ORIGINAL ARTICLE

Evaluation of the relationship between platelet indices and spontaneous echo contrast in patients with mitral prosthetic heart valves

Mitral protez kalp kapaklı hastalarda trombosit indeksleri ile spontan eko kontrast arasındaki ilişkinin araştırılması

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ABSTRACT

Objective: Spontaneous echo contrast (SEC) is defined as dynamic, smoke-like echoes within the cardiac cavities with a characteristic swirling motion seen on echocardiography. Clinical studies have demonstrated that SEC is a risk factor for left atrial thrombus formation and an important indicator for potential systemic embolism. Platelet indices have been associated with the presence of SEC in patients with mitral stenosis. The aim of this study was to investigate the relationship between platelet indices and SEC in patients with prosthetic heart valves.

Methods: A total of 89 patients [female: 38 (42.4%); median age: 52 years (range: 36-67 years)] with SEC formation in the left atrium, and 257 control subjects [female: 123 (47.5%); median age: 56 years (range: 45-65 years)] without SEC formation were enrolled. All of the patients were evaluated by using transthoracic and transesophageal echocardiography. Laboratory tests including complete blood count and biochemical parameters were analyzed.

Results: Patients with SEC formation had more frequent atrial fibrillation, higher left atrial diameter (LAD) and lower left ventriular ejection fraction values. Platelet indices including platelet count, platelet distribution width, mean platelet volume, and plateletcrit did not differ between the groups. Increased LAD was detected as the only independent predictor of SEC development.

Conclusion: Platelet indices were not found to be associated with the presence of SEC formation in the left atrium among patients with mitral prosthetic valves. Therefore, the use of platelet indices alongside known echocardiographic and clinical risk factors to predict SEC development in patients with a mitral prosthesis is debatable.

ÖZET

Amaç: Spontan eko kontrast (SEK) ekokardiyografi ile kalp boşluklarında karakteristik girdapsı hareketi olan dinamik duman benzeri yansımalar olarak tanımlanmaktadır. Önceki klinik çalışmalar SEK mevcudiyetini sol atriyal trombüs gelişimi için bir risk faktörü ve olası sistemik embolizm için önemli bir gösterge olduğunu kanıtlamıştır. Mitral stenozu olan hastalarda SEK varlığı ile trombosit indeksleri arasındaki ilişki gösterilmiştir. Bu çalışmada mekanik protez kapaklı hastalarda trombosit indeksleri ve SEK arasındaki ilişkinin araştırılması amaçlanmıştır.

Yöntemler: Bu kilinik çalışmaya sol atriyumda SEK formasyonu izlenen 89 hasta [kadın: 38 (%42.4), ortalama yaş: 52 (36-67) yıl] ve SEK formasyonu izlenmeyen 257 kişiden oluşan kontrol grubu [kadın: 123 (%47.5), ortalama yaş: 56 (45-65) yıl] dahil edildi. Tüm hastalar transtorasik ve transözafajiyal ekokardiyografinin yanında tam kan sayımı ve biyokimyasal parametrelerinin olduğu labaratuvar testleri ile değerlendirildi.

Bulgular: SEK formasyonuna sahip hastalarda daha sık atriyal fibrilasyon, daha geniş sol atriyal çap ve daha az sol ventrikül ejeksiyon fraksiyonu izlendi. Trombosit sayısı, trombosit dağılım genişliği, ortalama trombosit hacmi ve pletaletkritten oluşan trombosit indeksleri açısından iki grup arasında farklılık izlenmedi. Artmış sol atriyum çapı SEK formasyonunun tek bağımsız öngörücüsü olarak belirlendi.

Sonuç: Mitral mekanik protez kapaklı hastalarda sol atriyumda SEK formasyonu ile trombosit indeksleri arasında bir ilişki bulunamadı. Bu nedenle, trombosit indekslerinin daha önceden bilinen ekokardiyografik ve klinik risk faktörleri ile birlikte mitral protez kapaklı hastalarda SEK formasyonunun öngörüsünde kullanımı tartışmalıdır.

