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Impact of multivessel coronary artery disease on early and late clinical outcome in ST-Segment elevation myocardial infarction patients who underwent percutaneous coronary intervention: insight from Indonesia

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ABSTRACT

It is estimated that 15 people for every 1000 Indonesian residents suffer from cardiovascular disease (CVD) including ST-segment elevation myocardial infarction (STEMI). Percutaneous coronary intervention (PCI) is often performed in patients with STEMI. Several factors affect clinical outcome after PCI procedure including multivessel coronary artery disease. This study aimed to measure the impact of multivessel coronary artery disease on the early and late outcomes of STEMI patients undergoing PCI procedures. This was a prospective cohort study on STEMI patients undergoing PCI procedures from the period of August to December 2021. Two expected cohorts were performed i.e. patients who suffered from single-vessel disease (SVD) and patients who suffered from multivessel disease (MVD). Forty six patients with STEMI were enrolled in this study consisting of 24 (52.17%) patients with MVD and 22 (47.83%) patients with SVD. No significant difference in baseline characteristics between MVD and SVD groups was observed ($p > 0.05$). The MVD group (91.67%) used a more radial percutaneous approach compared with the SVD group (54.55%; $p = 0.04$). In addition, no significant difference between the SVD group and the MVD group in major adverse cardiovascular events (MACE) and echocardiographic outcome after 90-d follow up was observed ($p > 0.05$). In conclusion, MVD has similar impacts on early and late clinical outcomes compared with SVD in STEMI patients undergoing PCI procedures.

ABSTRAK

Diperkirakan 15 orang dari setiap 1000 penduduk Indonesia menderita penyakit kardiovaskular (CVD) termasuk infark miokard elevasi segmen ST (STEMI). Intervensi koroner perkutan (PCI) sering dilakukan pada pasien STEMI. Beberapa faktor mempengaruhi luaran klinis setelah prosedur PCI termasuk penyakit arteri koroner multivesel. Penelitian ini bertujuan untuk mengukur dampak penyakit arteri koroner multivesel terhadap luaran awal dan akhir pasien STEMI yang menjalani prosedur PCI. Penelitian ini merupakan studi kohort prospektif pada pasien STEMI yang menjalani prosedur PCI pada periode Agustus hingga Desember 2021. Dua kohort yang diharapkan dilakukan yaitu pasien yang menderita penyakit pembuluh darah tunggal (SVD) dan pasien yang menderita penyakit pembuluh darah ganda (MVD). Empat puluh enam pasien dengan STEMI dilibatkan dalam penelitian ini yang terdiri dari 24 (52,17%) pasien dengan MVD dan 22 (47,83%) pasien dengan SVD. Tidak ada perbedaan signifikan terhadap karakteristik awal antara kelompok MVD dan SVD yang diamati ($p > 0,05$). Kelompok MVD (91,67%) menggunakan pendekatan perkutan yang lebih radial dibandingkan dengan kelompok SVD (54,55%; $p = 0,04$). Selain itu, tidak ada perbedaan yang signifikan antara kelompok SVD dan kelompok MVD dalam hal kejadian efek samping kardiovaskular utama (MACE) dan hasil ekokardiografi setelah observasi 90 hari ($p > 0,05$). Kesimpulannya, MVD memiliki dampak serupa dalam hal luaran klinis awal dan akhir dibandingkan dengan SVD pada pasien STEMI yang menjalani prosedur PCI.

Keywords:
multivessel disease;
acute myocardial infarction;
percutaneous coronary intervention;
major adverse cardiovascular events

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INTRODUCTION

The burden of cardiovascular disease (CVD) remains the most prevalent killer disease in the world including in Indonesia.[1,2] It was estimated more than 17 million people died from cardiovascular disease worldwide. In Indonesia, it was reported that 15 people for every 1000 Indonesian residents suffer from cardiovascular disease.[2] Myocardial infarction (MI) is one of the life-threatening coronary-associated pathologies characterized by sudden cardiac death. Myocardial infarction accounts for one-third to one-half of the cases of CVD.

