Neutrophil-to-lymphocyte ratio as a predictor of inflammatory response in patients with acute kidney injury after transcatheter aortic valve implantation

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Abstract

Background. Persistent inflammatory response after transcatheter aortic valve implantation (TAVI) is one of the possible causes of early and mid-term postprocedural adverse events.

Objectives. To establish the predictive role of whole blood parameters on inflammatory response characteristics within a 1-year follow-up.

Materials and methods. The study group comprised 163 consecutive patients (52.1% females), mean age 78.6 (±6.6) years (± standard deviation (SD)) who underwent TAVI and completed 1-year follow-up on-site examinations. Patients were retrospectively divided into acute kidney injury (AKI) and non-AKI subgroups. Clinical and laboratory data were collected. In-hospital and follow-up outcomes were assessed.

Results. The clinical and procedural details did not show significant differences between AKI and non-AKI groups. Neutrophil-to-lymphocyte ratio (NLR) decreased from baseline to measurement after 1 year with a statistically significant decline in the whole study population and non-AKI subgroup (both $p = 0.005$). The baseline NLR cutoff value of 4.2 for the non-AKI group ((area under the curve (AUC) = 0.718, $p < 0.0001$; sensitivity 46.27%, specificity 92.31%) and of 3.8 for the AKI group (AUC = 0.673, $p = 0.0174$; sensitivity 59.25%, specificity 84%) had prognostic properties for persistent NLR elevation.

Conclusions. The NLR decreases after TAVI, and this phenomenon is more evident in patients without AKI. Furthermore, baseline NLR cutoff values may be considered predictors of persistence of inflammatory response.

Key words: acute kidney injury, heart failure, transcatheter, aortic stenosis, neutrophil-to-lymphocyte ratio

Background

Transcatheter aortic valve implantation (TAVI) has become an established method of treatment for patients with aortic stenosis. While first TAVI cohorts included only patients disqualified from surgical aortic valve replacement (SAVR), currently, a variety of subjects with low to high perioperative risk and low to severe comorbidity undergo the procedure.[1–3] The treated population is diverse; therefore, several issues should be evaluated, including the qualification process and the follow-up management, to obtain the best therapeutic results.

Chronic heart failure (chronic HF), as a common feature of the TAVI population, is associated with an inflammatory process, and circulating inflammatory cytokines can predict clinical outcomes.[4] For clinicians, simple and easily available markers of inflammation are most suitable for daily practice, while more advanced assessment of cytokines is often inaccessible, costly and time-dependent. Therefore, white blood cell (WBC) count and its subgroups are both common and most available markers of inflammation. Neutrophil-to-lymphocyte ratio (NLR) is derived from a routine complete blood count. The normal range is between 1 and 2, and higher values are warning signals of pathological state.[5] Neutrophil-to-lymphocyte ratio has been proposed as a prognostic marker of systemic inflammation in several cardiovascular and non-cardiovascular diseases, including HF, aortic stenosis and acute myocardial infarction, and in outcomes after coronary revascularization.[6–12]

Acute kidney injury (AKI) is a well-known complication after TAVI, which may impair long-term outcomes.[13,14] The NLR has been associated with the development of AKI after TAVI.[11,12] However, there are limited data concerning the role of NLR in long-term observation after the procedure.

Objectives

The aim of our study was to establish the predictive role of basic whole blood parameters on inflammatory response characteristics within a 1-year follow-up in patients with and without AKI after TAVI.

Materials and methods

Study design

Basic whole blood parameters were collected in the study population divided retrospectively into AKI and non-AKI subgroups. The NLR variations were analyzed in the whole population and in the subgroups. The risk of persistence of inflammatory response was studied.

Study patients

A total of 210 patients underwent TAVI between January 2013 and March 2017 in our hospital. All of the patients were qualified to the procedure after careful assessment of clinical history and diagnostic examinations. Patients who did not have blood test or echocardiographic examination during 1-year follow-up visit and those who presented with the signs of infection or neoplasm were excluded from the analysis. Moreover, 24 patients who died (time to death 137.5 (120.8) days (mean ± standard deviation (SD)) were not included in the study group. Five of them died due to perioperative complications and the others in course of HF and/or comorbidities/neoplasms.