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Spontaneous echo contrast (SEC) is the presence of smoke-like echoes with a characteristic swirling motion of blood observed on echocardiography. It occurs as a result of aggregation of the cellular component of blood in the situations with blood stasis and low bloodstream velocity. SEC is commonly seen in the left atrium and left atrial appendage.[1] Clinical studies have demonstrated that SEC is a risk factor for left atrial thrombus formation and an important indicator of potential systemic embolism originating in the heart.[2] Left atrial SEC has been noted to be a relatively frequent finding in patients after mitral valve replacement surgery, especially when conditions favoring blood stasis are present, such as atrial fibrillation or left atrial dilatation.[3] Transesophageal echocardiography (TEE) is a valuable diagnostic tool in the assessment of mitral valve prostheses. It allows examination of the left atrium from the posterior wall, avoiding the acoustic shadowing from the prosthesis.[4] Thus, SEC has been more frequently detected by TEE than with transthoracic echocardiography (TTE).

Abbreviations:

AUC	*Area under the curve*
CI	*Confidence interval*
EDTA	*Ethylenediaminetetraacetic acid*
LAD	*Left atrial diameter*
LVEF	*Left ventricular ejection fraction*
MPV	*Mean platelet volume*
PCT	*Plateletcrit*
PDW	*Platelet distribution width*
RBC	*Red blood cell*
ROC	*Receiver operating characteristic*
SEC	*Spontaneous echo contrast*
TEE	*Transesophageal echocardiography*
TTE	*Transthoracic echocardiography*
WBC	*White blood cell*

There are several potential physiopathological mechanisms underlying the formation of SEC. It occurs due to aggregation of the cellular component of blood; however, there is disagreement whether red blood cell or platelet aggregation causes this phenomenon. Sigel et al.[5] reported that the echogenicity of blood in SEC occurred with erythrocyte aggregation in plasma. Erbel et al.[6] found evidence of increased platelet aggregation in patients with SEC and resolution after antiplatelet therapy. These data suggest that SEC may reflect not only stasis of blood in the left atrium, but may also be associated with blood characteristics, including erythrocytes and platelets.

Platelet indices, such as platelet count, platelet distribution width (PDW), mean platelet volume (MPV), and plateletcrit (PCT), are easily measurable parameters in a complete blood count. In a previous study, MPV and PCT levels were found to be associated with the presence of SEC in patients with mitral stenosis.[7] To our knowledge, the relationship between platelet indices and SEC in patients with prosthetic heart valves has not yet been studied. The objective of this study was to examine any association between platelet indices and SEC formation in patients with mitral prosthetic valves.

METHODS

Study population

Between August 2014 and September 2018, among patients with normally functioning mitral prosthetic valves as confirmed by TEE, 89 patients [female: 38 (42.4%); median age: 52 years (range: 36–67 years)] with SEC formation in the left atrium, and 257 control subjects [female: 123 (47.5%); median age: 56 years (range: 45–65 years)] without SEC formation were enrolled in this single-center, case-control study. Patients with prosthetic valve thrombosis, pannus, vegetation, paravalvular leakage, presence of additional valve prosthesis, subtherapeutic anticoagulation, current therapy with corticosteroids or nonsteroidal anti-inflammatory drugs, end-stage liver or kidney disorders, chronic inflammatory diseases, connective tissue diseases, infective endocarditis, active infection, pregnancy, thyroid disease, and malignancies were excluded from the study.

Laboratory analyses

All of the blood samples were obtained from the participants after a 12-hour fasting period. A complete blood count, including white blood cell (WBC), neutrophil, and lymphocyte counts; red blood cell (RBC) parameters (RBC count, hemoglobin, hematocrit, mean corpuscular volume, RBC distribution width); and platelet indices (platelet count, MPV, PCT, PDW) was obtained using an automatic blood counter (Cell Dyn 3700 Abbott Diagnostics Division, Lake Forest, IL, USA). The neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio were calculated using the same automated blood samples. Fasting blood glucose, urea, creatinine, uric acid, aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, albumin, international normalized ratio, total cholesterol (TC), high density lipoprotein (HDL), and triglyceride (TG) levels were measured. The low-density lipoprotein (LDL) level was calculated using the Friedewald formula [LDL (mg/dL)=TC-(HDL+TG/5)].[8]

