Prognostic Impact of the Metabolic Syndrome and Its Components in Acute Type A Aortic Dissection After Surgery: A 3-Year Follow-Up

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Research Article

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Abstract

Background

The aim of this study is to explore whether or to what extent the metabolic syndrome (METs) and its components was associated with poor outcome in acute type A aortic dissection patients (ATAAD) after surgery.

Methods

This study involved 353 ATAAD patients undergo surgery. Data on demographic and clinical characteristics were collected. Subgroup analysis, mixed models regression analysis, score systems and receiver-operating characteristic curves (ROC) analysis were done.

Results

Overall, 353 inpatients were assigned to the poor outcome group (n = 69) and control group (n = 284) with or without METs. Compared to control group, the incidence of METs was higher in poor outcome group. Poor outcome were present in 0%, 4.4%, 12.3%, 47.6%, 71.4% and 100% of the six groups, who met the diagnostic criteria of MetS 0, 1, 2, 3, 4 and 5 times. For multivariable logistic regression, quartiles of BMI remained the risk factors of poor outcome after adjustment other risk factors. After adjustment for potential confounding factors, METs was an independent risk factors in several models. Assigning a score of one for each components, the AUC were 0.877 (95%CI: 0.823-0.923) in all patients, 0.864 (95%CI: 0.7945-0.935) in METs and 0.700 (95%CI: 0.567-0.833) in non-METs by Receiver-operating characteristic.

Conclusions

METs, especially for BMI, confers greater risk for poor outcome in ATAAD after surgery during 3-year follow up.

Introduction

Acute type A aortic dissection (ATAAD) is a life-threatening cardiovascular disease with high mortality, which characterized by a tear in the ascending aortic intima allowing blood to travel along the length of the aorta[1]. Historically, medical intervention was common therapy to limit dissection, alleviating pain and control hypertension. With significant improvements in surgical methods and techniques, the early mortality of ATAAD was decrease[2]. Due to older, comatose state, long operating times, the outcome was still high for ATAAD. Previous study found body mass index was an independent prognosis risk factor of aortic dissection patients, which indicated Obesity may play a critical role in the process of disease[3]. Besides, dyslipidemia, hypertension and diabetes also influence the prognosis in aortic dissection patients[4-6].

Metabolic syndrome (METs) is often ignored in clinic [practice](#) and comprises five components, BMI, blood pressure, fasting plasma glucose, high-density lipoprotein and triglycerides[7]. As a complex disorder, METs was an independent risk factor of cardiovascular diseases and influence outcome of patients. The relationship between METs and aortic dissection was not describe[8]. In present study, we investigated the association of the METs and its components with the outcome of ATAAD after surgery and deduced the usefulness of the METs for the diagnosis and risk assessment of ATAAD in clinical practice, which also provide a new sight for the incidence and outcome of ATAAD.

Methods

Study cohort

This is an retrospective study. A total of 353 consecutive ATAAD patients who received surgery in the Department of General Surgery at the First Hospital of Hebei Medical University were enrolled in this study from January 2013 to January 2018. The inclusion criteria were as follows: 1) diagnosed with ATAAD confirmed by CT angiography of the aorta and 2) underwent surgical treatment. The major exclusion criteria included the following: 1) other causes of aortic dissection such as Marfan syndrome; 2) patients who did not undergo surgery; 3) with other system serious diseases; 4) other causes of aortic dissection such as Marfan syndrome. The study was approved by the Institutional Review Board of the First Hospital of Hebei Medical University. All subjects provided written informed consent. The detailed recruitment process is shown in Figure 1.

Baseline demographic and clinical characteristics

Data regarding sex, age, body mass index (BMI), blood pressure, heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), ventricular ejection fraction (LVEF), history of hypertension (HT), type 2 diabetes mellitus (T2DM), coronary artery disease (CAD) and thoracic surgery were collected. Preoperative laboratory tests were performed within 24 h before surgery, including tests for fasting blood glucose (FBG), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), white blood cells (WBCs), platelets (PLTs), creatinine (Cr), uric acid (UA), troponin I, and red blood cells (RBCs). Surgery variables included length of surgery, cardiopulmonary bypass time, cross-clamp time, circulatory arrest, minimum temperature, ICU stay time, hospital stay time.