Finally, the study group was selected and comprised 163 consecutive patients (85 of them females, 52.1%) with the mean (±SD) age of 78.6 (±6.6) years, who underwent TAVI and completed the 1-year follow-up (12 ±1 months) on-site examinations. Patients were divided into AKI and non-AKI subgroups according to the Valve Academic Research Consortium 3 (VARC-3) criteria[15] (increase of serum creatinine ≥1.5× within 7 days compared with baseline or increase of ≥0.3 mg/dL (≥26.4 mmol/L) within 48 h or hemofiltration) (Fig. 1).

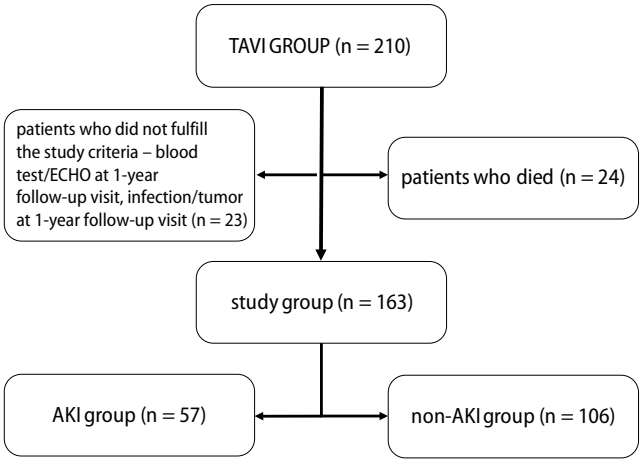

Fig. 1. Flowchart of the study inclusion and explanation of exclusion criteria

TAVI – transcatheter aortic valve implantation; AKI – acute kidney injury.

Details of TAVI

The TAVI procedures were performed in a hybrid room by the same team of cardiologists and cardiac surgeons, under fluoroscopic and echocardiographic guidance. In a majority of patients (n = 158, 96.9%), percutaneous access (using Prostar XL or Perclose ProGlide systems (both from Abbott, Chicago, USA)) was performed. General anesthesia was used in 72.4% of patients, whereas 27.6% (n = 45) had local anesthesia with sedation. In transapical access (n = 1), left anterolateral minithoracotomy was performed through the 6th intercostal space. In direct aortic

Table 1. Demographic, clinical and procedural characteristics

Variable	Whole group n = 163	AKI group n = 57	Non-AKI group n = 106	p-value[#]
Males, n	78 (47.9)	28 (49.1)	50 (47.2)	0.814
Age [years]	80 (75–83)	80 (76–83)	80 (75–83)	0.851
BMI [kg/m^2]	28 (25.35–30.85)	29.6 (26.9–31.2)	27.6 (24.6–29.7)	0.03
EuroSCORE II [%]	4.7 (2.735–9.265)	5.45 (3.13–10.12)	4.4 (2.587–8.067)	0.146
STS score [%]	5.3 (3.381–14.312)	5.06 (3.33–13.457)	5.85 (3.7–14.718)	0.278
T2DM	51 (31.3)	22 (38.6)	29 (27.4)	0.140
Hypertension	118 (72.4)	42 (73.7)	76 (71.7)	0.787
AF	54 (33.1)	17 (29.8)	37 (34.9)	0.511
COPD	33 (20.2)	10 (17.5)	23 (21.7)	0.529
MI history	56 (34.4)	23 (40.4)	33 (31.1)	0.237
Stroke or TIA history	29 (17.8)	11 (19.3)	18 (17)	0.712
eGFR [mL/min/1.73 m^2]	56 (46–67.5)	49 (40–66)	58.5 (49–69.5)	0.007
MPG [mm Hg]	57 (47–69)	56.5 (47–66)	56.5 (47.25–69)	0.640
PPG [mm Hg]	90 (78.5–109.5)	90 (78–109)	90 (80–110)	0.965
LVEF [%]	55 (45–60)	55 (45–60)	55 (45–60)	0.967
Predilatation	79 (48.5)	28 (49.1)	51 (48.1)	0.902
Prosthesis Medtronic CoreValve/Evolut R Lotus Symetis	 131 (80.4) 30 (18.4) 2 (1.2)	 49 (86) 8 (14) 0	 82 (77.3) 22 (20.8) 2 (1.9)	0.312
Anesthesia general local	 118 (72.4) 45 (27.6)	 43 (75.4) 14 (24.6)	 75 (70.8) 31 (29.3)	0.524
Access femoral apical/direct aortic	 158 (96.9) 5 (3.1)	 56 (98.2) 1 (1.8)	 102 (96.2) 4 (3.8)	0.475
TAVI time [min]	75 (70–90)	75 (65–95)	75 (75–90)	0.290
Volume of contrast media [mL]	182.5 (150–250)	200 (150–230)	180 (150–250)	0.691
Hospitalization [days]	7 (6–9)	9 (7–13)	7 (6–8)	<0.001

