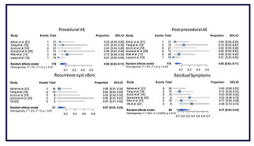

Safety and Effectiveness of Sclerotherapy for Nonparasitic Splenic Cysts: A Systematic Review and Meta-Analysis

Alessandro Gasparetto, MD, Jaime Alonso, MD, Michael Temple, MD, Dimitri Parra, MD, George Chiramel, MD, Rajat Chand, MD, and Joao Amaral, MD

ABSTRACT

Purpose: To assess the reported safety and effectiveness of sclerotherapy for the treatment of nonparasitic splenic cysts through a systematic review and meta-analysis.

Materials and Methods: A systematic search of PubMed MEDLINE, Embase, Web of Science, and the Cochrane Library through July 2023 was performed. Studies including at least 5 patients reporting percutaneous sclerotherapy of nonparasitic splenic cysts, initial and posttreatment cyst size, clinical symptoms as well as adverse events (AEs), and recurrence rates were included. A 0–8-point scale for case reports and case series was used to assess bias. Data were analyzed using random-effects meta-analysis.

Results: Twenty-three of 833 citations were selected for full-text assessment, and 7 studies were included for a total of 99 patients. The methodological quality of the studies included scored 3–7. Composite analysis demonstrated 38% (95% CI, 23%–55%) rate of recurrence after treatment with significant heterogeneity; however, when assessed for a cyst size of <8 cm, recurrence dropped to 7% (95% CI, 2%–20%). Residual symptoms after treatment completion were present in 17% (95% CI, 7%–33%). Intraprocedural and postprocedural AE rates were 6% (95% CI, 3%–13%) and 6% (95% CI, 3%–12%) respectively.

Conclusions: Sclerotherapy of splenic cysts seemed to be safe, with a high rate of recurrence for cysts ≥8 cm.

ABBREVIATION

AE = adverse event, CA = carbohydrate antigen

Splenic cysts are conventionally divided into parasitic and nonparasitic. Parasitic cysts are a rare condition in non-endemic areas and develop due to an underlying parasitic infection, such as echinococcosis or toxoplasmosis (1). The currently employed classification of splenic cysts was proposed by Morgenstern (2), who classified nonparasitic splenic cysts as congenital, neoplastic, traumatic, or degenerative. A definitive diagnosis can only be made with pathologic examination: the typical gross appearance of a congenital cyst is white or grayish, smooth, and glistening, with prominent coarse fibrous trabeculations and the presence of a complete or partial epithelial layer (2). However, with the development of spleen-preserving surgeries and minimally invasive procedures, the diagnosis is often based on imaging findings. Cysts are categorized as congenital if they are unilocular without history of trauma, tumor, or exposure to infectious diseases (3). The incidence of congenital splenic cysts is reported to be 0.75% per 100,000 in the general population (4). Most cysts are asymptomatic and do not require treatment. The presence of symptoms represents the main indication for procedure or sclerotherapy. Symptoms are often nonspecific and include pleuritic pain, dyspnea, abdominal discomfort, or pain; loss of appetite as well as hypertension due to extrinsic compression of the mass on the renal artery; and hypersplenism (5,6). Additionally, although there is a lack of evidence-based treatment guidelines, a diameter larger than 5 cm is adopted in the existing surgical literature owing to reported cases of increased risk of rupture and infection (2,7,8). Surgical technique recurrence rates vary from 0% for open techniques, including total or partial splenectomy (or 3% for open cystectomy) (9), to 88% for laparoscopic cystectomy

Table E1 can be found by accessing the online version of this article on www.jvir.org and selecting the Supplemental Material tab.

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RESEARCH HIGHLIGHTS

- This systematic review and meta-analysis on sclerotherapy to treat nonparasitic splenic cysts included 7 studies and a total of 99 patients.
- The most frequently used agents were alcohol, polidocanol, and doxycycline.
- Recurrence occurred in 38% of patients overall but in 7% of patients when the cyst size was <8 cm.
- Residual symptoms were present in 17% of patients.
- Intraprocedural adverse events, including hemorrhage and pain, occurred in 6% of patients, and postprocedural adverse events, including infection and hemorrhage, occurred in 6% of patients.

