<u>Original Research</u>

The Predictive Value of NGF, TMAO, SIRT1 and apoA1 in Patients With Ischemic Heart Failure

Ping Yang, MM; Tian Dai, MM; Bo Liu, MM; Lu Huang, MM; Jun Yin, MM; Fan Zhao, MM; Hong Zhuang, MM

ABSTRACT

Objective • The present study aimed to explore the predictive value and prognosis of SYNTAX score, nerve growth factor (NGF), trimethylamino oxide (TMAO), silent information regulator 1 (SIRT1), and apolipoprotein A1 (apoA1) for ischemic heart failure (IHF) patients.

Methods • From January 2020 to January 2021, 87 patients diagnosed with IHF in the Sixth Hospital of Wuhan, Affiliated Hospital of Jianghan University, and 42 healthy people were included and analyzed retrospectively. The 87 patients were divided into 3 subgroups according to New York Heart Association (NYHA) heart function classification, as group 1 (n=9, classes I-II heart function), group 2 (n = 7, class III heart function), and group 3 (n = 31, class IV heart function). The levels of left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD), left atrium diameter (LAD), NGF, TMAO, SIRT1, SYNTAX score, and apoA1 were compared among these groups.

Results • The SIRT1 and apoA1 of patients with classes I-II, III, and IV heart function were significantly lower than that of healthy people in the control group, while TMAO and NGF were significantly higher than those of healthy people (all P < .05). The SYNTAX score of grade I-II, grade III, and grade IV groups was significantly lower than that of the healthy group (P < .05). The two groups had no significant difference in the number of coronary artery lesions (P > .05). The SIRT1 and apoA1 of patients with classes III and IV heart function were significantly

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INTRODUCTION

With people's aged tendency, heart failure incidence is increasing yearly. According to the relevant epidemiological lower than that of patients with classes I -II heart function, while TMAO and NGF were significantly higher than those of class I-II people (all P < .05). The SIRT1 and apoA1 of patients with class IV heart function were significantly lower than those of patients with class III heart function, while TMAO and NGF were significantly higher than those of patients with class III heart function (all P < .05). After 1 year follow-up of these IHF patients, 22 patients were readmission because of cardiac events, and 6 patients died in hospital or during follow-up. These 28 patients were allocated to the event group, while the rest 59 patients were allocated to the events-free group. The SIRT1 and apoA1 level in event group was significantly lower than those of event-free group, while the TMAO, SYNTAX score, and NGF level were significantly higher than those of the event-free group (all P < .001). Baseline characters and heart function with significant differences (LVEF, LAD and LVEDD) among these groups, and NGF, TMAO, SIRT1, SYNTAX score and apoA1 were enrolled into Logistic regression. SYNTAX score, NGF, TMAO, SIRT1 and apoA1 were independent risk factors for the prognosis of IHF patients (all P < .05).

Conclusion • SIRT1, apoA1, TMAO and NGF serum levels in patients with IHF are abnormally expressed and closely related to cardiac function. The levels of SYNTAX score, NGF, TMAO, SIRT1, and apoA can effectively predict adverse events in patients with IHF. (*Altern Ther Health Med.* 2024;30(6):234-239).

study, it is estimated that there will be more than 8 million adults (\geq 18 years old) with heart failure in the United States by 2030.¹ The epidemiological survey in China in 2018 showed that there were 8.9 million heart failure patients in China, with a prevalence rate of about 1.3%, which increased 44% over that of 2003.² The China Cardiovascular Disease Report 2018 showed that the prevalence of cardiovascular diseases in China was on rise, and the death rate of cardiovascular disease has become the leading cause of heart failure death in China, accounting for 50%-84% mortality in 5 years. Therefore, the exploration of effective and convenient markers for the diagnosis of ischemic heart failure (IHF) is of great significance for guiding treatment.