Metabolic syndrome

According to the criteria of the American National Cholesterol Education Program[9], MetS was defined as the presence of three or more of the following criteria: body mass index (BMI) > 30 kg/m², high-density lipoprotein (HDL) <50 mg/dL among women and <40 mg/dL among men, fasting plasma triglycerides (TG) ≥150 mg/dL, systolic blood pressure (SBP) ≥130 mmHg, diastolic blood pressure (DBP) ≥85 mmHg, fasting plasma glucose (FPG) ≥100 mg/dL or previously diagnosed type 2 diabetes mellitus (T2DM).

Follow-Up

Poor outcome were included all-cause death, hospitalization for recurrence aortic dissection or aortic surgery and systemic-related diseases during 3 years follow-up. Systemic complications included stroke, renal failure, hepatic failure, heart failure, et al. The main methods of follow-up included outpatient review, telephone and visits by two doctors.

Statistical methods

Statistical computations were performed using SPSS v25.1 (IBM Inc., Armonk, NY, USA). Measurement data are reported as the mean ± standard deviation for normally distributed data or as the median and quartiles (Q1, Q3) for nonnormally distributed data. Grade data are expressed as frequencies and percentages and were compared using the chi-square test. Multivariable Cox regression analyses were performed to detect the relationship between outcome and METs. In the multivariate analysis, hazard ratios (HRs) and 95% confidence intervals (CIs) for Poor outcome were calculated using a COX regression model after adjusting for potential confounding variables. To verify the robustness of our results, subgroup analyses were performed to explore the association between the number of MetS components and adverse event. Survival curves were performed by using the Kaplan-Meier method. These predictors of metabolic syndrome components were assigned points based on their regression coefficient, and a scoring system was produced. Receiver operating characteristic (ROC) curves were constructed, and the areas under the curves (AUCs) were calculated to assess the discriminatory power of the scoring system for MetS. A two-sided *p* value <0.05 was considered statistically significant.

Results

Baseline characteristics

353 patients were enrolled the study and 69 patients occur the poor outcome. Compared to control group, the age, BMI and FBG was higher in poor outcome group(all *P* < 0.001). For Mets, there were 49 patients (71.0%) in poor outcome and 46 patients (16.2%) in control group, respectively. Compared to control group, the incidence of HT was significantly higher in poor outcome for all patients (all *P* < 0.001). Besides, compare to the control group, the age and BMI was higher in poor outcome for both Mets and non-Mets subgroup (all *P* < 0.001). For Surgical procedure, there were no significant difference between overall and subgroup (all *P* ≥ 0.05)(table 1).

The METs number and clinical characteristics

Patients were divided into six groups: 14 (4.0%), 137(38.8%), 114(32.3%), 63 (17.8%), 21(5.9%) and 4(1.2%) who met the diagnostic criteria of MetS 0, 1, 2, 3, 4 and 5 times, respectively. Poor outcome was present in 0%, 4.4%, 12.3%, 47.6%, 71.4% and 100.0% of the six groups, which indicated the statistically differences (*P* < 0.05, table 2 Figure 2). There were significant difference in BMI, HT, T2DM, SBP, DBP, FBG, TG,HDL-c among six group (all *P* ≤ 0.05). For comparison among groups, the difference were the most in BMI.

METs components and in-hospital complications

After adjustment for some risk factors, such as male, age, smoker, aortic valve disease, peripheral vascular disease, hospital stay, the quartiles of BMI (adjusted HR = 1.422, 95% CI 1.205-1.678, *P* < 0.05), HDL-C (adjusted HR = 0.723, 95% CI 0.569-0.981, *P* < 0.05) and FBG (adjusted HR = 1.402, 95% CI 1.110-1.7711, *P* < 0.05) remained independent factors of poor outcomes. HT was also independent risk factors of the incidence of adverse events. Compared with the first BMI quartile, the HRs were 2.727 (95% CI 1.617-4.597) and 3.306 (95% CI 2.135-5.492) for the third and fourth BMI quartiles, respectively, after adjusting for potential risk factors (Table 3).

METs and Poor outcome

Table 4 show the results of multivariate cox regression that the association between the poor outcome and MetS. There were five models after adjusted for Age,male,heart rate,Aortic valve disease,stroke,LVEF,Length of surgery,Cardiopulmonary bypass time,Cross-clamp time,Circulatory arrest,Isolated supracoronary ascending aorta replacement,total aortic arch replacement,total aortic arch replacement,partial aortic arch replacemen,others,smoker,WBC,PLT,ICU time, hospital stay time,CR,eGFR,UA. The HRs were 7.537, 7.369, 8.036, 8.137,9.905 for MetS in model 1, 2, 3, 4,5 (all *P* < 0.05) (Table 4).