Continuous variables are expressed either as the means with standard deviations (SD) (if normally distributed) or the medians (Q1–Q3) (the others), whereas categorical variables are expressed as the numbers (n) with percent (%). [#] – comparison between AKI and non-AKI subgroups; AKI – acute kidney injury; EuroSCORE II – European System for Cardiac Operative Risk Evaluation II; eGFR – estimated glomerular filtration rate; TAVI – transcatheter aortic valve implantation; TIA – transient ischemic attack; STS – Society of Thoracic Surgeons; MPG – mean pressure gradient; PPG – peak pressure gradient; BMI – body mass index; T2DM – type 2 diabetes mellitus; COPD – chronic obstructive pulmonary disease; LVEF – left ventricular ejection fraction; AF – atrial fibrillation; MI – myocardial infarction.

(n = 4) access, the ministernotomy was performed and aorta was punctured. The procedural data are presented in detail in Table 1.

Analyzed clinical and laboratory data

Demographic and clinical data were collected and analyzed. Blood samples were collected at baseline, after the procedure (on daily routine) and at the 1-year follow-up visit. The following parameters were taken into consideration: WBC count, neutrophils (NEU), lymphocytes (LYMPH), NLR, and creatinine concentration (CREA). Estimated glomerular filtration rate (eGFR) was calculated. Echocardiography was performed in all patients before and after the procedure, at discharge and at 1-year follow-up. In-hospital and follow-up outcomes were also assessed, the latter based on hospital follow-up visit records and national database.

Statistical analyses

Continuous variables were checked for normality by means of the Shapiro–Wilk W test. These satisfying criteria of normal distribution were presented as mean ±SD and compared using the unpaired t-test or repeated measures analysis of variance (ANOVA). If continuous data were not normally distributed, they were expressed as median with interquartile range (IQR: 1st to 3rd quartile (Q1–Q3)) and compared with the use of nonparametric Mann–Whitney U test. Categorical

variables were reported as numbers (n) and percentages (%), and then compared with the use of the Fisher's exact test. The p-values less than 0.05 were considered statistically significant. The cutoff values of the baseline NLR that discriminated between patients with and without inflammation persistence were calculated using a receiver operating characteristic (ROC) curve. We performed multivariable logistic regression analysis, adjusted for total clinical parameters and echocardiographic and procedural variables, to evaluate predictors of failed decrease of NLR during 1-year follow-up. Statistical analysis was performed using JASP statistical software (https://jasp-stats.org/) and IBM SPSS v. 23 (IBM Corp., Armonk, USA).

The study was approved by the Institutional Ethics Committee of Poznan University of Medical Sciences (approval No. 971/15) and respected the principles outlined in the Declaration of Helsinki.

Results

Clinical characteristics

The clinical profile and procedural details did not show significant differences between the AKI and non-AKI groups, besides lower eGFR and body mass index (BMI) in the AKI group. Baseline characteristics are presented in Table 1. Before TAVI, 89.6% (n = 146) of patients presented symptoms of class III or IV HF, and 10.4% of class II HF according to the New York Heart Association (NYHA) classification. During the 1-year follow-up, patients presented significant and sustained clinical (97% had NYHA class I or II) and echocardiographic improvement.