Echocardiography

All of the patients were evaluated using TTE, 2-dimensional and real-time 3-dimensional TEE with an X7-2t transducer on an iE33 ultrasound machine (Philips Healthcare, Inc., Andover, MA, USA). TTE was performed using the same echocardiography device and a 3-1 MHz S5-1 adult probe with the patient in the left lateral decubitus position. Parasternal long-axis and short-axis views and the apical 5-chamber view were used during the TTE evaluation. Transmitral pressure gradients and the effective orifice area were measured with TTE according to the current guidelines.[9] Left atrial diameter (LAD) was measured on the parasternal long-axis view. Left ventricular ejection fraction (LVEF) was calculated using the biplane Simpson's method. For the echocardiographic examination, SEC was defined as observation of dynamic, smoke-like echoes within the cardiac cavities with a characteristic swirling motion (Fig. 1a and b) that could not be eliminated by changes in gain settings.[1] The patients were classified according to the severity of SEC. Mild SEC was defined as minimal echogenicity located in the left atrial appendage or sparsely distributed in the left atrial cavity and not visible at low gain settings, moderate SEC was defined as a more dense swirling pattern with a similar distribution pattern and detectable without increased gain settings, and severe SEC was defined by more intense echo density and a very slow swirling pattern distributed throughout both the left atrium and the left atrial appendage that was detectable at low gain settings throughout the cardiac cycle. All of the patients were evaluated by 2 experienced cardiologists who were blinded to patient data and interobserver agreement was calculated.

The patient demographic characteristics of age; gender; prosthetic valve type and leaflet status; heart rhythm; frequency of diabetes mellitus, hypertension, dyslipidemia, or coronary artery disease; smoking status; echocardiographic parameters of transmitral pressure gradients, mitral valve area, LVEF and LAD; and the laboratory parameters of a complete blood count and biochemical values were entered into a database. All of the patients provided written informed consent. The study protocol was approved by the local ethics committee of the hospital and conducted in accordance with the Declaration of Helsinki and the International Conference on Harmonisation Good Clinical Practice guidelines.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 19.0. (IBM Corp., Armonk, NY, USA). Descriptive statistics were reported as mean±standard deviation for continuous variables with normal distribution or median (25^{th}-75^{th} percentiles) values for continuous variables without normal distribution and as frequency with percentages for categorical variables. The Shapiro-Wilk test was used to test the normality of the distribution of continuous variables. The Student's t-test or the Mann-Whitney U test was used to compare continuous variables, as appropriate. Categorical variables were compared using a chi-square test. Multivariate regression analysis

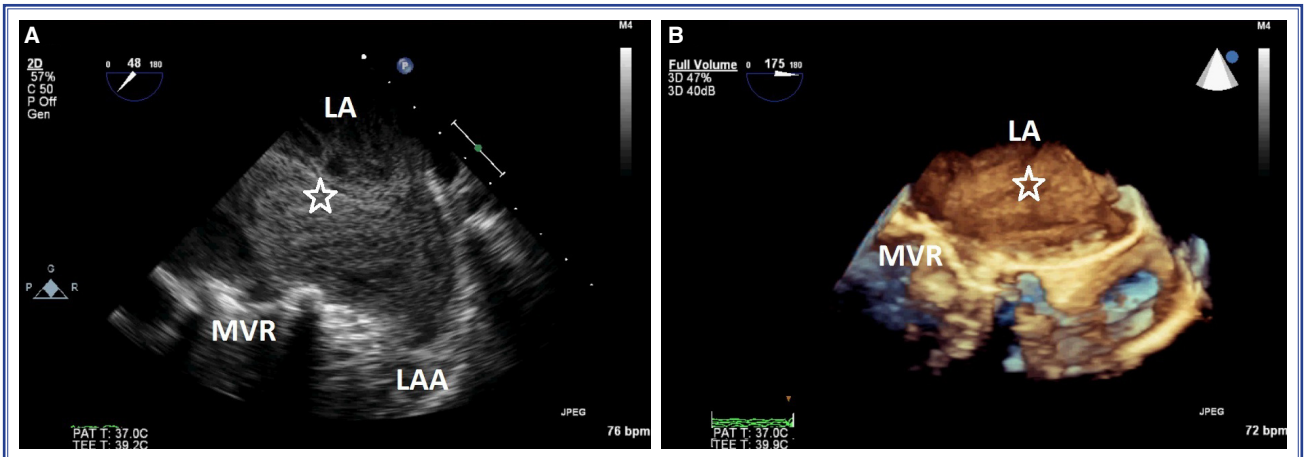

Figure 1. **(A)** Two-dimensional and **(B)** real-time 3-dimensional transesophageal echocardiography views revealing spontaneous echo contrast (stars) as dynamic, smoke-like echoes within the left atrium with a characteristic swirling motion. LA: Left atrium; LAA: Left atrial appendage; MVR: Prosthetic mitral valve.

