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Coronary artery tortuosity and mid-term all-cause mortality of patients with ischemia and non-obstructive coronary arteries

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Abstract:

Background: Coronary artery tortuosity (CAT) is a frequently encountered angiographic feature of patients with ischemia and non-obstructive coronary arteries (INOCA). However, there is limited data regarding the possible correlation between CAT and all-cause mortality in these patients.

Aim: To assess the survival prognostic implications of CAT in INOCA patients and the predictors of all-cause mid-term mortality of these patients.

Methods: All consecutive INOCA patients, with preserved ejection fraction evaluated for clinical ischemia by coronary angiography in our department between January 2014 and December 2020 were considered for inclusion. Patients with epicardial coronary artery stenosis ≥ 50%, severe pulmonary hypertension, or decompensated extra cardiac disease were excluded.

Eleid classification was used for CAT severity characterization.

We assessed all-cause mortality in January 2023.

Results: Our sample included 328 INOCA patients. 15.54% died during the mean follow-up of 3.75 ± 1.32 years. 79.88% had CAT. CAT patients were older (65.10±9.09 versus 61.24±10.02 years, p=0.002), and more often female (67.18% versus 31.82%, p<0.001).

CAT was inversely correlated with all-cause mid-term mortality (OR 0.35, 95%CI 0.16 – 0.77, p=0.01). CAT severity had no impact on survival.

In CAT patients the initial multivariable analysis identified NT-proBNP levels (HR 3.96, p=0.01), diabetes mellitus (DM) (HR 4.76, p=0.003), and atrial fibrillation (HR 2.68, p=0.06) as independent predictors of all-cause mortality. In the final analysis, NT-proBNP and DM were the main independent predictors of survival.

Conclusions: In our INOCA cohort, CAT patients were older and more likely female. CAT was inversely correlated with mid-term all-cause mortality. NT-proBNP and DM were the main independent predictors of mortality of CAT patients.

Keywords: non-obstructive coronary arteries, coronary artery tortuosity, all-cause mortality.

What is new/important?

Our study is among the few to assess mid-term all-cause mortality in patients with coronary artery tortuosity, ischemia with non-obstructive coronary arteries and preserved left ventricular ejection fraction.

The presence of coronary artery tortuosity or the severity of this adaptive phenomenon were not risk factors for the outcome. For these patients, the association of diabetes mellitus and the heart failure severity expressed by higher NT-proBNP levels were the independent predictors for survival.

INTRODUCTION

Over one million of coronary angiographies are performed annually in the United States [1] and 3.5 million in Europe [2]. Despite the newer non-invasive techniques for investigating coronary anatomy, coronarography remains the gold standard for the diagnostic of coronary artery disease. Up to 50% of women and 7–17% of men are free from significant lesions [3,4]. This heterogeneous group of patients with ischemia and non-obstructive coronary arteries (INOCA) is usually trivially treated. Coronary artery tortuosity (CAT) is a condition often associated with non-obstructive

coronary disease [5,6]. Regarding the clinical profile of the patients with CAT we only know that they are more frequently women, with more advanced age, and hypertensive [6,7]. There is a paucity in the literature in identifying the clinical profile of CAT patients. Considering the echocardiographic changes in left ventricular function part of the clinical profile of these patients, we found limited data that corelated the diastolic disfunction and CAT [8]. Another correlation investigated the relation between the shortening of the left ventricle and CAT [9]. Regarding the prognosis of these patients, to date we found no research to identify independent predictors of mortality for patients with ischemia with non-obstructive coronary artery disease and CAT. In INOCA patients, one meta-analysis found that older age, smoking, diabetes mellitus and hypertension had been associated with increased all-cause mortality [10]. Therefore, the aim of our study was to identify the clinical, biological, and echocardiographic profile of patients with CAT, as well as the predictors of vital prognosis.

MATERIAL AND METHODS

STUDY DESIGN

This is a single-center, cross-sectional, retrospective cohort study that included consecutive INOCA patients.

POPULATION

Consecutive patients who underwent coronary angiography (CAG) and were diagnosed ischemia with non-obstructive coronary lesions, between January 2014 and December 2020 in our Interventional Cardiology Department were considered for inclusion. INOCA was defined based on anginal symptoms, evidence of inducible ischemia at functional testing (where it was deemed necessary) and CAG findings.