NLR analysis

Median baseline NLR values related to main clinical variables are presented in Table 2. The NLR decreased from baseline to the measurement after 1 year in the whole population and subgroups; however, a statistically significant

Table 2. Median neutrophil-to-lymphocyte ratio (NLR) values in relation to the presence (1) or absence (0) of clinical variables

Variable	1	0	p-value
Gender – female	3.040 (2.215–4.343)	3.868 (2.556–4.801)	0.041
COPD	3.733 (2.433–4.558)	3.307 (2.360–4.588)	0.693
Hypertension	3.381 (2.336–4.639)	3.385 (2.458–4.558)	0.866
T2DM	4.495 (2.762–6.164)	3.051 (2.284–4.161)	0.001
Metabolic syndrome	3.506 (2.533–4.835)	3.231 (2.199–4.471)	0.097
AF	3.449 (2.516–4.703)	3.323 (2.253–4.558)	0.529
Stroke in history	2.957 (2.213–4.027)	3.534 (2.401–4.703)	0.121
MI in history	3.860 (2.961–4.888)	3.000 (2.168–4.498)	0.009
General anesthesia	3.534 (2.497–4.582)	2.709 (1.894–4.684)	0.071

Continuous variables are expressed as the medians (Q1–Q3). COPD – chronic obstructive pulmonary disease; T2DM – type 2 diabetes mellitus; MI – myocardial infarction; AF – atrial fibrillation.

Table 3. Neutrophil-to-lymphocyte ratio (NLR) levels at baseline, discharge and 1-year follow-up visit

Study group	Baseline NLR	Discharge NLR	1-year NLR	Baseline compared to 1-year p-value	Discharge compared to 1-year p-value
Whole group	3.385 (2.38–4.586)	3.741 (2.659–4.993)	2.978 (2.327–4.438)	0.005	<0.001
AKI group	3.385 (2.433–4.684)	4.451 (2.987–5.605)	3.255 (2.324–4.441)	0.328	0.003
Non-AKI group	3.404 (2.372–4.532)	3.468 (2.623–4.708)	2.891 (2.331–4.428)	0.005	0.042

Continuous variables are expressed as the medians (Q1–Q3). AKI – acute kidney injury.

Table 4. Creatinine levels at baseline, discharge and during 1-year visit

Study group	Baseline creatinine	Discharge creatinine	1-year creatinine	Baseline compared to 1-year p-value	Discharge compared to 1-year p-value
Whole group	104.4 (84.35–122.25)	101.05 (80.65–126.95)	105.95 (84.35–125.85)	0.112	0.031
AKI group	111.5 (97.2–137.7)	123.5 (93.1–138.45)	116.3 (98.2–139.2)	0.818	0.441
Non-AKI group	97.3 (80.525–112.675)	94.7 (76.35–112.3)	99.4 (82.1–117)	0.066	<0.001

Continuous variables are expressed as the medians (Q1–Q3). AKI – acute kidney injury.

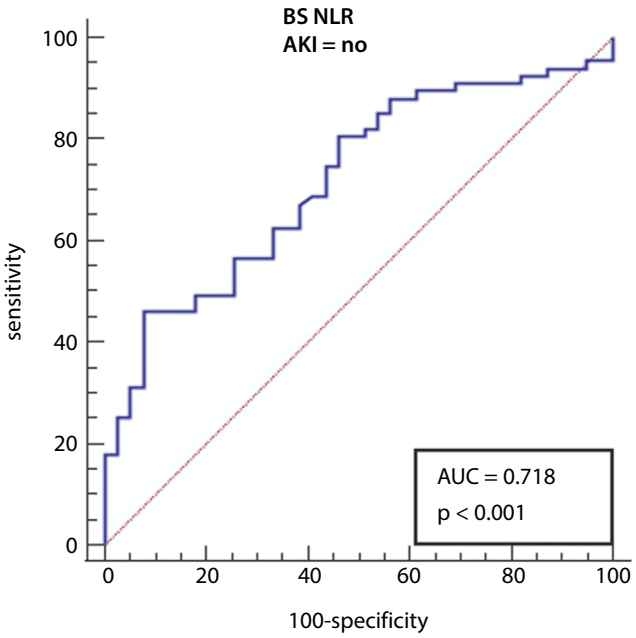

Fig. 2. The receiver operating characteristic (ROC) curve analysis of the baseline neutrophil-to-lymphocyte ratio (BS NLR) for predicting inflammatory response persistence in the non-acute kidney injury (AKI) group

