Srce i krvni sudovi 2026; 45(3): 45-51

Case report

Electrocardiographic versus echocardiographic predictors of heart failure with preserved ejection fraction in patients on renal replacement therapy

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Abstract

Background: While heart failure with preserved ejection fraction (HFpEF) is prevalent among patients on renal replacement therapy (RRT), predictors of HFpEF are not fully identified. In this prospective study, we assessed electrocardiographic (ECG) and echocardiographic predictors of HFpEF in patients on RRT.

Methods: A total of 83 consecutive RRT patients with ejection fraction ≥50% (mean age 61±13 years, 43% female, 88% on hemodialysis) underwent 12-lead ECG, including Sokolow-Lyon product (SLP) calculation, as well as comprehensive echocardiography with guideline-recommended diastolic function assessment.

Results: HFpEF was diagnosed in 20% of patients who had significantly higher values of SLP. Normal and indeterminate diastolic function was detected in 18% and 41% of patients with HFpEF, respectively. SLP showed moderately strong correlations with left ventricular mass index (r=0.39, p<0.001), left atrial volume index (r=0.46, p<0.001), mitral E/e' ratio (r=0.39, p<0.001), and maximal tricuspid regurgitation velocity (r=0.47, p<0.001). Patients with diastolic dysfunction (2311±787 mm/ms) and indeterminate diastolic function (2198±933 mm/ms) had higher values of SLP than those with normal diastolic function (1575±675 mm/ms, p=0.001). With a cutoff value of 2038 mm/mV, SLP showed a good sensitivity (77%) and specificity (70%) for identifying HFpEF. In multivariate analysis, only SLP [odds ratio (OR) 1.001, 95% confidence interval (CI) 1.000-1.002, p=0.030] and coronary artery disease (OR 33.091, 95% CI 4.097 –267.266, p<0.001) remained independently associated with HFpEF.

Conclusions: SLP is associated with structural and functional cardiac abnormalities in HFpEF patients on RRT. This simple ECG marker is associated with HFpEF and may complement echocardiographic assessment in patients on RRT.

Key-words diastolic function, Sokolow-Lyon product, heart failure with preserved ejection fraction

Introduction

Ischemic heart disease and heart failure (HF) are the leading causes of mortality in patients with end-stage renal disease[1,2,3]. HF in patients on renal replacement therapy (RRT) is a complex clinical syndrome that can result from many structural or functional cardiac disorders – left ventricular (LV) hypertrophy, coronary artery disease (CAD), valvular heart disease, arrhythmias, volume overload from arteriovenous fistula, infiltrative cardiomyopathies and other less frequent causes[4,5]. While the association between renal failure and HF with reduced ejection fraction (EF) is well established[6,7,8], the prevalence and prognostic implications of LV diastolic dysfunction and HF with preserved EF (HFpEF) in patients on RRT have not been fully elucidated.

Apart from the signs and symptoms of HF and LVEF ≥50%, the diagnosis of HFpEF requires objective evidence of cardiac structural or functional abnormalities consistent with the presence of LV diastolic dysfunction[9]. Among other, structural cardiac abnormalities associated with HFpEF include LV hypertrophy which may be detected by both electrocardiography (ECG) and echocardiography.

However, previous studies reported low sensitivity of conventional ECG criteria for the detection of structural heart disease[10,11,12], and also low sensitivity of guideline-proposed echocardiographic algorithm for detection of LV diastolic dysfunction[13]. On the other hand, an easily applicable ECG marker of HFpEF, the Cornell product, was shown to predict poor prognosis by reflecting the severity of diastolic dysfunction and LV hypertrophy[14]. Taken together, it is possible that simple ECG product of either Cornell or Sokolow-Lyon voltage and QRS duration could improve detection of LV hypertrophy and HFpEF. Therefore, in this observational, prospective study, we

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assessed electrocardiographic and echocardiographic predictors of HFpEF in patients on RRT.

