

Echocardiographic manifestation of infective endocarditis — a single-centre experiences

Echokardiograficzna manifestacja infekcyjnego zapalenia wsierdza — doświadczenia jednego ośrodka

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Abstract

Introduction. Infective endocarditis (IE) is a life-threatening disease and still remains a medical challenge. Echocardiography is a key diagnostic tool in patients with a suspicion of IE. The aim of this study was a retrospective analysis of echocardiographic findings in patients with IE diagnosed in a single cardiac centre.

Material and methods. We analysed echocardiograms of 57 patients with IE (mean age 56.9 ± 17.9 years; 61.4% male) diagnosed in our Echolab between 2005 and 2017. Cardiac location of IE, type of lesions and vegetation size were assessed. The percentage of surgically treated and deceased patients was calculated and a comparison was made between the echocardiographic features in patients with a history of kidney disease and those of others.

Results. Most often IE affected native valves (66.6%). It was primarily IE of the left-sided native valves (61.4%). Vegetations were the most frequent echocardiographic abnormalities (89.5%). In 54.4% of all patients, vegetation size exceeded 10 mm. An abscess was confirmed in 26% of patients, twice more often on the aortic valve. Severe regurgitation was found in 58% of patients and in more than 50% of them there was aortic regurgitation. Most of the patients were treated conservatively (70.2%), and only one third of the group underwent surgery (29.8%). Eleven patients died due to complications of endocarditis (19.3%). Most of them (81.8%) had a history of kidney disease.

Conclusions. In patients with a suspicion of IE, echocardiographic findings determine the diagnosis. Left-sided native valves are very often affected by IE. Vegetations are the most common echocardiographic findings, but perivalvular complications also indicate IE and may be dangerous, particularly in the aortic valve. Severe regurgitation due to IE leads to heart failure, which is the main indication to surgery. Mortality due to endocarditis in patients with a history of kidney disease is higher than in other groups.

Key words: infective endocarditis, echocardiography, vegetations

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Introduction

Infective endocarditis (IE) is a medical challenge and remains a life-threatening disease.

Despite antibiotic therapy, patients affected by IE can develop serious complications [1–4]. Diagnosis of

IE should be based on clinical symptoms, positive blood cultures and echocardiographic findings [1, 5].

A special role for echocardiography in the diagnosis of IE was identified for the first time in the Duke criteria [6]. It is well known that transthoracic echocardiography (TTE) and transoesophageal echocardiography (TEE) are

two imaging techniques of choice for the diagnosis of suspected IE [1, 3].

TTE should be performed in all patients with suspected IE as soon as possible. TEE should be used in patients with a high suspicion of IE and suboptimal, unclear or negative TTE images, as well as in patients with prosthetic valves or implanted cardiac devices, and patients with perivalvular extension of IE [1, 3, 5]. However, TEE is not required in a case of right-sided native valve IE when TTE is undoubtedly negative [1, 3].

Major echocardiographic criteria of IE include vegetations, an abscess, a pseudoaneurysm, or a new dehiscence of a prosthetic valve. Valve perforation with severe regurgitation also suggests IE [1, 3, 5]. Sometimes, the features of IE are found incidentally. Echocardiographic findings are important predictors of systemic embolism and stroke, and have a significant impact on the decision-making process in terms of the necessity and time of surgical treatment [3, 7, 8].

The aim of this study was a retrospective analysis of echocardiographic findings in patients with infective endocarditis diagnosed in a single cardiac centre.

Material and methods

We reviewed echocardiographic examinations performed between July 2005 and November 2017. During this period, 680 patients were referred to our Echolab with an IE suspicion. The diagnosis of IE was confirmed in 48 of them (7.0%). Additionally, in nine other patients examined for other reasons, echocardiographic features typical of IE were unexpectedly found.

Finally, we analysed the records of 57 patients (61.4% male; mean age 56.9 ± 17.9 years). The main risk factors for IE in this group were immunosuppressive treatment, valve prostheses, dialysis catheters, pacemaker electrodes, and the use of illicit intravenous drugs.

All the 57 patients underwent a detailed TTE, and 47 of them (82.5%) also had a TEE. Standardised examinations with two-dimensional (2D), three-dimensional (3D), M-mode and Doppler assessment were performed. Both TTE and TEE images were interpreted by an experienced physician according to the recommendations of the guidelines of the ESC and the European Association of Cardiovascular Imaging [3, 9, 10].