The SYNTAX study was formally proposed for the first time at the European Society of Cardiology Congress (ESC) in 2008. The content of SYNTAX score includes the dominant type of coronary artery, the number of lesions, the involved segments, and the lesion characteristics (total occlusion, tribifurcation, bifurcation, aorta, ostial lesions, severe tortuosity, lesion length > 20 mm, severe calcification, thrombosis, and diffuse/primary canine lesions), and is an important method to evaluate the complex severity of coronary artery lesions quantitatively. Nerve growth factor (NGF) is a neuroactive factor which can regulate the processes and links of neuronal apoptosis, transmitter synthesis and secretion, and prevent the cyclic circulation of vascular endothelial cells. It plays a certain role in protecting neural cells and restoring ischemia-reperfusion.⁴ Currently, clinical research on NGF mainly focuses on brain diseases such as hypoxic-ischemic encephalopathy.5 Silent information regulator 1 (SIRT1), an important member of the sirtuins family of the third class of histone deacetylases, is a nicotinamide adenine dinucleotide (NAD*) dependent histone deacetylase.⁶ Previous studies have confirmed⁷ that SIRT1 plays an important role in the occurrence and development of aging-related diseases such as cardiovascular diseases, metabolic disorders, nervous system degeneration and chronic heart failure.8 Apolipoprotein A1 (apoA1) is a polypeptide composed of 243 amino acids. It is the main apolipoprotein of high-density lipoprotein cholesterol and participates in the reverse transport of cholesterol.9 Compared with healthy people, the level of apoA1 in patients with heart failure decreased, indicating that it has diagnostic value for heart failure¹⁰ Trimethylamino oxide (TMAO), is closely related to a variety of cardiovascular diseases as a metabolite of intestinal microflora.¹¹ Suzuki et al.¹¹ showed that elevated TMAO levels were independently associated with poor prognosis in patients with acute heart failure. Tang et al.¹² showed that the increase of TMAO level was associated with the increase in all-cause mortality. However, there are few clinical reports about the predictive value and prognosis of NGF, TMAO, SIRT1 and apoA1 in ischemic heart failure.

Thus, this study aimed to explore the predictive value and prognosis of NGF, TMAO, SIRT1, and apoA1 in patients with ischemic heart failure.

METHODS

Clinical characters

Ninety-two patients (Figure 1) diagnosed with IHF from January 2020 to January 2021 in our hospital were included in this retrospective study, and another 42 healthy people were also included. After screening, 87 IHF patients were selected and divided to 3 groups according to New York Heart Association (NYHA) heart function classification.¹² There were 29 patients with class I-II heart function in group 1, 27 patients with class III heart function in group 2, and 31 patients with class IV heart function in group 3. Healthy people enrolled in this analysis were set as control.

Figure 1. Flow chart for enrolled patients



Inclusion and exclusion criteria

Patients with IHF meeting the following criteria were included: (I) diagnosed as IHF according to "Guidelines of diagnosis and treatment for heart failure in China, version 2021".¹³ (II) with classes I to IV of NYHA heart function. (III) with written informed consent. (IV) diagnosed by myocardial zymogram, electrocardiogram, B-ultrasound, coronary angiography, etc.

Healthy people who met the following criteria were also included: (I) without cerebrovascular disease. (II) without immune system disease. (III) without infectious disease. (IV) without malignancy.

Patients with IHF and healthy people meeting the following criteria were excluded: (I) failure to cooperate with body examination. (II) with congenital heart disease, femur muscle injury, unstable angina pectoris or pulmonary artery embolism. (III) with hepatic and renal insufficiency. (IV) with cognition and mental disorders. (V) with metabolic disease.

Methods

Baseline characteristics. The following characteristics of participants enrolled in this analysis were recorded: age, sex, education background, body mass index (BMI), hemoglobin (Hb), aspartic transaminase (AST), alanine transaminase (ALT), blood urea nitrogen (BUN), triglyceride (TG), comorbidity, smoking and alcohol drinking.

Heart function test. Left ventricular ejection fraction (LVEF), left atrial diameter (LAD), and left ventricular enddiastolic dimension (LVEDD) of all participants were recorded. Ultrasound system (VIVIDI, GE Ltd. USA) was used for the evaluation.

NGF, TMAO, SIRT1 and apoA1 test. Totally 5ml fasting venous blood was extracted from the patient in the morning and centrifuged (3000 r/min, 15 min, 15 cm). Then, the blood serum was separated and stored at -80°C. Serum NGF, TMAO, and SIRT1 were determined by enzyme linked

immunosorbent assay (ELISA). The kit was purchased from Guangzhou Chaobo Technology Co., Ltd. ApoA1 was detected by immunoturbidimetry, and the kit was purchased from Beijing Kangmei Tianhong Biotechnology Co., Ltd.