Score system of METs and ROC

Based on the Regression Coefficeint, point was assigned to METs components and subsequently summed to obtain a total difficulty score after adjusted for covariates. Elevated BMI was for 7, Elevated BP was for 3, Elevated FBG was for 3, Reduced HDL was for 2 and Elevated TG was for 1 (Table 5). The ROC curves were performed for score system. The AUC were 0.877 (95%CI: 0.823-0.932) in all patients, 0.864 (95%CI: 0.7945-0.935) in METs and 0.700(95%CI: 0.567-0.833) in non-METs. (Table 6, Figure 3).

Discussion

When the dissection involves the ascending aorta, the patients were defined as type A aortic dissection. With the improvement of anesthetic techniques, extracorporeal perfusion, types of prosthetic grafts and surgical techniques, the outcome was improved markedly. Due to the pathophysiology of aortic dissection, the incidence of adverse events were still high[10].

One of our main findings was that METs values could significantly predict the incidence of poor outcome in ATAAD patients after surgery during 3 years follow-up by multivariable and subgroup analyses. After adjusting for confounding factors, METs was also an independent risk factor for adverse events. METs had five components, BMI, blood pressure, fasting plasma glucose, high-density lipoprotein and triglycerides[11]. As a complex and common disease, it ties together insulin resistance, visceral adiposity, dyslipidemia and hypertension, which were risk factors of cardiovascular diseases[12]. Previous studies had found that its components were associated with the outcome of aortic dissection.

Obesity was a risk factor of cardiovascular disease, which also exhibited effects on multiple systems, such as the respiratory and ureaplasma systems[13]. Some underlying changes were occurred in the heart for patients with high BMI level. Glucose metabolism to expanded fatty acid oxidation, insulin resistance, imbalance of hormones and inflammatory cytokines could contribute to the incidence of adverse events[14]. Besides, previous studies had found that BMI was an independent predictor of acute kidney injury in ATAAD after surgery and preoperative hypoxemia in ATAAD before surgery[15]. A study enrolled 777 ATAAD patients divided into three groups according to BMI. After analysis, BMI was an independent risk factor of in-hospital major adverse outcomes in patients after surgery[16]. Lio A et al were found that ATAAD patients with BMI ≥ 30 kg/m² had higher operative mortality rates and an increased risk of low cardiac output syndrome, pulmonary complications and other postoperative morbidities after surgery[17]. In our study, BMI was the strongest predictor of the poor outcome during 3-year follow up by METs components analysis. For establish score system and ROC analysis, it was showed a better predictive power.

For blood glucose, there were controversial in the effect of ATAAD prognosis. In a clinical observational study, T2DM reduced the clinical complications and mortality in Stanford type B aortic dissection after thoracic endovascular aortic repair during 3-year follow up[18]. While, Lin YJ et al were found that glucose variability was associated with the incidence of postoperative delirium in acute aortic dissection patients[19]. For T2DM, there was not significant difference between two groups in our study. As a METs component, elevated blood glucose or T2DM was an independent factor of ATAAD prognosis after surgery. The specific mechanism was unclear. We speculated that the effect of insulin resistance were expanded by the synergism of other METs components, which triggered the common signal. Besides, The long-term outcome of ATAAD after surgery involved multiorgan and multisystem. Blood glucose or T2DM played an important role in other systems. In order to elucidate the underlying mechanism, the basic research and the influence of hemoglobin should perform in the future.

Hypertension was the common cause of aortic dissection that 72.1% of aortic dissection patients had history of hypertension. The high blood pressure aggravated hematoma expansion and expanded of false lumen. Therefore, the control of blood pressure was the main treatment of ATAAD and alleviated the chest pain[20]. It was also influenced the Renin-Angiotensin-Aldosterone System, sympathetic sensory system incitement and cytokines level, which related to the adverse events[21]. In Bossone E et al study, there was a J-curve association between SBP and in-hospital mortality in acute aortic dissection[22]. In our study, blood pressure was an important factor to predict the adverse outcome.