AUC – area under the curve.

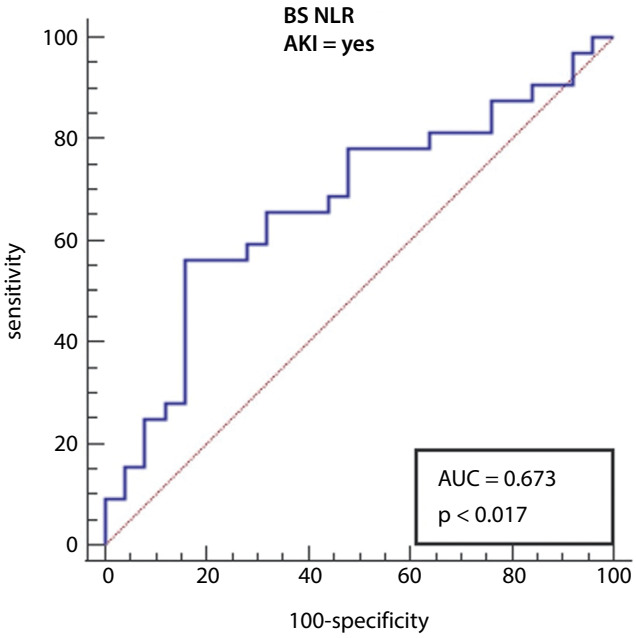

Fig. 3. The receiver operating characteristic (ROC) curve analysis of the baseline neutrophil-to-lymphocyte ratio (BS NLR) for predicting inflammatory response persistence in the acute kidney injury (AKI) group

AUC – area under the curve.

decline was noted in the whole group and in non-AKI subgroup (both p = 0.005) (Table 3). The creatinine level did not change significantly in the measurements before and 1 year after the procedure (Table 4).

In both subgroups, there were some patients characterized by continuous NLR persistence during the observation

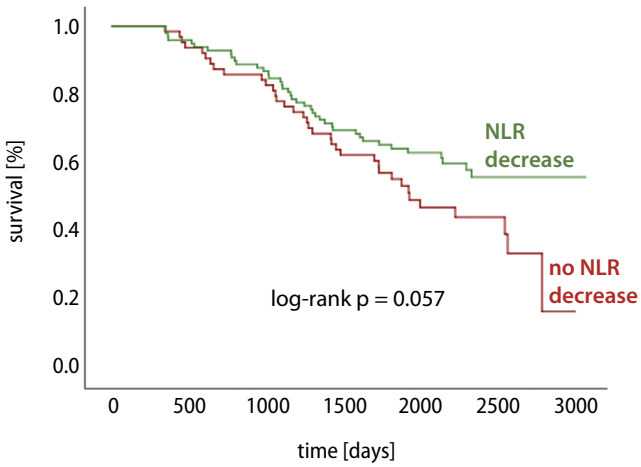

Fig. 4. All-cause mortality after 1-year follow-up in patients with and without neutrophil-to-lymphocyte ratio (NLR) decrease

time. For the non-AKI group, the ROC curve presented the baseline NLR cutoff value of 4.2 as a significant predictor for persistent NLR elevation (Fig. 2). Even more interestingly, a corresponding group of patients in AKI subgroup who presented with chronic NLR elevation were characterized by the baseline NLR cutoff value of 3.8 in ROC analysis ((area under the curve (AUC) = 0.673, p-value = 0.017, Fig. 3).