One-third of the MI manifested as ST-elevation myocardial infarction (STEMI) which urgently needed percutaneous coronary intervention (PCI).[3] Previous studies reported that a large number of STEMI patients were not able to undergo PCI due to limited facilities and human resources. Based on the guideline for STEMI management, the PCI procedure should be performed in less than 120 min to obtain optimal clinical outcome. However, only 25-60% of PCI procedures can achieve the ideal time as the guideline recommended. Therefore, 40-75% of STEMI patients had worse clinical outcomes after undergoing PCI procedure.[4-6]

The clinical outcome of the PCI procedure is affected by some factors including multiple vessel disease (MVD). However, studies of the effect of the MVD on clinical outcome of the PCI procedure are limited in Indonesia. This study was conducted to evaluate the impact of MVD on early and late clinical outcomes in STEMI patients undergoing the PCI procedure. This study will give benefits to patients, caregivers, and health policymakers.[7-9] Moreover, this study can also give insights to decide the preference of revascularization strategy in emergency PCI, between culprit vessel-only and complete vessel revascularization.

MATERIALS AND METHODS

Study design

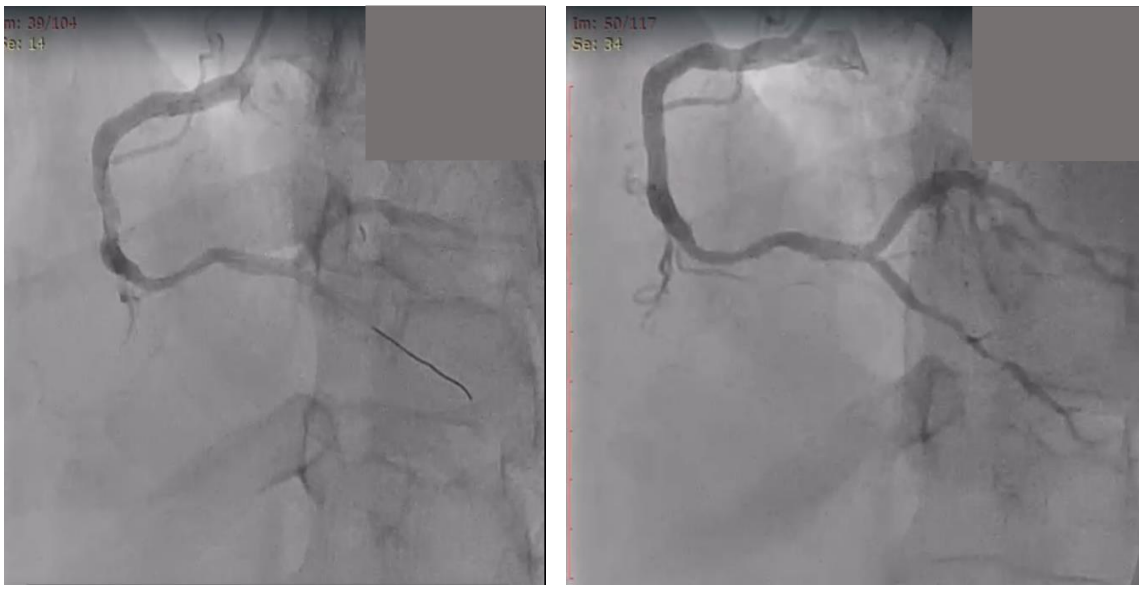
This was a prospective cohort study with two expected cohorts. The first cohort was individual who suffered from single vessel disease (SVD). The second cohort was individuals who suffered from MVD.

Study population and subject

The study subjects were recruited consecutively from individuals who presented to the Emergency Department of Dr. Sardjito General Hospital, Yogyakarta with standard criteria of STEMI diagnosis. All patients who underwent primary PCI with a drug-eluting stent or bare metal stent implanted into the naïve coronary vessel within 24 h of onset were included. Exclusion criteria were applied when there was one of the conditions as follows: extensive coronary heart disease which was planned for coronary artery bypass graft procedure in 30-d, other non-cardiac disease comorbid which was life-threatening, and creatinine clearance <30 mL/min.

Coronary angiography procedure

The patient was prepped and draped after they arrived at the surgery laboratory. A local anesthesia was administered with 2% lidocaine. The sheath was inserted into the radial or femoral artery. A wire was inserted and subsequently catheter was advanced. Left and right coronary artery angiography were performed in multiple views (FIGURE 1).



