we did in our study. Albendazole has less toxicity on the biliary tract than other scolicidal agents, sterilizes the cyst cavity by affecting scolices in the cavity in the long term as well, and is as effective as hypertonic saline. Although the end effect is not different, the PAI method is easier and faster than the PAIR method. All those support the use of albendazole. To our knowledge, ours is the first study of the use of albendazole in humans. This study needs to be validated by others investigators.

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