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Original Article

Predictors of mortality after transcatheter aortic valve implantation

Abdullah Sokmen, Ekrem Aksu, Ahmet Cagri Aykan, Gulizar Sokmen, Hakan Gunes, Akif Serhat Balcioglu, Enes Celik, Sami Ozgul

Department of Cardiology, Faculty of Medicine, Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey

Abstract

Aim: Transcatheter aortic valve implantation has been used widely as an alternative treatment method for patients with symptomatic aortic stenosis carrying high surgical risk. Despite technological advances and increased experience, its early and late mortality rate is still relatively high and it is important to predict upcoming cardiac events and mortality for the management of patients. In this study, we aimed to investigate the clinical and laboratory parameters affecting mortality after these procedures performed in our clinic.

Material and Methods: The patients who underwent TAVI due to severe AS between May 2015 and March 2019 were investigated retrospectively. Demographic, echocardiographic and laboratory data of all patients were recorded. During the follow-up period (mean: 556 days), patients were divided into 2 groups; deceased patients (group 1, n=13) and living patients (group 2, n=34). The data of the patients before TAVI procedure were compared between the two groups.

Results: Among demograhic data, the ratio of chronic kidney disease was significantly higher in the deceased group. Among echo parameters, left ventricular ejection fraction was significantly lower and pulmonary artery pressure was significantly higher in the deceased group. Of laboratory parameters, blood urea nitrogen and creatinine levels were significantly higher and toral protein levels were significantly lower in the deceased group. Additionally, leukocyte, uric acid, CRP and CRP/albumin ratio were significantly higher and albumin was significantly lower in the deceased patients.

Conclusion: The presence of chronic kidney disease, low left ventricular EF, high pulmonary artery pressure, high CRP levels, increased CRP/albumin ratio and high uric acid levels preceding TAVI may be helpful to determine the risk of mortality after the TAVI procedure.

Keywords: Aortic stenosis; mortality; transcatheter aortic valve implantation

INTRODUCTION

Aortic stenosis (AS) is the most common valvular heart disease (2-4.6%) in elderly especially in developed countries (1-3). When AS becomes symptomatic, its mortality increases considerably and the definitive treatment is surgery. Surgical mortality is high in elderly patients due to concomitant chronic diseases. Transcatheter aortic valve implantation (TAVI), which was introduced as an alternative method to surgery in 2002, has become widely used all over the world recently. Despite technological advances and increased experience in TAVI procedure, its early and late mortality rate is still relatively high. Procedural mortality and 30-day mortality after the procedure have been reported that range was changing between 1.1 and 5.8% (4-6). Moreover, 1-2 years mortality rate has been reported as 22-30% (7-10). Although mortality has been partially reduced in recent years with the advances in TAVI method and devices and experienced operators, it is still important to predict upcoming cardiac events and to determine the patients with relatively high risk of mortality in order to guide management and follow-up. In previous studies, various biochemical, inflammatory, electrocardiographic, echocardiographic, inflammatory and technical parameters were evaluated to determine the mortality risk after TAVI (6,8,11-13). In this retrospective study, we aimed to investigate the clinical, laboratory and echocardiographic factors affecting mortality after TAVI procedures performed in our clinic.

MATERIAL and METHODS

The patients who underwent TAVI due to severe AS between May 2015 and March 2019 were investigated retrospectively in this study. These patients admitted to our clinic with symptomatic AS and determined to have high risk for surgical valve replacement were evaluated by our heart team consisting of two cardiologists, one

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Corresponding Author: Abdullah Sokmen, Department of Cardiology, Faculty of Medicine, Kahramanmaras Sutcu Imam University, Kahramanmaras, Turkey, **E-mail:** abdullahs27@yahoo.com

cardiovascular surgeon and one anesthesiologist. The patients with STS score ≥ 8 or porcelain aorta or previous cardiac surgery were taken as surgically high risk patients, and TAVI was performed to the patients with suitable anatomy and clinical profile. Femoral access was used in all patients. The aortic valve was crossed by the Amplatzer Left (AL) 1-2 catheter and a 260 cm stiff guidewire was placed into the left ventricle. Aortic balloon valvuloplasty (20-25 mm, NuMed) was performed and an appropriate sized self-expandable prosthetic aortic valve (Medtronic Corevalve Evolut-R) was implanted into the aortic annulus under the application of temporary pacing. Post-dilatation was applied in the presence of aortic regurgitation. Activated clotting time was maintained around 250–300 s throughout the procedure by heparin infusion. A percutaneous closure device was used (Perclose Proglide Suture-mediated Closure System, Abbott, Abbott Park, IL, USA) in most of the patients. Two patients underwent surgical closure of femoral artery due to failure of closure device. Patients were followed up for 24 hours in the coronary intensive care unit.

