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Comparison of clinical efficacy and prognosis between interventional occlusion and surgical treatment for acute myocardial infarction with ventricular septal perforation.

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Keywords: acute myocardial infarction; interventricular septal perforation; interventional occlusion; Killip class; EuroScore II; NYHA class; 6-minute walk test.

Abstract. This retrospective study compared the clinical outcomes and prognostic factors in acute myocardial infarction-related patients with interventricular septal perforation (AMI-VSP) who underwent interventional occlusion (IO group) or surgical intervention (SI group). Forty-six patients were analyzed based on comprehensive clinical data, laboratory results, and follow-up evaluations. The SI group had higher EuroScore II scores and more patients in Killip class IV. Both treatments showed improved laboratory indices, but the IO group had higher left ventricular ejection fraction and lower levels of specific biomarkers. The postoperative hospital stay and total hospitalization time were shorter in the IO group. Survival rates did not significantly differ between the two groups during the follow-up period. Logistic regression analysis identified a history of coronary heart disease as a significant risk factor affecting prognosis and survival rates. Both interventional occlusion and surgical intervention proved effective, with IO showing faster recovery and more favorable prognoses, while surgery was preferred for severe cases. Coronary heart disease was a key factor influencing postoperative survival in AMI-VSP patients.

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Comparación de la eficacia clínica y el pronóstico entre la oclusión intervencionista y el tratamiento quirúrgico en el infarto agudo de miocardio con perforación del septo ventricular.

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Palabras clave: infarto agudo de miocardio; perforación del septo interventricular; oclusión intervencionista; clasificación de Killip; EuroScore II; clase NYHA; prueba de marcha de 6 minutos.

Resumen. Este estudio retrospectivo comparó los resultados clínicos y los factores pronósticos en pacientes con infarto agudo de miocardio con perforación del septo interventricular (AMI-VSP) que se sometieron a oclusión intervencionista (grupo OI) o intervención quirúrgica (grupo IQ). Se analizaron cuarenta y seis pacientes en función de datos clínicos completos, resultados de laboratorio y evaluaciones de seguimiento. El grupo IQ tenía puntajes más altos de EuroScore II y más pacientes en la clase IV de Killip. Ambos tratamientos mostraron mejoras en los índices de laboratorio, pero el grupo OI tenía una fracción de eyección ventricular izquierda más alta y niveles más bajos de ciertos biomarcadores. La estancia hospitalaria posoperatoria y el tiempo total de hospitalización fueron más cortos en el grupo OI. Las tasas de supervivencia no diferían significativamente entre los dos grupos durante el período de seguimiento. El análisis de regresión logística identificó la historia de enfermedad coronaria como un factor de riesgo significativo que afecta el pronóstico y las tasas de supervivencia. Tanto la oclusión intervencionista como la intervención quirúrgica resultaron efectivas, con la oclusión intervencionista mostrando una recuperación más rápida y pronósticos más favorables, mientras que la cirugía se prefería para casos graves. La enfermedad coronaria fue un factor clave que influyó en la supervivencia posoperatoria en pacientes con AMI-VSP.

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INTRODUCTION

Acute myocardial infarction (AMI) is characterized by severe ischemic necrosis resulting from coronary artery occlusion, leading to high clinical morbidity and mortality rates. Complications such as interventricular septal perforation (VSP), papillary muscle rupture, cardiogenic shock, and free wall rupture are all frequently observed in AMI patients [1,2]. Among these complications, VSP is a rare and lethal complication of AMI that is mainly represented by cardiogenic shock or acute heart failure [3,4]. Available data indicate that the clinical incidence of this condition is approximately 0.17% to 0.31% among AMI patients, with a meagre one-month survival rate of only 6% under drug treatment alone [5,6]. Surgical intervention currently represents an effective approach for managing VSP following AMI. Compared to pharmacotherapy, timely surgical intervention can significantly enhance surgical success rates and improve patient survival rates [7]. In recent

years, interventional techniques have rapidly advanced, and interventional occlusion has emerged as a viable treatment method for VSP patients, boasting advantages such as reduced trauma, shorter procedure duration, and rapid postoperative recovery. For patients with suitable anatomical characteristics, including the appropriate size and shape of the VSP, interventional occlusion may serve as a potential alternative to surgical intervention [8]. However, it should be noted that interventional occlusion is frequently associated with residual shunting in postoperative patients, as the underlying myocardial infarction causes necrosis of cardiomyocytes, leading to the thinning of the infarcted myocardium and interstitial fibrosis [9,10].