was performed to identify any independent variables associated with SEC formation. A receiver operating characteristic (ROC) curve analysis was performed to evaluate the sensitivity, specificity, area under the curve (AUC), and confidence interval (CI) of the LAD measurement to predict the presence of SEC. Interobserver agreement for the diagnosis and grading of SEC formation was evaluated using Cohen's kappa test. Agreement was rated as moderate for kappa values of 0.41–0.60, kappa values of 0.61–0.8 were considered substantial, and those >0.80 were judged to be good. The significance level of $p<0.05$ was accepted in all of the statistical analyses.

RESULTS

The clinical and demographical characteristics of patients with and without SEC formation are presented in Table 1. There was no significant difference between the groups in terms of age; gender; prosthetic valve type and leaflet status; frequency of diabetes mellitus, hypertension, and dyslipidemia; smoking status; or coronary artery disease. Comparison of the cardiac rhythm of the patients revealed that atrial fibrillation was observed more frequently in the SEC(+) group than in the SEC(-) group (65.2% vs 51.8%; p=0.028). There was no significant difference in the

Table 1. Comparison of the clinical and demographical characteristics between the SEC (+) and SEC (-) groups

Variables	SEC (+) group (n=89)	SEC (-) group (n=257)	*p*
Age, years	52 (36–67)	56 (45–65)	0.475
Gender, n (%)			
Male	51 (57.6)	134 (52.5)	0.399
Female	38 (42.4)	123 (47.5)	
Leaflet type, n (%)			
Monoleaflet	12 (72.7)	39 (70)	0.698
Bileaflet	77 (18.2)	218 (17.5)	
Valve type, n (%)			
Bioprosthetic	6 (6.7)	26 (10.1)	0.344
Mechanical	83 (93.3)	231 (89.9)	
ETSVS, (months)	31 (14–76)	36 (18–72)	0.233
Time in therapeutic range, (%)	83 (75–92)	86 (78–89)	0.472
Mean INR in the last 3 months	2.6 (2.1–3.3)	2.7 (2.2–3.1)	0.687
Antiplatelet agent usage, n (%)	16 (18)	55 (21.4)	0.491
Cardiac rhythm, n (%)			
Normal sinus rhythm	31 (34.8)	124 (48.2)	0.028
Atrial fibrillation	58 (65.2)	133 (51.8)	
Hypertension, n (%)	42 (47.2)	111 (43.2)	0.513
Diabetes mellitus, n (%)	9 (10.1)	38 (14.8)	0.267
Dyslipidemia, n (%)	17 (19.1)	56 (21.8)	0.592
Smoking status, n (%)	21 (23.6)	48 (18.7)	0.317
Coronary artery disease, n (%)	26 (29.2)	64 (24.9)	0.424
Left atrial diameter (mm)	53.8±7.8	49.9±5.4	<0.001
Left ventricular ejection fraction (%)	51.9±6.4	53.4±5.2	0.026
Transmitral gradients (mmHg)			
Mean gradient	3.58±0.82	3.39±0.97	0.897
Peak gradient	8.54±1.4	8.78±1.9	0.643
Mitral valve area (cm^2)	2.23±0.32	2.34±0.43	0.793

ETSVS: Elapsed time since valve surgery; INR: International normalized ratio; SEC: Spontaneous echo contrast.

elapsed time since valve surgery between the groups. The therapeutic time range percentages and mean international normalized ratio values in the previous 3 months were also similar between patients with and without SEC formation. Several patients were using antiplatelet agents, including acetylsalicylic acid and clopidogrel, for different indications. There was no significant difference in terms of antiplatelet agent usage between the groups. The echocardiographic parameters of mean and peak transmitral pressure gradient and mitral valve area were similar between the groups, except for LAD and LVEF. The mean LAD measurement was significantly greater in the SEC(+) group than in the controls (53.8±7.8 mm vs 49.9±5.4 mm; p<0.001) (Fig. 2a), whereas the mean LVEF percentage was significantly smaller in the SEC(+) group than in the controls (51.9±6.4% vs. 53.4±5.2%; p=0.026).

