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Echo-guided pericardiocentesis in patients with clinically significant pericardial effusion

Outcomes over a 10-year period

Pericardiocentesis for "clinically significant" pericardial effusion (PE; i.e., the largest pericardial fluid collection of ≥1 cm with or without cardiac tamponade) was performed under fluoroscopic guidance alone or blind for decades. This was associated with a high rate of complications. With the wide availability of echocardiography, it has become the technique of choice for pericardiocentesis since echocardiography promptly and reliably confirms the presence and hemodynamic impact of pericardial effusion [1, 2].

Another change that has occurred in recent years is that underlying etiological causes of PE can now be diagnosed more easily with the help of advances in medical imaging (e.g., multi-slice computerized tomography and magnetic resonance imaging), molecular biology [e.g., polymerase chain reaction ([PCR)], immunohistochemistry, and several others.

The purpose of the present study is to evaluate *current* echocardiographically (echo)-guided pericardiocentesis practice with regard to procedural success, complication rate, and the etiology and clinical outcomes in patients with PE.

Patients and methods

Patients who underwent echo-guided pericardiocentesis in a tertiary referral center between January 2004 and February 2014 were identified using an institutional code for the procedure. The patients (n=17) whose essential medical records were not available were excluded. The patients or their legally designated surrogates were contacted and informed consent was obtained for study participation. Additional data for death, recurrences, and diagnoses established during the subsequent years were obtained by interviewing patients or their relatives (directly or by telephone). The study was approved by the institutional review board.

Technical aspect of the procedure

The approach route (subcostal or apical) was at the operator's discretion. The Seldinger technique with a 16–18 gauge needle was used for puncture. In general, a maximum fluid collection of 1 cm, loculated and/or posterior effusions, and a high bleeding risk (platelet <50,000 per mm^3, high INR>1.5, or uncorrected coagulopathy) were considered unsuitable conditions for pericardiocentesis. Echocardiography was used in all procedures to guide the operator, who was a consultant physician or supervised cardiology registrar. Fluoroscopic or electrocardiographic guidance was *never* used. Most procedures were performed in the coronary care unit except for the effusions developed as a complication of a catheter-based procedure, which was treated in the catheterization laboratory. All procedures performed in the catheterization laboratory were under the guidance of a handheld echocardiography device as well. The patient was positioned supine with the head of the bed elevated at a 30–60-degree angle and in a slight left lateral decubitus position if the apical approach was used. Blood pressure and heart rhythm were monitored continuously. Confirmation of the needle tip was achieved by injecting agitated saline, particularly when the aspirated fluid had a bloody appearance or in the presence of a pleural effusion. After a sheathless insertion technique, a 65-cm standard pigtail angiocatheter with multiple side holes was used for prolonged drainage. The catheter was removed once the aspirated fluid volume decreased to <25–50 ml in a day.

Laboratory testing

Complete blood cell count, serum creatinine levels, thyroid function tests, international normalized ratio (INR), and C-reactive protein levels were measured and chest X-rays were routinely ordered. In selected cases, biochemical, cytological, and bacteriological characteristics of the fluid samples were analyzed to differentiate between exudate and transudate, to determine the adenosine deaminase level, for acid-fast and Gram staining, for cultures for microorganisms, for PCR for *M. tuberculosis*, and for detection of neoplastic cells. To limit the use of additional tests such as antinuclear antibody, anti-ds-DNA, rheumatoid factor, tumor markers, and serological testing for unusual microorganisms, a multidisciplinary approach with cooperation between cardiologists, rheumatologists, oncologists, and infectious disease specialists was adopted in complex cases.

