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Original Research

Long-Term Clinical Outcomes of Coronary Drug-Coated Balloon Angioplasty With and Without Intravascular Ultrasound in Patients With Acute Coronary Syndrome

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Abstract

Background: Drug-coated balloon (DCB) angioplasty has emerged as a stentless revascularization option for selected coronary lesions; however, the role of intravascular ultrasound (IVUS) guidance during DCB treatment in patients with acute coronary syndrome (ACS) remains uncertain. Therefore, this study aimed to explore the association between IVUS-guided DCB angioplasty and long-term clinical outcomes in patients with ACS. **Methods:** This study included 255 patients with acute coronary syndrome who underwent DCB angioplasty between January 1, 2019, and December 31, 2021. Of these, 85 received IVUS guidance, and 170 underwent angiography-guided treatment only. The primary endpoint was a composite of major adverse cardiovascular events (MACEs). **Results:** Over a mean follow-up of 1.8 years, the incidence of target-vessel ischemic events and MACEs was lower in the IVUS-guided group than in the angiography-guided group. In a multivariate Cox analysis, the use of IVUS was associated with a reduced risk of MACEs (hazard ratio (HR) = 0.344, 95% confidence interval (CI): 0.166–0.710; $p = 0.004$). Subgroup analyses suggested that these findings were more pronounced in patients with diabetes and myocardial infarction; however, these observations were exploratory. **Conclusion:** This real-world study found that IVUS-guided DCB angioplasty yields more favorable long-term outcomes for patients with ACS than angiography alone.

Keywords: acute coronary syndromes; drug-coated balloon angioplasty; intravascular ultrasound; percutaneous coronary intervention; major adverse cardiovascular events

1. Introduction

Acute coronary syndrome (ACS) is a typical clinical manifestation of coronary artery disease and is associated with high mortality and morbidity in the world at present [1]. In the treatment of patients with this disease, the incidence of cardiovascular adverse events and cardiac death should be reduced. The importance of Percutaneous coronary intervention (PCI) is self-evident. Current interventional treatment strategies include drug-eluting stent (DES) implantation or drug-coated balloon (DCB) angioplasty. At present, although DES has been continuously improved in manufacturing and dual antiplatelet therapy has been developed, the risk of bleeding and the incidence of late stent thrombosis and in-stent restenosis are still relatively high [2,3]. The concept of intervention without stent implantation has been put forward, and DCB has been developed, which delivers antiproliferative drugs without leaving a permanent stent, and the time of dual antiplatelet therapy has been significantly shortened [4]. At present, DCB has been recognized as an effective treatment for patients with ACS, especially those with in-stent restenosis. Evidence from the REVELATION study suggested that DCB angioplasty provided comparable effectiveness to DES implantation while maintaining an acceptable safety profile in ST-segment elevation myocardial infarction (STEMI) patients [5]. At present, the long-term efficacy of DCB in the treatment of patients with ACS should be analyzed in depth. Coronary angiography (CAG) is a major diagnostic method but lacks detailed intraluminal structure information and consistency among operators. Intravascular ultrasound (IVUS) provides detailed assessment of vessel size, plaque morphology, and procedural results beyond conventional angiography [6]. The previous study pointed out that DES implantation guided by IVUS can significantly reduce the incidence of major adverse cardiovascular events (MACE) and the mortality of patients with this disease [7,8], but the research on IVUS-guided DCB angioplasty is relatively scarce [4]. Given the need to clarify whether IVUS guidance improves the long-term outcomes of DCB angioplasty in patients with ACS, this real-world study aimed to compare the long-term clinical outcomes of IVUS-guided and angiography-guided DCB treatment.