Comparisons of laboratory parameters between the groups are presented in Table 2. There was no significant difference between the groups in terms of the complete blood count and biochemical test parameters. The WBC, neutrophil, and lymphocyte counts; neutrophil-to-lymphocyte ratio, and platelet-to-lymphocyte ratio were similar between the groups. The RBC indices of RBC count, hemoglobin, hematocrit, mean corpuscular volume, and RBC distribution width were also similar between the groups. Upon comparison of the platelet indices between the patients with and without SEC formation, no significant difference was detected in the platelet count, MPV, PCT, or PDW (Fig. 3).

Multivariate regression analysis was used to evaluate the univariate parameters that were possible predictors of SEC development (Table 3). Increased LAD was the only independent predictor of SEC development (Odds ratio: 1.655, 95% CI: 1.054–1.1141; p=0.021). In the ROC curve analysis, LAD values >50.5 mm predicted SEC formation with a sensitivity of 78% and a specificity of 61% (AUC: 0.641, 95% CI: 0.571–0.712; p<0.001) (Fig. 2b).

The patients were classified according to the severity of SEC. The interobserver agreement was good with a kappa value of 0.87. There were 23 patients with mild SEC, 32 patients with moderate SEC and 34 patients with severe SEC. All of the comparisons were performed between these groups; however, there was no significant difference between groups in terms of clinical, echocardiographic, or laboratory parameters.

DISCUSSION

In this single-center, case-control study, we focused on a potential relationship between platelet indices and SEC formation in patients with mitral prosthetic

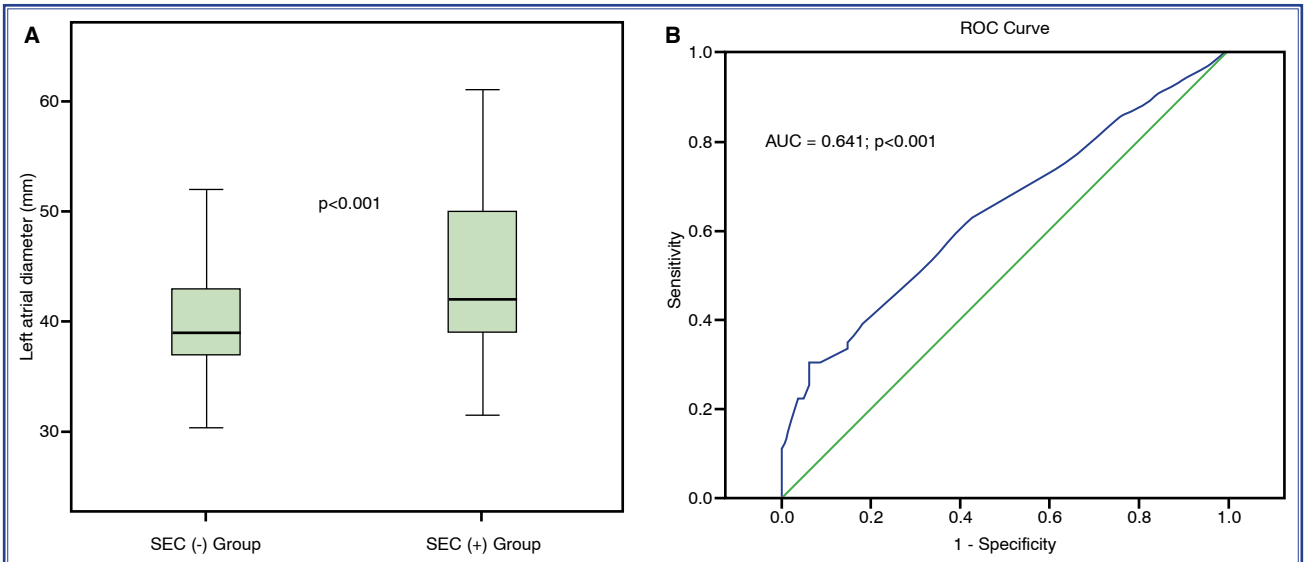

Figure 2. **(A)** Comparison of the left atrial diameter of patients with and without spontaneous echo contrast (SEC) formation; **(B)** Receiver operating characteristic curve revealing the area under the curve (AUC) for left atrial diameter to predict the presence of SEC.