The risk of failed NLR decrease between baseline and 1-year values was evaluated based on demographic, clinical and procedural data (Fig. 4). In the multivariate logistic regression analysis, peak pressure gradient (PPG; p = 0.008) and predilatation (p = 0.028) were significant predictors of NLR decrease failure in AKI group, while in non-AKI group, only diabetes (p = 0.031) showed prognostic value (Table 5).

Echocardiographic assessment

During the 1-year follow-up echocardiographic examination, parameters of blood flow through bioprostheses were comparable to the findings in the discharge echocardiography. The transvalvular pressure gradients were: mean pressure gradient (MPG) 9.00 (±5.2) mm Hg and peak pressure gradient (PPG) 16.9 (±8.6) mm Hg in non-AKI subgroup, and MPG 9.1 (±5.0) mm Hg and PPG 17.8 (±7.7) mm Hg in AKI subset of TAVI patients (mean (±SD)).

The median (IQR) changes of pressure gradients (PGs) were as follows: MPG (–23.3% (–36.4%; 16.6%) in non-AKI subgroup compared to –12.5% (–26.7%; 19.0%) in AKI subgroup; p = 0.12); PPG (–16.2% (–31.1%; 18.7%) in non-AKI subgroup compared to –5.6% (–23.8%; 29.3%) in AKI subset; p = 0.21).

Of note, in some of them decrease and in the others increase in PGs have been noted. An increase in absolute values of PPG was observed in 34.5% of non-AKI patients and 44.2% of AKI patients, whereas an increase in MPG absolute values in 38.9% of non-AKI patients and

Table 5. Association of clinical, echocardiographic and procedural characteristics with the risk of failed decrease of NLR during follow-up in a multivariable* logistic regression analysis

Variable	AKI group n = 57		Non-AKI group n = 106	p-value
	OR (95% CI)	p-value	OR (95% CI)	
Males, n	–	–	–	–
Age [years]	–	–	–	–
BMI [kg/m^2]	–	–	–	–
EuroSCORE II [%]	–	–	–	–
STS score [%]	–	–	–	–
T2DM, n	–	–	0.30 [0.10; 0.90]	0.031
Hypertension, n	–	–	–	–
AF, n	–	–	–	–
COPD, n	–	–	–	–
MI in history, n	–	–	–	–
Stroke or TIA in history, n	–	–	–	–
eGFR [mL/min/1.73 m^2]	–	–	–	–
MPG [mm Hg]	–	–	–	–
PPG [mm Hg]	0.96 [0.92; 0.99]	0.008	–	–
LVEF [%]	–	–	–	–
Predilatation	4.25 [1.17; 15.40]	0.028	–	–
Non-femoral access	–	–	–	–
Self-expandable valve	–	–	–	–
TAVI time [min]	–	–	–	–
Volume of contrast media [mL]	–	–	–	–
Hospitalization [days]	–	–	–	–

All variables entered into multivariable logistic regression with backward stepwise selection at a Wald p-value of 0.1. The final model containing statistically significant variables is shown. OR – odds ratio; 95% CI – 95% confidence interval; AKI – acute kidney injury; eGFR – estimated glomerular filtration rate; EuroSCORE II – European System for Cardiac Operative Risk Evaluation II; TAVI – transcatheter aortic valve implantation; STS – Society of Thoracic Surgeons; MPG – mean pressure gradient; PPG – peak pressure gradient; BMI – body mass index; T2DM – type 2 diabetes mellitus; COPD – chronic obstructive pulmonary disease; TIA – transient ischemic attack; LVEF – left ventricular ejection fraction; AF – atrial fibrillation; MI – myocardial infarction.

40.5% of AKI patients was noted, but these differences were not of statistical significance (p = 0.30 and p = 0.87, respectively).