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2. Methods

2.1 Study Cohort

This is a single center retrospective study, which includes all patients who have undergone DCB angioplasty in the Fifth Affiliated Hospital of Sun Yat-sen University from January 1, 2019 to December 31, 2021. Patients who have undergone PCI are identified through the hospital information system, and whether IVUS is used in the process of PCI is recorded. Eligible participants are adults over 18 years of age, including those with unstable angina, STEMI, and non-ST-segment elevation myocardial infarction (NSTEMI), but those who have previously undergone PCI or coronary artery bypass grafting (CABG), had severe renal insufficiency, have used DES in the process of PCI, have undergone optical coherence tomography (OCT), need to use intra-aortic balloon pump (IABP) and extracorporeal membrane oxygenation (ECMO) support during PCI, had autoimmune diseases or malignancies, or had an expected survival of less than one year. Baseline demographic variables included age, sex, height, weight, body mass index (BMI), medical history, smoking and alcohol history, discharge diagnosis, medication use, and insurance status. Laboratory results included triglycerides, low-density lipoprotein cholesterol, creatine kinase-MB, troponin I, and left ventricular ejection fraction. Procedural data included the extent of coronary artery involvement, balloon size and number, contrast agent volume, and operation time. The Gensini score was used to evaluate the coronary complexity of patients. Patients were classified according to the imaging guidance strategy used during the procedure (IVUS-guided vs angiography-guided). The unequal distribution between the angiography groups and IVUS groups reflects real-world clinical practice during the study period, where IVUS use was at the operator's discretion rather than protocol-driven.

2.2 Treatment

Angiography and PCI were performed according to the guidelines of ACS, all patients received loading dose of aspirin and a loading dose of clopidogrel or ticagrelor [1]. The choice of revascularization strategy, pre-dilation balloon, guidewire selection, and the decision to use IVUS were determined by the interventional cardiologist. All DCB angioplasties were performed using paclitaxel-coated balloons (SeQuent Please, B. Braun, Germany).

In clinical practice, 40 MHz catheter (Boston Scientific Corporation, Marlborough, MA, USA) is used to obtain IVUS images, and manual traction technology is used to carry out the operation. After the operation, all patients should be given medical treatment in accordance with the guidelines, including angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs) antiplatelet agents, statins and β-blockers.

2.3 Outcome

The primary endpoint outcome was MACE, defined as a composite of target-vessel ischemic events, acute heart failure, unplanned revascularization (UR), and MI. Target-vessel ischemic events was defined as recurrent ischemic symptoms leading to hospital admission that were attributable to the previously treated target vessel, with non-target vessel disease excluded. Target-vessel ischemic events was adjudicated according to the available clinical records, including ischemic symptoms, electrocardiographic findings, biomarker changes, and coronary angiography or other ischemia-related examinations when available. No deaths occurred during follow-up; therefore, death was not included in the analyzed composite endpoint. Follow-up was conducted for at least one year, ending on January 31, 2023, or upon the occurrence of a primary endpoint event. The study was approved by the Ethics Committee of the Fifth Affiliated Hospital of Sun Yat-sen University, which waived the requirement for informed consent due to the retrospective nature of the study.

2.4 Statistical Analysis

When describing the distribution of data, we use mean ± standard deviation and interquartile range. For variables with skewed distribution, we use the interquartile range. For the comparison of continuous variables, we choose the appropriate method according to the specific situation, and the comparison of categorical variables should be based on the results of the chi-square test and Fisher's exact test. The analysis of time-to-event outcomes should use the Kaplan-Meier method and compare the results of the log-rank test between the two groups.

In order to achieve balance, the propensity score matching method was used in the analysis of the two groups. Propensity scores were estimated with a logistic regression model, and patients were matched 1:1 using a greedy nearest-neighbor algorithm with a caliper of 0.02. Matching quality was assessed using standardized differences, with 0.1 considered the threshold for acceptable balance. The model constructed in this study includes a series of covariates, such as age, gender, body mass index, triglyceride level, whether they have a history of hypertension, Gensini score, whether they have chronic coronary occlusion, and whether they use ACEI/ARB. A total of 65 pairs of patients were matched in this study. The matched patients were analyzed by Cox regression to find the factors that affect the prognosis of patients. Univariate Cox proportional hazards regression analysis was used to explore the relationship between IVUS and clinical outcomes. Variables with $p < 0.10$ in the univariate Cox analysis and clinical factors were included in the multivariate Cox proportional hazards model. The proportional hazards hypothesis was evaluated using standard diagnostic methods, and no major violations were observed. In addition, this study also analyzed the influence of cardiovascular risk