Table 2. Comparison of laboratory parameters between the SEC(+) and SEC(-) groups

Laboratory parameters	SEC (+) group (n=89)	SEC (-) group (n=257)	*p*
White blood cell (x10^3/μL)	7.3±1.7	7.2±1.6	0.472
Neutrophil (x10^3/μL)	4.5±1.5	4.6±1.5	0.631
Lymphocyte (x10^3/μL)	1.98±0.72	1.97±0.75	0.897
Red blood cell (x10^6/μL)	4.5±0.5	4.6±0.4	0.675
Hemoglobin (g/dL)	13.4±1.7	13.6±1.4	0.399
Hematocrit (%)	40.3±4.8	40.8±4.2	0.343
Mean corpuscular volume (fL)	87.9±5.4	88.6±4.5	0.293
Red cell distribution width (%)	15.6±2.1	15.2±1.6	0.096
Platelet count (x10^3/μL)	226.7±55.6	230.9±57.7	0.869
Mean platelet volume (fL)	8.2±1.4	7.9±1.3	0.163
Plateletcrit (%)	0.25±0.07	0.24±0.06	0.413
Platelet distribution width (%)	12.3±3.2	12.2±2.5	0.698
Neutrophil-to-lymphocyte ratio	2.65±0.8	2.74±0.6	0.647
Platelet-to-lymphocyte ratio	130±51	134±60	0.590
Glucose (mg/dL)	105.9±28.7	104.4±25.9	0.643
Urea (g/dL)	34 (28-41.5)	34 (28-39)	0.689
Creatinine (g/dL)	0.8 (0.7-1.0)	0.8 (0.7-0.9)	0.437
Uric acid (mg/dL)	5.6±1.6	5.4±1.5	0.633
Aspartate aminotransferase (U/L)	22 (19-28)	21 (19-25)	0.237
Alanine aminotransferase (U/L)	19 (14-27)	18(13-25)	0.319
Lactate dehydrogenase (U/L)	253 (202-432)	244 (194-446)	0.616
Albumin (g/dL)	3.9±0.5	4.1±0.5	0.857
Total cholesterol (mg/dL)	207.4±49.2	213.78±41.3	0.691
Triglyceride (mg/dL)	143.5±59.5	148.7±61.6	0.805
Low-density lipoprotein (mg/dL)	121.9±34.7	123.3±37.5	0.495
High-density lipoprotein (mg/dL)	45.4±10.9	45.1±10.6	0.752
International normalized ratio	2.5±0.5	2.4±0.6	0.217

SEC: Spontaneous echo contrast.

heart valves. There was no significant difference between the patients with and without SEC formation in terms of the platelet indices of platelet count, MPV, PCT, or PDW. A larger LAD measurement was found to be the only independent predictor of SEC development in patients with mitral prosthetic valves.

SEC is a well-known phenomenon that has been observed occasionally in patients with low flow states, such as the echoes seen in the left atrium in patients with mitral valve diseases or in the left ventricle in severe left ventricular systolic dysfunction.[10] There are limited data regarding SEC formation in patients with mechanical prosthetic mitral valves, and the clinical significance of SEC in these patients is unclear. The particles causing these echoes are probably too small to cause clinically recognized emboli, and the long-term effect is unknown.[3,11,12]

Prosthetic valve thrombosis is a potentially life-threatening complication associated with high morbidity and mortality.[13] Inadequate anticoagulation, the early postoperative period, a history of atrial fibrillation, left atrial enlargement, multiple valve replacement, ventricular dysfunction, and pregnancy are the major risk factors for the development of prosthetic valve thrombosis.[15–16] SEC formation in the left atrium has been noted to be a relatively frequent finding in patients after mitral valve replacement, especially when conditions favoring blood stasis, like