STUDY DETAILS

Study type: Systematic review and Meta-analysis

Level of evidence: 3 (SIR-C)

and 49% for laparoscopic decapsulation/unroofing (10,11). Interventional radiology treatments such as sclerotherapy are a minimally invasive alternative, inducing damage to the cyst capsular lining using injectable irritants, resulting in decreased fluid production and subsequent fibrosis and shrinking of the lesion. The safety and effectiveness of this treatment remains controversial owing to a limited number of reports, with authors advocating that surgical intervention should still represent the treatment of choice. This systematic review and meta-analysis aims to report the results of sclerotherapy of nonparasitic splenic cysts, in particular, agents used, rate of decrease in cyst size, rate of recurrence, clinical symptoms resolution, and adverse events (AEs).

MATERIAL AND METHODS

A systematic review of published English literature was performed to identify studies that evaluated the safety and an effectiveness of sclerotherapy of splenic cysts. This study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (12).

Search Strategy

PubMed MEDLINE, Embase, Web of Science, and the Cochrane Library were systematically searched by a professional librarian. Keywords and search strategy are summarized in **Table E1** (available online on the article's Supplemental Material page at *www.jvir.org*). A citation manager (EndNote) was used to remove duplicate exported studies. Titles and abstracts were screened, and articles were assessed for inclusion by 2 independent investigators (A.G., J.Alonso).

Inclusion and Exclusion Criteria

Inclusion criteria were studies including adults and/or pediatric patients who underwent single or multiple sessions of sclerotherapy for nonparasitic splenic cysts. Randomized controlled trials and prospective or retrospective studies were included. Studies labeled as case series that contained sufficient data to conduct reanalysis in accordance with the study "Distinguishing case series from cohort studies" by Dekker et al (13) were also included.

Exclusion criteria were studies with overlapping patient data (only the most recent studies were included). Studies with less than 5 patients were excluded to reduce publication bias. Non-English literature was also omitted.

Data Extraction

Data were extracted into a standardized form, including patient characteristics (age, sex, and baseline cyst size), indication for treatment, treatment characteristics (type, amount of sclerosant agent used, multiple- or single-day sclerotherapies, and number of treatments), cytologic and tumoral marker findings, cyst volume after the procedure, follow-up length, symptomatic change, rate of cyst recurrence, type and frequency of AEs, and hospitalization time. Recurrence was defined as an enlargement of the cyst or failure to shrink to less than 5 cm of diameter after initial treatment or after treatment completion.

Standardization and Data Synthesis

Where possible, a 2-stage method was used on subsets of data to draw conclusions about the overall population. In 3 articles, cysts size was reported as the volume of the ellipsoid based on the triaxial diameters measurements, and for the remaining 4 articles, cysts size was reported as the largest diameter. To facilitate the comparison, for cyst volumes and volume reduction, if the original authors only presented the largest diameter, the cyst volume was approximated using the formula $V = 4/3\pi r^3$.

In addition to reporting the incidence of AEs, narrative synthesis was used to enumerate and classify them according to Society of Interventional Radiology guidelines (14). A tool proposed by Murad et al (15) to assess case reports and case series was used by 2 authors (A.G., J.Alonso) independently to evaluate the methodological quality of said studies, including selection, ascertainment, causality, and reporting.

Statistical Analysis

An analysis of intraprocedural and postprocedural AEs was calculated as a proportion of the total procedures performed. Recurrence and residual symptoms were calculated as a proportion of patients who underwent sclerotherapy. Data heterogeneity was assessed using I^2; an I^2 of >50% was considered to represent substantial heterogeneity. Subgroup analysis of recurrence was performed for cysts measuring less than 8 cm. Statistical analysis was performed using Rstudio version 4.2.2 (Posit Software, PBC, Boston, Massachusetts).

RESULTS

Inclusion and Critical Appraisal

The literature search yielded 1,094 publications. After removal of 261 duplicated records and exclusion of 833