A B

FIGURE 1. Percutaneous coronary intervention procedure in Dr. Sardjito General Hospital. A) Before intervention in the right coronary artery; B) After intervention in the right coronary artery

RESULTS

The study included 46 patients, consist of 22 SVD and 24 MVD group, with mean ages of 54.55 ± 9.82 y.o. and 53.00 ± 9.94 y.o., respectively. No significant difference in baseline data characteristics were observed (TABLE 1). The radial percutaneous entry approach was more performed in MVD cases (91.67%) than in SVD cases (54.55%; p=0.04) (TABLE 2). In addition, the mean stent diameter in MVD cases (2.91 ± 0.29 mm) was smaller than in SVD cases (3.03 ± 0.31 mm; p = 0.04).

TABLE 1. Baseline characteristics of the subjects.

Baseline characteristics	SVD (n = 22)	MVD (n = 24)	p
Male [n (%)]	20 (90.91)	22 (91.67)	1.00
Age (mean ± SD yr)	54.55 ± 9.82	53.00 ± 9.94	0.60
GRACE score (mean ± SD)	101.35 ± 23.81	107.00 ± 22.02	0.42
Risk factors [n (%)]			
• Active smoker	17 (77.27)	21 (87.50)	0.10
• Past smoker	3 (13.63)	7 (29.17)	0.12
• Dyslipidemia	-	4 (16.6)	0.11
• Hypertension	14 (63.64)	17 (70.83)	0.60
• Diabetes mellitus	4 (18.18)	3 (12.50)	0.69
• Family history	-	1 (4.1)	1.00
• MI history	-	1 (4.1)	1.00
• Documented CAD	-	-	-
• History of heart failure	-	-	-

TABLE 1. Cont

Baseline characteristics	SVD (n = 22)	MVD (n = 24)	p
• History of CVD	1 (4.54)	1 (4.17)	1.00
• History PVD	-	-	-
• History of CKD	-	-	-
Mean admission HR (beats/min)	79.13 ± 17.61	80.38 ± 14.35	0.79
Mean admission SBP (mmHg)	135.95 ± 30.51	123.08 ±24.65	0.12
Mean admission DBP (mmHg)	81.59 ± 17.08	74.92 ± 12.66	0.37
Thrombolytics [n (%)]	5 (22.73%)	5 (20.83%)	1.00
Types of thrombolytics [n (%)]			
• Streptokinase	3 (13.63)	1 (4.17)	0.52
• Alteplase	2 (9.09)	4 (4.17)	0.52
Initial management [n (%)]			
• Heparin	15 (68.18)	22 (91.67)	0.06
• Aspirin	22 (100.00)	24 (100.00)	-
• Clopidogrel 75 mg	1 (4.54)	-	0.48
• Clopidogrel 300 mg	1 (4.54)	6 (25.00)	0.10
• Clopidogrel 600 mg	20 (90.91)	18 (75.00)	0.41
Laboratory result (mean ± SD)			
• Creatinine (mg/dL)	1.08 ± 0.20	1.18 ± 0.56	0.43
• Hb (g/dL)	14.75 ± 1.58	14.08 ± 1.65	0.16
• Hct (%)	42.80 ± 4.53	41.59 ± 4.52	0.37
• Leukocyte (x 10^3/µL)	13.71 ± 4.34	13.31 ± 2.77	0.71
• Thrombocyte (x 10^3/µL)	289.72 ± 99.74	289.96 ± 127.40	1.00
• Neutrophil (%)	77.64 ± 8.23	79.40 ± 7.34	0.45
• Lymphocyte (%)	14.74 ± 7.84	13.33 ± 6.68	0.52
• Monocyte (%)	6.01 ± 2.32	6.06 ± 1.87	0.93
• Eosinophil (%)	0.69 ± 0.73	0.58 ± 0.81	0.64
• Basophil (%)	0.88 ± 3.33	0.15 ± 0.13	0.28
• Hs-troponin on admission (g/dL)	23644.25 ± 18724.10	16732.63 ± 6461.00	0.22
• Hs-troponin on discharge (g/dL)	25680.40 ± 13535.08	26643.95 ± 14120.50	0.82
• Fasting blood glucose (mg/dL)	136.81 ± 38.96	137.96 ± 50.69	0.93
• HbA1C (%)	6.73 ± 1.42	6.70 ± 1.93	0.98
• Total cholesterol (mg/dL)	189.29 ± 41.87	189.04 ± 40.35	0.98
• LDL (mg/dL)	125.41 ± 34.08	126.08 ± 42.01	0.95
BMI (mean ± SD kg/m^2)	24.51 ± 3.36	24.60 ± 3.38	0.93
ECG on admission			
• Sinus	18 (81.82)	20 (83.33)	1.00
• Junctional	-	1 (4.17%)	1.00
• Atrial fibrillation	-	-	-
• AV block	4 (18.18)	3 (12.50)	0.69
Region of STEMI			
• Anterior	14 (63.64)	16 (66.67)	0.83
• Lateral	7 (18.18)	2 (8.33)	0.07