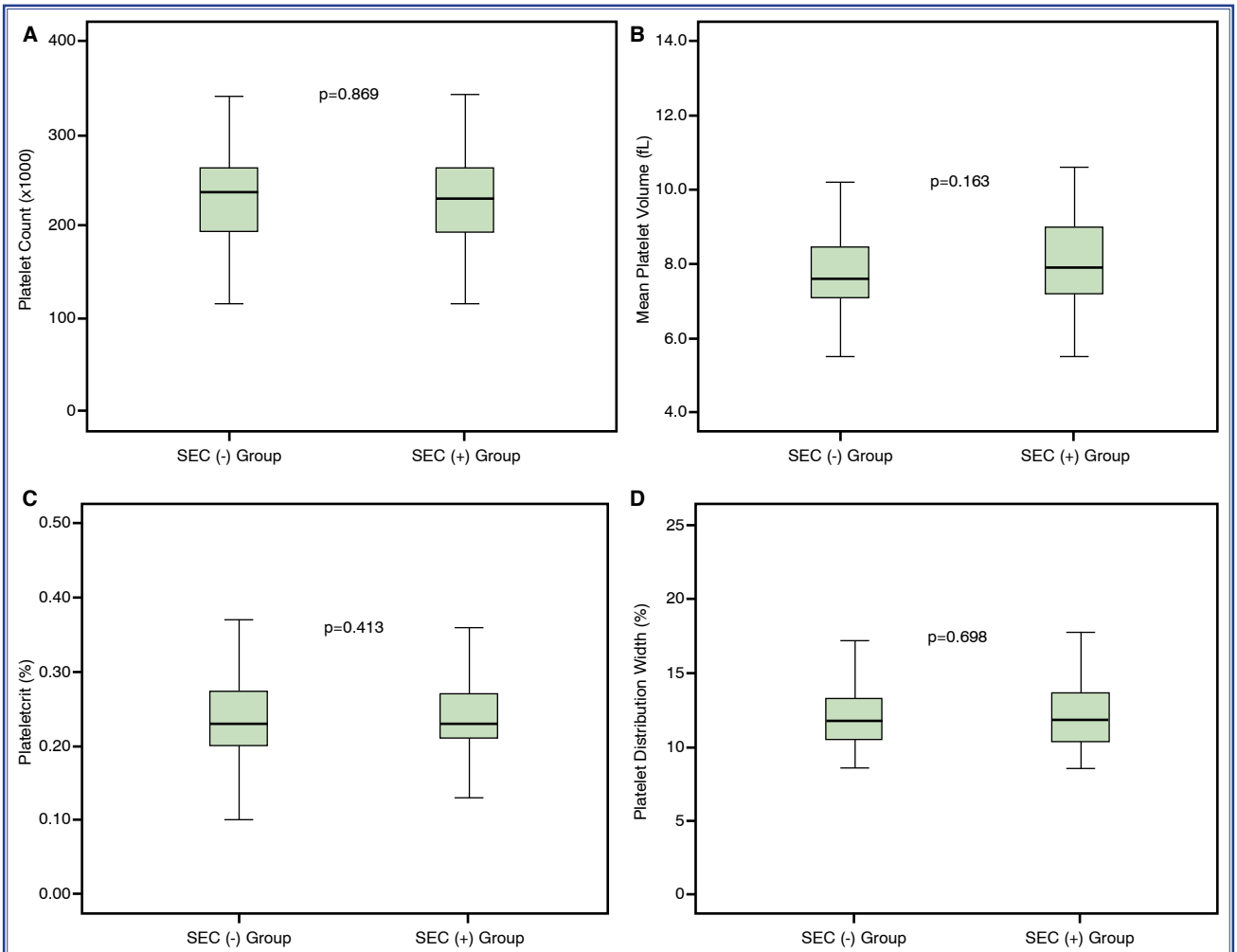

Figure 3. (A-D) Comparison of platelet indices between patients with and without spontaneous echo contrast (SEC) formation.

atrial fibrillation or left atrial dilatation, which have been shown to be risk factors for systemic embolization, are present.[17]

SEC formation has been demonstrated in cardiac cavities where circumstances of slow blood flow would be expected to prevail.[1] This phenomenon is best evaluated with TEE within the atrial cavities. TEE provides superior image quality of both the left atrium and the left atrial appendage when compared with TTE, and it is more sensitive in the detection of SEC due to the utilization of higher frequency transducers.[18,19] The accurate diagnosis of SEC is dependent on transducer frequency, gain setting, and the echocardiographic equipment. It is essential to set the proper gain settings to diagnose SEC, as excessive gain can mislead the diagnosis. High-frequency transducers are more capable of detecting SEC formation in the cardiac chambers. Since newer echo machines have been introduced with transducers that offer higher sensitivity and higher frequency, the vi-

Table 3. Multivariate regression analysis of possible predictors of spontaneous echo contrast