TG were transported from the liver to peripheral tissues to meet energy needs. It had more direct effects on inflammatory responses. Besides, TG also involved the process of oxidative stress and aortic stiffness[23]. As a protect particles, HDL played pivotal role in reverse cholesterol transport, which also exert a protective influence on inflammation, oxidation, angiogenesis and glucose homeostasis[24]. For aortic dissection, increased TG and decreased HDL indicated the poor outcome. A study found that the in-hospital mortality was increased for type B acute aortic dissection patients when TG level was increased and HDL level was decreased. The TG/HDL ratio was a risk factor of in-hospital mortality[4]. In our study, reduced HDL was independent risks of poor outcome after adjusted for potential confounding variables. While, the function of TG was not robust.

When patient met multiple criteria and diagnosis METs, The risk were higher than met isolated one. Insulin resistance, inflammation and neurohormonal activation exert the synergistic effect. METs was an independent risk factors of outcome, which might also a risk factor of aortic dissection. There were several METs diagnostic criteria, such as National Cholesterol Education Program criteria (NCEP), International Diabetes Federation (IDF), and The American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI). Research found that NCEP MetS definition may be more suitable for Chinese population, So we So choice the NCEP criteria in our study. Recent study demonstrated that compared to AHA/NHLBI and IDF criterion, the prevalence of cardiovascular disease was more evident when MetS was defined according to the NCEP criterion (OR:1.40)[25].

There were some limitations in our study. First, this was a single-centre and not large number of enrolled patients, which may have introduced selection bias. Second, the underlying mechanistic link between MetS and adverse events is not clear that potential risks may affect the incidence of poor outcome. Further large and randomized controlled trial need to be done to confirm our results. Lastly, due to the inclusion of ATAAD patients undergoing surgery only, our conclusions might not be applicable to aortic dissection patients with conservative treatment.

Conclusions

For ATAAD patients after surgery, the occurrence of poor outcome seems tightly linked to METs during 3-year follow up, especially in BMI. After adjusted potential risks and established score system, METs was an independent risk factor for poor outcome during 3-year follow up.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Institutional Review Board of The First Hospital of Hebei Medical University, Shijiazhuang Hebei, China.

Consent for publication

Yes

Availability of data and materials

Data available on request from the authors

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

Peng Liu: design of the work and have drafted the work;

Feng Zhang: the acquisition, analysis;

Zibin Wang: design of the work;

Miao Zhang: interpretation of data;

Xupeng Niu: interpretation of data;

Yaru Han: substantively revised it.

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Tables

Table 1 Clinical characteristics in METs and No METs patients with poor outcome.