The study protocol was approved by the hospital's ethics committee, in accordance with the Helsinki Declaration. Only patients with written informed consent to have their data anonymously analyzed were considered for inclusion. Patients with symptoms of ischemia and/or positive stress testing, presenting with chronic coronary syndromes, acute coronary syndromes, normal ejection fraction and non-obstructive coronary lesions were eligible for inclusion. Patients with left ventricular ejection fraction < 50%, epicardial coronary artery stenosis ≥ 50%, severe pulmonary hypertension, or decompensated extra cardiac disease were excluded.

CORONARY ANGIOGRAPHY

All patients underwent selective CAG according to Judkins's technique with a Siemens Artis Zee X-ray system. Left anterior descending artery (LAD), left circumflex artery (LCX) and right coronary artery (RCA) were investigated in cranio/caudal and left/right angulation to identify coronary angulations. Patients with stenosis ≥50% identified on visual estimation and quantitative coronary angiography (QCA) were considered non-eligible for the study.

CORONARY ARTERY TORTUOSITY CLASSIFICATION

For evaluating the coronary artery tortuosity, we used Eleid classification [11]. Beyond the description of the curvature angles this classification proposed severity markers for coronary tortuosity. Tortuosity was defined as at least 3 bends ≥ 45° (change in vessel direction) in at least one epicardial artery larger than 2 mm present during systole and diastole. Moderate tortuosity was defined as 3 bends of 90°–180°. Severe tortuosity was defined as 2 bends ≥180°. For each coronary artery Eleid *et al.* proposed a score: 0 – no tortuosity; 1 – mild tortuosity; 2 – moderate tortuosity; 3 – severe tortuosity. A global index of tortuosity (GIT) for all three coronary arteries was defined as the sum of scores for each vessel.

We considered tortuosity present if the patient had the GIT ≥3. We defined severe tortuosity if GIT ≥ 6 or if the markers of severe tortuosity were present: the corkscrew sign, intravascular symmetry, or multivascular symmetry (Table 1) [12].

CLINICAL RISK FACTORS

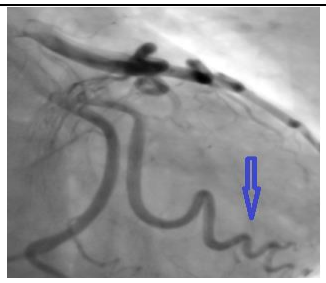
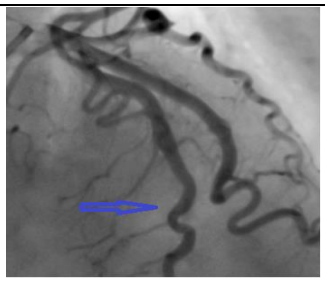
During the index hospitalization every patient had a standard blood sample analysis including blood type, full blood count and biochemistry markers. The cardiovascular risk factors were defined according to of the European Society of Cardiology 2021 guidelines [13], as follows: dyslipidemia - total cholesterol ≥200 mg/dL or LDL-cholesterol ≥130 mg/dL or on lipid lowering medication at inclusion time; arterial hypertension - systolic blood pressure ≥140 mmHg

or diastolic blood pressure ≥90mmHg or on antihypertensive medication; type 1 and 2 diabetes mellitus - if fasting glucose ≥126 mg/dL or antidiabetic medication; cigarette smoking - active or former smokers including the use of smokeless tobacco [13].

High cardiovascular risk was defined according to the aforementioned guidelines [13].

Table 1

Markers of severe tortuosity

	Intravascular symmetry	Multivascular symmetry	"Corkscrew" sign
Coronary angiography appearance			
Definition	Multiple symmetrical curves in one vessel	Multiple symmetrical curves in at least two vessels	Single or multiple 360° spiral turns

SPECIFIC INVESTIGATIONS

In relation to the clinical presentation of each patient, we considered specific investigations. Transthoracic echography was used for the evaluation of systolic and diastolic left ventricular function, wall motion abnormalities, as well as valvular pathology. For patients presenting with chronic coronary syndromes, functional testing was used to assess inducible ischemia, respectively ECG stress test or dobutamine echocardiographic stress test. Patients with acute coronary syndromes were evaluated by coronary angiography, in accordance with specific guideline indications. Laboratory findings included full blood count, lipid profile, markers of renal function, thyroid function, high sensitivity cardiac troponin T (hsTnT), N-terminal pro-brain natriuretic peptide (NT-proBNP), and electrolyte levels.