All images of patients with IE were assessed in relation to their clinical symptoms. We analysed the cardiac location of IE and the type of lesion. The vegetation size was classified as small (< 10 mm) or large (≥ 10 mm) and in most cases was measured using TEE.

Due to the large number of patients with kidney disease in the study group, we formed two subgroups: 1) patients after kidney transplantation treated with immunosuppressive drugs and with end-stage renal disease treated with

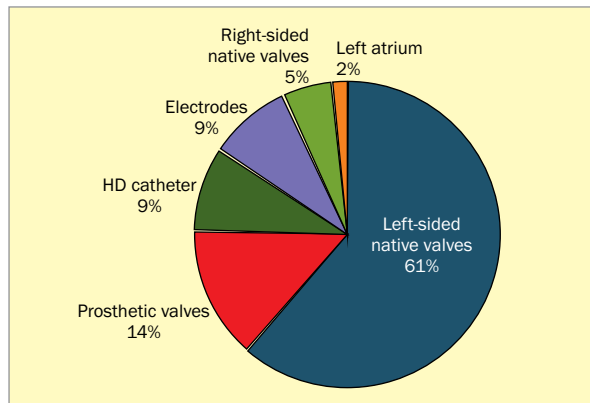


Figure 1. Cardiac location of infective endocarditis

haemodialysis (Group I), and 2) other patients with no history of kidney disease (Group II).

In both groups, the percentage of surgically treated and deceased patients was calculated and their characteristics were investigated. A comparison of echocardiographic features between patients in Groups I and II was carried out.

Statistics

Descriptive statistics for continuous variables are expressed as means and standard deviations. Qualitative data are expressed as counts and percentages. The relationships between qualitative variables were studied in contingency tables using the chi-square test or Fisher's exact. Between-group comparisons for quantitative variables were performed using t-test. Effects were considered significant at p -value < 0.05.

Results

Most cases of endocarditis affected native valves (66.6%). This was primarily IE of the left-sided native valves (61.4%). IE of valve prostheses, electrodes, and dialysis catheters also occurred. Right-sided IE included only tricuspid valve lesions. Figure 1 presents data on the cardiac location of IE.

Among patients with native valves IE, the aortic valve (AV) was affected in 38.6% of them, the mitral valve (MV) in 35.1%, and both in 12.3%. Tricuspid valve IE occurred only in three patients (5.3%), who had a history of intravenous drug abuse. Prosthetic valve IE was slightly more frequent in patients after AV replacement. We found IE in the same number of patients with haemodialysis catheters and implanted electrodes. Three patients presented a rare location of IE on the Eustachian valve and the left atrial wall. Detailed data on affected valves and devices is presented in Table 1.

Vegetations were the most frequent echocardiographic abnormalities (89.5% of patients). Vegetations ≥ 10 mm were seen in 60.8% (54.4% of all patients) and vegetations > 15 mm affected 37.3% (33.3% of all patients). In 11.8% (10.5% of all pts) the vegetation size exceeded 25 mm

Table 1. Affected valves and devices*

Parameter	All patients, N [%] (N = 57)	Group I, N [%] (N = 27)	Group II, N [%] (N = 30)	I vs II p
Native valves	38 (66.6)	15 (55.6)	23 (76.7)	0.103
Aortic valve	22 (38.6)	7 (25.9)	15 (50.0)	0.111
Mitral valve	20 (35.1)	10 (37.0)	10 (33.3)	0.99
Both aortic + mitral	7 (12.3)	3 (11.1)	4 (13.3)	1.0
Tricuspid valve	3 (5.3)	1 (3.7)	2 (6.7)	1.0
Prosthetic valves	8 (14.0)	4 (14.8)	4 (13.3)	1.0
Aortic:	5 (8.8)	4 (14.8)	1 (3.3)	0.179
• mechanical	3 (5.3)	3 (11.1)	0 (0)	0.100
• biological	2 (3.5)	1 (3.7)	1 (3.3)	1.00
Mitral:	3 (5.3)	0 (0)	3 (10.0)	0.239
• mechanical	2 (3.5)	0 (0)	2 (6.7)	0.492
• biological	1 (1.8)	0 (0)	1 (3.3)	1.0
HD catheter	5 (8.8)	5 (18.5)	0 (0)	0.019
Electrodes:	5 (8.8)	2 (7.4)	3 (10.0)	1.0
• pacemaker	4 (7)	2 (7.4)	2 (6.7)	1.0
• ICD	1 (1.8)	0 (0)	1 (3.3)	1.0
Eustachian valve	2 (3.5)	2 (7.4)	0 (0)	0.42
Left atrium	1 (1.8)	1 (3.7)	0 (0)	0.96

