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INTERVENTIONAL RADIOLOGY

ORIGINAL ARTICLE

Percutaneous sclerotherapy using a 4 F pigtail catheter and 40 milliliters of 5% ethanolamine oleate for symptomatic large hepatic cysts

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PURPOSE
We retrospectively evaluated the efficacy of percutaneous sclerotherapy using a 4 F catheter and 40 mL of 5% ethanolamine oleate (EO) for symptomatic large hepatic cysts.

METHODS
Twenty-four patients, including 10 with polycystic liver disease (PLD), were eligible. The mean long- and short-axis diameters of the cyst on computed tomography (CT) were 145.0 ± 35.5 mm (range, 72-216 mm) and 110.5 ± 21.4 mm (range, 63-150 mm), respectively. After aspiration of the fluid contents using a 4 F pigtail catheter, 40 mL of 5% EO was injected into the cyst for 30 min. Then, the catheter was withdrawn after EO removal. Symptomatic relief and complications were evaluated. The percentage reductions at the early (1-3 months later) and late (at the final follow-up) responses were evaluated using an estimated cyst volume calculated by using the following formula: volume = $\pi/6 \times$ long-axis diameter $\times$ (short-axis diameter)^2 on the maximum cross-section image on CT. Spearman's rank correlation coefficient (ρ) was used to evaluate the correlation between the pretreatment estimated cyst volume and percentage reduction of early and late responses and between the percentage reduction of the late response and length of the follow-up period after sclerotherapy.

RESULTS
The symptoms disappeared in 23 patients and improved in 1 patient with PLD. The mean aspirated fluid volume was 1337.8 ± 845.4 mL (range, 140-3200 mL). In 1 patient, EO injection was postponed until the second procedure was performed 40 days later due to intraperitoneal leakage of contrast material. In another patient, the EO volume was reduced to 20 mL because of a small cyst size. The mean early and late percentage reductions of the treated cyst were 52.3% ± 23.8% and 87.5% ± 20.4% (mean follow-up period: 48.0 ± 42.4 months), respectively. The symptom recurred in 2 patients with PLD and 1 underwent additional sclerotherapy 14 months later due to re-enlargement of the treated cyst. Another patient underwent transarterial embolization 5 years and 4 months later for other enlarged cysts, although the treated cyst markedly shrank. There were significant negative correlations between the pretreatment estimated cyst volume and percentage reduction of early ($P = .027$, $\rho = -0.46$) and late ($P = .007$, $\rho = -0.52$) responses. However, there were no significant correlations between the percentage reduction and length of the follow-up period ($P = .19$, $\rho = 0.31$). Transient pain developed in 1 patient and low-grade fever in 3.

CONCLUSION
Sclerotherapy using a 4 F catheter and 40 mL of 5% EO is safe and effective for symptomatic large hepatic cysts.

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Simple hepatic cysts are very common, and the majority of hepatic cysts causes no clinical symptoms. However, large hepatic cysts may cause progressive abdominal pain and/or distention.[1] Additionally, polycystic liver disease (PLD), which is autosomal dominant and has multiple cysts, arbitrarily >10, is associated with a risk of developing large cysts.[2] Among various management options for symptomatic hepatic cysts, percutaneous aspiration with sclerotherapy has become the first-line treatment because of its reduced invasiveness.[3]

To date, percutaneous sclerotherapy for symptomatic hepatic and renal cysts has been attempted using various kinds of substances.[3-12] In few reports, ethanolamine oleate (EO)

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was used successfully for sclerotherapy of hepatic and renal cysts because EO destroys cystic epithelial cells immediately, leading to cyst resolution.[9-11] However, the optimal volume of EO, as well as the techniques of sclerotherapy, has not been established yet.

We have performed percutaneous sclerotherapy using a 4 F catheter and 40 mL of 5% EO for symptomatic large hepatic cysts. The purpose of this manuscript was to evaluate the efficacy of our technique for symptomatic large hepatic cysts.