TABLE 1. Cont

Baseline characteristics	SVD (n = 22)	MVD (n = 24)	p
• Inferior	8 (31.82)	9 (37.50)	0.94
• Posterior	4 (18.18)	5 (20.83)	1.00
• Righr sided	6 (27.27)	5 (20.83)	0.61
Killip [n (%)]			
• I	21 (95.45)	20 (83.33)	0.35
• II	1 (4.54)	3 (12.50)	0.63
• III	-	-	-
• IV	-	1 (4.17)	1.00
Ischemic time (mean ± SD hr)	13.50 ± 9.96	23.65 ± 23.25	0.11
Wire crossing time (mean ± SD min)	179.44 ± 88.93	177.95 ± 157.112	0.97
Length of stay (mean ± SD d)	5.23 ± 1.82	4.63 ± 1.31	0.20

Note: SVD= single vessel disease; MVD=multiple vessel disease; GRACE=global registry of acute coronary events; MI=myocardial infarction; STEMI=ST-elevation myocardial infarction; CAD= cardiac artery disease; CVD= cardiovascular disease; PVD= peripheral vascular disease; CKD= choric kidney disease; HR= heart rate; SBP= systolic blood pressure; DBP= diastolic blood pressure; BMI= body mass index; ECG= electrocardiogram.

TABLE 2. PCI procedure characteristics of the subjects.

PCI procedure characteristics	SVD (n = 22)	MVD (n = 24)	p
Radial percutaneus entry [n (%)]	12 (54.55)	22 (91.67)	0.04
Culprit lesion [n (%)]			
• LAD	13 (59.09)	14 (58.33)	0.98
• LCX	-	-	-
• RCA	8 (36.36)	9 (37.50)	0.69
• Left main	1 (4.55)	1 (4.17)	1.00
Fluoroscopy time (mean ± SD min)	30.86 ± 45.13	22.58 ± 14.50	0.40
Contrast volume (mL)	144.50 ± 44.54	164.58 ± 70.77	0.28
Total dose (mGy)	850.64 ± 704.36	1325.38 ± 1740.387	0.24
PCI status [n (%)]			
• Primary PCI	19 (86.36)	19 (79.17)	0.70
• Rescue PCI	1 (4.54)	2 (8.33)	1.00
• Pharmacoinvasive PCI	2 (9.09)	3 (12.50)	1.00
Coronary dominance [n (%)]			
• Right	22 (100.00)	23 (95.83)	1.00
• Left	-	-	-
• Co dominance	-	1 (4.17)	1.00
Lesion [n (%)]			
• Ostial	-	-	-
• LMS	-	-	-
• CTO	1 (4.54)	3 (11.11)	0.48
• Thrombus	18 (81.82)	21 (11.78)	0.69

TABLE 2. Cont

PCI procedure characteristics	SVD (n = 22)	MVD (n = 24)	p
• Calcified	2 (9.09)	3 (11.11)	0.60
Pre PCI TIMI flow [n (%)]			
• 0	10 (45.45)	13 (43.33)	0.86
• 1	1 (4.54)	-	1.00
• 2	4 (18.18)	7 (23.33)	0.73
• 3	7 (31.82)	10 (33.33)	0.90
Post PCI TIMI flow [n (%)]			
• 0	-	1 (3.44)	1.00
• 1	-	-	-
• 2	1 (4.54)	4 (13.79)	0.61
• 3	21 (95.45)	24 (82.76)	0.61
Guide catheter French size [n (%)]			
• 6	20 (90.91)	21 (87.50)	1.00
• 7	2 (9.09)	3 (12.50)	1.00
Dissection post procedure [n (%)]	-	1 (4.17)	1.00
Slow or no reflow [n (%)]	1 (4.54%)	5 (20.83)	0.24
Number of stent per lesion treated			
• 1	17 (77.27)	15 (83.33)	0.10
• 2	4 (18.18)	8 (33.33)	0.24
• 3	1 (4.54)	3 (12.50)	0.61
Stent diameter (mean ± SD mm)	3.03±0.31	2.91±0.29	0.04
Stent length (mean ± SD mm)	30.50±31.00	29.56±7.05	0.83
Intracoronary device [n (%)]			
• Aspiration catheter	1 (4.54)	-	1.00
• Microcatheter	-	1 (4.17)	1.00
• Extension catheter	-	-	-
• POBA	1 (4.54)	-	1.00