	Odds ratio	95% Confidence interval	*p*
Increased left atrial diameter	1.655	1.054 – 1.141	0.021
Decreased left ventricular ejection fraction	0.960	0.920 – 1.012	0.098
Presence of atrial fibrillation	1.097	0.984 – 2.783	0.087

sualization of SEC formation could become a more common phenomenon.[20]

The presence of atrial fibrillation, increased age, left atrial dilatation, and severe mitral stenosis have been proposed as means to determine the individual risk for SEC formation in patients with mitral stenosis.[21] Consistent with the literature findings, increased LAD, decreased LVEF, and the presence of atrial fibrillation were found to be associated with the presence of SEC formation in patients with mitral prosthetic valves in the present study. In addition to echocardiographic and clinical determinants, the role of hematological indices that are inexpensive and derived from routine complete blood counts has been debated in several reports.[22,23] Platelet indices have been found to have a prognostic and diagnostic value in certain diseases, including cardiovascular diseases. However, the clinical significance, reference values, and usefulness of these indices are still under investigation.[24]

Platelets are dynamic blood particles that have a primary role in achieving hemostasis. When stimulated, platelets interact with each other, as well as with leukocyte and endothelial cells, and undergo a change in shape, increase their surface area, and activate the secretion of bioactive molecules stored within their granules.[25] In addition to the important role in hemostasis and thrombosis, accumulating evidence has demonstrated that platelets contribute to the inflammatory process, microbial host defense, wound healing, angiogenesis, and remodeling.[26]

There is conflicting evidence regarding the role of platelet indices in patients with SEC formation. Several studies have reported that high values of MPV and PCT were associated with the presence of left atrial SEC formation in patients with mitral valve disease.[7,27] In contrast, Peverill et al.[23] and Gülcihan Balcı et al.[28] reported that the MPV did not differ between mitral stenosis patients with and without SEC formation. The relationship between platelet indices and SEC in patients with prosthetic heart valves was studied for the first time in this study, and we did not observe any significant differences in the platelet indices of the platelet count, MPV, PCT, or PDW between SEC(+) and SEC(-) groups. The variation in results may be explained by the lack of a standardized complete blood count measure around the world.[29] Different characteristics of the selected study populations can also affect the findings. Platelet hyperactivity has been suspected of a role in the pathogenesis of intracardiac SEC formation.[23] However, all of the platelet indices investigated in this study are morphological parameters and do not provide data regarding platelet activity. This limitation may have affected our results.

Increased neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio levels have been reported in patients with prosthetic valve thrombosis compared with subjects with a normofunctional prosthesis.[30] However, in the present study we did not observe any significant difference in terms of these novel hematological inflammatory parameters between patients with and without SEC formation.

Study limitations

The primary limitation is that our study was a non-randomized, single-center study with a relatively small number of patients. A second limitation may be the method of complete blood count measurement. It has been previously reported that use of ethylenediaminetetraacetic acid (EDTA) vacutainers for blood collection could cause swelling of platelets and alter platelet morphology. However, Dastjerdi et al.[31] found that MPV can be measured accurately using both methods of anticoagulation, that is, with EDTA or citrate, if the analysis is performed within 1 hour of sampling.[31] EDTA-based anticoagulated blood samples were used to measure the complete blood count parameters in our study. The blood samples were analyzed within 30 minutes in our study and therefore, our laboratory work-up could be considered sufficiently strong regarding the reliability of the results. Finally, platelet function tests of platelet activity were not performed.

Conclusion

The platelet indices studied were not found to be associated with the presence of SEC formation in the left atrium in patients with mitral prosthetic valves. The results indicated that platelet indices do not seem to enhance the prediction of SEC in patients with mitral prosthetic valves. Previously known echocardiographic and clinical risk factors remain the major determinants of SEC development in patients with mitral prosthetic valves.

Ethics Committee Approval: The study was approved by the local ethical committee (date: 15.11.2018, no: 2018.8/10-140).

Peer-review: Externally peer-reviewed.

Conflict-of-interest: None.

Authorship contributions: Concept: M.K., A.G.; Design: M.K., M.Y.; Supervision: M.Ö., S.G., M.O.G.; Materials: E.B., S.K., M.O.G.; Data: S.K., E.B., A.G.; Analysis: M.K., S.G., S.K.; Literature search: M.K., A.G., M.Y., S.C.; Writing: M.K., A.G., M.Y.; Critical revision: M.Ö., S.G., M.O.G.

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