Consequently, even with successful closure, residual shunting may persist due to cardiac alterations. Residual shunting is a critical factor impacting cardiac function and postoperative recovery [11]. In order to comprehensively evaluate the clinical utility of interventional occlusion, a retrospective analysis was conducted on 46 AMI-VSP-related patients at The First Affiliated Hospital of Medical College of Zhejiang University, aiming to assess the therapeutic effects and prognosis of interventional occlusion and surgical intervention, and providing valuable insights to enhance the clinical survival rates of AMI-VSP related patients.

MATERIALS AND METHODS

Study design and patients

In this retrospective study, a total of 55 patients diagnosed with AMI complicated by VSP treated at The First Affiliated Hospital of Medical College of Zhejiang University from January 2015 to December 2021 were included. The subjects in this study met the following criteria. (1) Patients were older than 18 years old. (2) Patients with AMI diagnosed by ECG, coronary angiography and transthoracic echocardiography (TTE). (3) TTE confirmed the existence of interventricular septal echo continuity with shunt from left to right. (4) Left ventriculography indicated that the contrast medium flows from the left ventricle to the right ventricle. Patients with a history of congenital heart disease or old myocardial infarction with VSP were excluded.

Clinical data collection procedure

The clinical data of the patients were obtained from the hospital's medical record system following standardized protocols. Trained professionals conducted follow-up assessments via telephone. The collected clinical data encompassed various aspects, including patient demographics such as age and gender, as well as the presence of comorbidities (hypertension, diabetes, hyperlipidemia, coronary heart disease, ventricular aneurysm, and renal disease). The data of the examination results of the patients after admission, the time from AMI to VSP, the total hospitalization time and the postoperative hospital stay were also collected.

Examination results mainly included infarction location (anterior/extensive anterior or others), culprit lesion (left anterior descending artery (LAD), left circumflex artery (LCX), right coronary artery (RCA), diameter of VSR, pulmonary circulation / systemic circulation (Qp/Qs), EuroScore II score and Killip classification. Additionally, preoperative and postoperative laboratory examination results were recorded, encompassing parameters such as left ventricular ejection fraction (LVEF), left ventricular end-diastolic diameter (LVEDD), cardiac troponin I (cTNI), creatine kinase-MB (CK-MB), N-terminal pro-brain natriuretic peptide (NT-proBNP), low-density lipoprotein (LDL), high-density lipoprotein (HDL), aspartate aminotransferase (AST), and alanine aminotransferase (ALT). Before discharge, one patient died of operation failure in the IO group, and two patients died in the SI group, so the data from postoperative laboratory examination were not included in the statistics.

During the follow-up period, adverse events (death and residual shunting) were documented. Additional data collected during follow-up included LVEF, LVEDD, New York Heart Association (NYHA) class, 6-minute walk test results, and specific time points for the initial and final follow-up assessments.

Statistical analysis

The data in this study were analyzed using IBM Statistic Package for Social Science (SPSS)® 26.0 statistical software (IBM, Armonk, NY, USA). Continuous variables were described using mean ± standard deviation ($\bar{x}\pm SD$), and the differences between groups were compared by t-tests. The continuous variables that were not normally distributed are expressed in the form of medians and quartiles, and the differences between groups were analyzed by the Mann-Whithey U-tests. The classified variables were described in the form of frequency (percentage) [n (%)], and the differences between groups were compared by analysis of variance or Fisher exact tests. The survival rate of patients during the follow-up period was analyzed using the Kaplan-Meier survival curve, generated using the https://hiplot.com.cn website, and the log-rank tests were used to assess the differences between groups.