Methods

Our institutional review board approved this retrospective analysis (Approval number: 2020-016), and individual patient consent was waived. Written informed consent was obtained from each patient before sclerotherapy.

Patients

Between December 2005 and December 2019, 36 patients with a symptomatic large hepatic cyst underwent percutaneous sclerotherapy with EO in our hospital. Among them, the following patients were excluded from this study: (1) patients who underwent placement of a 7.2-10 F drainage catheter for several days due to infectious or hemorrhagic cysts (n = 9) and (2) patients who were lost to follow-up without evaluation of the early response to sclerotherapy by computed tomography (CT) performed 1-3 months after the procedure (n = 3). Therefore, 24 patients were eligible for this study. The patients' backgrounds are summarized in Table 1. There were 5 men and 19 women, and the mean age ± standard deviation was 67.0 ± 11.1 years (range, 50-82 years). One patient had a history of open surgery for large hepatic cysts. The numbers of hepatic cysts were 1 (n = 1), 2-5 (n = 7), 6-10 (n = 6), 11-50 (n = 9), and >200 (n = 1). The largest cysts were in the right hepatic lobe (n = 9), left hepatic lobe (n = 6), and between the bilateral hepatic lobes (n = 9). The mean long- and short-axis diameters were 145.0 ± 35.5 mm

Table 1. Summary of patient backgrounds

Patient No./age (y) /sex	Clinical symptoms	No. of cysts	Location of the largest cyst	Size the largest cyst (mm)	Bile duct dilatation
1/80/F	Pain	5	S4-S5-S8	147 × 108	Yes
2/51/F	Abdominal distension	43	S5	110 × 90	
3/69/F	Pain	35	S4	114 × 88	Yes
4/70/F	Pain	28	S5	80 × 71	
5/77/M	Abdominal distension Elevated liver enzymes	10	S4-S5	112 × 109	Yes
6/50/F	Abdominal distension Elevated liver enzymes	25	S4-S5	124 × 96	
7/68/M	Pain	2	S4	156 × 117	Yes
8/65/F	Abdominal distension	>200	S3	72 × 63	
9/74/F	Abdominal distension	42	Left lobe	149 × 105	
10/82/F	Pain	10	Right lobe	169 × 128	Yes
11/66/F	Pain	10	S4-S5	136 × 110	
12/68/F	Pain	5	S4	103 × 87	Yes
13/79/M	Abdominal distension	8	Right lobe	170 × 126	
14/63/F	Pain	12	Left lobe	153 × 103	Yes
15/60/F	Abdominal distension	27	Right lobe	15.3 × 11.7	
16/58/F*	Pain	34	S4-right lobe	183 × 124	Yes
17/81/M	Abdominal distension	1	S4-right lobe	211 × 150	Yes
18/62/F	Pain	21	Right lobe	166 × 122	
19/56/F	Elevated liver enzymes	2	S4-S5-S8	14 × 11.2	
20/66/F	Abdominal distension	8	Right lobe	17.5 × 13.1	
21/54/F	Pain	4	Right lobe	115 × 96	
22/80/F	Pain	8	Right lobe	198 x 144	
23/69/F	Abdominal distension	2	S4-S5	129 × 107	
24/55/F	Abdominal distension	5	S4-S5-S8	216 × 148	

S, segment according to Couinaud's classification.
The "left or right lobe" indicates that the cyst occupies almost the entire unilateral hepatic lobe.
*This patient had a history of surgical intervention.

Main points

- Percutaneous sclerotherapy using a 4 F catheter and 5% ethanolamine oleate (EO) might be a less invasive and effective treatment for a symptomatic large hepatic cyst.
- Our results showed that the total dose of 5% of EO might be reduced to 40 mL, that is a smaller volume compared with the previous reports (10% of the volume of aspirated fluid).
- Further study is required to establish the standardized measurements of symptom relief and optimal timing for evaluating the therapeutic effects of sclerotherapy with EO for hepatic cysts.