Variables	Overall			MetS			non-MetS
	Poor Outcome	Control	P Value	Poor Outcome	Control	P Value	Poor Outcome
	n=69	n=284		n=49	n=46		n=20
Male,n(%)	50(72.5)	214(75.4)	0.620	33(67.3)	32(69.6)	0.816	17(85.0)
Age,years	56.4±5.1	51.7±4.7	<0.001	55.4±4.9	50.8±4.6	<0.001	58.9±4.9
BMI,Kg/m2	29.2±3.1	24.6±2.3	<0.001	29.7±3.0	24.9±2.4	<0.001	27.9±3.0
HT,n(%)	52(75.4)	150(52.8)	0.001	39(79.6)	26(56.5)	0.016	13(65.0)
T2DM,n(%)	15(21.7)	47(16.5)	0.310	15(30.6)	16(34.8)	0.665	0(0)
CAD,n(%)	8(11.6)	36(12.7)	0.807	6(12.2)	15(32.6)	0.017	2(10.0)
Aortic valve disease,n(%)	6(8.7)	18(6.3)	0.485	5(10.2)	4(8.7)	0.802	1(14.0)
Metabolic syndrome,n(%)	49(71.0)	46(16.2)	<0.001	-	-	-	-
smoker,n(%)	26(37.7)	72(25.4)	0.040	20(40.8)	9(19.6)	0.025	6(30.0)
Stroke,n(%)	5(7.2)	26(9.2)	0.615	4(8.2)	6(13.0)	0.439	1(5.0)
Peripheral vascular disease,n(%)	3(4.3)	8(2.8)	0.512	2(4.1)	3(6.5)	0.595	1(5.0)
SBP,mmHg	143.2±12.0	140.8±13.0	0.160	143.6±12.9	142.8±10.8	0.755	142.2±9.7
DBP,mmHg	81.1±7.1	78.6±6.6	0.001	81.2±7.6	79.4±5.6	0.195	82.6±5.6
HR,bpm	70.6±11.3	71.0±10.7	0.757	69.8±12.0	71.2±7.4	0.513	72.4±9.5
LVEF,%	56.1±5.8	57.5±6.7	0.115	55.0±5.9	59.5±7.4	0.002	58.7±4.7
FBG, mmol/L	6.4±1.7	5.3±1.0	<0.001	6.8±1.7	5.6±1.1	<0.001	5.3±1.1
TG, mmol/L	1.5(1.1,1.8)	1.3(1.0,1.7)	0.064	1.7(1.2,1.9)	2.2(1.8,3.0)	<0.001	1.3(1.0,1.6)
HDL-C, mmol/L	1.2(0.9,1.4)	1.7(1.2,2.2)	<0.001	1.0(0.9,1.3)	1.0(0.9,1.7)	0.729	1.3(1.2,1.8)
WBC,1012/L	10.0±1.5	10.0±1.5	0.801	10.0±1.7	10.4±1.4	0.232	9.9±1.0
PLT,109/L	211.8±61.1	222.2±57.2	0.180	201.9±57.2	212.1±51.5	0.907	235.8±65.0
Cr, μmol/L	75.6±18.4	76.3±19.1	0.786	76.1±18.9	82.5±28.7	0.212	74.3±17.7
UA, μmol/L	338.2(271.0,435.3)	346.7(302.1,407.0)	0.578	335.8(273.8,437.6)	369.3(311.8,418.2)	0.403	339.6(255.3,430.9)
eGFR, mL/(min·1.73 m2)	90.8±15.8	91.8±15.6	0.643	89.9±17.1	88.1±18.7	0.643	93.3±12.0
Surgical procedure							
Length of surgery, min	276.6±25.3	275.8±23.7	0.803	278.1±26.9	278.4±21.1	0.937	273.2±21.2
Cardiopulmonary bypass time, min	169.3±22.7	168.7±23.8	0.847	166.3±23.4	168.6±18.9	0.604	176.5±19.4
Cross-clamp time, min	89.1±14.6	89.0±13.0	0.953	89.1±15.1	87.7±13.7	0.652	89.1±13.6
Circulatory arrest, min	43.2±7.6	42.3±6.9	0.343	44.0±7.8	42.1±6.8	0.202	41.0±6.6
ICU stay time,day	6.2±1.4	6.0±1.4	0.217	6.2±1.2	5.8±1.5	0.160	6.3±1.9
Hospital stay time,day	21.1±1.3	19.7±1.1	<0.001	21.1±1.3	19.8±1.1	<0.001	20.9±1.5
Isolated supracoronary ascending aortareplacement,n (%)	27(39.1)	134(47.2)	0.228	20(40.8)	25(54.3)	0.187	7(35.0)
Total aortic arch replacement,n (%)	24(34.8)	82(28.9)	0.337	16(34.8)	16(32.7)	0.826	8(40.0)
Partial aortic arch replacement,n (%)	14(20.3)	51(18.0)	0.654	11(22.4)	4(8.7)	0.066	3(15.0)
others,n (%)	4(5.8)	17(6.0)	0.953	2(4.1)	1(2.2)	0.595	2(10.0)

Elevated BMI,n (%)	36(52.2)	6(2.1)	<0.001	30(61.2)	3(6.5)	<0.001	6(30.0)
Elevated BP,n (%)	67(97.1)	248(87.3)	0.019	48(98.0)	44(95.7)	0.520	19(95.0)
Elevated FBG,n (%)	37(53.6)	63(22.2)	<0.001	35(71.4)	22(47.8)	0.019	2(10.0)
Reduced HDL-C,n (%)	37(53.6)	65(22.9)	<0.001	34(69.4)	29(63.0)	0.513	3(15.0)
Elevated TG,n (%)	27(39.1)	72(25.4)	0.022	23(46.9)	24(52.2)	0.324	4(20.0)

Table 2 Baseline characteristics of the number of METs.