Furthermore, univariate and multivariate logistic regression was performed to evaluate the factors affecting the prognosis and survival of AMI-VSP-related patients, age, treatment modality, hypertension, diabetes, hyperlipidemia, coronary heart disease, EuroScore II, LVEF, LVEDD, NT-proBNP, cTnI, and CK-MB were included as variables in the analysis. Variables with statistically significant results in the univariate analysis were subsequently subjected to multivariate logistic regression analysis. The logistic regression analysis results were expressed as odds ratio (OR) with corresponding 95% confidence intervals. Statistical significance was $p<0.05$, indicating a statistically significant difference between the analyzed data.

RESULTS

Results of patient recruitment

From a total of 55 AMI-VSP-related patients screened for inclusion in the study were excluded three patients with congenital heart disease, two patients with VSP resulting from old myocardial infarction, and four patients who were unable to comply with the follow-up protocol. Ultimately, 46 patients were enrolled in the study, and all the patients were divided into two groups based on the treatment modality, including the interventional occlusion group (IO group, $n=20$) and the surgical intervention group (SI group, $n=26$). The follow-up period ranged from July 14th, 2015, to February 18th, 2021, with a maximum follow-up duration of 1069 days, a minimum of 11 days, and an average follow-up time of 625.00 (417.05-811.00). The mean follow-up time was 605.00 (445.00-815.00) days in the IO group and 657.50 (398.75-795.75) days in the SI group (Fig. 1).

Characteristics of AMI-VSR-related patients

The average age of all the patients was 63.50 ± 3.86 years, with 35 (76.09%) patients over 60 years and 35 (60.87%) female. Regarding comorbidities and past medical history, there were 23 (50.00%) patients with hypertension and diabetes, 24 (52.17%) patients with hyperlipidemia, 15 (32.61 %) patients with coronary heart disease, 13 (28.26%) patients with ventricular aneurysms and nine (19.57%) patients with renal diseases. There were no significant differences in age, gender, or distribution of comorbidities between the IO group and the SI group ($p>0.05$). Analysis of hospitalization time revealed that the total hospitalization time and postoperative hospital stay were significantly shorter in the IO group compared to the SI group ($p<0.001$). The time from AMI to VSP was similar between the two groups ($p>0.05$). The EuroScore II score in the IO group was 12.00 (12.00,