No statistical significance of echocardiographic parameters between patients with persistent NLR and without persistent NLR was found. The baseline transvalvular pressure gradients were as follows: mean (±SD) MPG of 55.2 (±16.6) mm Hg and 59.4 (±17.6) mm Hg (p = 0.142), and mean (±SD) PPG of 90.2 (±25.9) mm Hg and 94.7 (±27.3) mm Hg (p = 0.302) in patients without persistent NLR and with persistent NLR, respectively. The median (Q1–Q3) left ventricular ejection fraction (LVEF) was 60% (47.25–60%) and 55% (45–60%) (p = 0.248) in patients without persistent NLR and with persistent NLR, respectively. Similarly, echocardiographic parameters after TAVI did not differ significantly between both subgroups: median (Q1–Q3) MPG values were 8 (6.025–9.975) mm Hg and 9 (7–11.25) mm Hg (p = 0.076), median (Q1–Q3) PPG values were 16.9 (12–20) mm Hg and 18 (13.1–22.75) mm Hg (p = 0.069), while median (Q1–Q3) EF values were 60% (50–60%) and 55% (50–60%) (p = 0.112), in patients without persistent NLR and with persistent NLR, respectively. Likewise, paravalvular leak (PVL) presence did not show statistical significance (p = 0.359).

Discussion

There are 2 major findings of our study. First, inflammatory response represented by the NLR decrease after the TAVI procedure; second, the decrease is more profound and statistically significant in patients without AKI occurring as a complication of the procedure. Patients who suffered from AKI after the procedure did not achieve significant NLR reduction within a 1-year follow-up. Moreover, baseline NLR cutoff values of 4.2 for non-AKI group and of 3.8 for AKI group were found as predictors of inflammatory long-lasting persistence.

Preprocedural planning and patient selection process are crucial for optimal TAVI results. Clinical profile evaluation, echocardiography and computed tomography (CT) examination analyses play fundamental roles, enabling a precise diagnosis as well as the choice of approach and

the device type which will more likely achieve the best result.[16–20] Several cardiac and cardiosurgical scores, including the European System for Cardiac Operative Risk Evaluation II (EuroSCORE II), Society of Thoracic Surgeons (STS) score and Intermountain Risk Score,[21–23] have been used to determine the mortality risk. Simple laboratory analysis, with C-reactive protein (CRP),[24,25] leucocytes[25] as well as NLR evaluation,[11] may facilitate prediction of clinical outcomes.

The NLR was pointed out as a marker of systemic inflammation and worse prognosis in patients with HF.[7,8] Moreover, systemic inflammation has been recognized as a dominant feature of HF deterioration,[26] particularly when reduction in left ventricular function is observed.[26,27] Aortic stenosis is characterized with constant progression of HF. The pathogenesis of calcific aortic stenosis is multifactorial. Inflammation, including both innate and adaptive immune responses, is an essential process which initiates calcification and acts in progression of the disease.[28–30] Baratchi et al. used an in vitro model to investigate the effect of shear stress present in aortic stenosis on the adhesion of monocytes to endothelial cells.[31] They showed that the shear forces in aortic stenosis translate into the amplification of inflammation and further progression of valve degeneration.

The NLR as a simple marker of inflammation provides an easy and quickly available prognostic evaluation of patients with aortic stenosis and HF. Gul et al. did not find a decrease in NLR in an observation after TAVI; however, the study group was small (33 patients) and the follow-up short – only up to 4 months.[32] Conversely, Afşin et al. presented a decrease in NLR after 1 month and 6 months after the procedure.[33] We believe that our longer, 1-year observation period may reflect long-lasting results of cardiac remodelling after the procedure. Left ventricular remodelling occurs after TAVI, with reductions in left ventricular end-diastolic volume index, end-systolic volume index, left ventricular mass index, and increased LVEF.[34] Abu Khadija et al. showed that the reduction of the NLR as an inflammatory marker after TAVI in group with reduced left ventricular function caught up with the NLR in patients with preserved left ventricular function after 6 months of follow-up.[26]

Condado et al. showed that elevated NLR and platelet–lymphocyte ratio (PLR) are associated with a higher Society of Thoracic Surgeons – Predicted Risk of Mortality (STS-PROM) score.[35] Therefore, high NLR may characterize patients with higher perioperative risk. In the same analysis, baseline NLR and PLR did not predict the 1-year outcome. However, change in NLR from baseline to discharge by a level variation greater than 8 resulted in a worse 1-year clinical outcome.