Methods

This prospective, observational study included 83 consecutive patients with LVEF ≥50% and end-stage renal failure on RRT (both hemodialysis and peritoneal dialysis) at the Clinical Hospital Center Zemun, Belgrade, Serbia. The study was conducted from March 2018 to April 2019. Patients were not considered for the study in case of LVEF<50%, poor echocardiographic image quality or the presence of moderate or severe valvular lesions. Standard demographic and clinical data, including history of CAD, HF and arterial hypertension, were collected by a blinded investigator who reviewed all medical records of study patients at commencement of RRT. CAD was considered established in case of previously documented myocardial infarction, surgical or percutaneous myocardial revascularization or angiographically proven significant coronary artery stenosis (>50%) before the study. The diagnosis of HFpEF was made before the study, by attending cardiologists, based on the presence of preserved LVEF and clinical signs and symptoms of HF, including dyspnea, increased jugular venous pressure, basal crepitations or radiographic evidence of pulmonary venous congestion[9]. The study was approved by the Institutional Ethics committee and all patients signed the informed consent.

Electrocardiography

ECG was recorded after 10 minutes of rest, immediately before echocardiographic examination, at a paper speed of 25 mm/s and a standardization of 10 mm/1 mV using an automated 12-lead ECG machine (Cardiovit AT-102, Shiller Medical, Baar, Switzerland). The ECG machine automatically measured the heart rate, QRS width, PR interval and QTc duration, S in lead V1, and R in lead V5 (Sokolow–Lyon voltage criteria), while R in lead aVL and S in lead V3 (Cornell voltage) were measured manually. Specifically, the duration of the QRS complex was automatically taken from the beginning of the first detected Q-wave from all 12 averaged QRS complexes, to the end of the last S-wave from all 12 averaged QRS complexes.
Left ventricular hypertrophy (LVH) was assessed using Sokolow-Lyon, Cornell and modified Cornell criteria: (1) Sokolow-Lyon criteria: the sum of S wave in lead V1 and the tallest R wave in V5>35 mm[15]; (2) Cornell criteria: the sum of S wave in lead in V3 and the R wave in aVL >28 mm for males and >20 mm for females[15]; and (3) Modified Cornell criteria: the amplitude of R wave in lead aVL > 12 mm[16].
The Cornell product was calculated as the Cornell voltage (+0.6 mV in females) ×QRS duration, while Sokolow-Lyon product was calculated multiplying Sokolow-Lyon voltage by QRS duration (17). All ECG measurements were performed by an investigator unaware of any other patient data.

Doppler echocardiography and speckle tracking analysis

All patients underwent a comprehensive two-dimensional transthoracic echocardiographic examination during interdialytic 2-day interval using commercially available Canon Aplio i900 scanner (Canon Medical Systems Europe) with 2.5 MHz probe. Image loops of three consecutive heart cycles were digitally stored for further off-line analysis on the same device. All measurements were performed by two echocardiographers blinded to other data, according to the 2015 Recommendations for chamber quantification of the European Association of Cardiovascular Imaging and the American Society of Echocardiography[18]. The corresponding guideline-proposed cutoffs for each echocardiographic parameter were used to assess the prevalence of echocardiographic abnormalities. LV mass was calculated using the Devereux formula and indexed to the body surface area (BSA). LV hypertrophy was defined as LV mass index >95 g/m^2 in women and >115 g/m^2 in men[18]. LVEF was assessed using the modified Simpson biplane method[18], and patients with LVEF<50% were excluded from the study. Mitral flow Doppler measurements were obtained from the apical 4-chamber view to assess mitral E/e' ratio. LV diastolic function was assessed according to the algorithm from 2016 ASE/EACVI Guidelines in patients with normal LVEF, that includes: (1) average mitral E/e' ratio >14; (2) early diastolic mitral annular septal e' velocity <7 cm/s or lateral e' velocity <10 cm/s; (3) tricuspid regurgitation velocity >2.8 m/s; and (4) left atrial volume index >34 ml/m^2. Based on algorithm, patients were classified as normal diastolic function, indeterminate diastolic function or diastolic dysfunction. Left atrial (LA) volume was estimated using the biplane method of discs in apical 4- and 2-chamber views and indexed to BSA. Right ventricular basal diameter, right atrial area, tricuspid annular plane systolic excursion and tricuspid regurgitation maximal velocity were acquired and measured according to the latest guidelines[19].
Global longitudinal strain (GLS) was assessed using two-dimensional speckle tracking method and commercially available software (Aplio i900 Diagnostic Ultrasound System, 2D Wall Motion Tracking, V5.1). All images were acquired at >60 frames/s. Patients with two or more segments with poor tracking were excluded from the analysis. The software generated longitudinal strain curves for all LV segments and GLS was calculated as the average of all segmental peak systolic strain values.