(range, 72-216 mm) and 110.5 ± 21.4 mm (range, 63-150 mm), respectively. Twelve (50%) patients presented with abdominal pain, 9 (37.5%) with abdominal distension, 2 (8.3%) with abdominal distension and slightly elevated serum levels of liver enzymes, and 1 (4.2%) with slightly elevated serum levels of liver enzymes. Nine (37.5%) patients had dilatation of the intrahepatic bile duct due to compression by the cyst but did not present with jaundice.

Technique of sclerotherapy

After local anesthesia, the cyst was punctured with a 19-gauge, 20 cm needle (Elaster Needle, Hakko) under sonographic guidance. To avoid leakage of EO, a puncture line traversing normal liver parenchyma was determined. After aspiration of 20 mL of fluid to send for cytologic and bacteriologic examination, a 0.035-inch guidewire (Amplatz Super Stiff, Boston Scientific) was inserted and a 4 F pigtail catheter (Jet Balance, Terumo) was placed in the cyst over the guidewire. Then, the cyst contents were aspirated as much as possible using the combination of a 50 mL syringe and plunger of a 10 mL syringe (Figure 1). First, the plunger of the 50 mL syringe was fully pulled and it was locked by inserting the plunger of the 10 mL syringe between the distal ends of the 50 mL plunger and syringe. Then, the cyst contents were aspirated by negative pressure. When 50 mL of fluid was aspirated, the plunger of the 10 mL syringe was removed and the contents were dumped into the drainage bottle. This procedure was repeated until all cyst contents were aspirated. Thereafter, cystography was performed with 40 mL of half-diluted contrast material (Urografin 76%, Bayer) to check for leakage from the cyst into the vessel, biliary tree, and peritoneal space. If leakage was demonstrated, the procedure was ended without injection of EO after aspiration of contrast material. When leakage was not demonstrated, contrast material was aspirated and 40 mL of 5% EO (a mixture of 20 mL of 10% EO, Ordamin, Takeda and 20 mL of contrast material, Iopamiron 300, Bayer) were injected. Then, the catheter was clamped for 30 minutes and the patient was positioned supine for 10 minutes, on one side for 10 minutes and on the other side for 10 minutes. Thereafter, EO was aspirated from the cyst and the catheter was also withdrawn without any tract embolization. After the procedure, the patient was put to bed rest for 2 hours in supine position.

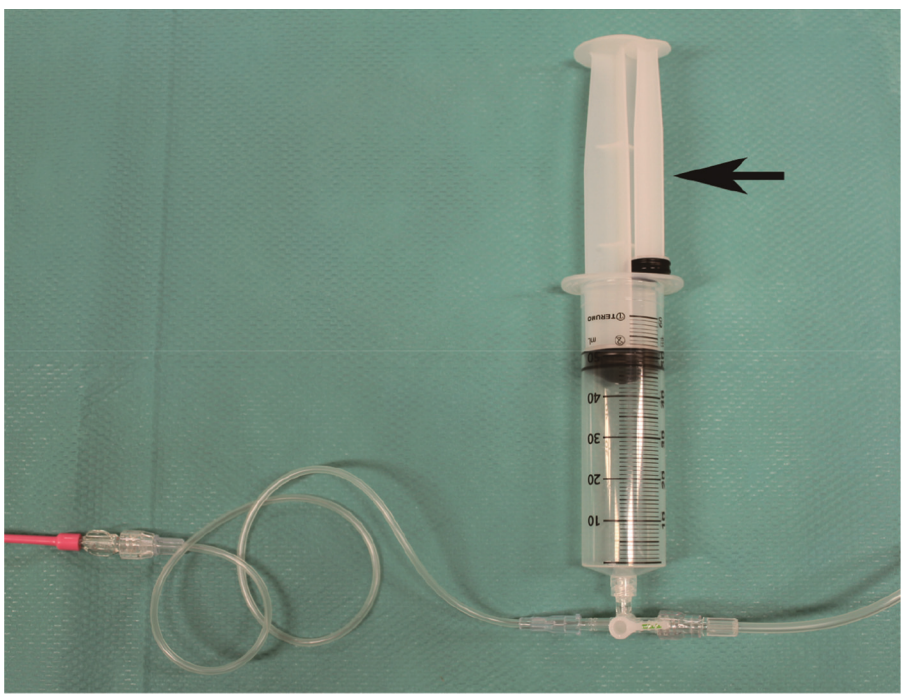

Figure 1. A photograph of an aspiration system using a 50 mL syringe and plunger of a 10 mL syringe (*arrow*).