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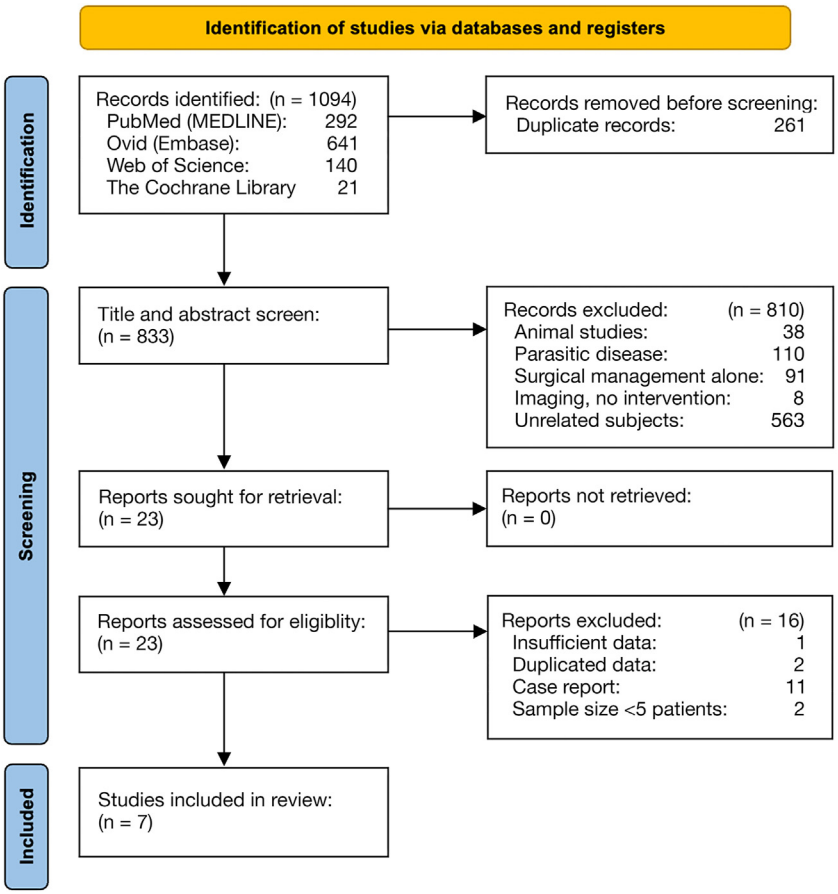

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram.

articles (38 animal studies, 110 related to parasitic disease, 91 surgical management alone, 8 imaging only, and 563 unrelated subjects), 23 were selected for full assessment, and ultimately, 7 publications were included for final assessment for a total of 99 patients (16–22) (**Fig 1**). The publications scored 3–7 out of 8 points in the methodological quality scale used for case series (**Table 1**).

Patient Characteristics

Studies included both pediatric and adult patients, 21%–63% were male, and symptoms at presentation were present in 47%–100% at the time of treatment. In addition to symptoms, another indication for treatment was cysts with a diameter >5 cm in 4 studies.

The most frequent symptoms at presentation were abdominal pain and discomfort, varying from 40% to 71%; less frequent symptoms included pleuritic pain, dyspnea or shortness of breath, gastrointestinal symptoms, and left-sided back pain. A mass could be palpated in 12%–40% of cases (**Table 2**).

Procedural Characteristics

A total of 33 patients in 3 series underwent the procedure using only local anesthesia; these cohorts were composed of adult patients exception made for 2 pediatric patients in the series by Giurazza et al (20) Thirty-two procedures (all in pediatric patients) in 2 series were performed with general anesthesia, and 24 procedures in a mixed pediatric and adults series were performed with sedation; 1 series did not report the type of anesthesia used. A variety of imaging methods were used to measure the size of the cysts, including ultrasound, computed tomography, and magnetic resonance imaging. Cytologic fluid aspirates were obtained in 5 of 7 series, confirming absence of malignant cells. Yang et al (18) demonstrated an increased carbohydrate antigen (CA) 19-9 in 13 of 15 patients, with normalization at 3 months after procedure. The most used sclerosing agent was ethanol alone or in association with other sclerosants in 79 patients, followed by detergent-type sclerosing solutions, such as polidocanol or sodium tetradecyl sulfate 3%, again alone or in association with other sclerosing agents, in 23 patients. Fifty-eight patients underwent a single-day procedure, with the remainder undergoing procedures on multiple days. The volume of sclerosant injected varied from 20% to 50% of the calculated volume of the cyst.