*Data expressed as counts and percentages; HD – haemodialysis; ICD – implantable cardioverter-defibrillator

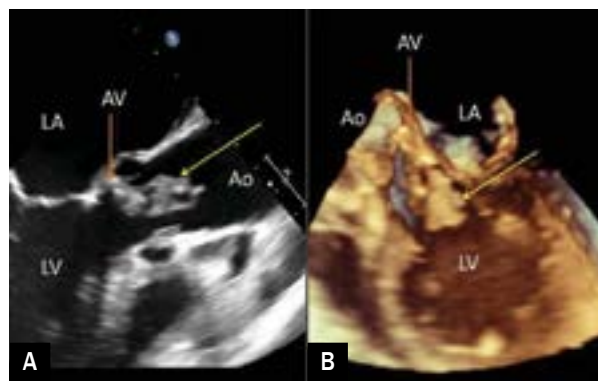


Figure 2. Aortic valve (AV) endocarditis: very large vegetation attached to the AV (yellow arrow); **A.** Two-dimensional (2D) transoesophageal echocardiography (TEE); **B.** Three-dimensional (3D) TEE; Ao – aorta; LA – left atrium; LV – left ventricle

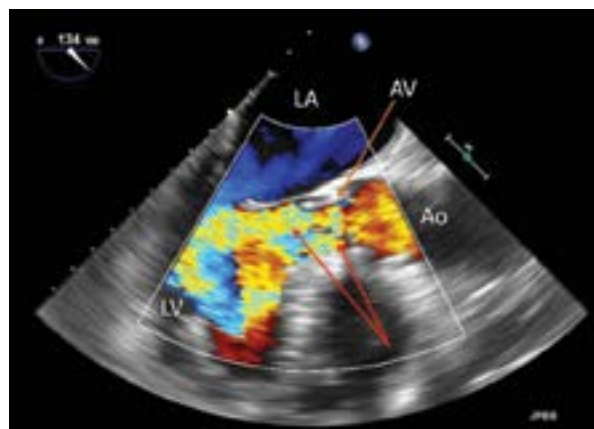


Figure 3. Severe aortic regurgitation caused by endocarditis: two jets of regurgitation (red arrows). Transoesophageal echocardiography (TEE), colour Doppler; Ao – aorta; AV – aortic valve; LA – left atrium; LV – left ventricle

(Figure 2). We found vegetations < 10 mm in 57.0% (50.9% of all studied patients).

Native valve perforation occurred in 42%, especially in the AV (26% of all cases and 68% of AV IE). The presence of an abscess was confirmed in TEE in 26% of patients. It occurred twice as often on the AV as in the MV.

Severe regurgitation was found in 58% of patients. In more than 50% of them, there was aortic regurgitation (AR)

(Figure 3) and in almost 40% mitral regurgitation (MR). Severe tricuspid regurgitation occurred in all three cases of tricuspid valve IE. An analysis of the echocardiographic findings is presented in Table 2.

Group comparison

Group I consisted of 27 patients (47.4%), while 30 patients formed Group II (52.6%). Mean age of patients in Group

Table 2. Echocardiographic findings*

Parameter	All patients (N = 57)	Group I (N = 27)	Group II (N = 30)	I vs II p
Vegetations:	51 (89.5%)	23 (85.2)	28 (93.3%)	0.238
• < 10 mm	29 (50.9%)	11 (40.7%)	18 (60.0%)	0.245
• ≥ 10 mm	31 (54.4%)	15 (55.5%)	16 (53.3%)	1.0
Perforation:	24 (42.1%)	11 (40.7%)	13 (43.3%)	1.0
• aortic valve	15 (26.3%)	4 (14.8%)	11 (36.7%)	0.117
• mitral valve	9 (15.8%)	6 (22.2%)	3 (10.0%)	0.283
• tricuspid valve	1 (1.8%)	1 (3.7%)	0 (0%)	0.474
Abscess:	15 (26.3%)	8 (29.6%)	7 (23.3%)	0.812
• aortic valve	10 (17.5%)	6 (22.2%)	4 (13.3%)	0.492
• mitral valve	5 (8.8%)	2 (7.4%)	3 (10.0%)	1.0
Severe aortic regurgitation	17 (29.8%)	4 (14.8%)	13 (43.3%)	0.039
Severe mitral regurgitation	13 (22.8%)	7 (25.9%)	6 (20.0%)	0.829
Severe tricuspid regurgitation	3 (5.3%)	1 (3.7%)	2 (6.7%)	1.0

*Data expressed as counts and percentages

I was significantly lower than in Group II, and the percentage of women was higher (Table 3).