Assessment of coronary artery disease. The Judkin method was used for coronary angiography, and cardiovascular interventional specialists judged the results. The diagnosis of coronary heart disease was defined as a limited stenosis of >50% in the lumen diameter of any one of the left main coronary artery, the anterior descending artery, the circumflex artery, and the right coronary artery disease was evaluated by the SYNTAX scoring system, which uses the 16-segment coronary artery method to score lesions with a diameter > 1.5mm and a stenosis degree >50% by combining the dominant distribution, lesion location, stenosis degree, and lesion characteristics of the coronary artery (http: // www.syntaxscore.com/). The SYNTAX score was divided into low score 0-22, medium scores 23-32, and high scores≥33.

Observational index

Heart function, SYNTAX score, NGF, TMAO, SIRT1, and apoA1 of patients in these groups were compared. Prognostic values of SYNTAX score, NGF, TMAO, SIRT1 AND apoA1 were explored for IHF patients with or without cardiac event (myocardial infarction and left heart failure).

Follow-up

All patients should take follow-up for one year. Patients who were readmitted because of cardiac events (like heart failure) or who died in hospital or during follow-up were defined as endpoints.

Statistical analysis

All the data collected in this study were analyzed using SPSS 22.0 software. Normally distributed measurement data were expressed as mean±standard deviation (SD), and the comparisons were examined by Student *t* test. The categorical data were expressed as n(%), and the differences between the two groups were examined by chi-square analysis or Fisher's exact test. Logistic regression was carried out for odds ratio (OR) and 95% confidence interval (CI). P < .05 was considered statistically significant.

RESULTS

Comparison of baseline characters among these groups

There was no difference of sex, age, BMI, Hb, AST, ALT, BUN, TG among 4 groups (all P > .05). There was also no difference in comorbidity among patients with different heart functions (P > .05) (Table 1).

Comparison of heart function among these groups.

The LVEF of patients with IHF in groups 1, 2 and 3 were all significantly lower than that of healthy people in the control group (P < .001), while the LAD and LVEDD were all significantly higher than that of the control group (P < .001). The LVEF of patients with classes III and IV heart function were significantly lower than those of patients with classes I-II

Table 1. Comparison of baseline characters among these groups.

Variablas	Grade I-II	Grade III	Grade IV	Controls	Develope	
variables	(n = 29)	(n = 27)	(n=31)	(n = 42)	P value	
Sar (mala/famala)	15 (51.72%) /	15 (55.56%) /	17 (54.84%) /	24 (57.14%) /	679	
Sex (male/lemale)	14 (48.28%)	12 (44.44%)	14 (45.16%)	18 (42.86%)	.078	
Age (year)	59.87±10.82	60.19±10.46	60.32±10.63	60.59±10.76	.994	
BMI (kg/m ²)	24.93±2.87	24.89±2.37	24.98±2.46	24.58±2.56	.906	
Hb (g/L)	143.28±23.28	142.19±26.98	140.76±25.39	145.97±24.39	.836	
AST (U/L)	123.97±21.28	121.89±20.97	122.93±21.38	125.38±22.32	.921	
ALT (U/L)	133.87±17.83	132.63±17.68	132.03±20.84	136.83±19.83	.714	
BUN (U/L)	6.43±1.68	6.39±1.73	6.49±1.87	6.51±1.89	.993	
TG (mmol/L)	1.99±0.54	2.03±0.51	2.06±0.56	2.09±0.59	.879	
Comorbidity (n)						
Diabetes	3 (10.34%)	5 (18.52%)	6 (19.35%)	0 (0.00%)	.659ª	
Coronary heart disease	4 (13.79%)	6 (22.22%)	5 (16.13%)	0 (0.00%)	.691ª	
Hypertension	3 (10.34%)	6 (22.22%)	5 (16.13%)	0 (0.00%)	.482ª	
Alcohol drinking (n)	3 (10.34%)	2 (7.41%)	5 (16.13%)	6 (14.29%)	.567ª	
Smoking (n)	7 (24.14%)	4 (14.82%)	5 (16.13%)	4 (9.52%)	.421ª	

^acomparison among IHF patients excluding the health group.

Abbreviation: BMI, body mass index; Hb, hemoglobin; AST, aspartic transaminase; ALT, alanine transaminase; BUN, blood urea nitrogen; TG, triglyceride.

Table 2. Comparison of cardiac function among these groups.

	Grade I-II	Grade III	Grade IV	Controls	
Variables	(n = 29)	(n = 27)	(n = 31)	(n = 42)	P value
LVEF (%)	52.32±4.28	42.38±5.32	36.19±5.48	58.78±5.38	<.001
LAD (mm)	41.02±4.48	43.54±4.52	46.87±4.87	34.08±3.38	<.001
LVEDD (mm)	54.34±5.09	60.32±5.48	67.54±6.01	47.34±4.87	<.001

Abbreviation: LVEF, left ventricular ejection fraction; LAD, left atrial diameter; LVEDD, left ventricular end diastolic dimension.