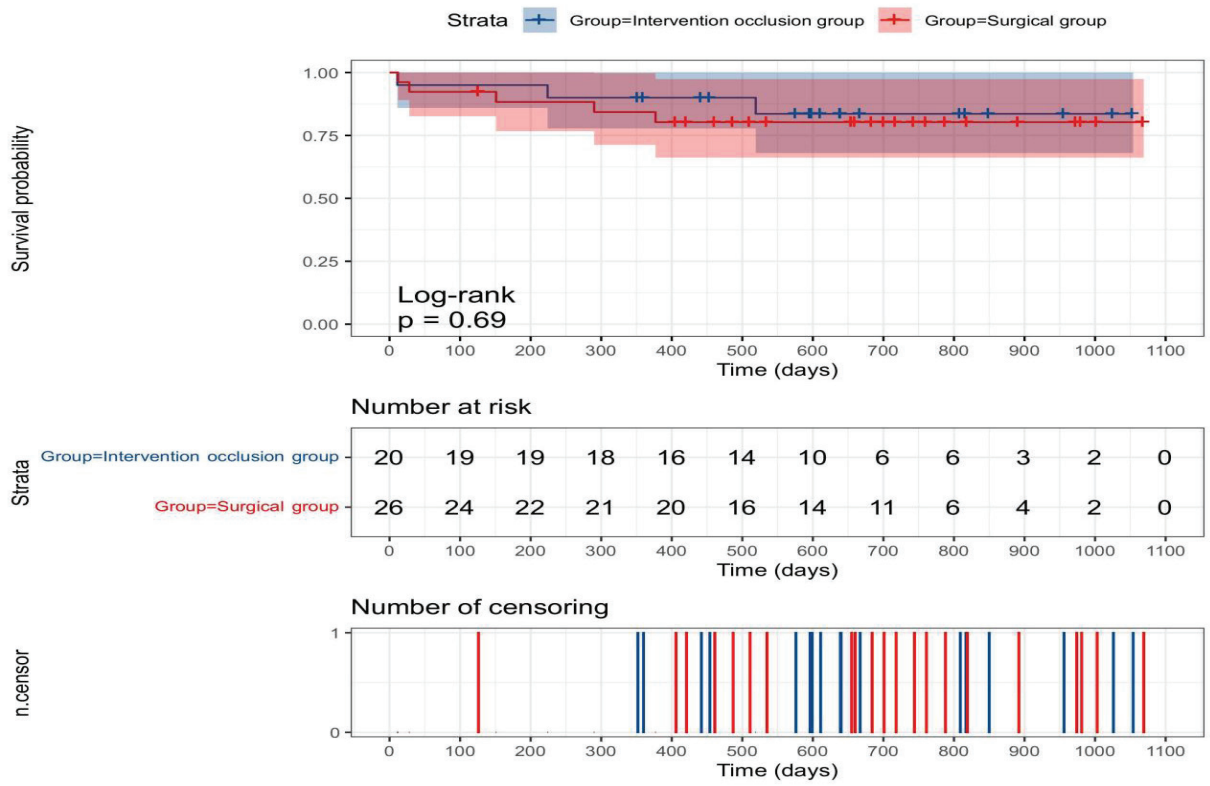

Fig. 1. Cumulative survival curves during the follow-up period of IO group and SI group. The survival rate of IO group was 85.00% (the blue line), and the SI group was 80.77% (the red line).

13.00), which was lower than that in the SI group ($p>0.05$). It was also found that the Killip grade of most patients (interventional occlusion group vs surgery group = 85% vs. 84.62%) was grade III/IV, and there was no significant difference in the distribution of Killip grades between the two groups ($p>0.05$). The above information is shown in Table 1.

Results of coronary angiography and trans thoraciceechocardiography

Analysis of coronary angiography results showed that 84.78% of patients had anterior wall infarction or extensive anterior wall infarction, and 58.70% had apical perforation. Most patients had involvement of a single culprit lesion (63.04%), with the LAD (91.30%) being the most frequent one. There were no significant differences in the location of myocardial infarction, location of VSP and culprit lesion between the IO group and the SI group ($p>0.05$).

TTE results revealed that the diameter of VSP in the IO group was 11.30±1.75 mm, which was significantly smaller than that in the SI group ($p<0.001$). The Qp/Qs ratio was 2.82±0.37 and also lower in the IO group compared to the SI group ($p<0.001$).

Preoperative and postoperative variables in AMI-VSR related patients

Table 2 presents the preoperative and postoperative laboratory examination results in both groups. In the preoperative period, the IO occlusion group exhibited significantly lower levels of cTNI (47.30±8.53 ng/mL) and ALT (466.05 ± 170.35 U/L) compared to the SI group ($p<0.05$). The two groups had no significant difference in other laboratory tests ($p>0.05$). The value of LVEF in both groups increased in

Table 1. Data and examination results of AMI-VSP related patients after admission.