Statistical analysis

Depending on the distribution, the data were summarized and presented by proportions, mean values, standard deviations, medians and percentiles. Continuous data were compared between the two groups using the Student's t-tests, while Fisher's exact test was used for the comparison of categorical variables. For comparison of continuous variables among three groups, analysis of variance was performed with post hoc pairwise comparisons between the groups, whereby adjustments to the

Table 1. Baseline characteristics of study population

	All patients (n=83)	Without HFpEF (n=66)	HFpEF (n=17)
Age, years	61±13	60±14	64±11
BMI, kg/m^2	25.1±5.0	25.2±5.2	24.7±4.7
Female sex, n (%)	36 (43.4)	27 (40.9)	9 (52.9)
Coronary artery disease, n (%)	11 (13.3)	4 (6.1)	7 (41.2)*
Atrial fibrillation, n (%)	7 (8.4)	4 (6.1)	3 (17.6)
Diabetes mellitus, n (%)	21 (25.3)	16 (24.2)	5 (29.4)
Peripheral artery disease, n (%)	3 (3.6)	2 (3.0)	1 (5.9)
Arterial hypertension, n (%)	75 (90.4)	62 (93.9)	13 (76.5)
Active smoking, n (%)	18 (21.6)	14 (21.2)	4 (23.5)
ACEi/ARB, n (%)	50 (60.2)	40 (60.6)	10 (58.8)
Beta blockers, n (%)	47 (56.6)	36 (54.5)	11 (64.7)
Calcium channel blockers, n (%)	52 (62.7)	44 (66.7)	8 (47.1)
Hemodialysis/peritoneal dialysis, n (%)	73/10 (88/12)	57/9 (86.4/13.6)	16/1 (94.1/5.9)
Duration of RRT, months	56±58	53±51	70±81

*denotes p=0.001
HFpEF – heart failure with preserved ejection fraction, BMI – Body mass index, ACEi/ARB – angiotensin-converting-enzyme inhibitor/ Angiotensin II receptor blocker, RRT – renal replacement therapy.

significance level were made using the Fisher's least significant difference method. The discriminative power of Sokolow-Lyon product, Cornell product and LV mass index for the prediction of HFpEF was analysed by the area (AUC) under the receiver operating characteristic (ROC) curve. The AUC values of Sokolow-Lyon and Cornell products were compared using the method proposed by DeLong et al[20]. Correlations between Sokolow-Lyon product, LV mass index, LA volume index, mitral E/e' ratio and maximal tricuspid regurgitation velocity were described by Spearman correlation coefficient. Univariate and multivariate logistic regression analyses were performed in order to determine the value of traditional risk factors, and electrocardiographic and echocardiographic parameters for the prediction of HFpEF. The multivariable regression model included all variables with univariable p-value <0.05, except for LA volume index and mitral E/e' ratio which were incorporated in the assessment of LV diastolic function. All statistical tests were two-tailed, and a p-value <0.05 was considered statistically significant. Statistical analyses were performed using commercially available software (PASW Statistics, version 23, Chicago, IL, USA and and MedCalc, version 12.2.1.0, MedCalc-Software, Mariakerke, Belgium).

Results

Baseline characteristics of 83 RRT patients (43% female, 88% on hemodialysis) are shown in **Table 1**. Patients with HFpEF (20% of study population) more frequently had CAD than those without HFpEF. Electrocardiographic and echocardiographic data are summarized in **Table 2** and **Table 3**, respectively**.** Patients with HFpEF had significantly longer QRS complex duration and higher values of Sokolow-Lyon