Follow-up and additional treatment

Medical examination and CT were performed 1-3 months after the procedure to judge the early response to sclerotherapy. Thereafter, the clinical symptoms and the cyst size were followed up by medical examination and CT was performed at 3- to 12-month intervals. If the symptoms were not improved or recurred due to insufficient reduction of the treated cyst or enlargement of the other cysts, additional treatment was performed. The patients who underwent additional treatment other than sclerotherapy were excluded from the cohort on the date of the procedure.

Assessment of therapeutic effects

The symptomatic relief and complications were evaluated from the electronic medical records during the treatment course.

The volume of each cyst was estimated by measuring the long- and short-axis diameters on the maximum cross-section image on CT. Assuming the cyst shape to be ellipsoidal, the cyst volume was estimated using the following formula: volume = $\pi/6 \times$ long-axis diameter $\times$ (short-axis diameter)^2. According to the changes in the estimated cyst volumes between pre- and post-treatment CT, the percentage reduction was also calculated. The early response was evaluated with CT performed 1-3 months after sclerotherapy, and the late response was evaluated with the final CT images.

Spearman's rank correlation coefficient (ρ) was used to evaluate the correlation between the pretreatment estimated cyst volume and percentage reduction of early and late responses and between the percentage reduction of the late response and length of the follow-up period after sclerotherapy, as the response variables were not normally distributed. Statistical calculations were done using Excel (Microsoft). The two-sided P value < .05 was considered to indicate a significant difference.

Results

The results are summarized in Table 2. Figure 2 shows a representative case of a large hepatic cyst treated with sclerotherapy using 40 mL of EO.

The mean pretreatment estimated cyst volume was 1058.3 ± 664.3 mL (range, 149.6-2484.5 mL). The mean volume of the aspirated fluid was 1337.8 ± 845.4 mL