factors on the prognosis of patients with ACS, including diabetes, hypertension and smoking, which were included in the multivariate model regardless of whether they were statistically significant. In order to further explore the role of IVUS in different populations, this study carried out a subgroup analysis, all patients were divided into different subgroups according to age, ACS presentation, including unstable angina versus MI, history of hypertension, history of diabetes mellitus, and history of renal insufficiency. If the p value of all analyses <0.05, it is considered to be statistically significant. In this study, two-sided p values < 0.05 were considered to be statistically significant. Because this is a retrospective study, the sample size is not fixed and depends on the number of patients who can be treated during the study period. The missing data are relatively small, and the complete case analysis method is used in the processing process. SPSS 20.0 (IBM Corporation, Armonk, NY, USA) and R 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria) were used in the statistical analysis.

3. Results

3.1 General Clinical Baseline Characteristics

A total of 320 patients were included in the initial study, but 65 patients were excluded after screening, and only 255 patients were included in the study, including 170 patients in the angiography group and 85 patients in the IVUS group. The average age of patients in the angiography group was 58.55 years, with 84.1% being male, and the average age of patients in the IVUS group was 57.95 years. The two groups of patients had no significant differences in gender, age, BMI, type of coronary artery disease, hypertension, diabetes, smoking history, insurance status, hemoglobin A1c levels, total cholesterol, low-density lipoprotein cholesterol (LDL-C), left ventricular ejection fraction (LVEF), antiplatelet medication use, statin use, or ACEI/ARB use, etc. ($p > 0.05$). Compared with the angiography group, the IVUS group had higher GFR, higher triglyceride levels, lower troponin peak levels, lower peak, and lower incidence of beta-blockers (Table 1). The clinical characteristics of the two groups of patients were similar, and there was no significant difference in the culprit vessel, number of coronary arteries, total coronary occlusion, DCB diameter and number of affected vessels ($p > 0.05$). However, the IVUS group had longer operation times, higher Gensini scores, and higher contrast agent volumes. Procedural characteristics differed between groups, with the IVUS-guided strategy being associated with longer balloon length and a greater number of balloons used (Table 2).

Table 1. General demographic characteristics of 255 ACS patients undergoing DCB angioplasty.

	Angiography (n = 170)	IVUS (n = 85)	p value
Age, years	58.55 ± 12.14	57.95 ± 11.56	0.706
BMI, kg/m^2	25.66 ± 3.35	25.40 ± 3.34	0.567
Sex			0.581
Female	27 (15.8)	11 (13.0)	
Male	143 (84.1)	74 (87.1)	
Initial presentation			0.151
UA	87 (51.2)	48 (56.5)	
STEMI	44 (25.8)	13 (15.3)	
NSTEMI	39 (23.0)	24 (28.2)	
Hypertension	97 (57.1)	58 (68.2)	0.103
Diabetes	58 (34.1)	40 (47.1)	0.056
Current smoking	94 (55.3)	50 (58.8)	0.688
Medical insurance	147 (86.5)	78 (91.8)	0.302
Glycated hemoglobin, %	6.47 ± 1.47	6.59 ± 1.57	0.537
TG, mmol/L	1.40 (1.02–2.19)	1.45 (1.01–2.05)	0.040
TC, mmol/L	4.38 (3.84–5.15)	4.18 (3.46–5.12)	0.108
LDL-C, mmol/L	2.49 (2.00–3.25)	2.43 (2.01–3.19)	0.627
GFR, mL/min/1.73 m^2	92.28 (84.59–101.45)	96.90 (91.80–103.40)	<0.001
Peak CTnI, ng/mL	0.07 (0.01–2.58)	0.02 (0.01–0.71)	0.017
Peak CK-MB, U/L	18.3 (11.33–55.20)	15.3 (12.0–26.2)	0.002
LVEF, %	64.81 ± 8.54	63.11 ± 11.84	0.239
Anti-platelet	169 (99.4)	84 (98.9)	1
Statin	168 (98.8)	85 (100)	0.554
Beta blocker	135 (79.4)	56 (65.9)	0.022
ACEI or ARB	69 (40.6)	41 (48.2)	0.284