The occurrence of native valves IE did not differ between the groups. However, a native AV IE occurred half as often in Group I as in Group II. The number of cases of MV IE was similar in both groups. There was no difference in the percentage of prosthetic valve IE between the groups. IE associated with haemodialysis catheter was observed in five patients from Group I (18.5%). Four out of these five patients revealed vegetations > 10 mm in size (Figure 4). Cases of Eustachian valve and left atrium IE were found only in Group I.

The percentage of patients with vegetations, large vegetations, abscesses and perforations did not differ significantly between the groups. AV perforation occurred more than twice as often in Group II, and an MV perforation was found twice as frequently in Group I (Figure 5).

There were no noticeable differences in the number of abscesses.

Severe AR as a result of AV destruction was observed significantly more often in Group II than in Group I (43.3% vs 14.8%, $p = 0.039$).

Surgically treated and deceased patients

Most of the studied patients were treated conservatively (70.2%), and only one third of the group underwent surgery (29.8%). There was no percentage difference in the chosen treatments between Groups I and II (Table 3).

Mean age of surgically treated patients was 55.4 ± 20.6 years. In 64.7% of them IE affected the AV. Vegetations occurred in 14 patients (82.3%), a perivalvular abscess in 10 patients (58.8%), and a leaflet perforation in

13 patients (76.5%). Native AV endocarditis was developed in nine patients and in eight of them resulted in severe aortic regurgitation. In two patients with AV prostheses IE, significant perivalvular leaks were found.

Eleven patients died due to complications of endocarditis (19.3%; five women, six men; mean age 63.8 ± 10.6 years). Only four of them underwent surgery. None of the patients revealed clinically evident stroke. Vegetations were found in 63.6% of deceased patients, perivalvular abscesses and valve perforation in 45.5%. Most often IE affected native MV and in five patients severe MR due to leaflet perforation was observed. As many as nine out of the 11 deceased patients (81.8%) had a history of kidney disease. Thus, the percentage of deceased patients was significantly higher in Group I than in Group II (33.3% vs 6.7%, $p = 0.027$). The general characteristics of the patients are presented in Table 3.

Discussion

The role of echocardiography as a key imaging tool in patients with IE was identified in the Duke criteria and its later modifications [6, 11]. In current recommendations echocardiographic results positive for IE are important major criteria [1].

Both TTE and TEE should be used in the diagnostic process of IE as complementary methods. Importantly, TEE is mandatory in patients with implanted valve prostheses or cardiac devices [1, 3, 12].

In order to precisely diagnose IE, we supplemented TTE with TEE in 82.5% of patients with suspected IE. Vieira et al. performed TEE in all studied patients and Nagai et al. in

Table 3. Characteristics of the study group*

Parameter	All patients (N = 57)	Group I (N = 27)	Group II (N = 30)	I vs II p
Age [years]	56.9 ± 17.9	51.7 ± 17.1	61.7 ± 17.6	0.035
Gender (F/M)	22/35	15/12	7/23	0.026
Conservatively treated patients, N [%]	40 (70.2)	21 (77.8)	19 (63.3)	0.37
Surgically treated patients, N [%]	17 (29.8)	6 (22.2)	11 (36.7)	0.37
Deceased patients, N [%]	11 (19.3)	9 (33.3)	2 (6.7)	0.027

*Data expressed as means and standard deviations and as counts and percentages; F – female; M – male



Figure 4. Infective endocarditis associated with the presence of a haemodialysis catheter: large bacterial vegetation attached to the catheter (yellow arrow); **A.** Two-dimensional (2D) transoesophageal echocardiography (TEE); **B.** Three-dimensional (3D) TEE; IAS – interatrial septum; LA – left atrium; RA – right atrium