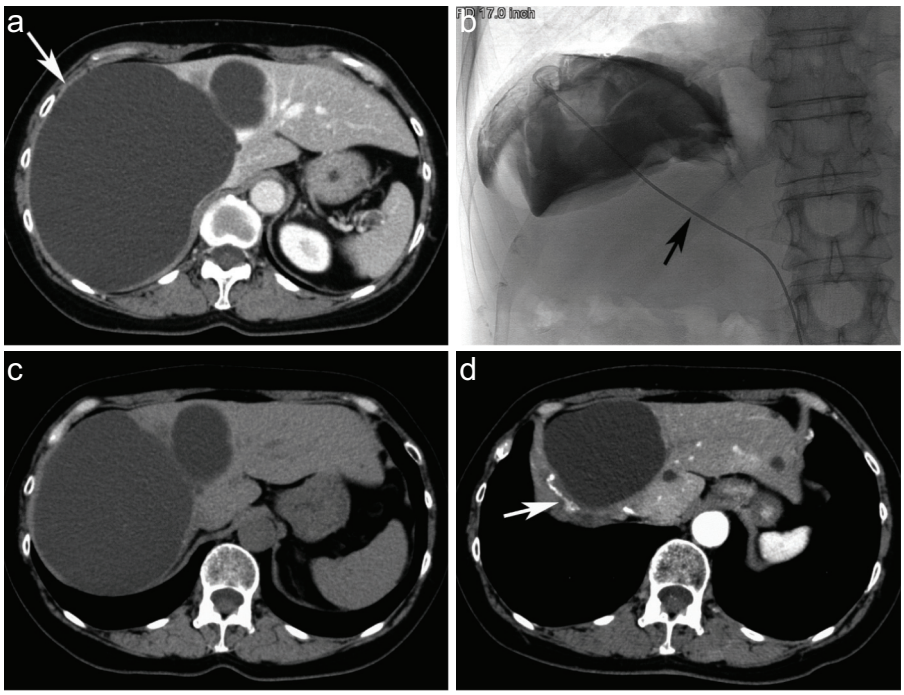

Figure 2. a-d. A 60-year-old woman with a large cyst in the right hepatic lobe. Enhanced CT (**a**) shows a large cyst in the right hepatic lobe (*arrow*). A small cyst is also seen adjacent to the large cyst. This patient has a history of surgical intervention for large hepatic cysts. Spot radiograph obtained during sclerotherapy using 40 mL of 5% EO after aspiration of 1800 mL of the fluid content (**b**) shows a large cyst. The *arrow* indicates a 4 F pigtail catheter. Unenhanced CT performed 3 months after sclerotherapy (**c**) shows that the density of the treated cyst contents is slightly elevated. The percentage reduction of the estimated cyst volume is 39.5%. Enhanced CT performed 3 years after sclerotherapy (**d**) shows that the cyst is organized with calcification (*arrow*). The neighboring cyst is enlarged.

(range, 140-3200 mL). The estimated cyst volume tended to be smaller than the aspirated fluid volume in the cysts with more than 1000 mL of the aspirated fluid. In all patients, the aspirated fluid was transparent, pale yellow in color, and not infectious. Cytologic examination confirmed no malignancy.

In one patient, cystography demonstrated intraperitoneal leakage of contrast material and the procedure was ended without EO injection. Sclerotherapy with EO was performed without leakage at the second procedure performed 40 days later. Forty milliliters of EO were used in all but one patient. In the remaining patient, the total volume of EO was reduced to 20 mL because the cyst size was relatively small (72 × 63 mm in diameter).

The clinical symptoms, such as abdominal pain and distension, disappeared in 22 of 23 (95.7%) patients immediately after the procedure. In the remaining patient with PLD >200 cysts, abdominal distension was improved. The laboratory abnormalities in 3 patients were also found to be normalized on the blood test performed 3 days to 4 weeks after the procedure.

On CT performed 1-3 months (mean, 2.3 ± 0.9 months) after sclerotherapy, all treated cysts shrank and the mean estimated cyst volume was reduced to 541.8 ± 449.2 mL (range, 6.6-1535.7 mL). The percentage reductions ranged from 18.7% to 99.1% (mean, 52.3% ± 23.8%), and there was a significant negative correlation between the pretreatment estimated cyst volume and percentage reduction (P = .027, ρ = −0.46). Of 9 patients with bile duct dilatation, it was improved in 8 patients (88.9%). In the remaining patient, it was not improved on CT performed 1 month after sclerotherapy, although the percent reduction of the treated cyst was 47.8%. After performing CT, this patient was lost to follow-up. In 17 of 24 (70.8%) treated cysts, the density of the cyst contents was slightly elevated (Figure 2), including 3 (12.5%) with a small amount of blood products.

Five patients were lost to follow-up after evaluation of the early response; therefore, late response was evaluated in 19 patients with a mean follow-up of 48.0 ± 42.4 months (range, 6-140 months) after sclerotherapy.

Seventeen patients (89.5%) had no clinical symptoms after sclerotherapy. One patient with PLD >200 cysts complained of abdominal distension 2 years and 11 months after sclerotherapy due to enlargement of other cysts, although the treated cyst markedly shrank (percentage reduction, 97.1%). The patient underwent transarterial embolization (TAE) with 100-300 μm microspheres (Embosphere, Merit Medical) 5 years and 4 months after the sclerotherapy. However, the embolized cysts were slightly enlarged for 4 years after TAE. This patient was excluded from the cohort on the day of TAE. In another PLD patient who underwent 2 procedures due to leakage of contrast material from the cyst, abdominal pain recurred 14 months after the sclerotherapy. On CT, the treated cyst was re-enlarged and the estimated cyst volume was increased from 1293.0 to 1310.2 mL. Additional sclerotherapy with 40 mL of 5% EO was performed and the symptom disappeared. However, the cyst gradually enlarged and the estimated cyst volume returned to 988.6 mL on the final CT performed 2 years and 6 months after the initial sclerotherapy. Abdominal discomfort also recurred 2 years 2 months after the initial sclerotherapy, 1 year after the second sclerotherapy.