We proved an NLR decrease in a long-term observation. In our analysis, NLR decreased significantly in the whole group, but particularly in non-AKI patients. This observation may reflect diminished inflammatory response in the course of heart remodelling after TAVI, which was shown by Abu Khadija et al. in patients with HF related to aortic stenosis.[26] Simultaneously, we did not observe a decrease in creatinine level from baseline to 1-year measurement in any of the study groups. An increase was observed between the measurements at discharge and at 1 year in the whole study population and non-AKI groups; however, it reflected the return to a value approximate to the baseline one. Therefore, we did not observe an improvement in renal function, but we found insufficient NLR decrease which may suggest a persistent inflammatory response in AKI patients.

Interestingly, in both subgroups (AKI and non-AKI), we noted patients without long-lasting NLR decrease after TAVI. In the multivariate analysis, in the AKI group, PPG and predilatation (while in the non-AKI group – diabetes) were prognostic factors of NLR decrease failure. We believe that this easily available hematologic index may enable differentiation of patients with clinically silent chronic inflammatory response. In patients who survived the periprocedural period without kidney injury, baseline NLR cutoff point of 4.2 was found as statistically significant for persistent chronic inflammation as a possible ominous factor, whereas the same parameter was even lower (NLR cutoff point of 3.8) in the AKI group. Therefore, we suppose that in AKI patients, lower baseline NLR may predict worse late outcomes in terms of HF- and kidney failure-related inflammatory status. Thus, we pointed out that the NLR changes presented throughout the study period may be interfered by AKI occurrence. Patients who experienced perioperative AKI may induce inflammatory reactions leading to persistence of NLR elevation up to 1 year following the procedure. Therefore, we emphasize the importance of baseline NLR assessment.

The novelty of the results from our study is the presentation of prolonged consequences of perioperative AKI. The kidney injury seemed transient in clinical observational characteristics, but in fact it changed the inflammatory status, with possible significant implications.

We suppose that in the TAVI population, persistent inflammation may influence the long-term performance of the biological prosthesis. A faster structural bioprosthesis degeneration is observed in patients with chronic renal insufficiency,[36] mainly because the underlying disease with systemic inflammation and metabolic disturbance is still active. In our study population, patients with AKI presented lower baseline eGFR, which reflects chronic renal impairment. Moreover, a majority of patients presented some degree of renal dysfunction resulting from the advanced age of that population and impairment in body organ blood flow in the presence of aortic stenosis. Based on these insights, we decided to compare the 1-year echocardiographic assessment of bioprostheses in AKI and non-AKI groups. The median changes in PPG and MPG were not significant in the study groups. We analyzed in detail the patients in whom an increase in PGs has been noted

between discharge and the measurement after 1 year. An increase in the absolute values of PPG was observed in 34.5% of non-AKI patients and in 44.2% of AKI patients, whereas of the absolute MPG values – in 38.9% and in 40.5% of non-AKI and AKI patients, respectively. These differences were noticeable but not statistically significant (p = 0.30 and p = 0.87, respectively).

Limitations

We assume that our study presents some trend, but the study period (12 months) and the relatively low number of subjects precludes a precise estimation of this phenomenon. This issue may be treated as a study limitation, and therefore larger studies with longer observation periods seem necessary to evaluate the influence of AKI-related inflammatory response on bioprosthetic performance. The significance of that matter is of particular importance since the inflammatory process may promote both valve calcification and thrombosis. Moreover, NLR is a multifactorial value influenced not only by aortic stenosis, but also by HF, atrial fibrillation after cardiac surgery, acute myocardial infarction, infections, etc.[37–39] Patients with signs of infection were excluded from the analysis, and there were no cases of acute coronary syndrome during hospitalization or at 1-year follow-up. We believe that changes in NLR levels are relevant to changes in exaggeration of HF. Therefore, HF in means of its remission is strictly included in the observed phenomenon.

Conclusions

The NLR decreases after TAVI procedure, and this phenomenon is more profound in patients without periprocedural AKI.

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