STUDY ENDPOINTS

The primary endpoint of our study was all-cause mid-term mortality. Survival status was assessed in January 2023 using the National Health System Database.

The secondary endpoint was the description of the clinical profile of CAT patients.

STATISTICAL ANALYSIS

IBM SPSS 19 and EpiInfo 2007 were used to perform the statistical analysis.

Continuous variables were expressed as mean ± standard deviation, if they had a normal distribution, or as median [interquartile range] otherwise. Categorical variables were expressed as percentages. The ANOVA test was used to compare normally distributed continuous variables. The Kruskal-Wallis test was used to compare non-normally distributed continuous variables. The Chi-square corrected (Yates) test was used to assess the correlation between categorical variables.

Binary logistic multivariable regression Enter method was used to assess independent predictors for the primary outcome. Backward and forward conditional methods were used to confirm the independent predictors. Sequential multivariable analyses were performed with different categories of variables to accommodate the number of outcomes. Independent predictors identified in the initial analyses were included in the final model.

Due to its skewed distribution, NT-proBNP was logarithmically transformed for the purpose of multivariable analysis.

A p value < 0.05 was considered statistically significant.

RESULTS

BASELINE CHARACTERISTICS

Our study included 328 INOCA patients. 262 (79.88%) had CAT. The most frequent ischemic condition was chronic coronary syndrome. The most prevalent disease was heart failure in more than half of the patients, followed by chronic kidney disease. Arterial hypertension and dyslipidemia were found in approximately three quarters of patients (Table 2).

Table 2

General characteristics

	All patients N = 328	**CAT patients** N = 262	**non-CAT patients** N = 66	p value
Age, years	64.14 ± 9.66	65.10 ± 9.09	61.24 ± 10.02	0.002
Female patients	197 (60.06%)	176 (67.18%)	21 (31.82%)	< 0.001
Cardiovascular risk factors				
Arterial hypertension	277 (84.45%)	223 (85.11%)	54 (81.82%)	0.63
Dyslipidemia	250 (76.22%)	199 (75.95%)	51 (77.27%)	0.94
Prediabetes	29 (8.84%)	21(8.02%)	8 (12.12%)	0.41
Diabetes mellitus	92 (28.04%)	72 (27.48%)	20 (30.30%)	0.76
Active cigarette smoking	37 (11.28%)	28 (10.69%)	9 (13.64%)	0.64
High CV risk	57 (17.37%)	44 (16.79%)	13 (19.70%)	0.70
Ischemic heart disease				
Acute coronary syndrome	138 (42.07%)	108 (41.22%)	30 (45.45%)	0.62
Chronic coronary syndrome	167 (50.91%)	134 (51.15%)	33 (50.00%)	0.97
Positive stress test	110 (33.53%)	90 (34.35%)	20 (30.30%)	0.63
Associated conditions				
PAD	22 (6.71%)	17 (6.49%)	5 (7.58%)	0.96
Heart failure	184 (56.09%)	148 (56.49%)	36 (55.38%)	0.98
Atrial fibrillation	78 (23.78%)	62 (23.75%)	16 (24.24%)	0.93
CKD	162 (49.39%)	136 (51.91%)	26 (39.39%)	0.09
Severe valve disease requiring surgery	26 (7.92%)	22 (8.4%)	4 (6.06%)	0.71
Biological profile				
NT-proBNP, pg/mL	320.7 [129 – 959.3]	312.6 [132.1 – 923]	459.1 [125.1 – 1183]	0.018
Glycemia, mg/dL	114.78 ± 39.11	116.69 ± 42.41	109.98 ± 27.44	0.22
HbA1c, %	6.76 ± 1.33	6.79 ± 1.27	8.83 ± 1.56	0.91
Total cholesterol	166.46 ± 47.16	167.32 ± 47.63	163.85 ± 45.27	0.59
LDL cholesterol, mg/dL		84.33 [60.96 – 111.74]	81.84 [65.78 – 113.86]	<0.001
Creatinine, mg/dL	0.81 [0.68 – 0.98]	0.80 [0.67 – 0.95]	0.87 [0.70 – 1.01]	0.03
eGFR, ml/min/1.72m^2	86.02 ± 19.88	85.51 ± 19.95	89.39 ± 19.19	0.12