On the final CT, all treated cysts shrank and the mean estimated cyst volume was reduced to 172.9 ± 296.8 mL (range, 0-998.6 mL). Ten of 19 cysts (52.6%) were organized 9-140 months (mean, 66 ± 44.2 months) after sclerotherapy. Calcification was seen in 5 cysts (26.3%) (Figure 2) and the density of the contents was also elevated in 8 cysts (42.1%). The percentage reductions ranged from 22.8% to 100% (mean: 87.5% ± 20.4%), and there was a significant negative correlation between the estimated pretreatment cyst volume and percentage reduction (P = .007, ρ = − 0.52). However, there were no significant correlations between the percentage reduction and length of the follow-up period (P = .19, ρ = 0.31).

Regarding the outcomes of 9 patients with PLD who could be followed-up, durable symptom disappearance was achieved

Table 2. Summary of outcomes in each patient

Pt. No.	Aspirated fluid volume (mL)	Injected EO volume (mL)	Estimated cyst volume (mL)	Estimated cyst volume 1-3 mo later (mL)	Percentage reduction (%) (early response)	Bile duct dilatation	Clinical symptoms	Follow-up period (mo)	Estimated cyst volume at final CT (mL)	Percentage reduction (%) (late response)	Recurrence of clinical symptoms (mo)	Complications
1	1400	40	897.3	468.9	47.8	No change	Disappeared	1	—			Fever
2	510	40	466.3	344.9	26		Disappeared	140	0.3	99.9	No	
3	540	40	462	35	92.4	Improved	Disappeared	130	0.7	99.8	No	
4	240	40	211	29.8	85.9		Disappeared	121	0.1	100	No	
5	750	40	696.4	8.3	98.8	Improved	Disappeared	100	0.3	100	No	Fever
6	600	40	598.1	447.7	25.4		Disappeared	104	0.8	99.9	No	
7	1315	40	1117.6	636.6	43	Improved	Disappeared	29	505.4	54.8	No	
8	140	20	149.6	57.1	61.8		Improved	64	4.3	97.1	Yes (35)[a]	
9	975	40	859.7	491.7	42.8		Disappeared	6	30.5	96.5	No	
10	2060	40	1449.1	803.2	44.6	Improved	Disappeared	2	—			
11	1150	40	861.2	686	20.3		Disappeared	12	200.9	76.7	No	Fever
12	780	40	408	147	64	Improved	Disappeared	60	68.7	83.2	No	
13	2300	40	1412.4	1153	18.7		Disappeared	54	26.8	98.1	No	
14	1300	40	849.	5376.6	55.7	Improved	Disappeared	2	—			
15	1800	40	1096.1	663	39.5		Disappeared	36	0	100	No	
16	1700	40	1472.6	1022.7	30.6	Improved	Disappeared	43	158.5	89.2	No	
17	3140	40	2484.5	1170.9	52.9	Improved	Disappeared	3	—			
18	2000	40	1293	545	57.9		Disappeared	33	998.6	22.8	Yes (14)[b]	
19	1000	40	1090.5	439.4	59.7		Disappeared	27	3.1	99.7	No	
20	2400	40	1571.7	941.4	40.1		Disappeared	2	—			
21	600	40	554.6	149.6	73		Disappeared	16	1.8	99.7	No	
22	1980	40	2148.7	1535.7	28.5		Disappeared	14	595.8	72.3	No	
23	900	40	772.9	6.6	99.1		Disappeared	9	0.1	100	No	Pain
24	3200	40	2476	1343.8	45.7		Disappeared	8	688.7	72.2	No	

CT, computed tomography; EO, ethanolamine oleate; mo, month; Pt., patient.
[a]This patient underwent transarterial embolization due to enlargement of the other cysts 5 years and 4 months after sclerotherapy.
[b]This patient underwent the second sclerotherapy 14 months after the first sclerotherapy due to enlargement of the treated cyst.

in 7 patients (77.8%), whereas durable cyst reduction in 8 patients (88.9%).