The patients were evaluated clinically at 1st, 3rd and 6th months after discharge. Echocardiographic examinations were performed before discharge, 1st month after discharge and when needed later. Dual antiplatelet agents (aspirin + clopidogrel) were given to the patients for at least 3 months, but used for longer durations in patients with compelling indications such as percutaneous coronary intervention.

The data of the patients were obtained from archive files and hospital automation system retrospectively. Demographic, echocardiographic and laboratory data of all patients were recorded. Information about patients' current medical status was obtained from the hospital follow-ups. If the patient was not able to come to hospital, then subjects' vital status was learned via phone call. The cause and the time of deaths of the patients were obtained from the Death Notification System of the Ministry of Health. Patients with incomplete or insufficient data were excluded from the study. Finally, 47 patients (30 females, 17 males) were included in the study. During the follow-up period (mean: 556 days), patients were divided into 2 groups; deceased patients (group 1, n = 13) and living patients (group 2, n = 34).

The study was designed in accordance with the principles outlined in the Helsinki Declaration, and was approved by the local Clinical Research Ethics Committee of our institution.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows version 22.0 (SPSS Inc., Chicago, IL, USA). Shapiro-Wilk test was used to determine the normality of the distribution. Continuous variables were expressed as mean ± standard deviation or median (Q1-Q3), and categorical variables were expressed as percentages. Chi-square test was used to compare differences between groups for categorical variables. According to the distribution, the differences between the groups for numerical parameters were compared with Student's t-test or Mann-Whitney U test. In t/MW-U/X2 formulation, t presented p value of Student's t-test, MW-U presented U value of Mann-Whitney U test, X2 presented Pearson's Chi-square value. Pearson's correlation analysis was used to determine the relationship of laboratory data with time of death. Univariate logistic regression analysis was used to determine the risk factors of mortality. Multivariate logistic regression analysis was used to determine the independent predictors of mortality. P <0.05 was considered statistically significant.

RESULTS

Totally 13 patients died during the mean 556 days of follow-up period. Two patients had to be resuscitated during hospital stay. One of them died on the 2nd day of the procedure. During hospital stay, two patients had transient ishemic event which resolved completely within hours. Totally 4 patients needed permanent pacemaker implantation, 3 patients during hospital stay and one patient 3 months after discharge. Twelve patients died after discharge (between 33 days-46 months after the procedure). As we obtained from Death Notification System of Ministry of Health, the causes of mortality were cerebrovascular event in 2 patients, septicemia in 1 patient, pneumonia in 1 patient, sudden cardiac death in 4 patients and heart failure in 2 patients, myocardial infarction in 3 patients.

Demographic characteristics of the groups were shown in Table 1. Age, sex, risk factors and ratios of comorbidities were similar between the groups (p> 0.05). Only the ratio of chronic kidney disease (CKD) was found to be significantly higher in group 1 (23.1% vs. 2.9%, p <0.05).

Basal and postoperative echocardiographic data of the groups were given in Table 2. There was no significant difference between groups considering basal and postoperative aortic peak and mean gradients, basal aortic valve area and diameter of the valve used in TAVI (p> 0.05). Left ventricular ejection fraction (LV EF) was significantly lower and systolic pulmonary artery pressure (PAPs) was significantly higher in group 1 (p <0.05).

Laboratory findings of the groups prior to TAVI procedure were presented in Table 3. Fasting blood glucose (FBG), total cholesterol, triglyceride, LDL cholesterol, HDL cholesterol, hemoglobin and hematocrit values were similar between the groups (p> 0.05). Blood urea nitrogen (BUN) and creatinine values were significantly higher and total serum protein values were significantly lower in the deceased group (p <0.005 and p <0.001 respectively).

Pre-procedural laboratory parameters related with the inflammation were shown in Table 4. Leukocyte, uric acid, C-reactive protein (CRP) and CRP/albumin ratio were significantly higher and albumin was significantly lower in the deceased patients (p <0.005 and p <0.001

respectively).