CAT – coronary artery tortuosity; CKD – chronic kidney disease; eGFR – estimated glomerular filtration rate; HbA1c – glycosylated hemoglobin; LDL cholesterol – low-density lipoprotein cholesterol; non-CAT – non-coronary artery tortuosity; NT-proBNP – N-terminal pro-B-type natriuretic peptide; PAD – peripheral artery disease; N – number of patients

CAT patients were older, more frequently women, with a higher prevalence of chronic kidney disease (Table 2). The clinical profile of patients with CAT was similar to that of patients without CAT in regards of ischemic heart disease, heart failure, cardiovascular risk factors and comorbidities. There was no significant difference between CAT and non-CAT patients in regards of the overall cardiovascular risk burden (Table 2).

The biological profile of CAT patients was characterized by lower NT-proBNP and higher LDL cholesterol levels, compared to non-CAT patients. The CAT subgroup had lower creatinine levels, however without significant differences in eGFR (Table 2). Up to half of the CAT patients had signs of severe tortuosity (Table 3).

DETERMINANTS OF ALL-CAUSE MORTALITY OF CAT PATIENTS

In the entire study group of INOCA patients, the presence of CAT was inversely correlated with the risk of all-cause mid-term mortality (OR 0.35, 95%CI 0.16 – 0.77, p = 0.01), during the follow-up period of 3.75 ± 1.32 years.

In CAT patients, of all cardiovascular risk factors, type 2 diabetes was the only one significantly correlated with mortality (Table 4). In univariable analysis, heart failure, increased NYHA class, AF, decreased kidney function and severe valvular disease were predictors of survival (Table 4).

Table 3

Characteristics of tortuosity severity

	N = 262 patients
Tortuosity score ≥ 6	100 (38.17%)
Multivascular symmetry	105 (40.08%)
Univascular symmetry	116 (44.27%)
Cork-screw sign	43 (16.41%)

Table 4

Univariable analysis of all-cause mortality predictors of CAT patients

	OR (95% CI)	p value
Cardiovascular risk factors		
Arterial hypertension	3.33 (0.43 – 25.74)	0.37
Grade 3 arterial hypertension	1.91 (0.70 – 5.20)	0.29
Left ventricular hypertrophy	1.54 (0.56 – 4.24)	0.57
Dyslipidemia	6.16 (0.80 – 47.15)	0.08
Diabetes mellitus	5.22 (1.96 – 13.88)	<0.001
Active cigarette smoking	1.63 (0.44 – 6.00)	0.71
Former cigarette smoker	0.69 (0.08 – 5.50)	1.00
Coronary syndrome at presentation		
Acute coronary syndrome	1.04 (0.40 – 2.67)	1
Unstable angina	1.02 (0.39 – 2.70)	1
NSTEMI	1.63 (0.19 – 13.77)	1
Chronic coronary syndrome	0.53 (0.20 – 1.39)	0.29
Any positive stress test	0.09 (0.01 – 0.73)	0.01
Comorbidities		
Peripheral arterial disease	0.78 (0.09 – 6.28)	1
Heart failure	3.1 (1.004 – 9.61)	0.04
NYHA class III/IV	4.72 (1.37 – 16.24)	0.03
Atrial fibrillation	4.05 (1.56 – 10.51)	0.005
eGFR<60	3.83 (1.34 – 10.95)	0.02
Chronic kidney disease	1.64 (0.62 – 4.32)	0.43
Thyroid disorders	0.41 (0.05 – 3.18)	0.61
Hypothyroidism	0.46 (0.05 – 3.61)	0.71
Severe valve disease requiring surgery	3.33 (1.001 – 11.09)	0.04

eGFR – estimated glomerular filtration rate; NSTEMI – non-ST elevation myocardial infarction; NYHA – New York Heart Association;

Neither acute nor chronic coronary syndromes were independently correlated with all-cause mortality in CAT patients. In this subgroup a positive stress test was inversely associated with the negative outcome (Table 4).