Effectiveness

Two series reported volume reductions, 3 series reported diameter reductions, 1 series reported both, and 1 series reported none. The primary reduction rate of the splenic cysts defined by volume decrease after a single treatment varied

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Table 1. Tool for Evaluating the Methodological Quality of Case Reports and Case Series According to Murad et al (15)

Article		Selection (max 1)	Ascertainment (max 2)	Causality (max 4)	Reporting (max 1)	Total (max 8)
Yang et al (18)	Summary score	1	2	2	1	6
	Overall judgment	The patients seem to represent the whole experience of the authors; clear description of the inclusion and exclusion criteria for the study.	The exposure and the outcomes were adequately ascertained: procedures and outcomes of all patients included in the analysis and used well-defined criteria to assess treatment success.	There is evidence for a causal relationship between the intervention and the outcome. No challenge-rechallenge or dose effect described in the article. Follow-up length seemed adequate.	The study is adequately reported. The authors provided sufficient details on the methods, results, and limitations of the study.	
Akhan et al(21)	Summary score	0	2	3	1	6
	Overall judgment	The patients included may not represent the whole experience of the authors because patients who had incomplete medical records were excluded.	The exposure and the outcomes were adequately ascertained, and the authors used well-defined criteria to assess treatment success.	The study provides evidence for a causal relationship between the intervention and the outcome. The authors clearly reported the interventions performed. A challenge-rechallenge phenomenon was reported for the patients who experienced recurrence and were treated more than once. No evidence confirming dose effect. Follow-up was adequate.	The study is adequately reported. The authors provided sufficient details on the methods, results, and limitations of the study.	
Accinni et al(19)	Summary score	1	2	3	1	7
	Overall judgment	The patients appear to represent the whole experience of the authors; clear description of the inclusion and exclusion criteria for the study.	The exposure and the outcomes were adequately ascertained: Detailed description of the technique and the postoperative monitoring.	There is evidence for a causal relationship between the intervention and the outcome. A challenge-rechallenge phenomenon was reported for the patients who experienced recurrence and were treated more than once. No evidence confirming dose effect. Follow-up was adequate.	The study is adequately reported. The authors provided sufficient details on the methods, results, and limitations of the study.	
Giurazza et al(20)	Summary score	1	2	3	1	7
	Overall judgment	The patients appear to represent the whole experience of the authors: The article provides a clear description of the inclusion and exclusion criteria for the study.	The exposure and the outcomes were adequately ascertained: detailed description of the technique and the postoperative monitoring.	There is evidence for a causal relationship between the intervention and the outcome. A challenge-rechallenge phenomenon was reported for the patients who experienced recurrence and were treated more	The study is adequately reported. The authors provided sufficient details on the methods, results, and limitations of the study.	

continued

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Table 1. Tool for Evaluating the Methodological Quality of Case Reports and Case Series According to Murad et al (15) *(continued)*

Article		Selection (max 1)	Ascertainment (max 2)	Causality (max 4)	Reporting (max 1)	Total (max 8)
				than once. No evidence confirming dose effect. Follow-up was adequate.		
Rifai et al (17)	Summary score Overall judgment	1 The patients appear to represent the whole experience of the authors: The article provides a clear description of the inclusion and exclusion criteria for the study; it also includes in the description 126 asymptomatic patients with smaller cysts that were not treated.	2 The exposure and the outcomes were adequately ascertained: detailed description of the technique and the postoperative monitoring.	3 There is evidence for a causal relationship between the intervention and the outcome. A challenge-rechallenge phenomenon was reported for the patients who experienced recurrence and were treated more than once. No evidence confirming dose effect. Follow-up was adequate.	0 The study is adequately reported. The authors provided sufficient details on the methods and results; however, compounded outcomes made comparison with other studies challenging.	6
López et al (16)	Summary score Overall judgment	0 Although the patients appear to represent the whole experience of the authors, the article did not report any specific inclusion or exclusion criteria.	1 Although the exposure to sclerotherapy was ascertained, a lack of details was noted in the description of the technique used and the outcomes.	2 There is evidence for a causal relationship between the intervention and the outcome, and a challenge-rechallenge phenomenon was reported for the patients who experienced recurrence. No evidence confirming dose effect. Follow-up was not clearly reported.	0 The authors provided insufficient details on the methods and results, which hampers the reproducibility of the study.	3
Ott et al (22)	Summary score Overall judgment	0 Although the patients appear to represent the whole experience of the authors, it is unclear how the patients were assigned to sclerotherapy, procedure, or expectant management.	1 Although the exposure to sclerotherapy was ascertained, the presented data were heterogeneous and incomplete.	2 There is evidence for a causal relationship between the intervention and the outcome, and a challenge-rechallenge phenomenon was reported for the patients who experienced recurrence. No evidence confirming dose effect. Follow-up was reported.	0 The authors provided insufficient details on the methods and results, which hampers the reproducibility of the study.	3