Note: SVD=single vessel disease; MVD=multiple vessel disease; PCI= percutaneous coronary intervention; LAD= left anterior descending artery; LCX= left circumflex artery; RCA= right coronary artery; LMS=left main stem; CTO=chronic total occlusion; TIMI= thrombolysis in myocardial infarction; POBA=percutaneous old balloon angioplasty

No significant difference between SVD cases and MVD cases groups in the parameters of ejection fraction (EF), left ventricular internal diameter end diastole (LVIDd), left atrial volume index (LAVI), tricuspid annular plane systolic excursion (TAPSE), global longitudinal strain (GLS), ΔEF, ΔTAPSE, ΔGLS ($p > 0.05$) after 30-d and 90-d of follow up was observed (TABLE 3-5).

On 90-d of observation in the SVD cases group, one patient suffered from an ischemic stroke on the 28th day after PCI. In the MVD cases group, one patient with cardiovascular was died on the 7th day and reinfarction occurred in one patient on the 62nd day (TABLE 6).

TABLE 3. 12-h post PCI echocardiographic profile.

Echocardiographic profile	SVD	MVD	p
LAVI (mean ± SD mL/m^2)	22.75 ± 3.72	20.33 ± 3.51	0.64
LVIDd (mean ± SD mm)	49.00 ± 2.80	53.00 ± 2.74	0.21
EF (mean ± SD %)	46.55 ± 9.16	45.13 ± 9.49	0.72
TAPSE (mean ± SD mm)	17.75 ± 2.50	20.33 ± 2.32	0.24

Note: SVD=single vessel disease; MVD=multiple vessel disease; LAVI= left atrial volume index; LVIDd= left ventricular internal diameter end diastole; EF= ejection fraction.

TABLE 4. 30-d echocardiographic profile.

Echocardiographic profile	SVD	MVD	p
LAVI (mean ± SD mL/m^2)	27.50 ± 9.15	30.69 ± 9.09	0.45
LVIDd (mean ± SD mm)	50.75 ± 5.50	53.85 ± 6.47	0.28
EF (mean ± SD %)	45.38 ± 12.35	46.53 ± 16.05	0.86
TAPSE (mean ± SD mm)	20.02 ± 4.03	19.46 ± 2.70	0.72
GLS (mean ± SD %)	-11.48 ± 6.18	-10.04 ± 9.08	0.95
ΔEF (mean ± SD %)*	3.25 ± 15.95	2.85 ± 12.97	0.95
ΔTAPSE (mean ± SD mm)**	2.63 ± 4.60	1.85 ± 2.76	0.63

Note: MVD=multivessel disease; SVD=single vessel disease; LAVI= left atrial volume index; LVIDd= left ventricular internal diameter end diastole; EF= ejection fraction; TAPSE= tricuspid annular plane systolic excursion; GLS= global longitudinal strain; *ΔEF= ejection fraction mean difference between 12-h and 30-d of follow up; **ΔTAPSE= tricuspid annular plane systolic excursion mean difference between 12-h and 30-d of follow up

TABLE 5. 90-d echocardiographic profile.