Tab. 1 Clinical and procedural characteristics of the patients

Age, years ± standard deviation (range)	61±17 (18–101)
Female, *n* (%)	149 (49.5)
Length of hospital stay, day (interquartile range)	8 (9)
Presentation, *n* (%)	
– Dyspnea	232 (77)
– Chest pain	6 (2)
– Cardiopulmonary arrest	4 (1)
– Combined	50 (17)
– Not available	2 (0.5)
Route of approach, *n* (%)	
– Subcostal	250 (83)
– Apical	46 (15)
– Not available	5 (2)
Procedural success rate, *n* (%)	291 (97)
Intervention-requiring complication rate, *n* (%)	4 (1.3)
Volume drained, ml (interquartile range)	1,000 (800)

Clinical definitions

Cardiac tamponade was defined as hemodynamically significant effusion with consistent symptoms/signs or echocardiographic features. The specific diagnosis was established in the absence of an alternative etiology and defined as being related to:

- *Acute viral/autoreactive pericarditis*: Presence of two or more of the following: typical pericardial chest pain, diffuse ST-segment elevation in electrocardiogram except in leads aVR and V_1, fever of >37°C, and friction rub.
- *Malignancy*: Presence of neoplastic cells in the fluid, or a known malignancy diagnosed in the last 2 years or within 6 months after pericardiocentesis.
- *Connective tissue disease*: A disease compatible with the Consensus Criteria for the Rheumatic Disorders.
- *Tuberculosis*: Known tuberculosis elsewhere in the body, or detection of *M. tuberculosis* in smear or culture of fluid/sputum, or positive PCR, or a clinical response to empirical antituberculous therapy in the presence of compatible clinical or radiological findings.

Tab. 2 Etiology of pericardial effusion

Cause	*n* (%)	Tamponade[a] (*n*) Yes | No	Macroscopic appearance of pericardial fluid[a] (*n*) Serous | Serosanguineous | Bloody	Recurrence (*n*)
Malignancy	84 (28)	72 | 10	8 | 17 | 55	27
– Lung	45 (14.9)	39 | 6	2 | 5 | 36	13
– Breast	9 (2.9)	9 | 0	2 | 2 | 5	3
– Lymph node (lymphoma)	5 (1.7)	4 | 1	1 | 3 | 1	2
– Kidney	3 (1)	3 | 0	0 | 1 | 2	3
– Rectum	2 (0.6)	1 | 0	1 | 1 | 0	0
– Stomach	2 (0.6)	2 | 0	1 | 0 | 1	1
– Other primary organs[b]	10 (3.3)	7 | 2	1 | 3 | 5	4
Unknown primary origin[c]	8 (2.6)	7 | 1	0 | 2 | 5	1
Cardiothoracic surgery	24 (7.9)	13 | 11	1 | 4 | 18	2
Chronic kidney disease	24 (7.9)	14 | 10	4 | 4 | 14	2
Acute viral/autoreactive pericarditis	22 (7.3)	7 | 15	5 | 9 | 8	0
Tuberculosis	20 (6.6)	2 | 18	0 | 10 | 10	4
Heart failure/severe valve disease	13 (4.3)	7 | 6	8 | 4 | 1	1
Hypothyroidism	12 (3.9)	0 | 12	5 | 3 | 4	2
Postmyocardial infarction[d]	11 (3.7)	11 | 0	0 | 2 | 9	0
Catheter-based procedure	5 (1.7)	5 | 0	0 | 0 | 5	0
Bacterial infection	3 (1)	2 | 1	0 | 2 | 0	0
Connective tissue disease	2 (0.7)	1 | 1	1 | 0 | 1	1
Drug-induced (gabapentin)	1 (0.3)	1 | 0	0 | 0 | 1	0
Crohn's disease	1 (0.3)	0 | 1	0 | 0 | 1	0
Idiopathic	28 (9.3)	10 | 16	5 | 5 | 16	3
Indeterminate	51 (17)	25 | 25	14 | 8 | 28	7
Total	301 (100)	170 | 126	50 | 68 | 171	49

[a]The sum of the individual numbers may differ from the total number, because data for the presence or absence of tamponade were not available for one patient with prostate cancer; pericardiocentesis was performed for only diagnostic purposes in five patients; and data for the macroscopic appearance of pericardial fluid were not available in ten patients. [b]Testis, prostate, ovary, endometrium, urinary bladder, thyroid, tongue, brain, right atrium (primary angiosarcoma), and pericardium itself (primary pericardial mesothelioma; *n*=1 for each). [c]In five of the eight patients, the diagnosis was established by means of *cytological examination* of the pericardial fluid. [d]The diagnosis was free wall rupture in five patients, early post-infarction pericarditis in one, and Dressler's syndrome in one, whereas no apparent cause could be identified in the remaining four patients