No correlations were found between the severity markers of CAT and survival prognosis (Table 5).

Initial multivariable analyses found NT-proBNP levels, diabetes mellitus, and AF as independent predictors of all-cause mortality in CAT patients. Final multivariable analysis identified NT-proBNP levels and diabetes mellitus as the strongest independent predictors of mortality in this subgroup of patients (Table 6).

Table 5

Severe coronary artery tortuosity and all-cause mid-term mortality

	OR (95% CI)	p value
Corkscrew sign	0.57 (0.12 – 2.60)	0.69
Univascular symmetry	0.90 (0.35 – 2.33)	1
Multivascular symmetry	1.09 (0.42 – 2.82)	1
Severe tortuosity	0.94 (0.35 – 2.47)	1

Table 6

Independent predictors of all-cause mortality of CAT patients

	HR (95%CI)	p value
Multivariable regression 1 – Heart failure characteristics		
Log_{10}NT-proBNP	3.96 (1.34 – 11.68)	0.01
Heart failure	0.79 (0.37 – 1.69)	0.54
NYHA class	2.57 (0.33 – 20.01)	0.37
Multivariable regression 2 – Cardiac and non-cardiac comorbidities		
Diabetes mellitus	4.76 (1.69 – 13.38)	0.003
Atrial fibrillation	2.68 (0.96 – 7.47)	0.06
Severe valve disease requiring surgery	0.32 (0.08 – 1.24)	0.09
eGFR<60ml/min	2.27 (0.71 – 7.32)	0.17
Multivariable regression 3 – Final independent predictors of mortality		
Log_{10}NT-proBNP	3.18 (1.06 – 9.56)	0.04
Diabetes mellitus	7.68 (2.29 – 25.74)	0.001
Atrial fibrillation	1.74 (0.50 – 6.00)	0.38

eGFR – estimated glomerular filtration rate; Log_{10}NT-proBNP – logarithmic transformation in the base of 10 of B-type natriuretic peptide; NYHA – New York Heart Association;

DISCUSSION

Our study is among the few to assess the survival implications of CAT in INOCA patients, as well as to determine the independent predictors of all-cause mid-term mortality of these patients. The main findings were (1) the inverse correlation between CAT and the primary endpoint in INOCA patients, (2) the lack of impact of CAT severity in predicting all-cause mortality in CAT patients, and (3) the identified determinants of all-cause mid-term mortality of patients with INOCA and CAT, respectively the NT-proBNP value, as a marker of HFpEF severity and the presence of diabetes mellitus.

Similar to prior reports, in our study CAT patients were older and more often female. The latter correlation is well-known and could be the consequence of hormonal and anatomical differences. It was proven that estrogen increases the elastin in the vessel wall while decreasing

collagen, therefore predisposing the coronary vasculature to bending and twisting [14,15]. In patients with smaller cardiac surface relative to heart mass, predominantly in women, the dynamic economy of space and flow requirement are considered the main factors for the development of CAT [5,16]. The "accordion" theory hypothesized that tortuous geometry in basal conditions allows adaptative elongation during ventricular dilatation in case of volume overload [17]. During pregnancy it was proven that blood flow increases by 45%, left ventricular wall thickness by 28%, and left ventricular mass by 52% [18]. This could be a plausible link between gender and CAT, respectively the mix of endocrine and structural changes in women that could later lead to coronary tortuosity. Aging is also associated with degenerative changes of the extracellular matrix resulting in tortuosity, stiffness, and arterial wall remodeling [19]. Moreover, after menopause, the ratio elastin/collagen is modified secondary to low levels of estrogen [15].