Variables		Total (*n*=46)	IO group (*n*=20)	SI group (*n*=26)	t/χ^2/Z value	*p*
Age (year, $\bar{x}\pm s$)		63.50±3.86	64.10±4.46	63.35±3.86	0.305	0.762
Age over 60 [*n*(%)]		35(76.09)	16(80.00)	19(73.08)	0.039	0.844
Gender (female,%)		28(60.87)	12(60.00)	16(61.54)	0.011	0.916
Comorbidities [n(%)]	Hypertension	23(50.00)	10(50.00)	13(50.00)	0.000	1.000
	Diabetes	23(50.00)	11(55.00)	12(46.15)	0.354	0.552
	Hyperlipidemia	24(52.17)	11(55.00)	13(50.00)	0.113	0.736
	Coronary heart disease	15(32.61)	6(30.00)	9(34.62)	0.110	0.741
	Ventricular Aneurysm	13(28.26)	6(30.00)	7(26.92)	0.053	0.818
	Renal disease	9(19.57)	4(20.00)	5(19.23)	0.000	1.000
Location of infarction [*n*(%)]	Anterior/Extensive anterior	39(84.78)	16(80.00)	23(88.46)	0.143	0.705
	Others	7(15.22)	4(20.00)	3(11.54)		
Number of Culprit lesion [*n*(%)]	1	29(63.04)	13(65.00)	16(61.54)	0.297	0.862
	2	11(23.91)	5(25.00)	6(23.08)		
	3	6(13.04)	2(10.00)	4(15.38)		
Culprit lesion [*n*(%)]	LAD	42(91.3)	17(85.00)	25(96.15)	0.114	0.945
	LCX	16(34.78)	7(35.00)	9(34.62)		
	RCA	11(23.91)	5(25.00)	6(23.08)		
VSR location [*n*(%)]	Apical	27(58.70)	13(65.00)	14(53.85)	0.630	0.730
	Anterior	13(28.26)	5(25.00)	8(30.77)		
	Posterior	6(13.04)	2(10.00)	4(15.38)		
Echocardiographic findings ($\bar{x}\pm s$)	Diameter of VSR (mm)	15.50±4.36	11.30±1.75	18.73±2.62	10.944	<0.001
	Qp/Qs	3.11±0.49	2.82±0.37	3.34±0.46	4.157	<0.001
Time elapsed [days,M(P25,P75)]	From AMI to VSR	2.00(1.00,3.00)	2.00(1.00,3.00)	2.00(1.00,3.00)	0.323	0.746
	Total hospitalization time	15.00(13.00,18.25)	13.00(13.00,15.00)	18.00(17.00,20.00)	5.749	<0.001
	Postoperative hospital stay	11.00(9.00,14.00)	9.00(8.00,11.00)	13.50(13.00,14.00)	5.835	<0.001
EuroSCORE II [%,M(P25,P75)]		12.00(13.00,14.00)	12.00(12.00,13.00)	13.00(12.00,14.75)	1.454	0.146
Killip class [n(%)]	I/II	7(15.22)	3(15.00)	4(15.38)	0.006	0.997
	III	14(30.43)	6(30.00)	8(30.77)		
	IV	25(54.35)	11(55.00)	14(53.85)		

▲ VSR, ventricular septal rupture; AMI, acute myocardial infarction; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; Qp/Qs, pulmonary circulation / systemic circulation; EuroSCORE II, European heart surgery risk assessment system II.

Table 2
Preoperative and postoperative laboratory examination results of patients.

Variables	Pre-operation		t /Z p	p	Post-operation		t /Z p	p
	IO group (n=20)	SI group (n=26)			IO group (n=19)	SI group (n=24)		
LVEF [%,M(P25,P75), $\bar{x}\pm s$]	43.00 (41.00,45.00)	45.00 (41.00,48.00)	1.527	0.127	48.84±1.80	46.83±3.57	2.397	0.022
LVEDD (mm,$\bar{x}\pm s$)	50.70±2.05	51.85±2.78	1.545	0.129	49.84±1.77	50.00±1.72	0.295	0.769
NT-pro BNP [pg/mL,M(P25,P75),$\bar{x}\pm s$]	7523.00 (6523.00,9631.00)	8662.00 (7533.00,9674.00)	1.396	0.163	5527.11±1647.88	5552.38±1607.29	0.051	0.960
LDL (mmol/L,$\bar{x}\pm s$)	1.89±0.27	1.89±0.23	0.070	0.945	1.71±0.21	1.68±0.23	0.467	0.643
HDL [mmol/L,M(P25,P75),$\bar{x}\pm s$]	0.73(0.65,0.81)	0.69 (0.59,0.93)	0.078	0.938	0.80±0.16	0.81±0.18	0.143	0.887
CTnI (ng/mL,$\bar{x}\pm s$)	47.30±8.53	53.15±5.90	2.750	0.009	43.00±6.94	48.29±8.17	2.380	0.022
CK-MB [ng/mL,M(P25,P75)]	6.38 (5.19,8.51)	6.82 (5.69,8.84)	1.385	0.166	3.59(3.25,4.85)	4.95(3.84,5.41)	2.423	0.015
AST (U/L,$\bar{x}\pm s$)	42.85±4.84	39.81±8.65	1.512	0.138	36.00±4.99	37.75±9.01	0.808	0.424
ALT (U/L,$\bar{x}\pm s$)	466.05±170.35	565.23±131.41	2.231	0.031	216.05±146.73	387.38±122.81	4.168	<0.001