We investigated the relationship of inflammation-related laboratory parameters (albumin, leukocyte, uric acid, CRP, CRP/Albumin) with time of death, and we found that only albumin was positively and significantly correlated with time of death (p=0.013, r=0.668). There was no significant correlation between echocardiographic parameters and time of death.

TAVI-related data of the groups were shown in Table 5. There was no difference between the groups considering balloon use before or after the procedure, diameter of the valve used, development of aortic regurgitation (AR), use of femoral artery closure device, and pacemaker requirement (p> 0.05).

The parameters differing significantly between the groups were analyzed by univariate logistic regression analysis to determine the risk factors for mortality after TAVI (Table 6). Upon the evaluation of these risk factors by multivariate logistic regression analysis, only leukocyte count was found to be independent predictor of mortality after TAVI. ROC analysis revealed that cut off value of 7.05x103/mL (Area under the curve=0.774, p=0.004) was a poor.

Table 1. Demographic features of the patients

	Group 1 (deceased) (n=13)	Grup 2 (living) (n=34)	t-MW-U/X²	P value
Age (years)	77.46±7.56	79.18±7.45	0.490[a]	0.486
Sex, women (%)	6 (46.2)	24 (70.6)	2.432[b]	0.119
CAD, n (%)	13 (100)	33 (97.1)	0.391[b]	0.532
PCI, n (%)	3 (23.1)	9 (26.5)	0.057[b]	0.811
Hypertension, n (%)	8 (61.5)	27 (79.4)	1.580[b]	0.209
Hyperlipidemia, n (%)	6 (46.2)	19 (55.9)	357[b]	0.550
DM, n (%)	7 (53.8)	14 (41.2)	0.611[b]	0.435
CHF, n (%)	7 (53.8)	10 (29.4)	2432[b]	0.119
AF, n (%)	2 (15.4)	4 (11.8)	0.111[b]	0.739
CVA, n (%)	1 (7.7)	3 (8.8)	0.015[b]	0.901
COPD, n (%)	7 (53.8)	14 (41.2)	0.611[b]	0.435
CKD, n (%)	3 (23.1)	1 (2.9)	4.897[b]	**0.027***
Follow-up, days (median) (Q1-Q3)	105.00 (49.00-304.50)	576 (454.75-762.00)	54.000[a]	**<0.001***

CAD: Coronary artery disease, PCI: Percutaneous coronary intervention, DM: Diabetes mellitus, CHF: Congestive heart failure, AF: Atrial fibrillation, CVA: Cerebrovascular accident, COPD: Chronic obstructive pulmonary disease, CKD: Chronic kidney disease
[a] Mann-Whitney U test; [b] Chi-square test, * Difference is statistically significant

Table 2. Echocardiographic data of the patients

	Group 1 (deceased) (n=13)	Group 2 (living) (n=34)	t/MW-U	P value
LV EF, (%) (median) (Q1-Q3)	55.00 (32.50-55.00)	57.50 (55.00-60.00)	119.500[a]	**0.013***
PAPs, (mmHg)	40.62±11.97	33.24±7.33	0.033	**0.014***
Aortic peak gradient, (mmHg) (median) (Q1-Q3)	65.00 (57.50-69.00)	66.00 (60.00-70.00)	196.500[a]	0.558
Aortic mean gradient, (mmHg) (median) (Q1-Q3)	42.15±7.29	43.00±6.03	0.756	0.686
AVA (cm2) (median) (Q1-Q3)	0.80 (0.80-0.80)	0.80 (0.70-0.83)	216.500[a]	0.907
LV EF after TAVI, (%) (median) (Q1-Q3)	55.00 (30.00-57.50	57.50 (55.00-60.00)	124.000[a]	**0.018***
Aortic peak gradient after TAVI, (mmHg) (median) (Q1-Q3)	11.00 (9.50-12.50)	11.00 (10.00-12.00)	212.000[a]	0.825
Aortic mean gradient after TAVI, (mmHg) (median) (Q1-Q3)	3.00 (2.50-4.00)	3.00 (3.00-4.00)	200.500[a]	0.608

LV EF: Left ventricular ejection fraction, PAPs: Systolic pulmonary artery pressure, AVA: Aortic valve area, TAVI: Transcatheter aortic valve implantation, Independent samples t test; a Mann-Whitney U test; * Difference is statistically significant