Coronary tortuosity could be a new phenotype of ischemia with non-obstructive coronary arteries, whose pathophysiological mechanism is yet to be fully uncovered, as previous authors have stated [20]. It might be the driver of ischemia, or only a marker of microvascular dysfunction, or an adaptative mechanism to dynamic myocardial oxygen supply and demand variability [20]. Therefore, a more in-depth understanding of this vascular variant could lead to improved patient outcomes. The patients in our cohort were evaluated for anginal symptoms and were diagnosed with INOCA. Over 40% had acute coronary syndromes and for those with coronary chronic syndromes, almost two thirds had a positive stress test. A positive functional stress test was significantly inversely associated with mortality in our group of INOCA and CAT patients. One hypothesis for this paradoxical finding could be the prompt diagnosis of ischemia implying the optimization of therapy, therefore preventing progression of the coronary disease. Another reason could be the higher prevalence of a positive test among women with INOCA, with preexisting data showing that women are more symptomatic than man when referring to angina, with a higher burden on quality of life and disability, yet a lower rate of obstructive lesions. The ischemic substrate has a higher prevalence of diffuse atherosclerotic disease and microvascular disfunction in women [21]. Although with a lower incidence of coronary obstructive lesions, women have more frequently inducible ischemia at invasive and non-invasive functional tests, a significant percentage attributable to INOCA [22]. Testing the coronary spasm and microvascular dysfunction in relation with coronary artery tortuosity, Jansen *et al.*, proved no significant differences in microvascular function indices, respectively the index of microvascular resistance and the coronary flow reserve between tortuosity groups [23].

In our cohort of INOCA patients, those with CAT had improved survival. Similar results were reported by Li *et al.* in a cohort of 1010 patients with or without CAD undergoing coronary angiography followed up for 2.4 ± 0.5 years [5]. CAD patients with or without CAT had similar outcomes in terms of MACE and all-cause mortality [5]. Conversely, in a recent pooled analysis of data from 6 trials including 6951 patients that underwent percutaneous coronary intervention of a single coronary lesion, moderate/severe CAT of the culprit vessel was associated with increased risk of target vessel failure either by target vessel-related MI or ischemia-driven target vessel revascularization [24]. Determinants for this independent correlation could be the procedural difficulty, device induced trauma, accelerated downstream atherosclerosis, or higher platelet activation [24, 25]. The major difference that individualizes the results of our study is the inclusion of INOCA patients only, therefore we might argue that CAT in the absence of significant coronary lesions has no prognostic correlation, while CAT of a culprit vessel is a predictor of worse outcomes.

Furthermore, in our studied subgroup of CAT patients with INOCA, severity of CAT played no role in determining all-cause mid-term mortality, unlike the significant contribution of moderate/severe CAT to the prognosis of patients with univascular coronary lesion requiring PCI found by Konigstein *et al*. [24]. Previous data found a significant association between severe coronary artery tortuosity and reversible myocardial perfusion defects, however without the certainty of a causative or coincidental finding. Since wall motion abnormalities were equally prevalent in CAT and non-CAT patients, the authors hypothesized that severe coronary tortuosity leads to mild decrease in myocardial flow, which is not sufficient to induce significant functional abnormalities [26]. The gradual bends of coronary tortuosity act as a "shear absorber", allowing a homogeneous distribution of shear stress during shortening along the longitudinal axis of the heart. It is well known that variable shear stress is associated with coronary artery disease. Thus, the uniformization of shear stress secondary to tortuosity could explain

the lower incidence of significant coronary artery atherosclerotic burden in these patients and by deduction, a neutral impact on mortality [5][16].

Another important contribution of our study was the survival analysis of CAT and INOCA patients. In terms of prognosis implications of CAT, there is data suggesting that CAT might be associated with restenosis after drug eluting stent implantation [27]. Kolbitsch *et al.* identified a correlation between CAT and uncontrolled hypertension and dyspnea severity [28]. An AI-enabled retinal image processing showed that in men arterial and venous tortuosity is significantly correlated with cardiovascular mortality [29]. This result is in contradiction with our results, but knowing the fact that severe hypertension is associated with retinal artery tortuosity, the correlation with cardiovascular mortality could be the result of strokes specifically for men. Also, in this study it is not specified whether there are other arterial territories affected by tortuosity, retinal tortuosity being only one part of a systemic arterial tortuosity syndrome. Although frequently encountered in INOCA patients, CAT was rarely evaluated as a prognostic marker. Cigarette smoking, advanced age, hypertension, and diabetes were validated as predictors of all-cause mortality in INOCA patients [10]. In our cohort of patients with INOCA and CAT, the strongest independent predictors of all-cause mid-term mortality were the NT-proBNP values, representing the main marker of HF severity in multivariable analysis, and the association of diabetes mellitus. Unsurprisingly, this correlation is confirming the overall prognosis burden of heart failure with preserved ejection fraction, a major contributor to worldwide mortality trends [30]. In the general population, in patients with ischemia and non-obstructed coronary arteries [31], as well as in CAT patients, the presence and severity of heart failure is an independent and powerful predictor of survival. Diabetes mellitus, the other independent predictor of all-cause mortality of our INOCA and CAT patients, is another frequently involved parameter of negative prognosis across different baseline pathologies, cardiovascular or non-cardiovascular in nature. It was validated as a prognostic marker in both INOCA patients [31] as well as HFpEF patients [32].