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Table 2. Patients and Procedural Characteristics for the Included Articles

Article	Methodology	Year	Country	No. of patients	Patients presenting with symptoms (n/%)	Palpable lesion (n/%)	Age (y)	Male	Inclusion criteria	How size was calculated	Agent (n)	Follow-up (mo)
Akhan et al (21)	Retrospective, single arm	2016	Turkey	24	24/100	2/12	22.7 ± 4.3* (3–65)†	5	Symptomatic	CT, US	Ethanol 96%	75.7 ± 62.8*
Yang et al (18)	Retrospective, single arm	2016	China	15	11/73	NA	33 ± 15.3* (17–62)†	4	Symptomatic and >5 cm	US, contrast-enhanced US, CT, MR imaging	Ethanol 99.5%	18.7* (2.8–59.2)†
Accinni et al (19)	Prospective, single arm	2015	Italy	15	7/47	6/40	12.5 ± 4.2* (3–17)†	8	Symptomatic and >5 cm	CT, MR imaging, contrast-enhanced US	Ethanol 96% + 10 mL minocycline hydrochloride 10%	36.7 ± 26.6*
Giurazza et al (20)	Retrospective, single arm	2022	Italy	6	5/83	NA	21* (11–34)†	3	Symptomatic and >5 cm	CT, MR imaging	Ethanol 96%	11.5 ± 4.3*
Rifai et al (17)	Retrospective, single arm	2013	Italy	12	11/100	NA	54 ± 17*	4	Symptomatic	US	Polidocanol (9); NaCl 10% (2)	57 ± 43*
López et al (16)	Retrospective, multiple arms	2017	United States	19	14/74	NA	14.3 (8–17)‡	12	NA	US	Doxycycline (5); STS 3% + ethanol (8); doxycycline + STS 3% + ethanol (6)	NA
Ott et al (22)	Retrospective, multiple arms	2023	United States	8	NA	NA	8.5 (4–14)‡	NA	Symptomatic and >5 cm	US	Doxycycline (8); ethanol (5)	29 (3–50)‡

CT = computed tomography; MR = magnetic resonance; NA = not available; STS = sodium tetradecyl sulfate; US = ultrasound.
*Mean ± SD.
†Range.
‡Median (interquartile range).

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Table 3. Technique and Cyst Size Reduction

Article	Cyst/agent volume (%)	Technique (n)	Cytologic results	No. of treatments	Anesthesia	Size of splenic cyst (mm)	Size of splenic cyst (mL)*	Primary volume reduction rate (%)	Cumulative volume reduction rate (%)	Cumulative diameter reduction (%)
Akhan et al (21)	30–50*	Single day (14); multiple consecutive days (7)	No malignant cells; no parasitic or bacterial infections	1 ± 0.5†	Sedation	NA	209.5‡ (40–5,408)§	86 ± 22†	89.1 ± 16.1†	NA
Yang et al (18)	50–100‖	Single day	No malignant cells; CA 19-9, 163,090 IU (20,970–478,300)‡ in 13 patients	1 ± 0†	Local	89 ± 22* (59–134)§	347‡ (95–1,192)§	94 ± 8.3†	94 ± 8.3†	NA
Accinni et al (19)	30–35*	Multiple consecutive days	No malignant cells	1 ± 0.8†	General anesthesia	94 ± 57.7* (30–230)§	176‡ ¶ (14–6,370)§ ¶	93† ¶	94† ¶	73 ± 20.8†
Giurazza et al (20)	20–30*	Single day	No malignant cells	1.5 ± 0.9†	Local	114 ± 50.8* (64–210)	226‡ ¶ (2–4,849)§ ¶	70† ¶	54.2 ± 35.8†	46.2 ± 28.9†
Rifai et al (17)	25‖	Single day (4); multiple days (8)	No malignant cells; 2 patients positive for staphylococcus coagulase	2.5 ± NA†	Local	90 ± 27*	381† ¶	NA	88† ¶	51.1 ± NA†
López et al (16)	NA	Single day	NA	4 (1–6)‡	NA	NA	65.5 (18–489)‡	NA	NA	NA
Ott et al (22)	≤50% ethanol; ≤100% doxycycline‖	Multiple days (8)	NA	2.6‡	General anesthesia	62 (43–131)‡	NA	NA	NA	~50

CA = charbohydrate antigen; NA = not available
*Volume based on imaging.
†Mean.
‡Median (interquartile range).
§Range.
‖Volume based on fluid aspirated.
¶Volume approximated to a sphere based on the provided maximum diameter.