▲ LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; NT-pro BNP, N-terminal pro-brain natriuretic peptide; LDL, low-density lipoprotein; HDL, high-density lipoprotein; cTnI, cardiac troponin I; CK-MB, creatine kinase-MB; AST, aspartate transaminase; ALT, alanine transaminase.

the postoperative period, and the result of the IO group was higher than that of the SI group ($p<0.05$). The results of cTNI and CK-MB in both groups were significantly lower than those in the preoperative period, and the treatment results in the IO group were lower than those in the SI group. Moreover, the values of LVEDD, NT-proBNP, LDL, AST and ALT decreased in the postoperative period, but there was no significant difference between the two groups ($p>0.05$). The HDL levels increased in both groups in the postoperative period, with the SI group exhibiting slightly higher average values, although the difference was not significant ($p>0.05$).

Characteristics of AMI-VSP-related patients during the follow-up period

As shown in Table 3, the survival rate during the follow-up period was 85.00% (17 /20) in the IO group and 80.77% (21/26) in the SI group. The results of the NYHA class revealed that 31.58% of patients had class I, and 47.37% had class II. The IO group demonstrated higher average LVEF and better results in the 6-minute walk test compared to the SI group ($p>0.05$), while the average LVEDD was lower in the IO group ($p>0.05$).

Analysis of survival curves in AMI-VSP-related patients

We employed the Kaplan-Meier curve to analyze the survival rates of the two groups of patients. The analysis indicated no significant difference in survival rates between the two groups during the follow-up period ($p>0.05$).

Univariable and multivariable regression analyses for prognostic factors

Univariable logistic regression and multivariable logistic regression were used to analyze the risk factors affecting the survival of patients in both groups in the postoperative period. The results showed that coronary heart disease, EuroScore II, LVEF, NT-proBNP, cTNI, and CK-MB were all significant influencing factors ($p<0.05$). Multivariate logistic regression analysis revealed that coronary heart disease may significantly affect patients' prognosis and survival rate ($p<0.05$). The analysis results of each index are presented in Table 4.

DISCUSSION

Interventional occlusion and surgical intervention have demonstrated efficacy in enhancing patients' survival rate and prognosis

This retrospective study aimed to analyze the clinical outcomes and prognosis of 46 patients with AMI complicated by VSP who underwent either interventional occlusion or surgical intervention. Our analysis of patient data revealed a higher prevalence of female

Table 3
Results of prognostic indexes of patients in two groups.

Variables	Total (n=46)	IO group (n=20)	SI group (n=26)	t /χ^2	p
Adverse events	8(17.39)	3(15.00)	5(19.23)	0.000	1.000
	12(26.09)	5(25.00)	7(26.92)	0.022	0.883
LVEF (%, $\bar{x}\pm s$)	50.84±2.27	51.59±1.66	50.24±2.55	1.967	0.057
LVEDD (mm, $\bar{x}\pm s$)	47.26±2.31	46.65±2.29	47.76±2.26	1.505	0.141
NYHA class [n(%)]	12(31.58)	6(35.29)	6(28.57)	0.306	0.858
	18(47.37)	8(47.06)	10(47.62)		
	8(21.05)	3(17.65)	5(23.81)		
6-min walk test (m, $\bar{x}\pm s$)	339.92±55.50	347.12±58.14	334.10±53.99	0.714	0.480

▲ LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; NYHA class, New York Heart Association class.