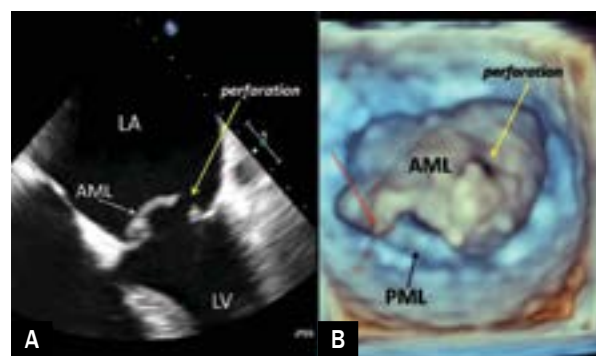


Figure 5. Mitral valve infective endocarditis in patient with end-stage renal disease: large perforation of anterior mitral leaflet (AML) (yellow arrow), a broken primary tendinous chord (red arrow); **A.** Two-dimensional (2D) transoesophageal echocardiography (TEE); **B.** Three-dimensional (3D) TEE; LA – left atrium, LV – left ventricle, PML – posterior mitral leaflet

74% of patients, although Rozwodowska et al. performed it in only 17% of patients [13–15]. While TEE was performed in almost all cases with 'left sided' IE, we did not perform TEE in three patients with tricuspid valve IE, where there was very good TTE imaging quality. Obviously, we did not perform TEE in seven patients who refused this examination.

In the study group IE most often affected native valves, especially left-sided heart valves, with a higher occurrence in the AV. This observation aligns with the findings of other authors [15].

Vegetations were the most common features of endocarditis revealed by echocardiography (almost 90% of all cases). Other authors have published similar results. Nagai et al. detected vegetations in 82%, di Salvo in 72%, and Rozwodowska et al. in 70.7% of cases [14–16]. In patients assessed by Vieira et al. vegetations were identified by TTE in 61 patients (54.4%) and by TEE in 88.2% of cases [13]. It must be noted that the diagnostic sensitivity for vegetations in native valves by TTE is 70%, and in prosthetic valves is 50%; in TEE examination the values exceed 96% and 92%, respectively [1, 5].

In the course of IE, embolic events occur in 20–50% of patients and echocardiographic findings help to predict them [1, 8]. Vegetation size measurement is necessary, and this should preferably be by TEE. Patients with large and mobile vegetations attached to the MV and AV are associated with a very high risk of neurological complications, including stroke [1, 17]. Leitman et al. analysed vegetation size in relation to the course of IE and showed that older patients (> 60 years) with large vegetations had a significantly increased risk of mortality, especially in staphylococcal infections [18].

Since 2013, we have routinely used 3D TEE for a detailed evaluation of valve destruction, and an accurate evaluation of vegetation size. There are reports indicating that in 2D TEE vegetation size may be underestimated. The use of the 3D option perfectly complements the assessment of vegetation size and morphology [19].

Perivalvular abscess remains a very serious complication of IE [1, 3]. It is usually a diagnostic difficulty. TTE sensitivity for the diagnosis of abscesses is low, about 50%, while TEE sensitivity reaches 90% [3].

An abscess rupture often results in valve destruction with significant regurgitation or perivalvular leak. Patients with perivalvular extension of IE need more urgent surgery and have a high mortality rate [13].

In our group, abscesses occurred in 26% of all patients, twice more often in the AV. Approximately 60% of surgically treated patients developed a perivalvular abscess and leaflet perforation was present in 76.5% in this group. Vieira et al. detected abscesses in 29% of patients, Nagai in 18%, and Rozwodowska in approx. 10% [13–15].

Heart failure is the main indication to surgery and an important predictor of a poor outcome [1, 5]. The most common cause of heart failure is destruction of the valve leading to significant AR or MR with serious haemodynamic consequences. We found severe regurgitation in 33 cases (58%) and more than 50% of them had AR.

Severe AR was a main indication for surgery in 11 patients (64.7%) and severe MR in 5 patients (29.4%). Other researchers have published similar data regarding indications for surgery [13, 15].

There were many patients with end-stage renal disease and patients after kidney transplantation treated with immunosuppressive drugs in the study group. Therefore, we compared their echocardiographic findings to the results of other patients. No significant differences in the occurrence of native or prosthetic valve IE between patients with kidney disease and others were established. The percentage of cases with vegetations, abscesses and perforations was similar in both compared groups.

Importantly, patients with a history of kidney disease were in the majority among the deceased patients (82%). They presented an MV perforation with severe regurgitation twice as frequently. This indicates that attention should be paid to this specific group of patients, because they are at a higher risk of infection than others.

Bhatia et al. in their large, multicentre, population-based observational study demonstrated a rising incidence of IE-related hospitalisations in dialysis patients and the association of long-term dialysis with worse in-hospital outcomes [20].