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Table 4. Symptom Resolution, Adverse Events, and Hospitalization

Article	Primary symptoms resolution (n/%)	Cumulative symptoms resolution (n/%)	Recurrence/no resolution after first treatment (n/%)	Intraprocedural AE (n)	Postprocedural AE (n)	Hospitalization (d)
Akhan et al (21)	15/63	24/100	7/29	Hypotension (1)	Catheter infection (1)	5.6* (2–15)†
Yang et al (18)	13/87	13/87	0/0	Pain (6); intracystic bleed (1)	Fever (2)	NA
Accinni et al (19)	5/71	15/100	4/27	Pain converted to anesthesia (1)	None	2‡
Giurazza et al (20)	3/60	4/80	3/50	Perisplenic hematoma (1)	None	5‡
Rifai et al (17)	7/58	10/83	5/42	Free intra-abdominal bleeding (1); hypotension (2)	Intracystic bleeding (1); cyst infections (1)	7.3* (3–18)†
López et al (16)	NA	NA	13/68	Bradycardia after intracystic lidocaine injection (1)	Fever (1)	NA
Ott et al (22)	NA	5/62.5	3/37.5	None	None	0‡ (0–3)†

AE = adverse event; NA = not available.
*Mean.
†Range.
‡Median.

from 60% to 94%. Cumulative reduction was defined as the cyst reduction achieved after multiple treatments: the cumulative volume reduction varied from 54% to 94%; the cumulative diameter reduction varied from 46% to 73%. Primary symptom resolution was achieved in 32%–100% of patients. After treatment was deemed complete, cyst recurrence ranged from 0% to 68% at a mean of 19 and 57 months, respectively. Composite analysis including 99 patients in 7 studies demonstrated a rate of recurrence after procedure of 38% (95% CI, 23%–55%) with substantial heterogeneity (I^2 = 53%; P = .05). However, subgroup analysis of cysts with maximum diameter measuring <8 cm or volume of <268 mL demonstrated recurrence in 7% (95% CI, 2%–20%) with no heterogeneity. The median hospital stay varied from 0 to 18 days. The median number of treatment sessions varied from 1 to 4 (**Tables 3, 4**). Composite analysis demonstrated residual symptoms after procedures completion in 17% (95% CI, 7%–33%).

Safety

Intraprocedural AEs included 1 case each of intracystic hemorrhage, perisplenic hematoma formation, and self-limited intra-abdominal bleeding. All cases were managed conservatively with observation. Additional AEs, likely related to differences in procedural anesthesia, included pain episodes of varying degree experienced by 7%–40% for a total of 7 patients, 2 of which required conversion from local to general anesthesia: 1 episode each of vasovagal reaction that resolved with intravenous fluid injection and bradycardia after intracystic injection of lidocaine that required interrupting the procedure. Composite analysis showed 6% (95% CI, 3%–13%) intraprocedural AEs. Postprocedural AEs included fever in a total of 3 patients; in 2 patients, it manifested immediately after the procedure and subsided within 12 hours with conservative management, and in 1 patient, it manifested after hospital discharge, requiring readmission. Severe postprocedural AEs included tube infection managed with tube exchange and antibiotics, cyst infection managed with a new tube insertion and antibiotics, and intracystic bleeding managed with a new tube insertion. The estimate of postprocedural AEs was 6% (95% CI, 3%–12%) (**Fig 2**).

DISCUSSION

This systematic review and meta-analysis, based on 7 publications, was conducted to summarize the existing data on safety and effectiveness of sclerotherapy for the treatment of splenic cysts (16–22).

The median age at the time of treatment varied from 14 to 33 years, confirming that this condition is diagnosed mainly during childhood and young adulthood. The most common presentation was abdominal pain or discomfort, followed by respiratory symptoms such as pleuritic pain, shortness of breath or dyspnea, and gastrointestinal symptoms, including nausea, sense of fullness or early satiety, and left-sided back pain. More than half the patients treated had a symptomatic cyst, with others treated based on cyst size and theoretical risk of cyst rupture (2,7,8,18,21,22). Notably, in 1 series, 14 of 25 patients had splenic cysts incidentally found, and they were followed up until they became symptomatic, highlighting the importance of follow-up of asymptomatic cysts (21).