Table 3. Comparison of NGF, TMAO, SIRT1 and apoA1

 level among these groups.

	Grade I-II	Grade III	Grade IV	Controls (
Variables	(n = 29)	(n = 27)	(n = 31)	n = 42)	P value
NGF (ng/L)	21.98±1.54	23.97±1.62	27.93±1.59	13.19±1.29	<.001
TMAO (mm)	6.06±1.98	8.18±2.09	10.02±2.01	2.07±0.73	<.001
SIRT1 (pg/mL)	1376.87±89.76	902.87±88.65	409.87±90.63	1598.82±90.76	<.001
apoA1 (g/L)	1.41±0.29	1.15±0.31	0.98±0.26	1.67±0.29	<.001

Abbreviation: NGF, nerve growth factor; TMAO, trimethylamino oxide; SIRT1, silent information regulator 1; apoA1, apolipoprotein A1.

heart function, while the LAD and LVEDD were significantly higher than those of healthy people (P < .001). The LVEF of patients with class IV heart function was significantly lower than that of patients with class III heart function, while the LAD and LVEDD were significantly higher than those of patients with class III heart function (P < .001) (Table 2).

Comparison of NGF, TMAO, SIRT1 and apoA1 among these groups.

The SIRT1 and apoA1 of patients with classes I-II, III, and IV heart function were significantly lower than that of healthy people in the control group, while TMAO and NGF were significantly higher than those of healthy people (all P < .001). The SIRT1 and apoA1 of patients with classes III and IV heart function were significantly lower than that of patients with classes I -II heart function, while TMAO and NGF were significantly higher than those of classes I-II patients (all P < .001). The SIRT1 and apoA1 of patients with class IV heart function were significantly lower than that of patients with class III heart function, while TMAO and NGF were significantly higher than those of patients with class III heart function (all P < .001) (Table 3). **Table 4.** Comparison of SYNTAX score and number of coronary artery lesions

Grade I-II	Grade III	Grade IV	Controls		
(n = 29)	(n = 27)	(n = 31)	(n = 42)	t	P value
7.39±1.09	10.98±1.27	14.38±1.32	-	241.21	<.001
				5 249	263
				5.21)	.205
23	18	16	-		
4	5	9	-		
2	4	6	-		
	Grade I-II (n = 29) 7.39±1.09 23 4 2	Grade I-II Grade III (n = 29) (n = 27) 7.39±1.09 10.98±1.27 23 18 4 5 2 4	Grade I-II (n = 29) Grade III (n = 27) Grade IV (n = 31) 7.39±1.09 10.98±1.27 14.38±1.32 23 18 16 4 5 9 2 4 6	Grade I-II Grade III Grade IV Controls (n = 27) 7.39±1.09 10.98±1.27 14.38±1.32 - 23 18 16 - 4 5 9 - 2 4 6 -	Grade I-II (n = 29) Grade III (n = 27) Grade IV (n = 31) Controls (n = 42) t 7.39±1.09 10.98±1.27 14.38±1.32 - 241.21 20 10.98±1.27 14.38±1.32 - 241.21 23 18 16 - - 4 5 9 - - 2 4 6 - -

Table 5. Comparison of NGF, TMAO, SIRT1 and apoA1 level

 in ischemic heart failurepatients with different prognosis.

Variables	Events (n = 28)	Events-free (n = 59)	P value
SYNTAX score (points)	19.63±2.38	6.98±2.13	<.001
NGF(ng/L)	26.86±3.29	22.18±3.31	<.001
TMAO(mm)	13.98±2.81	6.96±2.01	<.001
SIRT1(pg/mL)	479.81±32.81	1428.88±45.87	<.001
apoA1(g/L)	1.04±0.23	1.29±0.31	<.001

Abbreviation: NGF, nerve growth factor; TMAO, trimethylamino oxide; SIRT1, silent information regulator 1; apoA1, apolipoprotein A1.

Table 6. Logistic regression of ischemic heart failurepatients

 with different prognosis.