The average ± standard deviation and median (interquartile range) are used to describe the continuous variables. IVUS, intravascular ultrasound; BMI, body mass index; UA, unstable angina; STEMI, ST-segment elevation myocardial infarction; NSTEMI, non ST-segment elevation myocardial infarction; LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; ACEI, angiotensin-converting Enzyme Inhibitors; ARB, angiotensin receptor blocker; ACS, acute coronary syndrome; DCB, drug-coated balloon; GFR, glomerular filtration rate; TG, triglycerides; TC, total cholesterol; CTnI, cardiac troponin I; CK-MB, creatine kinase-MB.

3.2 Clinical Outcomes During Follow-up

The follow-up time was 1.8 years, among which the follow-up time of the IVUS group was 1.6 years and the follow-up time of the angiography group was 1.9 years. In the follow-up, the incidence of MACE in the IVUS group was significantly lower than that in the angiography group (Table 3). Kaplan-Meier analysis was used in this study to compare the incidence of MACE in the two groups. It was found that the incidence of MACE in the IVUS group

Table 2. Surgical data characteristics of 255 ACS patients undergoing DCB angioplasty.

	Angiography (n = 170)	IVUS (n = 85)	*p* value
Culprit vessel			0.091
LAD	69 (40.6)	46 (54.1)	
LCX	62 (36.5)	21 (24.7)	
RCA	39 (22.9)	18 (21.2)	
Total occlusions	50 (29.4)	31 (36.5)	0.318
Coronary artery dissection	12 (7.0)	6 (7.06)	1.000
Gensini score	34.5 (21.25–51.0)	50.0 (31.0–71.0)	<0.001
Diameter of balloon, mm	2.75 (2.50–3.00)	2.75 (2.50–3.00)	0.354
Length of balloon, mm	20.00 (20.00–26.00)	24.75 (20.00–26.33)	0.035
Number of balloons	1.02 ± 0.19	1.22 ± 0.45	<0.001
Surgical time, min	68 (57–85.75)	83 (70–113)	<0.001
Dose of contrast, mL	80 (70–100)	100 (80–120)	<0.001
Number of diseased vessels	1.92 ± 0.89	2.11 ± 0.939	0.120

The results of continuous variables are expressed as mean ± standard deviation or median (interquartile range). LAD, left anterior descending artery; LCX, left circumflex coronary artery; RCA, right coronary artery.

Table 3. Clinical follow-up results.

	Unadjusted			Propensity Score Matched		
	Angiography (n = 170)	IVUS (n = 85)	*p* value	Angiography (n = 65)	IVUS (n = 65)	*p* value
MACE	49 (28.8)	10 (11.8)	0.003	22 (33.8)	6 (9.2)	0.001
TVIE	38 (22.4)	8 (9.4)	0.015	17 (26.2)	4 (6.2)	0.003
UR	7 (4.1)	1 (1.2)	0.275	3 (4.6)	1 (1.5)	0.619
MI	3 (1.8)	0 (0)	0.553	1 (1.5)	0 (0)	1.000
AHF	1 (0.6)	1 (1.2)	1.000	1 (1.5)	1 (1.5)	1.000

TVIE, Target-vessel ischemic events; UR, Unplanned revascularization; MI, Myocardial infarction; AHF, Acute heart failure; MACE, major adverse cardiovascular event.

was lower than that in the angiography group (Log Rank p = 0.0183) (Fig. 1). Separation between the survival curves became apparent mid-term follow-up and persisted thereafter. Univariate Cox analysis was used in the study, which pointed out that the lower risk of MACE incidence in patients with ACS after DCB angioplasty was related to the use of IVUS [hazard ratio (HR) = 0.448, 95% confidence interval (CI) (0.226–0.889), p = 0.022]. Multivariate Cox analysis was also used in the study, which pointed out that the IVUS use remained associated with a lower risk of MACE incidence [HR = 0.344, 95% CI (0.166–0.710), p = 0.004] (Table 4).