Congenital cysts have an epithelial lining with secretory function. The effectiveness of sclerotherapy is dependent on the ability of the sclerosant to denature the proteins of the epithelial cells lining the cyst, preventing them from secreting fluid into the cavity (23). Studies have indicated that aspiration only has demonstrated success for

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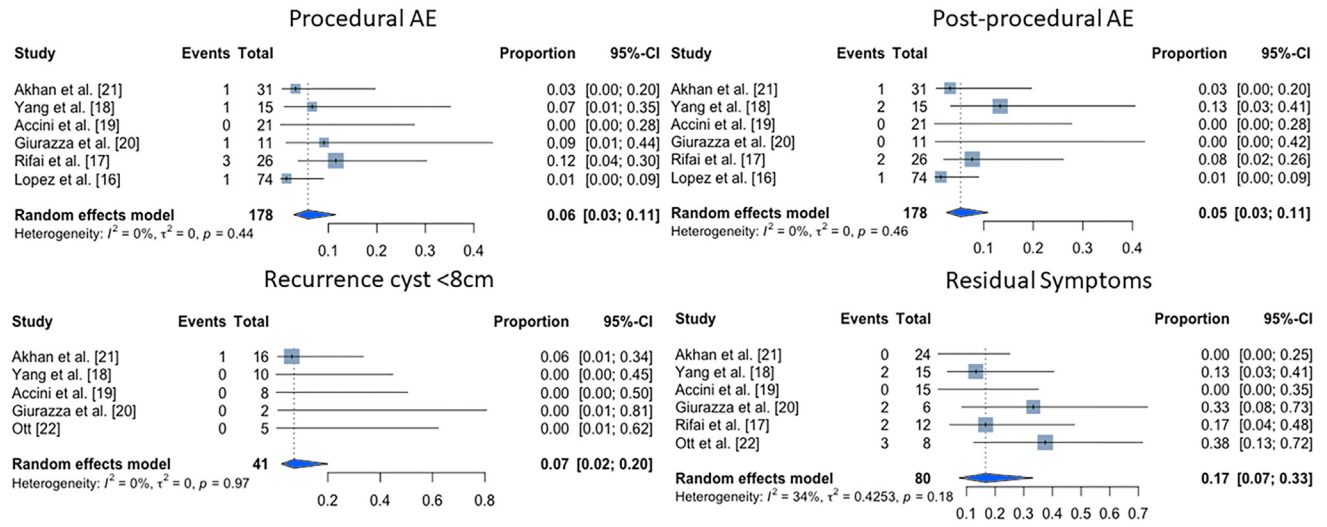

Figure 2. Forest plot diagram derived from composite data. AE = adverse event.

symptomatic treatment, likely due to a decreased mass effect. However, it has been proven insufficient in preventing cyst recurrences owing to the persistent functional epithelial lining within the cyst (24). However, it is important to notice that in the series by Rifai et al (17), 15 of 30 patients who underwent additional treatments were treated only with aspiration, the rationale being that the fluid reaccumulation after initial sclerotherapy is in response to the inflammatory stimulus rather than due to incomplete treatment.

Five articles reported the submission of cyst fluid for cytological analysis as part of their methodology; however, the fluid was collected at the time of treatment, indicating that the role of cytology in the current clinical practice strengthens the radiological diagnosis rather than representing a standalone preprocedural workup. Of note, Yang et al (18) demonstrated an increased serum level of CA 19-9 in 13 of 15 patients; this is a known although underinvestigated finding that may lead to misinterpretation and additional unwarranted diagnostic studies or procedures if interpreted by inexperienced clinicians (25).

Recurrence after a single treatment was present in 0%–67% of patients; the importance of the technique and sclerotherapy agents used could not be determined due to heterogeneity of the included studies; however, Akhan et al (21) found no difference in effectiveness and safety comparing multiple- and single-session techniques, concluding that leaving a drainage catheter in the cyst and performing sclerotherapy over multiple consecutive days may not result in improved outcome. Accinni et al (19) and Akhan et al (21) suggested that rolling the patient after intracystic instillation could improve the exposure of the endothelium to the sclerosant agent before reaspiration; however this approach could theoretically lead to sclerosant agent leakage into the peritoneum, causing damage to surrounding structures. Additionally, Accinni et al (19) showed that there was no advantage to administration and aspiration of alcohol followed by minocycline hydrochloride 10% injection that was left in the cavity, implying that there may not be a benefit from combining the 2 sclerosants.