Variables	HR	95% CI	P value
LVEF	0.782	0.348-1.009	.703
LAD	1.876	0.287-3.376	.579
LVEDD	1.141	0.931-1.389	.172
SYNTAX score	2.563	1.099-4.321	.013
NGF(ng/L)	1.003	0.709-1.537	.029
TMAO(mm)	2.198	1.531-2.876	.001
SIRT1(pg/mL)	0.799	0.419-1.287	.003
apoA1(g/L)	0.767	0.179-1.002	.006

Abbreviation: LVEF, left ventricular ejection fraction; LAD, left atrial diameter; LVEDD, left ventricular end diastolic dimension; NGF, nerve growth factor; TMAO, trimethylamino oxide; SIRT1, silent information regulator 1; apoA1, apolipoprotein A1.

Comparison of SYNTAX score and number of coronary artery lesions

The SYNTAX score of grade I-II, III, and IV groups was significantly lower than that of the healthy group (P < .001). There was no significant difference in the number of coronary artery lesions between the two groups (P = .263), as shown in Table 4.

Comparison of SYNTAX score, NGF, TMAO, SIRT1 and apoA1 level in IHF patients with different outcomes.

After 1 year follow-up of these IHF patients, 28 were with events and allocated to the event group. Of these, 22 patients were readmission because of cardiac events, and 6 patients died in hospital or during follow-up. The remaining 59 patients were allocated to the events-free group. The SIRT1 and apoA1 level in the event group was significantly lower than those of the event-free group, while the SYNTAX score, TMAO, and NGF level were significantly higher than those of the event-free group (all P < .001) (Table 5).

The prognostic factor of IHF patients.

Baseline characters and heart function with significant difference (LVEF, LAD and LVEDD) among these groups were enrolled into Logistic regression. Besides, NGF, TMAO, SIRT1, and apoA1 which might affect the prognosis of IHF were also entered into Logistic regression. NGF, TMAO, SIRT1, and apoA1 were independent risk factors for the prognosis of IHF patients (P = .029, .001, .003, .006, respectively) (Table 6).

DISCUSSION

With the aging of the population, the number of patients with heart failure is huge, with rising prevalence rate and mortality and hospitalization rate. Ischemic heart failure is the final manifestation of a variety of cardiovascular diseases, induced by long-term myocardial ischemia and myocardial hibernation caused by serious coronary artery lesions. Therefore, we conducted this study for early detection and intervention of heart failure in patients with IHF.

Liu et al.¹⁷ showed that color Doppler echocardiography could effectively predict the cardiac function of patients with heart failure. Meng et al.¹⁸ proposed that the severity of IHF patients was closely related to cardiac function. The present study showed that the LVEF levels of patients with classes I - II, classes III, and grade IV heart function were significantly lower than those of healthy people, while the levels of LAD and LVEDD were significantly higher than those of healthy people. The LVEF, LAD, and LVEDD levels of patients with classes III and IV heart function were significantly lower than those of patients with classes I and II heart function but significantly higher than those of healthy people. The LVEF level of patients with class IV heart function was significantly lower than that of patients with class III heart function, while the LAD and LVEDD levels were significantly higher than those of patients with class III heart function (P < .05), suggesting that patients with IHF had abnormal cardiac function.

The higher the SYNTAX score is, the more severe the vascular lesions are. The higher the SYNTAX score is, the more serious and complex the vascular lesions are. It is also important for clinicians to preliminarily judge and choose the revascularization strategy. The results of this study showed that the SYNTAX score of patients with IHF was lower than that of the healthy group (P < .05), suggesting that the SYNTAX score of patients with IHF increased and increased with the grade of cardiac function.

NGF is an important active cardiovascular and nervous system substance, which can promote peripheral nerve vascular regeneration. In addition, it can promote the differentiation, survival, regeneration, growth and development, and function maintenance of neurons.¹⁸ Lazarovici et al.¹⁹ and Zhao et al.²⁰ showed that NGF was the main protein that maintains the differentiation, maturation, and survival of a variety of neurons. It was suggested that NGF, synthesized and secreted by cardiomyocytes, would participate in the occurrence and development of acute myocardial infarction and the process of sympathetic innervation, regeneration, and over innervation after myocardial infarction. NGF promoted angiogenesis and the presence of stunned cardiomyocytes, which could promote myocardial healing after infarction.¹⁹ TMAO is one of the metabolites of intestinal flora, which bridges the theory of heart