After matching propensity scores, there were 65 patients in each group. The follow-up results showed that the incidence of MACE in the IVUS group was lower than that in the angiography group (Table 3). Univariate Cox analysis pointed out that the IVUS use was associated with a lower risk of MACE incidence [HR = 0.366, 95% CI (0.170–0.788), p = 0.010]. Multivariate Cox analysis further confirmed this finding [HR = 0.298, 95% CI (0.130–0.684), p = 0.004] (Table 4). Subgroup analysis pointed

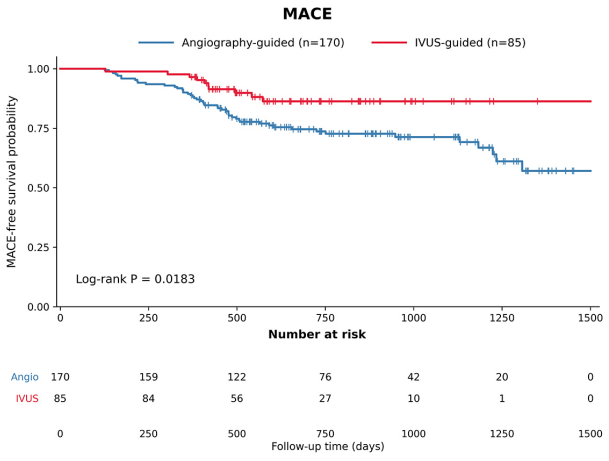


Fig. 1. Kaplan-Meier survival curves for patients in the IVUS and angiography groups.

out that the association between IVUS guidance and lower MACE risk appeared more pronounced in patients with MI [HR: 0.281, 95% CI: 0.085–0.934, p = 0.0380, p for inter-

Table 4. Cox proportional hazards.

	Unadjusted		Multivariate	
	HR (95% CI)	*p* value	HR (95% CI)	*p* value
MACE	0.448 (0.226, 0.889)	0.022	0.344 (0.166, 0.710)	0.004
TVIE	0.451 (0.210, 0.970)	0.042	0.327 (0.145, 0.735)	0.007
	Unadjusted (after PSM)		Multivariate (after PSM)	
	HR (95% CI)	*p* value	HR (95% CI)	*p* value
MACE	0.366 (0.170, 0.788)	0.010	0.298 (0.130, 0.684)	0.004
TVIE	0.379 (0.160, 0.900)	0.028	0.253 (0.097, 0.660)	0.005

TVIE, Target-vessel ischemic events; PSM, Propensity Score Matched; HR, hazard ratio; CI, confidence interval.

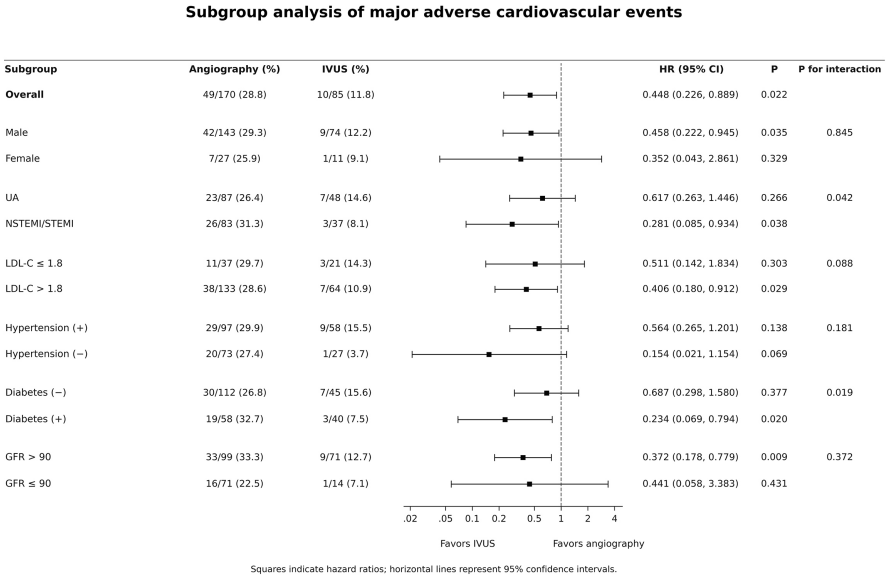


Fig. 2. Subgroup analyses forest plot.