Table 3. Laboratory data of the patients

	Group 1 (deceased) (n=13)	Group 2 (living) (n=34)	t/MW-U	P value
FBG, (mg/dL) (median) (Q1-Q3)	139.00 (99.50-177.00)	100.00 (91.75-142.00)	147.000[a]	0.078
BUN, (mg/dL) (median) (Q1-Q3)	34.00 (24.50-55.00)	20.00 (14.75-27.75)	85.000[a]	**0.001***
Creatinine (mg/dL)	1.60±1.30	0.89±0.32	<0.001	**0.004***
Total cholesterol, (mg/dL)	153.92±52.02	180.85±54.56	0.035	0.132
Triglyceride, (mg/dL)	160.38±93.18	148.00±77.88	0.634	0.646
LDL cholesterol (mg/dL) (median) (Q1-Q3)	87.00 (72.00-100.00)	100.50 (87.00-131.75)	144.000[a]	0.067
HDL cholesterol (mg/dL) (median) (Q1-Q3)	38.00 (27.50-44.50)	41.50 (35.00-51.50)	155.000[a]	0.116
Hemoglobine, (gr/dL) (median) (Q1-Q3)	10.00 (9.65-11.00)	11.00 (10.00-12.00)	165.000[a]	0.173
Hematocrite, (%)	33.09±3.23	34.64±3.44	0.236	0.167
Total protein, (mg/dL)	5.86±0.54	6.88±0.65	<0.001	**<0.001***

FBG: Fasting blood glucose, BUN: Blood urea nitrogen, LDL: Low density lipoprotein, HDL: high density lipoprotein.
Independent samples t test; [a] Mann-Whitney U test; * Difference is statistically significant

Table 4. Inflammation-related laboratory parameters of the patients

	Group 1 (deceased) (n=13)	Group 2 (living) (n=34)	t/MW-U	P value
Albumin, (mg/dL) (median) (Q1-Q3)	2.90 (2.55-3.55)	4.10 (3.80-4.30)	59.500[a]	**<0.001***
Leukocyte, (x10^3/mL)	9.62±2.16	7.44±1.87	0.004	**0.001***
Uric acid, (mg/dL) (median) (Q1-Q3)	9.00 (6.55-10.90)	5.30 (4.43-6.03)	38.500[a]	**<0.001***
CRP, (mg/L) (median) (Q1-Q3)	11.00 (8.00-21.00)	6.05 (3.35-9.28)	82.000[a]	**0.001***
CRP/Albumin, (median) (Q1-Q3)	4.23 (2.50-5.88)	1.42 (1.09-2.23)	40.000[a]	**<0.001***

CRP: C-reactive protein
Independent samples t test; [a] Mann-Whitney U test; * Difference is statistically significant

Table 5. TAVI-related data of the patients

	Group 1 (deceased) (n=13)	Group 2 (living) (n=34)	t/MW-U/X^2	P value
Predilatation, n (%)	3 (%23.1)	15 (%44.1)	1.762[b]	0.184
Valve diameter, (mm) (median) (Q1-Q3)	29.00(26.00-29.00)	26.00(26.00-29.00)	174.500[a]	0.238
Postdilatation, n (%)	6 (%46.2)	14 (%41.2)	0.095[b]	0.758
AR development, n (%)	7 (%53.8)	16 (%47.1)	0.499[b]	0.779
Closure device, n (%)	13 (%100)	32 (%94.1)	0.799[b]	0.371
Pacemaker, n (%)	0 (%0)	4 (%11.8)	1.672[b]	0.196

AR: Aortic regurgitation
[a] Mann-Whitney U test; [b] Chi-square test

DISCUSSION

A significant portion of the elderly patients cannot be operated due to high surgical risk as a result of advanced age and concomitant diseases. TAVI has been introduced in the early 2000s and become an alternative therapy to surgical aortic valve replacement. It is very important to predict the risk of cardiovascular events and mortality after TAVI. In this study, we investigated the various factors affecting mortality in patients undergoing TAVI in the last 5 years. Our study revealed that high levels of inflammatory markers such as leukocyte count, uric acid, CRP, CRP/albumin ratio and low albumin levels preceding TAVI might help to determine the increased risk of mortality, with only leukocyte count being the independent predictor of mortality after the procedure. In addition, we also found that low LV EF or high PAPs on echocardiography or the presence of CKD might be risk factors for mortality in these patients. Among these parameters,