Table 2. Electrocardiographic data

	All patients (n=83)	Without HFpEF (n=66)	HFpEF (n=17)
Heart rate (/min)	74±11	75±11	72±11
PR interval duration, ms	170±37	168±33	179±50
QRS complex duration, ms	94±19	91±14	108±27*
QTc duration in lead V3, ms	427±42	425±38	437±56
Sokolow-Lyon index, mm	21±8	20±8	24±10
Sokolow-Lyon product, mm×ms	1962±846	1828±787	2479±891*
Cornell criteria, mm	15±6	15±6	17±6
Modified Cornell criteria, mm	5.7±3.5	5.4±3.4	6.7±3.5
Cornell product, mm×ms	1463±784	1344±656	1922±257*
Bundle branch blocks			
RBBB, n (%)	2 (2.4)	1 (1.5)	1 (5.9)
LBBB, n (%)	1 (1.2)	0 (0)	1 (5.9)
Incomplete RBBB, n (%)	9 (10.8)	7 (10.6)	2 (11.8)
Left anterior hemiblock, n (%)	12 (14.5)	8 (12.1)	4 (23.5)
Pathologic Q wave, n (%)	0 (0)	0 (0)	0 (0)

*denotes p<0.05
HFpEF – heart failure with preserved ejection fraction, RBBB – right bundle branch block, LBBB – left bundle branch block

Table 3. Echocardiographic data

	All patients (n=83)	Without HFpEF (n=66)	HFpEF (n=17)
LV EDD, mm	48±6	48±6	49±6
LV ESD, mm	31±6	31±6	33±6
LV mass index, g/m^2	121±37	116±33	138±47*
LV ejection fraction, %	64±7	64±7	62±7
LV GLS, %	17.6±3.1	18±2.6	15.4±4.4
LA volume index, ml/m^2	40±18	37±16	53±22*
Mitral E/e' ratio	12.7±7.7	11.5±6.5	17±10*
LV diastolic function			
- normal, n (%)	36 (43)	33 (50)	3 (18)
- indeterminate, n (%)	22 (27)	15 (23)	7 (41)
- dysfunction, n (%)	25 (30)	18 (27)	7 (41)
RV basal diameter, mm	35±6	34±6	34±5
Right atrial area, cm^2	15±7	15±6	17±7
TAPSE, mm	23±5	24±5	22±6
TR Vmax, m/s	2.5±0.5	2.4±0.5	2.7±0.6

*denotes p<0.05
LV – left ventricle, EDD – end-diastolic diameter, ESD – end-systolic diameter, GLS – global longitudinal strain, RV- right ventricle, TAPSE- tricuspid annular plane systolic excursion, LA – left atrium, TR – tricuspid regurgitation.

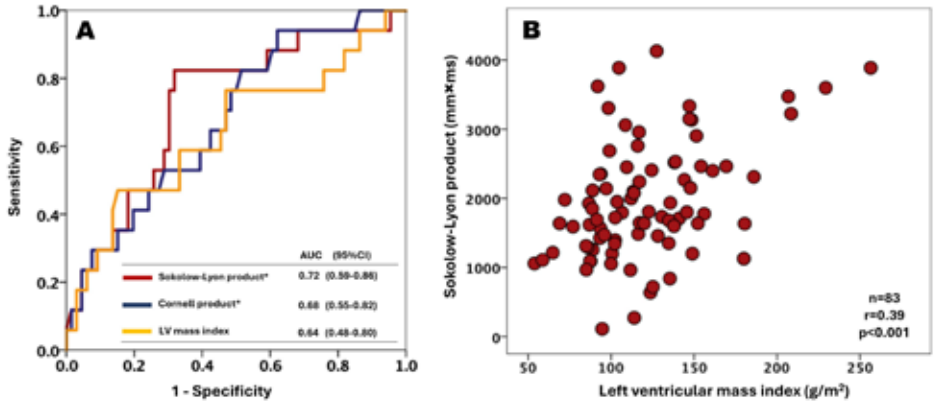


Figure 1. A. The receiver-operating characteristics curves of Sokolow-Lyon product, Cornell product and left ventricular (LV) mass index for identifying heart failure with preserved ejection fraction. B. Scatterplot showing correlation of the Sokolow–Lyon product to the left ventricular mass index.
*denotes p<0.05, AUC – area under the curve, CI – confidence interval.