Table 4
Correlation analysis of prognostic and survival factors in patients with AMI-VSP.

Predictor	Univariables OR (95% CI)	*p*	Multivariables OR (95% CI)	*p*
Age	0.846(0.668-1.072)	0.166		
Modality of treatment	0.741(0.155-3.554)	0.708		
Hypertension	0.242(0.043-1.361)	0.107	0.285(0.028-2.895)	0.288
Diabetes	3.706(0.661-20.765)	0.136	0.159(0.012-2.068)	0.160
Hyperlipidemia	0.6(0.125-2.873)	0.523		
Coronary heart disease	0.103(0.018-0.605)	0.012	0.074(0.006-0.891)	0.040
EuroScore II	18.957(1.879-191.235)	0.013		
LVEF	0.663(0.445-0.988)	0.044		
LVEDD	1.245(0.915-1.694)	0.164		
NT-proBNP	1.001(1.000-1.002)	0.032	1.001(0.999-1.003)	0.272
cTnI	1.231(1.026-1.476)	0.025	1.04(0.770-1.404)	0.798
CK-MB	3.302(1.394-7.823)	0.007		

▲ EuroSCORE II, European heart surgery risk assessment system II; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end-diastolic diameter; NT-pro BNP, N-terminal pro b-type natriuretic peptide; cTnI, cardiac troponin I; CK-MB, creatine kinase-MB.

individuals and those over 60 years old, aligning with the findings of Yip *et al.* [12], who observed a higher risk of AMI with VSP in older individuals and women. The underlying mechanism for this higher incidence in advanced age and females remains unclear, but it may be attributed to age-related changes in left ventricular compliance and myocardial structure [12]. Differences in the cardiac collagen skeleton and collagen matrix in the infarcted myocardium between genders may contribute to the observed disparities [13]. The location of myocardial infarction and perforation was found to be closely associated with postoperative mortality, with the anterior wall and extensive anterior wall of the myocardium being predominantly affected and the infarcted vessels primarily involving the left anterior descending branch [14,15].

Notably, there were no significant differences in baseline characteristics, including sex, age, location of myocardial infarction and VSP between the two groups. Thus, comparing both groups' preoperative and postoperative laboratory measurements could better elucidate the clinical effects of the different treatments. A comparison of preoperative and postoperative laboratory measurements revealed higher LVEF and LDL levels and decreased LVEDD, NT-proBNP, HDL, CTnI, CK-MB, AST, and ALT levels in both groups. Clinically, LVEF reflects the extent of myocardial injury or myocardial stunning in AMI patients and serves as an important prognostic indicator for AMI mortality [16]. NT-proBNP, derived from B-type natriuretic peptide released by cardiomyocytes, reflects heart injury to some extent [17]. CTnI and CK-MB are specific markers with clinical sensitivity for myocardial injury [18].

Moreover, Kaplan-Meier survival analysis showed that the postoperative survival rates of both groups were approximately 80% and had no significant difference. Previous studies have highlighted a generally higher clinical mortality rate of AMI combined with VSP, ranging from 40% to 80% [19]. So our results indicate that both interventional occlusion and surgery intervention are effective treatment measures for AMI-VSP-related

patients, effectively improving cardiac function and survival rates.

Furthermore, the prognosis of the two groups was analyzed, revealing further improvements in the LVEF and NYHA classes. The results of the 6-minute walk test also demonstrated significant enhancement in cardiovascular function among the patients. While the reliability and validity of NYHA scores have been debated, they are widely used to assess cardiac function improvements following heart disease treatment [20,21]. The 6-minute walk test is commonly employed to evaluate endurance and walking ability in patients with various conditions and serves as a reference indicator for assessing the recovery of cardiac function [22]. The improvements observed in the abovementioned indices in both groups support the notion that interventional occlusion and surgery intervention can effectively improve patient prognosis.

