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The characteristic of acute coronary syndromes of patients with multivessel coronary artery disease in centers with and without cardiac surgery on-site

Krzysztof Brust[1], Karol Śmiech[1], Kamil Bujak[2], Tomasz Roleder[1], Mariusz Gąsior[2]

[1]Regional Specialist Hospital, Wroclaw, Poland
[2]Silesian Center for Heart Diseases, Zabrze, Poland

Abstract

Background: *Multivessel disease (MVD) is diagnosed in a fair number of patients with acute coronary syndrome (ACS). There are 36 cardiac-surgery (CS) centres and 157 catheterization laboratories dedicated to treat ACS in Poland. The aim of the study was to analyze MVD patient outcomes presented with ACS in centers with or without CS on-site.*

Methods: *The present study is a retrospective analysis (2017–2020) of MVD ACS patients (n = 4618) outcomes between those treated in centers with CS on site (n = 595) and those without CS (n = 4023).*

Results: *Patients in CS centers had a higher prevalence of renal failure (13.3% vs. 8.8%, p ≤ 0.001) and a more frequent history of coronary angioplasty — percutaneous coronary intervention (18.9% vs. 14.4%, p = 0.005). During the coronary angiography a femoral artery access was more often used in CS center patients (47.1% vs. 15.2%, p < 0.001). Percutaneous coronary intervention of MVD was more often performed in CS centers (74.6% vs. 71.0%, p = 0.054). In-hospital death (7.6% vs. 4.6%, p = 0.002), reinfarction (1.1% vs. 0.1%, p < 0.001), hemorrhagic complications (6.4% vs. 1.6%, p < 0.001), recurrent target vessel revascularization (1.8% vs. 0.4%, p ≤ 0.001) and pulmonary edema (3.7% vs. 1.5%, p < 0.001) occurred more often in CS centers.*

Conclusions: *The safety of ACS treatment in MVD patients in centers without CS on site is non-inferior to their treatment in centers with CS on site. Interestingly, there were more in-hospital adverse events observed in ACS MVD patients treated in centers with CS.* (Cardiol J)

Keywords: acute coronary syndrome, multivessel coronary artery disease, registry, percutaneous coronary intervention, coronary artery bypass grafting

Introduction

Acute coronary syndrome (ACS) is the most dangerous manifestation of coronary artery disease (CAD). CAD is associated with 17.8 million deaths per year worldwide [1]. Each year more than 100,000 ACSs are diagnosed in Poland, which makes ACS one of the most common life-threating conditions in the Polish population (39.9 mln). ACS include ST-segment elevation myocardial infarction (STEMI), non-STEMI (NSTEMI), and unstable angina [2].

For this reason, it is obligatory to have nationwide treatment in accordance with the newest guidelines. To date there are 36 cardio-surgical centers and 157 catheterization laboratories available in Poland dedicated to treating ACS.

A significant number of patients with ACS are patients with multivessel coronary artery disease (MVD). MVD is defined as the presence of significant stenosis (≥ 70%) in two or more major epicardial coronary arteries of 2.5 mm diameter or more [3]. MVD patients have a considerable clinically rel-

Address for correspondence: Dr. Krzysztof Brust, Regional Specialist Hospital, ul. H. Kamieńskiego 73A, 51–124 Wrocław, Poland, tel: +48 502 107 439, e-mail: krzysztof.brust@gmail.com

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evant burden of adverse cardiovascular events following ACS. Therefore, the question arises as to whether the clinical outcomes vary between centers with and without cardiac-surgery (CS) on site.

Methods

This was a retrospective analysis from 1st January, 2017 to 31st December, 2020, of ACS patients outcomes using data from the Polish Registry of Acute Coronary Syndromes (PL-ACS). PL-ACS registry is an ongoing Polish archive of ACS patients, in which data are obtained from all cardiology and cardiac surgery departments in Poland. The registry is supervised by the Polish Ministry of Health and concerns data regarding a patient's hospitalization. The obtained registry data are presented on the website: https://pl-acs.sccs.pl.

Patients with a prior history of coronary artery bypass grafting (CABG) were excluded. MVD was defined as the presence of ≥ 70% diameter stenosis of three or more epicardial coronary arteries. The coronary arteries with diameter < 2.0 mm were not taken into the analysis.

A total of 4618 patients were enrolled for this study. Among them, 595 were hospitalized in the centers with cardiac surgery on-site, while 4023 were hospitalized in the centers lacking on-site cardiac surgery services.

Continuous variables were presented as mean ± standard deviation, and categorical variable as frequencies and percentages. Differences in continuous variables were analyzed using the Mann-Whitney U test. Categorical variables were analyzed using the chi-square test. Between-group differences were considered statistically significant if the p value was < 0.05.

Results

Study population

In the CS-group (cardiac surgery on site) the mean age was 70.8 years and 68.6% of patients were men. Patients in the non-CS-group were younger as compared to patients in CS-group (69.0 vs. 70.8 years, p = 0.008). The proportion of men to women in the non-CS-group was slightly lower than in the CS-group (67.2% vs. 68.6%, p = 0.49). In both groups, the most common cause of hospitalization was NSTEMI (53.6% in CS-group and 55.3% in the non-CS-group), while there was no statistically significant difference between the types of ACS on admission (p = 0.16). At admission patients were characterized by their hemodynamic status. Presence of cardiac arrest before arrival, blood pressure and Killip-Kimball classification were all evaluated in both groups. Patients in the CS group had higher prevalence of renal failure (13.3% vs. 8.8%, p < 0.001) and more frequent had a history of a past coronary angioplasty (18.9% vs. 14.4%, p = 0.005). Hyperlipidemia (50.8% vs. 37.0%, p < 0.001) and nicotinism (62.7% vs. 54.4%, p < 0.001) were more often observed in patients in the non-CS group. Among laboratory results at admission patients in the non-CS group had a higher level of total cholesterol (186 vs. 176, p = 0.003), low density lipoprotein (LDL)-fraction (115 vs. 108, p = 0.01) and hemoglobin (13.9 vs. 13.7, p = 0.01). Baseline characteristic of all patients with multivessel disease are summarized in Table 1.