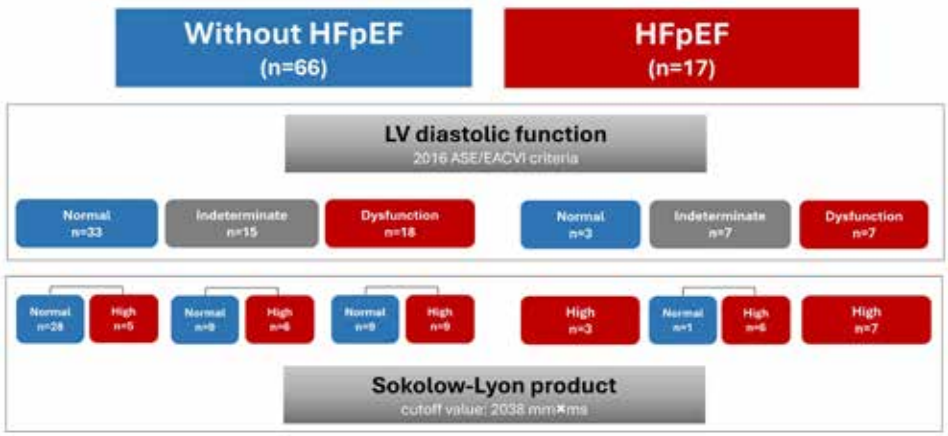


Figure 2. Distribution of different grades of left ventricular (LV) diastolic function and Sokolow-Lyon product values with regard to the presence of heart failure with preserved ejection fraction (HFpEF).
ASE – American Society of Echocardiography, EACVI – European Associations of Cardiovascular Imaging.

and Cornell products, while Sokolow-Lyon and Cornell voltages were similar between the groups (**Table 2**). LV mass index, LA volume index, and mitral E/e' ratio were significantly higher in patients with HFpEF (**Table 3**). LV diastolic dysfunction was found in 41% of patients with HFpEF versus 30% of patients without HFpEF. A significant proportion of patients from both groups (27%) had indeterminate diastolic function (41% with HFpEF versus 23% without HFpEF). ROC curves with Sokolow-Lyon product, Cornell product and LV mass index for identifying HFpEF are shown in **Figure 1A**. Sokolow-Lyon product had a nonsignificantly higher area under the curve than Cornell product (p=0.639). With a cutoff value of 2038 mm*mV, Sokolow-Lyon product showed a good sensitivity (77%) and specificity (70%) for identifying HFpEF. Cornell product (with a cutoff value of 1297 mm*mV) would identify HFpEF with a sensitivity of 71% and specificity of 53%. Sokolow-Lyon product showed moderately strong correlations with LV mass index (**Figure 1B**), LA volume index (r=0.46, p<0.001), mitral E/e' ratio (r=0.39, p<0.001), and maximal tricuspid regurgitation velocity (r=0.47,

Table 4. Univariate and multivariate regression analyses to identify parameters predicting HFpEF

	Univariate		Multivariate	
	OR [95% CI]	**P-value**	**OR [95% CI]**	**P-value**
Age	1.027 [0.984 - 1.071]	0.220	–	–
Arterial hypertension	2.067 [0.346 – 12.361]	0.426	–	–
Coronary artery disease	10.850 [2.680 – 43.924]	0.001	33.091 [4.097 –267.266]	<0.001
Diabetes mellitus	1.302 [0.398– 4.261]	0.663	–	–
Peripheral artery disease	2.000 [0.170 – 23.461]	0.581	–	–
Dialysis duration (months)	1.004 [0.996 – 1.013]	0.274	–	–
Mitral E/e' ratio	1.083 [1.007 – 1.166]	0.033	–	–
Left ventricular mass index	1.015 [1.001 – 1.030]	0.035	1.001 [0.978 – 1.024]	0.959
Left atrial volume index	1.048 [1.016 – 1.081]	0.003	–	–
Global longitudinal strain	0.770 [0.628 – 0.945]	0.012	0.858 [0.662 – 1.113]	0.249
QRS duration	1.051 [1.014 – 1.089]	0.006	1.033 [0.978 – 1.092]	0.244
Sokolow – Lyon voltage	1.818 [0.939 – 3.522]	0.076	–	–
Sokolow – Lyon product	1.001 [1.000– 1.002]	0.007	1.001 [1.000 – 1.002]	0.030
Left ventricular diastolic function*	4.667 [1.226– 17.770]	0.024	0.881 [0.140 – 5.530]	0.893