Severe pain immediately after injection of EO occurred in one patient (4.2%), and the symptom disappeared approximately 10 minutes later by the administration of an analgesic (Pentagin, Daiichi-Sankyo). A transient fever of <38.0°C without any treatment was recorded the day after sclerotherapy in 3 patients (12.5%). No other complications developed during and after the sclerotherapy.

Discussion

Most hepatic cysts cause no symptoms, and only symptomatic cysts are considered as requiring treatment.[1-3] Laparoscopic fenestration for symptomatic hepatic cysts is an effective treatment; however, symptoms recurred in 9.6% of patients and reintervention was required in 7.1% of patients. Postoperative complications occurred in 10.8% including major complications in 3.3% of patients, and procedure-related mortality was reported in 1.0% of patients.[13] Therefore, percutaneous sclerotherapy is the first-choice treatment because of its minimally invasive character and safety of the technique.[3]

Percutaneous drainage of the cyst only results in temporary relief of symptoms;[14] therefore, various kinds of sclerosants, such as ethanol,[3,4] tetracycline chloride,[5] doxycycline,[6] minocycline chloride,[7,8] EO,[9-11] and polidocanol foam,[12] have been applied to sclerotherapy. Ethanol has been widely used, but it can cause severe complications when it leaks from the cyst.[15] Additionally, in a report by Erdogan et al.,[3] cyst recurrence was seen in 77.8% (7/9) of PLD patients after ethanol sclerotherapy. On the other hand, EO sclerotherapy led to resolution of the PLD cyst in only one treatment session in 93.3% (14/15) of cases and 2 sessions in 6.7% (1/15) of cases.[11] In our cohort, durable reduction of the treated cyst was achieved in 8 of 9 PLD patients (88.9%). Like ethanol, exposure to EO leads to cytolysis followed by thrombogenesis. Therefore, EO is a cytolytic agent owing to its anionic surfactant properties that brings about a change in cellular permeability.[16] Due to such a mechanism of action, EO is effective not only for obliteration of esophagogastric varices but also for sclerotherapy of hepatic or renal cysts and has higher efficacy as a sclerosant and lower complication rates than ethanol.[10,11] However, fetal complications of EO, such as acute respiratory distress syndrome[17] and anaphylactic shock caused by injection of a larger than normal volume of EO,[18] have also been reported.

There are no standards for the appropriate volume of EO in sclerotherapy of hepatic cysts. In previous reports, a volume of 5% EO equivalent to 10% of the volume of aspirated fluid was injected into the cyst.[10,11] In the present study, 40 and 20 mL of 5% EO were used in 23 and 1 patient, respectively, because the maximum dose of 5% EO in a single session of transvenous esophagogastric varices obliteration is 40 mL.[19] In our cohort, the maximum volume of aspirated fluid was 3200 mL; therefore, 320 mL of 5% EO might be required if 10% of the aspirated fluid volume of 5% EO is a standard dose. Unlike intravascular injection, most EO injected into the cyst can be removed; however, the injection of a large volume of EO into the cyst might be associated with a risk of systemic complications due to absorption of EO into the blood from the cyst, like ethanol, although it has never been investigated. Additionally, EO is expensive and its use in sclerotherapy of hepatic and renal cysts is off-label. For these reasons, we limited the maximum volume of 5% EO per session to 40 mL. Compared with previous reports,[10,11] the present study showed less reduction of the post-treatment estimated cyst volume at 1-3 months. This may indicate that the total volume of EO in this study might be small compared with the cyst volume, and there were significant negative correlations between the pretreatment estimated cyst volume and percentage reductions at early and late responses. However, the treated cysts gradually decreased in size and all but one could be well-managed during the follow-up. Therefore, we believe that 40 mL of 5% EO is sufficient for sclerotherapy of large hepatic cysts. However, it is unclear why one hepatic cyst only slightly shrank despite 2 sessions of sclerotherapy. We speculate that EO solution diluted with residual fluid due to insufficient aspiration of the cystic contents resulting in inadequate cyst collapse during the aspiration phase of treatment might reduce the chemical effects of EO. There is also another possibility that the cyst might be neoplastic,[20] although repeated cytological examinations showed no malignancy. Therefore, further careful observation is required for this patient.