- *Bacterial infection*: Positive fluid culture assumed not to be contaminated, or a clinical response to antibiotics in case of an acute febrile illness.
- *Catheter-based procedure*: Acute hemodynamic instability with newly developed effusion associated with any percutaneous cardiac intervention.
- *Hypothyroidism*: Elevated thyroid-stimulating hormone and decreased free thyroxine.
- *Heart failure/severe valve disease*: Severe systolic or diastolic dysfunction of both ventricles, and severe cardiac valve disease with associated right heart failure.
- *Chronic kidney disease*: Chronic hemodialysis or peritoneal dialysis, or known chronic kidney disease with a serum creatinine level of ≥2 mg/dl or estimated glomerular filtration rate of ≤60 ml/min/1.73 m^2.
- *Cardiothoracic surgery*: History of open heart surgery in the preceding 6 months.
- *Postmyocardial infarction*: The appearance of a pericardial friction rub within 1 week of myocardial infarction with associated typical pericardial chest pain (early peri-infarction pericarditis), or free wall rupture; or a pericardial friction rub, fever, leuko-

cytosis, and elevated C-reactive protein within 6 months after but not within 1 week of myocardial infarction (Dressler's syndrome).
- *Drugs*: Presence of cause and effect relationship between a drug and development of PE, with an appropriate time correlation.
- *Idiopathic*: Inability to identify an underlying disease consistent with PE despite an adequate work-up and a follow-up of ≥6 months.
- *Indeterminate*: Death of a given patient in a short time period without a chance for identification of the cause, or presence of two or more disorders concurrently, or patient lost to follow-up.

Statistical analysis

Continuous variables were defined as mean ± standard deviation or median (interquartile range); categorical variables were defined as percentages. Continuous variables were checked for the normal distribution assumption using Kolmogorov–Smirnov statistics. Differences between patients and control subjects were evaluated using the Kolmogorov–Smirnov test or the Student *t* test when appropriate. Categorical variables were tested by Pearson's χ^2 test or Fisher's exact test. All *p* values are two sided and values less than 0.05 were considered statistically significant. All analyses were carried out using SPSS 18.0 for Windows (SPSS Inc., Chicago, Ill.).

Results

A total of 301 patients were included in the analysis. The procedural success rate was 97% (*n*=291) (**Tab. 1**). The cause of effusion was determined in 74% of patients (*n*=223). The etiology could not be identified in the remaining 79 patients (26%) and classified as either idiopathic or indeterminate (**Tab. 2**). The reasons for indeterminate effusion were as follows: lost to follow-up (*n*=41), death in a short time period (*n*=8), and the presence of two disorders concurrently (*n*=2). Malignancy was the most common etiology (*n*=84, 28%). Only two of the malignancies were the primary tumors of the heart, name-

Abstract · Zusammenfassung

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Echo-guided pericardiocentesis in patients with clinically significant pericardial effusion. Outcomes over a 10-year period

Abstract

Background. The purpose of the present study is to evaluate current echocardiographically (echo)-guided pericardiocentesis practice with regard to procedural success, complication rate, etiological causes, and outcomes of patients with clinically significant pericardial effusion.

Patients and methods. Patients who underwent echo-guided pericardiocentesis between January 2004 and February 2014 were identified using an institutional code for the procedure. Other complementary data were obtained by interviewing patients or their relatives (directly or by telephone) and by searching the social security death index.

Results. A total of 301 patients were identified. The pericardium was approached via the subcostal (85%) or apical (15%) route under echo guidance in all procedures. The success rate was 97%, with an intervention-requiring complication rate of 1.3%. No patient died from complications. The most common etiology was malignancy (*n*=84, 28%). Patients were followed-up for a median of 35 months. Median survival for patients with malignant effusion was 5.9 months compared with 54 months for those with nonmalignant effusion.