Variables	the number of the presence of MetS						PValue	P≤0.05
	0	1	2	3	4	5		
	n=14	n=137	n=114	n=63	n=21	n=4		
Male,n(%)	10(71.4)	111(81.0)	84(73.7)	44(69.8)	13(61.9)	2(50.0)	0.224	e,i,l
Age,years	53.4±4.7	52.1±4.7	52.3±5.5	53.4±4.2	54.1±7.5	54.0±3.9	0.340	
BMI,Kg/m2	23.5±2.3	24.6±2.3	25.2±2.6	26.8±3.4	29.8±3.4	31.1±0.2	≤0.001	b,c,d,e,g,h,i,j,k,l,m,n
HT,n(%)	0(0)	72(52.6)	66(57.9)	49(77.8)	12(57.1)	3(75.0)	≤0.001	a,b,c,d,e,g,i,j
T2DM,n(%)	0(0)	3(2.2)	28(24.6)	18(28.6)	11(52.4)	2(50.0)	≤0.001	b,c,d,e,f,g,h,i,k,l,m
Poor outcome,n(%)	0(0)	6(4.4)	14(12.3)	30(47.6)	15(71.4)	4(100.0)	≤0.001	b,c,d,e,g,h,i,j,k,l,m,n
SBP,mmHg	121.2±4.9	142.2±13.2	141.1±11.2	143.6±13.4	141.8±10.5	142.5±10.3	≤0.001	a,b,c,d,e
DBP,mmHg	70.2±7.7	78.9±6.6	79.8±6.0	79.5±7.2	82.9±5.8	81.0±6.5	≤0.001	a,b,c,d,e,h,k,m
HR,bpm	68.6±8.4	71.9±12.1	70.3±9.8	70.5±8.4	69.0±10.7	79.0±24.8	0.400	
FBG,mmol/L	5.1±0.5	5.0±0.5	5.5±1.3	6.2±1.5	6.3±1.7	7.2±1.9	≤0.001	c,d,e,f,g,h,i,j,k,l
TG,mmol/L	1.1(0.8,1.3)	1.2(0.9,1.5)	1.4(1.1,1.9)	1.8(1.2,2.3)	1.9(1.2,2.8)	1.9(1.8,1.9)	≤0.001	a,b,c,d,e,f,g,h,i,j,k
WBC,1012/L	9.7±1.4	9.9±1.5	10.0±1.6	10.3±1.5	9.8±1.7	9.3±1.2	0.635	
PLT,109/L	214.4±39.5	224.5±61.4	225.7±56.6	206.4±56.5	209.1±55.9	209.5±53.9	0.273	f,j
Length of surgery, min	274.0±21.1	276.0±25.4	275.2±22.3	276.5±23.9	275.8±27.2	272.6±22.7	0.977	
Cardiopulmonary bypass time, min	164.7±24.8	168.7±23.8	169.5±24.5	167.4±21.2	165.0±24.1	172.7±22.9	0.868	
Cross-clamp time, min	83.6±16.0	88.8±12.8	88.9±12.3	89.3±16.0	86.5±12.0	89.3±10.1	0.775	
Circulatory arrest, min	41.3±6.4	41.8±6.8	43.1±7.2	42.5±7.6	44.0±6.7	42.2±7.1	0.636	
HDL-C, mmol/L	2.3(1.8,3.3)	1.8(1.4,2.3)	1.5(1.0,2.2)	1.0(0.9,1.5)	0.9(0.9,1.1)	0.8(0.5,1.0)	≤0.001	b,c,d,e,f,g,h,i,j,k,l
LVEF,%	55.4±7.3	57.4±6.7	57.7±6.0	56.7±6.9	56.7±6.7	54.8±6.5	0.718	

a:0vs1,b:0vs2,c:0vs3,d:0vs4,e:0vs5,f:1vs2,g:1vs3,h:1vs4,i:1vs5,j:2vs3,k:2vs4,l:2vs5,m:3vs4,n:3vs5,o:4vs5.

Table 3.Impact of MetS components on Poor outcome.