STUDY LIMITATIONS

This is a single center study, which may impact the heterogeneity of the patient population.

All-cause mortality used as the primary endpoint could be a drawback since cardiovascular mortality may play a different role for the selected subset of patients. However, we argue that all-cause mortality is a hard endpoint that is more robust and less prone to uncertaintly and bias, compared to cardiovascular mortality [33,34].

CONCLUSION

Among INOCA patients evaluated for anginal symptoms, those with CAT were older and more often female, with a higher prevalence of chronic kidney disease. CAT was inversely associated with all-cause mid-term mortality, and CAT severity had no impact on prognosis.

In patients with INOCA and CAT, the main independent predictors of mortality were NT-proBNP levels and diabetes mellitus.

Introducere: *Tortuozitatea arterelor coronare (TAC) este o caracteristică angiografică frecvent întâlnită la pacienții cu ischemie și artere coronare non-obstructive. Totuși, în literatură sunt puține date privind o posibilă corelație între TAC și mortalitatea globală la acești pacienți.*

Obiectiv: *Să evalueze impactul prognostic al TAC asupra mortalității globale în cadrul pacienților cu ischemie și artere coronare non-obstructive, precum și predictorii mortalității globale pe termen mediu pentru acești pacienți.*

Metodă: *Au fost considerați eligibili pentru includere toți pacienții cu artere coronare non-obstructive, cu fracție de ejecție prezervată, care au fost evaluați pentru ischemie clinică, investigați prin coronarografie în centrul nostru între ianuarie 2014 și decembrie 2020. Au fost excluși pacienții cu stenoze coronariene ≥ 50%, hipertensiune pulmonară severă și pacienți cu patologie non-cardiacă decompensată.*

Pentru caracterizarea severității TAC a fost utilizată clasificarea Eleid.

Mortalitatea globală a fost evaluată în luna ianuarie 2023.

Rezultate: *În eșantionul nostru au fost incluși 328 de pacienți cu ischemie și artere coronare non-obstructive. Dintre aceștia, 15.54% au decedat pe parcursul perioadei de*

urmărire de 3.75±1.32 ani. 79.88% dintre aceştia aveau TAC. Pacienții cu TAC au fost mai în vârstă (65.10±9.09 versus 61.24±10.02 ani, p=0.002) și mai frecvent de genul feminin (67.18% versus 31.82%, p<0.001).

TAC a fost invers corelată cu mortalitatea globală pe termen mediu (OR 0.35, 95%CI 0.16 – 0.77, p=0.01). Severitatea TAC nu a avut niciun impact asupra supraviețuirii.

Analiza multivariată inițială a pacienților cu TAC a identificat valoarea NT-proBNP-ului (HR 3.96, p=0.01), diabetul zaharat (DZ) (HR 4.76, p=0.003) și fibrilația atrială (HR 2.68, p=0.06) ca predictori independenți de mortalitate globală. Valoarea NT-proBNP-ului și DZ au fost principalii predictori independenți ai supraviețuirii.

***Concluzii:** În cohorta noastră de pacienți cu ischemie și artere coronare non-obstructive, pacienții cu TAC au fost mai în vârstă și mult mai frecvent femei. CAT a fost invers corelată cu mortalitatea globală pe termen mediu. Valoarea NT-proBNP-ului și DZ au fost principalii predictori independenți ai mortalității la pacienții cu TAC.*

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