Conclusions. Echo-guided pericardiocentesis has a high success and low complication rate in current practice. Among etiologies, malignancy remains the most common cause of clinically significant pericardial effusion and is associated with a poor prognosis.

Keywords

Cardiac tamponade · Causality · Complications · Pericardial effusion · Pericardiocentesis

Echokardiographisch kontrollierte Perikardiozentese bei Patienten mit klinisch signifikantem Perikarderguss. Ergebnisse im Zeitraum von 10 Jahre

Zusammenfassung

Hintergrund. Ziel der vorliegenden Studie war die Beurteilung des derzeitigen Untersuchungsablaufs bei echokardiographisch kontrollierter Perikardiozentese im Hinblick auf den Erfolg des Verfahrens, die Komplikationsrate, ätiologische Aspekte und Ergebnisse bei Patienten mit klinisch signifikantem Perikarderguss.

Patienten und Methoden. Die Patienten, bei denen zwischen Januar 2004 und Februar 2014 eine echokardiographisch kontrollierte Perikardiozentese durchgeführt worden war, wurden anhand eines einrichtungsbezogenen Codes für dieses Verfahren ermittelt. Weitere ergänzende Daten wurden durch Befragung der Patienten oder ihrer Angehörigen (direkt oder telefonisch) und mithilfe des Sozialversicherungssterbeindex gewonnen.

Ergebnisse. Insgesamt wurden 301 Patienten ermittelt. Der Zugang zum Perikard erfolgte subkostal (85%) oder apikal (15%) unter echokardiographischer Kontrolle aller Untersuchungen. Die Erfolgsrate betrug 97%, dabei lag die eine Intervention erfordernde Komplikationsrate bei 1,3%. Es starb kein Patient an Komplikationen. Die häufigste Ätiologie war ein Malignom (n=84; 28%). Im Mittel wurden die Patienten 35 Monate lang nachbeobachtet. Das durchschnittliche Überleben lag für Patienten mit einem malignen Perikarderguss bei 5,9 Monaten im Gegensatz zu 54 Monaten für Personen mit nichtmalignem Erguss.

Schlussfolgerung. Die echokardiographisch kontrollierte Perikardiozentese weist eine hohe Erfolgs- und niedrige Komplikationsrate bei dem derzeitigen Untersuchungsablauf auf. Ätiologisch liegt einem klinisch signifikanten Perikarderguss zumeist ein Malignom zugrunde, das mit einer schlechten Prognose einhergeht.