Patients in the SI group were relatively more severely affected

Significant differences were observed in VSP diameter and Qp/Qs results between the two groups. The SI group displayed significantly larger perforation diameters and higher Qp/Qs values. Additionally, the EuroScore II score and the number of patients with Killip class IV were slightly higher in the SI group compared to the IO group. EuroScore II is one of the effective scoring systems for evaluating the risk of cardiovascular surgery. The higher the score, the higher the risk [23]. The Killip classification is one of the ways to reflect the cardiac function of patients with AMI. Generally, a high Killip class means that the cardiac function of patients is poor and the area of myocardial infarction is larger [24]. Notably, the preoperative cTnI value was significantly higher in the SI group than in the IO group. These findings collectively suggest that while both groups presented with severe conditions, the SI group exhibited a more severe clinical profile. Surgical intervention becomes an effective life-saving measure when the size and shape of the VSP hinder successful occlusion through interventional means [25].

Interventional occlusion is more conducive to postoperative patient recovery

Our results show that the therapeutic effect of the IO group was relatively better, and patients' recovery rate was faster than surgical treatment. Postoperative laboratory measurements indicated lower levels of NT-proBNP, cTnI, and CK-MB in the IO group compared to the SI group. Notably, the reductions in cTnI and CK-MB, specific markers of myocardial injury, were more pronounced in the IO group. Additionally, the total hospitalization time and postoperative hospital stay were significantly shorter in the IO group, indicating a faster recovery rate among these patients. Prognostic indices in the IO group also showed slightly better outcomes. Yi *et al*. [26] have noted that timely interventional occlusion stabilizes hemodynamics and improves patient survival rates when the perforation diameter is less than 12 mm. The interventional occlusion procedure primarily employs the femoral artery or internal jugular vein for occluder insertion, resulting in a lesser impact on the patient's body than surgical thoracotomy. Furthermore, due to the smaller perforation diameter, patients in the IO group likely experienced a milder clinical condition, contributing to faster recovery.

Coronary heart disease represents an important factor influencing the prognosis and survival rate of AMI-VSP-related patients

Despite advancements in medical technology that have improved the success rate of surgical treatment for AMI-VSP-related patients, many patients still succumb to postoperative complications, particularly cardiogenic shock [27]. In this study, the majority of patients were older and presented with one or more comorbidities, including hypertension, hyperlipidemia, diabetes, and coronary

heart disease. Previous studies have identified hypertension and hyperlipidemia as risk factors affecting the prognosis of AMI patients [28]. Our logistic regression analysis identified a history of coronary heart disease as an essential factor influencing patient prognosis and survival rates. Coronary heart disease represents a significant cause of cardiac systolic dysfunction, and AMI is an acute manifestation of this condition [29,30]. Obstructive coronary heart disease has been associated with a higher incidence of myocardial infarction [31]. Therefore, when patients possess a history of coronary heart disease, careful consideration should be given to the selection of appropriate treatment methods and timing to improve postoperative survival rates.

The results of our study demonstrate that interventional occlusion is a viable alternative to surgical intervention for patients with AMI complicated by VSP under specific conditions, exhibiting satisfactory clinical efficacy and survival rates. Therefore, interventional occlusion represents an ideal choice for the clinical treatment of AMI patients with VSR. We also found that coronary heart disease can serve as a significant factor affecting the prognosis and survival rate of patients. It should be noted that this study employed a retrospective design, and the research data were limited. Moreover, the follow-up duration for some patients was relatively short, which may have affected the study's outcomes. Future considerations should include prospective studies with expanded sample sizes to reduce the potential for bias and further support the conclusions drawn in this study.

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Ethical compliance

The ethics committee of The First Affiliated Hospital of Medical College of Zhejiang University approved this study. Signed written informed consent were obtained from all participants before the study.

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Conflict of interests

The authors declared no conflict of interest.

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Author contributions

CN and YN designed the study and performed the experiments, CN and PH collected the data, YN and PH analyzed the data, and CN and YN prepared the manuscript. All authors read and approved the final manuscript.

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