* normal diastolic function versus indeterminate function and diastolic dysfunction.
HFpEF - heart failure with preserved ejection fraction, OR – odds ratio, CI – Confidence interval.

p<0.001). Patients with diastolic dysfunction (2311±787 mm/ms) and indeterminate diastolic function (2198±933 mm/ms) had higher values of Sokolow-Lyon product than those with normal diastolic function (1575±675 mm/ms, p=0.001). The ability of Sokolow-Lyon product and 2016 ASE/EACVI diagnostic algorithm to discriminate patients with regard to HFpEF is compared in **Figure 2**. All patients with normal and 6 out of 7 patients with indeterminate diastolic function would be correctly identified as having HFpEF (**Figure 2, right panels**). Among patients without HFpEF, 30% had high values of Sokolow-Lyon product, including 15% with normal diastolic function (**Figure 2, left panels**). The variables associated with HFpEF in univariate and multivariate regression analyses are shown in **Table 4.** The mitral E/e' ratio, CAD, LV mass index, LA volume index, GLS, QRS complex width, Sokolow – Lyon product and LV diastolic function were associated with HFpEF. In multivariate regression analysis, only Sokolow-Lyon product and CAD remained independently associated with HFpEF.

Discussion

In the current study, HFpEF was diagnosed in 20% of patients on RRT who more often had CAD than those without HFpEF, with similar prevalence of diabetes mellitus and arterial hypertension in both groups. Expectedly, patients with HFpEF had higher LV mass, mitral E/e' ratio and LA volumes on echocardiography and LV diastolic dysfunction was prevalent within this group (41%). However, in nearly 60% of patients, guideline-proposed algorithm for LV diastolic function assessment would yield indeterminate (41%) or even normal results (18%). Therefore, diagnosing HF in a RRT patient with normal LVEF can be challenging, particularly because symptoms and signs of HF may overlap with those of renal failure or comorbidities. Our data suggest that a simple ECG marker, Sokolow-Lyon product, has the potential to improve detection of HFpEF among patients on RRT. In contrast to echocardiography, Sokolow-Lyon product can be obtained virtually anywhere, as it is calculated by multiplying two numbers automatically measured by ECG monitor – Sokolow-Lyon voltage and QRS duration. Being widely available and inexpensive, Sokolow-Lyon product and similar ECG markers could become valuable screening tools for HFpEF and referral to echocardiography, but they could also be helpful if refinement of equivocal echocardiographic results is needed. Moreover, recent data from dialysis-dependent patients with preserved LVEF demonstrated that advanced echocardiographic markers, including GLS and mechanical dispersion, provide additional prognostic information and may improve risk stratification in this high-risk population[21].

While ECG voltage criteria are relatively insensitive markers of LV hypertrophy, ECG products seem to be reflective

of both LV hypertrophy and LV diastolic dysfunction severity. In our study, patients with LV diastolic dysfunction had greater values of Sokolow-Lyon product, and there were also significant, but only moderately strong correlations between Sokolow-Lyon product and LA volume, LV mass and mitral E/e' ratio. Krepp et al. reported that Cornell product was a strong predictor of LV diastolic dysfunction, even after adjustment for other potential risk factors and ECG variables[22]. Intriguingly, 15% of patients in our study with normal diastolic function and 40% of those with indeterminate diastolic function had high values of Sokolow-Lyon product despite not having HFpEF. Whether greater values of Sokolow-Lyon product in these patients may indicate the risk of developing HFpEF warrants further research.

Our data are consistent with previous studies investigating the relationship of ECG markers, LV hypertrophy and HFpEF. In patients with arterial hypertension, Ishikawa et al. found that Sokolow-Lyon voltage was related to the relative wall thickness and mitral E/e' even after adjusting for Cornell product, while Cornell product was related to reduced LV regional wall motion[23]. Also, in the Sara study[24], the Cornell and Sokolow-Lyon product improved the detection of LV hypertrophy in the hypertensive population. Further, in a recent study, Cornell product was able to distinguish HFpEF from hypertension, with threefold increased odds of HFpEF[14]. In patients with HFpEF, a Cornell product was associated with two times higher likelihood of all-cause mortality and HF hospitalizations[14].