action = 0.042] and the same was true for patients with diabetes [HR: 0.234, 95% CI: 0.069–0.794, $p = 0.02$, p for interaction = 0.019] (Fig. 2). Additional results of the propensity score–matching analysis are presented in **Supplementary Tables 1,2** and **Supplementary Figs. 1–3**.

4. Discussion

This real-world analysis suggests a potential association between IVUS-guided strategies and improved clinical outcomes among ACS patients undergoing DCB angioplasty, but it should be noted that this is only an association and not a causal relationship given the observational study nature. The reason why this phenomenon occurs is that intravascular imaging can evaluate the morphology of the lesion and the size of the blood vessel more accurately, and can also evaluate the effect of balloon angioplasty objectively, including whether there was residual stenosis or dissection.

Meta-analysis and other studies have confirmed that the incidence of MACE can be reduced by using IVUS-guided PCI in the follow-up of most previous studies [9,10,11], which is only about one year, focusing on the implantation of IVUS-guided DES, not analyzing the high-risk ACS population. The 2020 International Consensus Group on Drug-Coated Balloons and Chinese Expert Consensus on the Clinical Application of Drug-Coated Balloons suggest using IVUS to guide DCB angioplasty [4,12]. In the BASKET-SMALL2 trial, it was found that paclitaxel-coated balloon angioplasty was not inferior to drug-eluting stents in the treatment of small vessel coronary disease, and the feasibility of stentless strategy was confirmed [13]. Early experiences from the PEPCAD research program have further explored drug-coated balloon approaches in various clinical settings, providing a conceptual framework for DCB-based revascularization [14]. At present, there is no large-scale study on the long-term outcome of DCB angioplasty guided by IVUS in patients with ACS. Gao et al. (2024) [15] found that IVUS-guided DCB angioplasty could reduce lumen loss compared with angiography-guided procedures, but the study population

was broad. In contrast, this study focused on patients with ACS, who usually have complex coronary lesions and urgent clinical situations. In the present study, IVUS was primarily used to optimize several critical procedural steps during DCB angioplasty. Firstly, IVUS imaging can accurately evaluate the reference vessel diameter and lesion length, which facilitated appropriate balloon sizing and minimized geographic miss. Second, IVUS was used after lesion preparation to evaluate residual stenosis, plaque distribution, and the presence of significant dissections before DCB deployment.

In this study, baseline comparisons showed that the Angiography group had higher peak troponin, peak CK-MB levels, whereas triglyceride levels were slightly higher in the IVUS group. These are known risk factors for long-term prognosis in ACS patients [16,17]. Apart from these variables, the two groups were broadly comparable with respect to other conventional risk factors, including hypertension, diabetes, smoking status, LDL-C, and LVEF. Gensini scores were used to objectively evaluate coronary artery conditions, showing that the IVUS group had higher scores and more complex coronary conditions. IVUS allows for detailed observation of the coronary lumen, identifying plaque characteristics and guiding balloon expansion pressure to reduce complications such as coronary dissection and no-reflow phenomenon [18]. The study found that IVUS-guided DCB angioplasty could achieve favorable outcomes even in patients with complex coronary lesions. Zhang et al. [10] in the ULTIMATE trial, that DES implantation guided by IVUS can choose larger stents than angiography guidance. This was attributed to IVUS superior capability in accurately assessing lesion length and plaque morphology. In the present study, we applied IVUS in a similar manner to assess the length and extent of the target lesion during DCB angioplasty. In this study, the IVUS-guided strategy was associated with longer balloon length and a greater number of balloons used. These procedural differences likely reflect operator decision-making influenced by intravascular imaging rather than baseline lesion imbalance. This finding suggests that IVUS guidance enables more appropriate sizing and coverage of the lesion with DCB. This may enhance the uniformity of intimal contact and drug delivery, resulting in more complete treatment of the injured segment.