Variables	Quartiles of components		Poor/Good	HR(95%CI)	PValue
	Range	n			
HT,n(%)	-	202	52/150	2.092(1.148-3.812)	0.016
T2DM,n(%)	-	62	15/47	1.108(0.590-2.080)	0.749
BMI,Kg/m2	Per quartile	353	69/284	1.422(1.205-1.678)	<0.001
	Q1≤23.45	88	1/87	-	-
	23.45~Q2≤24.91	87	5/82	1.003(0.984-1.022)	0.772
	24.91~Q3≤27.30	89	18/71	2.727(1.617-4.597)	<0.001
	27.30~Q4	89	45/44	3.306(2.135-5.492)	<0.001
TG, mmol/L	Per quartile	353	69/284	1.053(0.841-1.318)	0.654
	Q1≤1.03	89	11/78	-	-
	1.03~Q2≤1.34	88	19/69	1.581(0.711-3.518)	0.262
	1.34~Q3≤1.78	88	17/71	1.321(0.583-2.994)	0.504
	1.78~Q4	88	22/66	1.569(0.735-3.351)	0.244
HDL-C,mmol/L	Per quartile	353	69/284	0.723(0.569-0.918)	0.008
	Q1≤1.03	88	27/61	-	-
	1.03~Q2≤1.52	89	26/63	1.098(0.611-1.973)	0.756
	1.60~Q3≤2.16	91	11/80	0.710(0.337-1.498)	0.369
	2.16~Q4	95	5/80	0.289(0.107-0.780)	0.014
SBP,mmHg	Per quartile	353	69/284	0.987(0.783-1.244)	0.911
	Q1≤132	89	14/75	-	-
	132~Q2≤140	85	14/71	0.799(0.359-1.777)	0.582
	140~Q3≤149	85	23/62	1.191(0.576-2.463)	0.637
	149~Q4	94	18/76	0.939(0.442-1.996)	0.870
DBP,mmHg	Per quartile	353	69/284	1.222(0.980-1.524)	0.075
	Q1≤74	83	10/73	-	-
	74~Q2≤80	107	18/89	1.205(0.518-2.803)	0.665
	80~Q3≤84	76	11/65	0.976(0.389-2.451)	0.959
	84~Q4	87	30/57	1.537(0.711-3.326)	0.275
FBG,mmol/L	Per quartile	353	69/284	1.402(1.110-1.771)	0.005
	Q1≤4.7	89	13/76	-	-
	4.7~Q2≤5.18	88	9/79	0.685(0.281-1.668)	0.404
	5.18~Q3≤5.7	88	10/78	0.838(0.355-1.979)	0.687
	5.7~Q4	88	37/51	2.239(1.133-4.425)	0.020

Table 4 hazard ratio and 95% confidence interval for poor outcome of MTEs

Models	MetS	
	HR(95%CI)	PValue
Model 1	7.537(4.446-12.775)	0.001
Model 2	7.369(4.309-12.601)	0.001
Model 3	8.036(4.675-8.036)	0.001
Model 4	8.137(4.718-14.033)	0.001
Model 5	9.905(5.161-19.012)	0.001

Model 1:adjusted for Age,male,heart rate

Model 2:adjusted for Age,male,heart rate,Aortic valve disease,stroke,LVEF

Model 3:adjusted for Age,male,heart rate,Aortic valve disease,stroke,LVEF,Length of surgery,Cardiopulmonary bypass time,Cross-clamp time,Circulatory arrest

Model 4:adjusted for Age,male,heart rate,Aortic valve disease,stroke,LVEF,Length of surgery,Cardiopulmonary bypass time,Cross-clamp time,Circulatory arrest,Isolated supracoronary ascending

aortareplacement,Total aortic arch replacement,Total aortic arch replacement,Partial aortic arch replacemen,others,smoker;

Model 5:adjusted for Age,male,heart rate,Aortic valve disease,stroke,LVEF,Length of surgery,Cardiopulmonary bypass time,Cross-clamp time,Circulatory arrest,Isolated supracoronary ascending

aortareplacement,Total aortic arch replacement,Total aortic arch replacement,Partial aortic arch replacemen,others,smoker,WBC,PLT,ICU time, hospital stay time,CR,eGFR,UA

Table 5 Multivariable analysis of the METs components.

Variables	HR(95%CI)	PValue	Regression Coefficeint	point
Elevated BMI	58.068(20.068-168.153)	<0.001	4.062	7
Elevated BP	5.633(1.009-31.459)	0.049	1.729	3
Elevated FBG	4.978(2.370-10.458)	<0.001	1.605	3
Reduced HDL-C	2.917(1.411-6.027)	0.004	1.070	2
Elevated TG	1.723(0.810-3.667)	0.158	0.544	1

Table 6 The ROC Curve analysis of the METs with poor outcome

Factors	AUC	P	95%CI	Se(%)	Sp(%)	Cut off point
All Patients	0.877	∕0.001	0.823-0.932	76.80%	90.50%	8
MetS	0.864	∕0.001	0.794-0.935	61.20%	93.50%	10
non-MetS	0.700	∕0.001	0.567-0.833	70.00%	60.90%	4

Figures

Figure 1

Population flowchart of enrolled patients.

Figure 2

Poor outcome rate of metabolic syndrome components.

Figure 3

ROC curve analysis of the scoring system for the prediction of Poor outcome.