Schlüsselwörter

Herztamponade · Kausalität · Komplikationen · Perikarderguss · Perikardpunktion

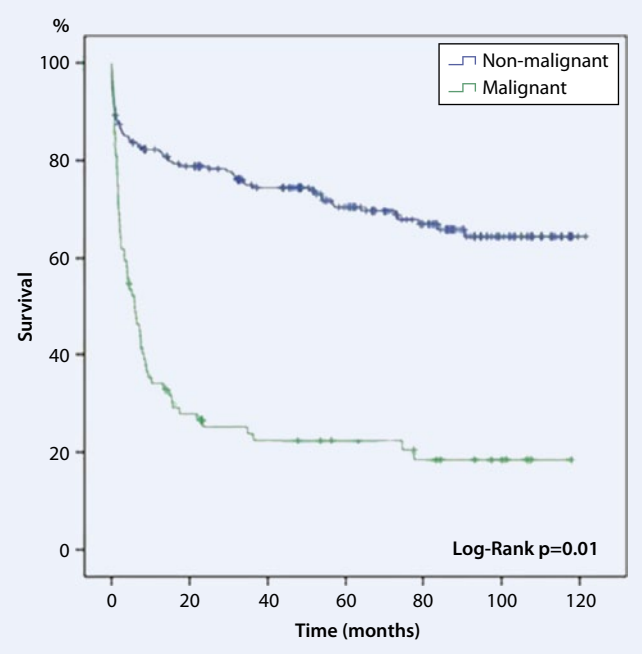

Fig. 1 ◀ Kaplan-Meier curves showing the overall survival rates

ly, right atrial angiosarcoma and pericardial mesothelioma. None of the effusions was caused by leukemia, trauma, or radiotherapy. Three cases with bacterial effusion were detected. Methicillin-sensitive *Staphylococcus aureus* was detected in two patients. No bacterial growth was seen in the third patient who was diagnosed with concurrent para-pneumonic empyema. One case presented with cardiac tamponade after the use of oral gabapentin. In this patient, no other cause could be found and no recurrence was encountered during a follow-up of 18 months. Together with the information obtained from the manufacturer's package insert that states gabapentin can rarely cause pericarditis or PE, it was classified as drug-related PE, although no case report regarding the association between gabapentin and PE was found in the literature search [3].

Pericardiocentesis was performed for only diagnostic purposes in five patients. None yielded a definitive diagnosis, although 5 months later, one patient was diagnosed with rectal cancer. Cytological examination of the fluids was performed in 146 patients. Neoplastic cells were detected in 33% (25 out of 76) of patients with malignancy. On the contrary, the primary origin of the cancer could not be determined in five patients with cytologically positive fluid.

Four (1.3%) complications requiring surgical correction were observed: one case of pneumothorax, one case of right coronary artery perforation, and two cases of right ventricular perforation. Although all were seen with the subcostal route, it should be noted that the apical route was preferred in only 15% of the patients. Another four patients had transient arrhythmia: one case of sinus bradycardia, one case of atrial flutter, and two cases of atrial fibrillation. Of note, no patient died from complications.

Patients were followed up for a median of 35 months (range: 0–121 months). Recurrence was seen in 49 (16%) patients (**Tab. 2**). The treatment options carried out for recurrent effusion were repeat pericardiocentesis in 21 and pericardial window surgery in 28 cases. Median survival for patients with malignant effusion was 5.9 months (interquartile range: 21 months) compared with 54 months (interquartile range: 72 months) for those with nonmalignant effusion (**Fig. 1**).

Discussion

In contrast to fluoroscopy or electrocardiography, echocardiography allows for the precise determination of the optimal puncture site where the fluid collection is the largest, and the optimal direction and depth the needle should be advanced. Thus, in current practice, pericardiocentesis has become a feasible and safe procedure under echocardiographic guidance. This provides high procedural success rates with low complication rates as reported in the present and other series [1, 2]. This could be accomplished without a need for additional guidance with fluoroscopy or electrocardiography even in the catheterization laboratory as demonstrated in the present study. In addition to guiding pericardiocentesis, echocardiography has also become a very important clinical tool in contemporary medicine with the remarkable progress in cardiac tissue Doppler analysis, strain and strain rate imaging by speckle tracking imaging, and especially three-dimensional echocardiography for the evaluation of various pericardial diseases, including constrictive pericarditis, effusive-constrictive pericarditis, absence of the pericardium, cysts, and tumors [4].

In the present study, which is the largest series after the 21-year series of data from the Mayo Clinic, the most common cause of PE was malignancy as in keeping with the other series, although Tsang et al. [1] reported cardiothoracic surgery replaced malignancy as the leading cause in recent years [5, 6, 7, 8]. The most common etiology was idiopathic in the studies of Sagristà-Sauleda et al. [9] and Levy et al. [10] (29% and 48%, respectively); and in the study of Corey et al. [11] it was infectious causes (27%) including unusual agents such as *M. pneumonia and M. avium-intracellulare*. Of note, in a recent prospective registry of 259 patients, an autoreactive etiology was the leading diagnosis in 35%, followed by malignancy in 28%, and viral etiology in 14% of the cases [12]. These discrepancies seem to mainly result from how aggressively the etiologic investigation was carried out.

The frequency of tuberculous effusions (6.6%) in the present study was more than that of high-income countries (1.8%), but less than that of low-income countries (69.5%) [5, 13]. This is in accordance with the positive correlation between the frequency of tuberculosis and the level of income of a given country.