Of 47 patients undergoing TAVI for symptomatic AS, 13 patients (28%) died within the follow-up period of 556 days. When we compared the demographic features of the living and deceased patients, we found that age, gender, coronary artery disease (CAD), percutaneous coronary intervention (PCI), hypertension (HT), hyperlipidemia, diabetes mellitus (DM), congestive heart failure (CHF), atrial fibrillation (AF), cerebrovascular accident (CVA) and chronic obstructive pulmonary disease (COPD) ratios were similar between the groups. Previous studies have reported diverse results considering the relationship between demographic data and mortality. Although most of the studies have reported no relationship between age and mortality, there are also studies suggesting that advanced age increases mortality in TAVI (6,8,11-13). Similar to the literature, no correlation was found between mortality and age in our study. Different results have also been reported regarding the effect of gender on mortality of TAVI. While there are studies reporting that gender does not affect 1-year mortality, there are also studies showing that 1-year mortality is decreased in women as compared to men (11,12,14,16,17). In addition, in-hospital and 30-day mortality after TAVI was reported to be higher in women (15). Although proportion of women was high in our study, there was no gender difference between the deceased and living patients. The reason for the higher number of female patients in our study is that the overall life expectancy of women is longer than men and the number of women who can reach advanced age and develop severe AS is higher. In our study, we determined that gender difference did not have an effect on mortality after TAVI.

While almost all of our patients had different degrees of CAD, the ratio of patients with severe CAD who underwent PCI before TAVI was similar in both groups. There was no significant difference in 30-day, 6-month and 1-year mortality after TAVI in patients with CAD, MI and bypass operation (8,11,12). Similarly, in our study, mortality was not different between the groups in terms of CAD and PCI. Nevertheless, although the presence of CAD is expected to have a negative impact on mortality in the long term, the presence of CAD in all patients may explain the absence of difference in mortality between the deceased and living patients.

There was no difference between deceased and living patients in terms of risk factors for CAD such as HT, hyperlipidemia and DM. Although there was no relationship between these three risk factors and mortality in some studies, it was shown in one study that high ratio of DM was the predictor of mortality after TAVI (8,11,12). In another study, HT ratio was lower in the deceased patients after TAVI, but it was not found to be an independent risk factor for mortality (13). Since the patients in both groups are older in our study, ratio of HT is expected to be high. In addition, the decrease in physical activity and unbalanced nutrition due to aging contribute to the high rate of DM in these patients. Although ratio of HT and hyperlipidemia was lower and DM ratio was higher in our deceased patients, the difference between the deceased and living patients was not statistically significant.

The presence of CHF was significantly higher in the deceased group (53.8% vs. 29.4%), but the difference did not reach statistical significance. As expected, the presence of CHF is associated with poor prognosis and mortality in all circumstances. In post-TAVI mortality studies, low LV EF or elevated BNP levels have been shown to increase mortality (12,13,19). To a lesser extent, there are studies reporting that EF and BNP do not affect mortality (8,11). In our study, the higher rate of CHF in the deceased group and the significantly lower LV EF values suggest that HF with reduced EF has negative impact on mortality.

There was no difference between the groups in terms of AF and previous CVA which were other additional diseases that could affect mortality. In the literature, two studies revealed that the presence of previous CVA or AF did not affect mortality after TAVI, but newly developed CVA during TAVI procedure was found to be related to mortality (8,12). On the contrary, there are studies reporting that mortality rate is higher in patients with AF (12,20). In our study, newly developed CVA related to the procedure was not seen in patients, and it was observed that presence of previous CVA and AF had no impact on mortality after TAVI. Presence of previous CVA and low ratio of AF in our study did not have any effect on mortality after TAVI.

Because of the high risk of cardiovascular surgery in patients with COPD, TAVI is considered as an alternative treatment in most of the patients with symptomatic severe AS and COPD. The incidence of COPD is between 21-43% in TAVI patients (7,8,21,22). Approximately half of our patients had COPD and COPD ratios were similar in both groups. In literature there are conflicting results related to the effect of COPD on mortality after TAVI (8,11,23,24). It is stated that the prognosis is worse especially in oxygen dependent patients with advanced COPD. The conflicting results in the literature may be

explained by the participants being in different stages of COPD. In one study, it was shown that COPD did not affect 30-day mortality but increased 1-year all-cause mortality although there was no difference in 1-year cardiovascular mortality rates (25). The absence of oxygen dependent patient with advanced COPD in the study groups may explain our finding that COPD was not associated with mortality after TAVI.