Surgical treatment due to endocarditis was performed only in one third of patients (29.8%). The majority of patients were treated conservatively, which corresponds to other clinical observations [15]. AV IE complicated by severe AR was more frequently observed in patients qualified for cardiac surgery.

Despite progress in diagnostic modalities, a diagnosis of endocarditis still remains a challenge. Echocardiography

plays a key role in detecting this disease. However, in cases of perivalvular complications, other imaging techniques such as multislice computed tomography (CT) or positron computed tomography (PET)/CT are helpful.

Study limitations

The main limitation of the study is that it is a single-centre observation. It must be noted that echocardiographic results obtained in one centre will depend on patient characteristics and the specialities of the departments from which they have been referred (e.g. dialysis station).

Additionally, we focused only on the results of echocardiographic examinations which finally confirmed IE, and the study does not include the data of microbiological results or pharmacological therapies, which would have provided more information.

Conclusions

In patients with a clinical suspicion of IE, echocardiographic findings determine the diagnosis and prognosis and may influence the choice of treatment. Transoesophageal echocardiography in its 2D and 3D options is a very helpful and valuable supplement for TTE, and should be used in the majority of patients. Vegetations are the most common echocardiographic findings, but perivalvular complications also indicate IE and must always be explained. Endocarditis of left-sided native valves is very often detected. Significant valve destruction resulting in severe regurgitation and haemodynamic instability is one of the most common indications to surgery. However, we must always pay special attention to persons with implanted prostheses or devices during echocardiographic examinations. Mortality due to endocarditis in haemodialysis patients, and among patients after kidney transplantation, is higher than in other groups.

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Conflict(s) of interest

The authors declare no conflicts of interests.

Streszczenie

Wstęp. Infekcyjne zapalenie wsierdzia (IE) pozostaje chorobą zagrażającą życiu i wciąż stanowi medyczne wyzwanie. Echokardiografia jest kluczowym narzędziem diagnostycznym u pacjentów z podejrzeniem IE. Celem pracy była retrospektywna analiza wyników badań echokardiograficznych u pacjentów z IE rozpoznany jednym ośrodkiem kardiologicznym.

Materiał i metody. Przeanalizowano echokardiogramy 57 pacjentów z IE (śr. wiek 56,9 ± 17,9 roku; 61,4% mężczyzn) rozpoznany w pracowni echokardiografii w latach 2005–2017. Oceniono lokalizację i rodzaj zmian typowych dla IE oraz dokonano **pomiarów znalezionych wegetacji**. Oszacowano odsetek osób leczonych chirurgicznie i zmarłych z powodu IE oraz porównano wyniki echokardiograficzne pacjentów z przewlekłą chorobą nerek z wynikami pozostałych badanych.

Wyniki. Najczęściej zapaleniem wsierdzia były zajęte zastawki natywne (66,6%), przede wszystkim w obrębie lewego serca (61,4%). Najczęstszym znaleziskiem echokardiograficznym, aż u 54,4% chorych, były wegetacje (89,5%), których rozmiar przekraczał 10 mm. Obecność ropnia potwierdzono u 26% badanych, 2-krotnie częściej na zastawce aortalnej. Ciężką niedomykalność stwierdzono u 58% chorych i w ponad połowie przypadków dotyczyła ona zastawki aortalnej. Większość pacjentów leczono zachowawczo (70,2%), a tylko 1/3 z nich poddano leczeniu operacyjnemu (29,8%). Jednocześnie chorych zmarło z powodu powikłań IE (19,3%), a większość z nich (81,8%) cierpiała na chorobę nerek.

Wnioski. U pacjentów z podejrzeniem IE o rozpoznaniu choroby decydują wyniki badań echokardiograficznych. Bardzo często zapalenie wsierdzia dotyczy zastawek lewego serca. Najczęstszym znaleziskiem echokardiograficznym są wegetacje, jednak na rozpoznanie IE wskazują także powikłania okołozastawkowe i mogą być groźne, szczególnie w obrębie zastawki aortalnej. Ciężka niedomykalność zastawki w przebiegu IE prowadzi do niewydolności serca będącej głównym wskazaniem do operacji. Śmiertelność z powodu IE u pacjentów dializowanych lub po przeszczepieniu nerki jest wyższa niż u pozostałych.

Słowa kluczowe: infekcyjne zapalenie wsierdzia, echokardiografia, wegetacje

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