Echocardiographic profile	SVD	MVD	p
LAVI (mL/m^2)	25.63 ± 9.04	24.25 ± 4.40	0.70
LVIDd (mm)	51.72 ± 5.73	48.38 ± 3.42	0.16
EF (%)	45.45 ± 14.79	56.13 ± 17.12	0.16
TAPSE (mm)	18.64 ± 4.48	21.75 ± 2.38	0.09
GLS (%)	-12.60 ± 5.65	-15.51 ± 4.96	0.27
ΔEF (%)*	-1.27 ± 20.77	8.38 ± 18.79	0.31
ΔTAPSE (mm)**	-1.45 ± 6.95	3.02 ± 3.07	0.11
ΔGLS (%)***	-0.69 ± 1.95	-5.48 ± 9.51	0.30

Note: MVD=multivessel disease; SVD=single vessel disease; LAVI= left atrial volume index; LVIDd= left ventricular internal diameter end diastole; EF= ejection fraction; TAPSE= tricuspid annular plane systolic excursion; GLS= global longitudinal strain; *ΔEF= ejection fraction mean difference between 12-h and 90-d of follow up; **ΔTAPSE= tricuspid annular plane systolic excursion mean difference between 12-h and 90-d of follow up; ***ΔGLS= global longitudinal strain mean difference between 30-d and 90-d of follow up

TABLE 6. Major adverse cardiovascular events in 90-d of observation

Echocardiographic profile	SVD	MVD	Observation day	p
Cardiovascular death	-	1	7	1.00
Reinfarction	-	1	62	1.00
Target vessel revascularization	-	-	-	-
Stroke	1	-	28	0.64
Total	1	2		1.00

Note: MVD=multivessel disease; SVD=single vessel disease

DISCUSSION

Similarities in the baseline demographic profile, atherosclerotic risk factors, initial evaluation, laboratory examination profile, Killip categorization, ischemia, and wire crossing time were reported in this study. From the descriptive data, it could be concluded that the wire crossing time from MVD disease (179.44 ± 88.93 min) and SVD case groups (177.95 ± 157.11 min) still could not achieve the ideal target of 120 min. More delay in wire crossing time was related to a higher risk of cardiovascular adverse events to occur.[10]

Most of the general characteristics in the PCI procedure data (type of PCI strategy, culprit vessel, lesion type, TIMI flow, intracoronary device, and periprocedural complication) were similar between the two groups ($p > 0.05$). In the MVD case group (91.67%), it was reported that the radial percutaneous entry approach was more often performed compared with the SVD case group (54.55%; $p = 0.04$). Previous studies reported that the radial approach provided a more beneficial outcome compared with the femoral approach. This radial approach would reduce the number of periprocedural adverse events, morbidity, and mortality.[11,12] However in this study, no significant differences of clinical outcomes between radial and femoral access ($p>0.05$). It was also reported that the stent diameter used in the MVD case group (2.91 ± 0.29 mm) was smaller compared with the SVD case group (3.03 ± 0.31 mm; $p = 0.04$). Plitt *et al.*[10] reported that in population of acute myocardial infarction and stable coronary artery disease patients, smaller stent diameter contributes to higher risk of major adverse cardiovascular events, driven by the increased rate of repeat revascularization.

One reinfarction event and one cardiovascular death were the two main adverse cardiovascular events discovered over the 90-day outcome follow-up period in the MVD case group. Furthermore, in the SVD case group, major adverse cardiovascular event or stroke was observed in one patient. No significant difference in major adverse cardiovascular events after 90-d follow up was observed. Anello *et al.*[13] also reported that there is no significant difference in major adverse cardiovascular events among Brazilian patients with single vessel and multiple vessel coronary artery disease younger than 50 y.o. undergoing coronary stent implantation. Furthermore, it was concluded from that the MVD has similarity in major adverse cardiovascular events compared with the SVD after underwent PCI procedure.[13]

In this study, the echocardiographic results including EF, TAPSE, LVIDd, LAVI, GLS, ΔEF, ΔTAPSE, and ΔGLS were not significantly different between the MVD case group compared with the SVD case group after 30-d and 90-d follow-up (TABLE 5). Although the MVD case group

had higher in EF and TAPSE as well as lower in LVIDd and LAVI, however they were not significantly different (p>0.05). The insignificant outcome difference in this study could be caused by some limitations of this study, including small sample size, short duration of follow-up, and difference in angiographic characteristics.

CONCLUSION

In conclusion, MVD has similar impacts on early and late clinical outcomes compared with SVD in STEMI patients undergoing PCI procedures. Revascularization of culprit vessel-only can be more considered than a complete revascularization strategy. However, further study with a larger sample size and longer duration of outcome follow-up is needed.

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