In our study, among comorbidities only CKD was found to be significantly higher in the deceased group. CKD is known to increase mortality in surgical aortic valve replacement (26). There are conflicting results in literature considering the effect of CKD on mortality after TAVI (8, 27-30). In one study, they showed that severe renal insufficiency (GFR ≤30 mL/min) predicted 1-year mortality but mild or moderate renal dysfunction did not affect mortality in patients undergoing TAVI (31). In another study, 30-day and 1-year mortality after TAVI was shown to increase in patients with moderate and severe renal dysfunction with GFR <60mL/min (28). In our study, BUN and creatinine levels, and the ratio of CKD before TAVI procedure were significantly higher in the deceased group. Impaired renal function is associated with both surgical and post-TAVI mortality.

In our study, there was no difference between groups considering preprocedural and post-procedural aortic peak and mean gradients and aortic valve areas. LV EF and PAPs was significantly different between the deceased and living groups. High pulmonary artery pressure is generally an independent predictor of mortality. Elevated PAPs is also associated with poor prognosis in aortic valve surgery as in all surgical procedures. In many studies, the relationship of PAPs with increased mortality after TAVI has been documented (8,13). In one study, it was shown that mortality was increased in patients with PAPs >60 mmHg and mean PAP>25 mmHg (8). Consistent with the literature, PAPs was found to be higher in the deceased group in our study. Although there are few contrary results regarding the role of systolic or mean PAP values in mortality after TAVI, it is thought to be due to the diverse number of patients in the studies and/or different ratios of other accompanying diseases (COPD, CHF, CKD etc) (11).

There was no significant difference between groups considering hemoglobin and hematocrit values. Although there was mild anemia in both groups, no blood transfusion was needed, and hemoglobin and hematocrit levels were not found to be related to mortality after TAVI. Protein and albumin levels were lower in the deceased group. Low serum protein and albumin values may be due to insufficient intake or increased excretion. Ratio of patient with CKD was significantly higher in the deceased group, and proteinuria developing as a result of renal dysfunction is the likely cause of low levels of serum protein and albumin in these patients. In one study, there was no significant difference between deceased and living patients considering serum protein levels, and lower levels of serum albumin in the deceased group was found not to predict mortality after TAVI (11).In our study, serum protein and albumin levels were significantly lower in the deceased group, but it did not predict mortality after TAVI similarly.

CRP is a non-specific protein released from the liver and an acute phase reactant associated with inflammation and infection. In general, CRP and leukocyte elevation is associated with increased mortality in many diseases (32,33). In our study, CRP and leukocyte count was found to be significantly higher in the deceased patients. In a study, it was shown that CRP levels in blood samples taken 1 day before the TAVI procedure were higher in the patients dying within 1 year (32). In another study, no correlation was found between CRP levels measured before the TAVI procedure and mortality (34). In our study, pre-procedural CRP and leukocyte levels were found to be higher in the deceased group. Furthermore, leukocyte count was also found to be independent predictor of mortality (sensitivity 84.6%, specificity 50.0%) after TAVI. Recently, an inflammatory-based index, CRP/albumin ratio has been suggested to be a predictor of mortality in CAD (35). We found that this ratio was also significantly higher in the deceased group of our study. In addition, serum uric acid level, another inflammatory marker, has been shown to be related to all-cause death, cardiovascular death and sudden cardiac death in many studies (36-38). In our study, we also found that uric acid level was higher in the deceased group of patients as compared to living group of patients. Although these three inflammatory markers were significantly higher in the deceased group of our study, they were not found to predict mortality after TAVI on regression analysis. Higher ratios of patients with CKD and DM and higher levels of fasting blood glucose in the deceased group might have caused the higher CRP levels in these patients. Moreover, inflammatory markers such as CRP, CRP/albumin ratio and uric acid may be affected by gender, renal function and the presence of CAD.

CONCLUSION

In conclusion, increased leukocyte count, low LV EF, high PAPs, high CRP levels, low albumin levels, increased CRP/albumin ratio and high uric acid levels preceding TAVI may be helpful to determine the risk of mortality after the TAVI procedure. Evaluation of these clinical factors in addition to standard examination may contribute to decision-making, therapeutic approach and follow-up steps of the management of patients who are candidates for TAVI.

Conflict of interest: The authors declare that they have no competing interest.

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Ethical approval: Kahramanmaras Sutcu Imam University, Clinical Research Ethic Committee approved the study. Approval date and number: 13.11.2019, 2019/21:01.

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