The frequency of effusions developed as a complication of catheter-based procedures has been reported to increase in

Tab. 3 Clinical features of patients who indeed had a likely diagnosis despite an assignment of indeterminate or idiopathic etiology

Patient Age (years), sex	Clinical features	Etiology	Why "indeterminate"?	Comment
52, M	Tuberculosis + advanced-stage lung cancer. Death, 1 month	Indeterminate	Two causes were present concurrently	Pericardial effusion was more likely caused by lung cancer
68, F	Subclinical hypothyroidism + moderate mitral valve insufficiency + mild mitral stenosis. Death, 16 months	Indeterminate	Lost to follow up ± Two causes were present concurrently	None of these diseases *alone* was expected to be the cause of clinically significant pericardial effusion, but together they could, or more possibly there was a relevant additional disease that could not be identified
56, M	High levels of tumor markers measured in the blood. Death, 2 months	Indeterminate	Death in a short time period	Malignancy likely
55, M	Mediastinal lymph nodes of 25 mm in diameter. Death, 6 weeks	Indeterminate	Death in a short time period	Tuberculosis? Malignancy; particularly lymphoma?
46, F	Positive ANA + positive RF + anemia + lymphopenia. Death, 1 month	Indeterminate	Death in a short time period	SLE likely (±malignancy; particularly non-Hodgkin's lymphoma)
29, M	Fever and night sweats for 4 days. Death, 10 days	Indeterminate	Death in a short time period	Bacterial infection likely
78, F	Weight loss of 20 kg in 3 months + multiple nodules in the lung. Death, 15 months	Indeterminate	Lost to follow-up	Malignancy likely
61, F	A mass of 2.7 cm in diameter, close to the portal vein	Indeterminate	Lost to follow-up	Malignancy likely
25, M	Fever and night sweats for 4 months	Indeterminate	Lost to follow-up	Tuberculosis? Lymphoma?
60, M	Chronic osteomyelitis + considerable weight loss and night sweats in the last few months	Idiopathic	N/A	Bacterial infection likely. Negative pericardial fluid culture; but positive bone culture for *Proteus spp.*
80, F	Subclinical hyperthyroidism	Idiopathic	N/A	Seems to be coincidental
31, F	Pyruvate kinase deficiency + moderate mitral valve insufficiency	Idiopathic	N/A	Seems to be coincidental

ANA anti-nuclear antibody, *N/A* not applicable, *RF* rheumatoid factor, *SLE* systemic lupus erythematosus

recent years in accordance with the increased use of percutaneous cardiac interventions [1]. The rate was 14% in the study of Tsang et al. [1], whereas it was 27.6% in that of Inglis et al. [5] and 8% in that of Ma et al. [7]. This rate was determined as 1.7% in the present study although a high volume of percutaneous cardiac interventions have been performed in our institute (around 2,200 percutaneous coronary interventions and 350 percutaneous interventions for structural heart disease per year). However, we recognize that some pericardiocentesis procedures might have been missed because the search was done only with an institutional code, or surgical correction might have been performed in these emergent circumstances. These might have caused a *false* low rate in our institute.

The recent position statement of the European Society of Cardiology on cardiac tamponade states that transudative PEs caused by heart failure *never* progress to tamponade [14]. However, in the present study, seven of 13 patients with heart failure/severe valve disease presented with tamponade, and among them four had transudative effusion. These patients were assigned to the heart failure/severe valve disease category after comprehensive examination (except for viral identification) to rule out alternative causes. In general, viral identification was not ordered since it has low diagnostic yield and does not generally change management strategy [15]. Thus, these four patients could indeed have superimposed viral pericarditis. In a similar way, absence of viral identification might have misclassified some patients with acute viral or autoreactive effusion as having idiopathic effusion as well.

PE secondary to trauma or radiotherapy was not observed in any case. The reason for this may be the fact that most trauma patients require emergent surgery, and modern radiotherapy practices might have prevented severe fluid accumulation after mediastinal radiotherapy.