Finally, in our study Sokolow-Lyon product was independently associated with HFpEF and had a slightly higher AUC for detecting LV hypertrophy than the Cornell product. A better performance of Sokolow-Lyon than Cornell product in detection of LV hypertrophy was also noted in the LARGE Heart study[25].

Limitations

We acknowledge several limitations of our study. First, the relatively small sample size and single-centre design may limit the generalizability of our findings. Second, the diagnosis of HFpEF was established noninvasively based on routine clinical assessments performed by attending cardiologists. While this approach may have resulted in both under- and overdiagnosis, it reflects the diagnostic challenges and uncertainty that continue to characterize HFpEF, particularly in patients undergoing haemodialysis. In addition, software for LA strain analysis, which could have improved the assessment of left ventricular diastolic function, was not available at the time of the study. Also, contemporary diagnostic scores such as HFA-PEFF and H_2FPEF were not used at the time of study enrolment. Finally, all measurements were obtained during the 2-day interdialytic interval to ensure consistency; however, previous studies have reported that QRS complex amplitude may increase during haemodialysis itself[26].

Conclusions

The Sokolow–Lyon product is associated with structural and functional cardiac abnormalities and was independently associated with HFpEF in patients on renal replacement therapy. This simple ECG marker may aid in the identification of HFpEF when echocardiographic findings are equivocal.

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Sažetak

Elektrokardiografski versus ehokardiografski prediktori pojave srčane insuficijencije sa očuvanom ejekcionom frakcijom kod pacijenata na terapiji zamene bubrežne funkcije

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Uvod: *Iako je srčana insuficijencija sa očuvanom ejekcionom frakcijom (HFpEF) rasprostranjena među pacijentima na terapiji zamene bubrežne funkcije (RRT), prediktori HFpEF nisu u potpunosti identifikovani. U ovoj prospektivnoj studiji, analizirali smo elektrokardiografske (EKG) i ehokardiografske prediktore HFpEF kod pacijenata na RRT.*
Metod: Ukupno 83 konsekutivna pacijenta na RRT sa ejekcionom frakcijom ≥50% (prosečna starost 61±13 godina, 43% žene, 88% na hemodijalizi) podvrgnuto je 12-kanalnom EKG-u, uključujući izračunavanje Sokolov-Lajonovog proizvoda (SLP), kao i sveobuhvatnoj ehokardiografiji sa procenom dijastolne funkcije prema aktuelnim smernicama.
Rezultati: *HFpEF je dijagnostikovan kod 20% pacijenata koji su imali značajno više vrednosti SLP. Normalna i neodređena dijastolna funkcija je otkrivena kod 18% i 41% pacijenata sa HFpEF, respektivno. SLP je pokazao umereno jake korelacije sa indeksom mase leve komore (r=0,39, p<0,001), indeksom zapremine leve pretkomore (r=0,46, p<0,001), odnosom mitralnog E/e' (r=0,39, p<0,001) i maksimalnom brzinom trikuspidalne regurgitacije (r=0,47, p<0,001). Pacijenti sa dijastolnom disfunkcijom (2311±787 mm/ms) i neodređenom dijastolnom funkcijom (2198±933 mm/ms) imali su veće vrednosti SLP od onih sa normalnom dijastolnom funkcijom (1575±675 mm/ms, p=0,001). Sa graničnom vrednošću od 2038 mm/mV, SLP je pokazao dobru osetljivost (77%) i specifičnost (70%) za identifikaciju HFpEF. U multivarijantnoj analizi, samo SLP [odnos šansi (OR) 1,001, 95% interval poverenja (CI) 1,000-1,002, p=0,030] i koronarna arterijska bolest (OR 33,091, 95% CI 4,097 –267,266, p<0,001) su ostali nezavisno povezani sa HFpEF.*
Zaključak: *SLP je povezan sa strukturnim i funkcionalnim srčanim abnormalnostima kod pacijenata sa HFpEF na RRT. Ovaj jednostavni EKG marker je povezan sa HFpEF i može dopuniti ehokardiografsku procenu kod pacijenata na RRT.*

Ključne reči: *dijastolna funkcija, Sokolow-Lyon produkt, srcana insuficijencija*