Total or partial splenectomy still represents the mainstay of splenic cyst treatment, with virtually no recurrence after intervention. The downside of complete spleen removal is linked to the immunologic function of the organ, which can lead to morbidity and mortality of up to 1.5%. Additionally, both procedures would require laparotomy, and it should be noted that partial splenectomy is a technically demanding procedure for the operator (9,26,27). In contrast with the belief that spleen-preserving laparoscopic procedures are affected by lower recurrence rates compared to sclerotherapy, this systematic review and meta-analysis suggests that despite significant heterogeneity, cyst reoccurrence after percutaneous interventions (38%; 95% CI, 23%–55%) is comparable with the 33%–88% of laparoscopy (10,11,28) and likely superior for cysts <8 cm (7%; 95% CI, 2%–20%).

The intraprocedural and postprocedural safety profile of sclerotherapy demonstrated AEs in 6% and 6%, respectively, none resulting in increased morbidity or mortality. Additional AEs related to sclerotherapy reported in the literature include splenic abscess and hemorrhage (29,30). No evidence for alcohol intoxication or sclerosant-related peritonitis was reported after procedure.

The limitations of the study are first due to the small number of studies and patients included. Although an attempt to reduce the risk of bias was made by including studies with at least 5 patients, the modest number of patients in the included studies and the variability in reporting prevented to control for the different sclerotherapy agents and techniques, likely major variables affecting the outcomes. Additionally, the reported heterogeneity certainly affects the conclusions significantly, highlighting the need for reporting standards.

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In conclusion, sclerotherapy of splenic cysts seems to be safe and effective across multiple experiences. Recurrence rates drop significantly for cysts <8 cm.

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None of the authors have identified a conflict of interest.

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Table E1. Search Strategy.

Search number	Query	Results
1	"Spleen"[MeSH] OR "Splenic diseases"[MeSH] OR (Splenic*[tw] OR spleen[tw] OR spleens[tw])	243,907
2	"Cysts"[MeSH] OR "Cyst Fluid"[MeSH] OR (Cyst[tw] OR cysts[tw] OR cyst fluid*[tw])	191,753
3	#1 AND #2	3,745
4	(aspiration sclerotherap*[tw] OR sclerotherap*[tw])	9,735
5	"Sclerotherapy"[MeSH] OR "Sclerosing Solutions" [Pharmacological Action] OR "Sclerosing Solutions"[MeSH]	17,780
6	((Inject*[tw] OR drug*[tw] OR solution*[tw] OR agent*[tw]) AND (scleros*[tw]))	61,857
7	(Sclerosant*[tw])	1,152
8	"Instillation, Drug"[MeSH] OR "Infusions, Intralesional"[MeSH] OR ((Instillation[tw] OR instillment [tw] OR intralesion*[tw]) AND (drug*[tw] OR agent*[tw] OR infusion*[tw]))	21,771
9	"Ablation Techniques"[MeSH] OR (Ablat*[tw] OR Aspiration*[tw])	324,843
10	"Drainage"[majr] OR (Drain*[tw] OR Evacuation*[tw])	199,163
11	"Injections"[Majr] OR "Punctures"[Majr]	63,771
12	(Infusion*[tw] OR Injection*[tw] OR punctur*[tw])	1,145,024
13	"Radiology, Interventional"[MeSH] OR "Ultrasonography, Interventional"[MeSH]	36,046
14	((Percutaneous*[tw] OR Transdermal*[tw] OR transdermic*[tw] OR Transcutaneous*[tw]) AND (ultrasound guided[tw] OR radiograph guided[tw]))	4,143
15	#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14	1,742,091
16	#3 AND #15	434
17	Safety[mesh] OR treatment outcome[MeSH] OR Risk[MeSH]	2,527,603
18	(safe*[tw] OR risk[tw] OR risks[tw] OR outcome*[tw] OR adverse event*[tw] OR efficac*[tw] OR effective*[tw] OR reaction*[tw] OR complication*[tw] OR Event*[tw] OR adverse effect*[tw])	13,140,209
19	#17 OR #18	13,195,736
20	#16 AND #19	292

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