failure and intestinal flora dysregulation.²⁰ Li et al.²¹ showed that TMAO is related to cardiovascular events such as myocardial infarction. Tang et al.¹² showed that the fasting plasma TMAO level of patients with heart failure was generally increased, and the increase of its level indicated that the risk of long-term death was increased. SIRT1 is an important member of the sirtuins family of the third class of histone deacetylases. It is highly expressed in mammalian heart tissues and can regulate a variety of cellular functions through acetylated histones and nonhistones, such as energy metabolism, oxidative stress, intracellular calcium regulation, autophagy, and apoptosis.²² SIRT1 can up-regulate the mitochondrial manganese superoxide dismutase expression and exerts myocardial protection via HIF-2a.22 Hariharan et al.22 showed that SIRT1 played an important role in maintaining autophagy in cardiomyocytes; In addition, it can regulate p53 activity, inhibit cardiomyocyte apoptosis, and then protect cardiomyocytes. The apoA1 is the most important component of HDL. It affects blood lipid metabolism and plays an important role in the occurrence and development of cardiovascular and cerebrovascular diseases.²³ Navab et al.²³ showed that apoA1 had the ability to remove dodecadienoic acid and hydrogenated eicosatetraenoic acid from LDL, so that LDL would not be oxidized by arterial wall cells and exert its antioxidant effect. In addition, apoA1 can prolong the half-life of prostacyclin in the blood and enhance HDL's anti platelet aggregation effect, which had a certain auxiliary effect on preventing thrombosis in the coronary artery. Walldius et al.24 showed that apoA1 could predict the occurrence of cardiovascular events in patients with myocardial infarction. The present study showed that the the SIRT1 and apoA1 level of patients with classes I-II, III and IV heart function were significantly lower than those of patients in the healthy group, while the TMAO and NGF levels were significantly higher than those of patients in the healthy group. The SIRT1 and apoA1 levels of patients with classes III and IV heart failure were significantly lower than those of patients with classes I-II heart failure, while the TMAO and NGF levels were significantly higher than those of patients in the healthy group. The SIRT1, apoA1, TMAO and NGF levels of patients with class IV heart failure were significantly lower than those of patients with class III heart failure but significantly higher than those of patients with class III heart failure (P < .05), suggesting that the serum levels of SIRT1, apoA1, TMAO and NGF in patients with IHF were abnormally expressed and closely related to cardiac function. In addition, this study further analyzed the prognosis of patients with IHF. The results showed that serum SIRT1 and apoA1 levels in the event group were significantly lower than those of the event-free group, and the SYNTAX score, TMAO and NGF levels were significantly higher than those of the eventfree group (P < .05). It suggested that if the prognosis of patients with IHF was poor, the SIRT1 and apoA1 levels were much lower, and the SYNTAX score, TMAO, and NGF levels were much higher.

Guo et al.²⁵ showed that NGF would be lowly expressed in rat heart failure model and aggravate the development of heart failure. Wang et al.²⁶ showed that TMAO was a risk factor for elderly patients with chronic heart failure and could be used as an effective factor to evaluate prognosis. Zhong et al.²⁷ showed that apoA1 was a risk factor for heart failure in elderly patients with ischemic cardiomyopathy. Lai et al.²⁸ proposed that serum SIRT1 could effectively predict chronic heart failure. The present study showed that the risk factors for adverse events in patients with IHF were SYNTAX score, NGF, TMAO, SIRT1, and apoA1, suggesting that SYNTAX score, NGF, TMAO, SIRT1, and apoA could effectively predict adverse events in patients with IHF. Predicting cardiac function in patients with IHF by color Doppler echocardiography could be greatly influenced by the operator's subjective judgment. Blood tests can be more objective. Therefore, doctors could accurately judge the prognosis of patients with the help of examination results, early detection and early intervention, and better outcomes have been achieved. These meaningful indicators are more detailed and comprehensive than the existing papers.

The study also had several limitations. First, there was unavoidable biases due to the retrospective nature of the present study. Secondly, this was a single-center analysis with a small sample size; more prospective large cohort studies should be conducted in the future.

CONCLUSION

In conclusion, the serum levels of SYNTAX score, SIRT1, apoA1, TMAO and NGF in patients with IHF are abnormally expressed and closely related to cardiac function. SYNTAX score, NGF, TMAO, SIRT1, and apoA can effectively predict adverse events in patients with IHF.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was approved by the Ethics Committee of the Sixth Hospital of Wuhan, Affiliated Hospital of Jianghan University. Informed consent was obtained from all the study subjects before enrollment.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIAL

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTIONS

PY and HZ contributed to the conception and design of the study; TD, BL, LH, JY and FZ performed the experiments, collected and analyzed data; PY and HZ wrote the manuscript; YJ L and YM D revised the manuscript. All authors reviewed and approved the final version of the manuscript.

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