Although pericardial involvement is relatively common in many connective tissue diseases (e.g., >50% in systemic lupus erythematosus and 30% in rheumatoid arthritis), large fluid accumulation is not expected [16]. This could partly explain why only two cases were determined in the present study. However, it is also likely that some patients classified as having idiopathic or indeterminate effusion might actually have had one of these disorders.

Although pericardial biopsy and pericardioscopy are nowadays used in selected centers to establish an etiologically based diagnosis by safe and targeted biopsy technique, these modalities were not routinely available at our institution [17]. In most cases, the underlying disease for effusion was clear by the clinical setting in which it had occurred, or identified with simple blood tests. In general, indications for pericardiocentesis (PE with or without tamponade) and macroscopic appearance of the fluid (serous, serosanguineous, or

bloody) were not helpful in the differential diagnosis (Tab. 2). There was significant overlap between different etiologies by these features, in contrast to some studies [10, 18]. As an example, although malignancy was the most common cause of PE (28%; 84 out of 301) and had the highest probability of developing cardiac tamponade (88%; 72 out of 82 malignant effusions), the probability of a malignancy being the underlying cause in a patient presenting with cardiac tamponade was 42% (72 out of 170 patients with cardiac tamponade). In a similar way, although malignant effusion had a bloody appearance in most circumstances (69%; 55 out of 80 malignant effusions), only 32% of bloody effusions (55 out of 171) was related to malignancy. However, there were exceptional findings that could be useful for the differential diagnosis: Patients with tuberculosis (n=20) had either serosanguineous or bloody effusion upon gross inspection, i.e., none had a serous effusion. In patients with heart failure/severe valve disease (n=13), a bloody effusion was seen in only one patient but he had undergone traumatic cardiopulmonary resuscitation. Finally, all patients with hypothyroidism (n=12) presented with asymptomatic effusion (Tab. 2).

The number of patients in whom a diagnosis could not be established, i.e., the patients with idiopathic or indeterminate effusion, may be lower in clinical practice than in this report. Forty-one patients could not be reached on the home telephone number given in this study of retrospective design. Also, ten patients with indeterminate effusion indeed had a *likely* cause of effusion (Tab. 3).

This study had several limitations. The data were acquired via a retrospective analysis of hospital records. It is possible that some patients could be diagnosed with a different etiology because of the absence of a systematic diagnostic work-up. This is most relevant for autoreactive pericarditis. Since PCR for the identification of cardiotropic viruses in pericardial fluid was not carried out in the present study, these patients might have constituted part of the patients with idiopathic pericarditis [12, 19]. In addition, analysis of tumor markers (CEA, CA 19-9 etc.) and cytokines (interleukin-6, interferon-γ etc.) in pericardial fluid was not performed. We recognize the afore-mentioned diagnostic parameters could have contributed to assigning patients into a malignant, autoreactive, or viral etiology, and could have a potential to tailor an adequate therapy beyond antiphlogistic treatment [20, 21, 22]. As for the other causes, a long period of follow-up (median: 35 months) might have reduced the possibility of misdiagnosis. Another limitation was the lack of sufficient data for the mean duration of having a pericardial drain in situ. Finally, it should be emphasized that the present series included only patients with clinically significant effusion; however, in real-life practice, mild effusions are known to be more common and the spectrum of etiologies may differ.

Conclusion

Echo-guided pericardiocentesis has a high success and low complication rate in current practice. This can be achieved without the need for additional guidance with fluoroscopy or electrocardiography. Among the underlying etiological causes, malignancy remains the most common cause and is associated with a poor prognosis.

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Compliance with ethical guidelines

Conflict of interest. S. Akyuz, A. Zengin, E. Arugaslan, S. Yazici, T. Onuk, U.S. Ceylan, B. Gungor, U. Gurkan, T. Kemaloglu Oz, H. Kasikcioglu, and N. Cam state that there are no conflicts of interest.

All studies on humans described in the present manuscript were carried out with the approval of the responsible ethics committee and in accordance with national law and the Helsinki Declaration of 1975 (in its current, revised form). Informed consent was obtained from all patients included in studies.

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