In the long-term follow-up, it is found that the incidence of MACE, UR, and target-vessel ischemic events (TVIE) in the IVUS group is lower than that in the Angiography group, and the conclusion is the same after propensity score matching. The discrepancy between the relatively higher incidence of target-vessel ischemic events and the lower rate of repeat revascularization reflects contemporary DCB treatment strategies. Following DCB angioplasty, recurrent ischemic symptoms are frequently managed with optimized medical therapy unless objective indications for repeat intervention are present. Kaplan-Meier analysis found that the incidence of MACE in the IVUS group was lower (Log rank, $p = 0.0183$). Although the incidence of UR and MI in the IVUS group is lower, the difference is not significant, which is related to the small sample size.

Subgroup analysis indicated that the association between IVUS guidance and lower MACE risk appeared more pronounced in patients with diabetes and myocardial infarction. These populations are often characterized by more complex plaque morphology, diffuse disease burden, and impaired microvascular function. In such settings, angiography alone may underestimate lesion severity or vessel dimensions, whereas IVUS enables more precise assessment and individualized device selection, potentially improving procedural quality and clinical outcomes. However, it should be noted that the number of samples in this study is small, the number of events is small, and the confidence interval is relatively large, which should be regarded as exploratory and hypothesis-generating.

The study also supports the feasibility of IVUS-guided DCB angioplasty in MI patients, addressing concerns about increased procedure time and safety. At the same time, the research results show that IVUS can play an important role in the treatment of myocardial infarction, and can also show that DCB angioplasty is noninferior to DES implantation in terms of long-term efficacy [5].

Generally speaking, in the process of formulating a strategy based on DCB, intravascular imaging can play a role in the optimization of the strategy, even for high-risk patients.

5. Limitations

In the process of analyzing the results of this study, we should realize its limitations. First, it was a retrospective analysis, and the use of IVUS is not random, which will lead to residual confounding. Therefore, we should not regard the conclusion as a causal relationship, but as an association. Second, although we have made efforts to adjust for multiple variables and carry out propensity score matching, we can not completely eliminate the interference of unmeasured confounding factors. Third, the research did not systematically collect intravascular imaging parameters, which was not conducive to the in-depth analysis of the mechanism. Fourth, the target-vessel ischemic events was identified according to the clinical records, but there was no unified diagnostic algorithm, and not all suspected cases were examined by coronary angiography. Finally, the sample size is relatively small, and the research is based on a single center, which is not conducive to the promotion of the research results, and we need to organize multi-center prospective research.

6. Conclusion

In this study, 255 patients with ACS were selected, all of whom were treated with DCB angioplasty, and it was

found that the long-term prognosis of patients using IVUS guidance was more favorable than that of patients using angiography guidance, which further proves that the use of IVUS can optimize the treatment process and achieve the purpose of revascularization.

Availability of Data and Materials

The datasets generated and analyzed during the current study are not publicly available and are not available from the authors upon request due to the sensitive nature of patient-level clinical information and patient confidentiality considerations.

Author Contributions

(I) Conception and design: ZZ, XW, BC; (II) Administrative support: BC; (III) Patient recruitment and acquisition of clinical data: XW, HL, SL, YO; (IV) Collection and assembly of data: XW, ZZ; (V) Data analysis and interpretation: XW, ZZ; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors; (VIII) Agreed to be accountable for all aspects of the work: All authors.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of The Fifth Affiliated Hospital of Sun Yat-sen University (K282-1 25-11-2024). The data are anonymous, and the requirement for informed consent was therefore waived.

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Conflicts of Interest

The authors declare no conflicts of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/RCM49074.

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