In previous studies, a 5 to 8.5 F angiographic or drainage catheter was used for percutaneous sclerotherapy of hepatic and renal cysts.[4,6,10-12] We used a 4 F pigtail catheter for sclerotherapy of hepatic cysts if the content was not hemorrhagic or infectious. This catheter had a 0.038-inch inner lumen, and the fluid contents could be easily aspirated using our hand-made aspiration system. A small catheter has the advantage of reducing the leakage of EO or bleeding through the puncture tract after catheter removal. No severe complications related to this catheter developed in the present study.

The reported symptomatic reduction rates are 72%-100% of patients after a median follow-up period of 2-54 months and complete symptom disappearance rate range from 56% to 100%.[21] However, the problem of the assessment of sclerotherapy is that cyst diameter reduction does not reflect treatment success,[22] and the variety of reported symptomatic relief is high between studies.[21] The large range may be partly explained by underlying disease; patients with a solitary or small number of cysts have an especially high clinical response rate. In our cohort, durable symptom disappearance was achieved in all 10 patients (100%) with cysts ≤10. On the other hand, patients with PLD usually have numerous cysts; therefore, the symptomatic relief is strongly influenced by the conditions of coexisting cysts. In our cohort, the durable symptom disappearance was achieved in 7/9 (77.8%) PLD patients who had a large dominant cyst accompanied with small cysts <50. On the other hand, in one patient with PLD with cysts >200, the symptom was improved but recurred due to enlargement of other cysts. Another factor that may have contributed to variety outcomes is a lack of standardized measurements of symptom relief in most studies,[21,22] including the present study. Therefore, the establishment of the evaluation protocol of this treatment is necessary, mainly focused on the symptomatic relief rather than on reduction of the cyst volume.

There are several limitations in the present study. First, 5 patients (20.8%) were lost to follow-up after evaluation of the early response to sclerotherapy. This might make long-term outcomes of this therapy inaccurate. Second, there was a tendency that the estimated cyst volumes were smaller than

the aspirated fluid volumes, especially for large cysts with more than 1000 mL of contents. This indicates that the long and short axes of the large hepatic cyst might not be in the axial plane of CT images. Therefore, the percentage reduction in this study might be underestimated. Finally, there is no consensus regarding the optimal timing to assess therapeutic outcomes of sclerotherapy for cysts. After sclerotherapy with minocycline chloride, imbalances occur in the secretion and absorption of cystic fluid during early-stage therapy, resulting in transient enlargement of cysts.[8] The same phenomenon was also reported at the one-month follow-up after sclerotherapy with EO.[10] Therefore, we evaluated the therapeutic effects at 2 different times: early and late; however, the length of the follow-up period in patients widely varied, although there were no significant correlations between the percentage reduction of the estimated cyst volume and length of the follow-up period. A well-designed study with strict follow-up schedules, as well as standardized assessment of symptomatic relief, is required to determine the optimal timing for evaluating the therapeutic effects of sclerotherapy with EO for hepatic cysts.

In conclusion, percutaneous sclerotherapy using a 4 F catheter and 40 mL of 5% EO is a safe and effective treatment for symptomatic large hepatic cysts. We believe that this technique can reduce the invasiveness and patients' burden of sclerotherapy for large hepatic cysts.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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