Diagnostic coronarography and planned revascularization

In the CS group coronarography was more often performed from femoral access as compared to non-CS group (47.1% vs. 15.2%, p < 0.001), while radial access was the most common vascular access in the non-CS group (83.9%). Patients with a history of percutaneous coronary intervention (PCI) in the CS group more often had bifurcation lesions than ones in the non-CS group (6.3% vs. 2.1%, p = 0.01). Patients hospitalized in centers with cardiac surgery on-site had a higher percentage of significant stenosis of the diagonal artery (22.5% vs. 14.6%, p < 0.001). In both groups' arteries — circumflex artery (Cx), right coronary artery (RCA) and left anterior descending artery (LAD) were all significantly narrowed. More often unknown localization of culprit lesion was observed in patients in CS group (35.5% vs. 25.4%, p < 0.001), while patients in non-CS group had higher percentage of culprit lesions localized in Cx (16.8% vs. 12.6%, p < 0.001). Revascularization by PCI was planned more often in patients in the CS-group (74.6% vs. 71.0%, p = 0.054), as well as revascularization by CABG (13.3% vs. 12.6%, p = 0.054). In centers without cardiac surgery more patients had a conservative treatment of ACS (14.8% vs. 11.1%, p = 0.054). However, the differences in planned revascularization between groups were not statistically significant (p = 0.054). Results of diagnostic coronary angiography are shown in Table 2.

Coronary revascularization

Patients in the CS-group had a higher percentage of PCI of LAD artery (40.0% vs. 34.1%, p = 0.005), diagonal artery (5.6% vs. 2.3%, p < 0.001), Cx (38.0% vs. 27.4%, p < 0.001), left marginal coronary artery

Table 1. Baseline patient clinical characteristics of the study.

	Patients hospitalized due to ACS in centers with cardiac surgery on-site (CS group), n = 595	Patients hospitalized due to ACS in centers without cardiac surgery on-site (non-CS group), n = 4023	P
Age [years]	70.8 (63.4–78.4)	69.0 (62.6–77.0)	0.008
Gender (male)	408 (68.6%)	2702 (67.2%)	0.49
BMI [kg/m^2]	27.5 (24.5–31.0)	27.7 (24.9–31.1)	0.12
Cause of hospitalization (ACS)			0.16
STEMI	206 (34.6%)	1248 (31.1%)	
NSTEMI	319 (53.6%)	2221 (55.3%)	
UA	70 (11.8%)	548 (13.6%)	
Status on admission			
Cardiac arrest before admission	17 (2.9%)	106 (2.6%)	0.76
Blood pressure:			
Systolic [mmHg]	135 (120–155)	138 (120–152)	0.94
Diastolic [mmHg]	80 (70–90)	80 (70–90)	0.37
The Killip–Kimball classification:			0.11
Class I	475 (79.8%)	3210 (79.9%)	
Class II	71 (11.9%)	556 (13.8%)	
Class III	31 (5.2%)	137 (3.4%)	
Class IV	18 (3.0%)	117 (2.9%)	
Risk factors			
Hypertension	414 (73.1%)	2902 (74.4%)	0.52
Hyperlipidemia	193 (37.0%)	1867 (50.8%)	< 0.001
Diabetes mellitus	193 (34.3%)	1429 (36.4%)	0.32
Nicotinism	283 (54.4%)	2145 (62.7%)	< 0.001
Obesity (BMI ≥ 30)	140 (24.3%)	953 (25.2%)	0.62
Coronary artery disease	119 (20.3%)	816 (20.7%)	0.83
Prior myocardial infarction	132 (22.3%)	777 (19.4%)	0.10
Family history of CAD	46 (8.5%)	349 (9.3%)	0.53
Heart failure	47 (8.1%)	420 (10.6%)	0.06
LVEF ≥ 50%	256 (47.5%)	1440 (43.3%)	0.07
Atrial fibrillation/flutter	67 (11.4%)	387 (9.7%)	0.21
CNS stroke	42 (7.1%)	257 (6.4%)	0.54
Peripheral arterial disease	50 (8.5%)	311 (7.9%)	0.57
Kidney failure	78 (13.3%)	350 (8.8%)	< 0.001
Chronic lung disease	24 (4.1%)	194 (4.9%)	0.41
Cancer	21 (3.6%)	107 (2.7%)	0.23
Prior PCI	111 (18.9%)	576 (14.4%)	0.005
Laboratory results			
Creatinine [mg/dL]	1.0 (0.8–1.2)	1.0 (0.8–1.2)	0.93
Total cholesterol [mg/dL]	176 (141–212)	186 (150–221)	0.003
LDL [mg/dL]	108 (77–141)	115 (84–148.5)	0.01
HDL [mg/dL]	43 (36–51)	44 (37–53)	0.11
Triglycerides [mg/dL]	121 (87–164)	121 (89–170)	0.50
Hemoglobin [mg/dL]	13.7 (12.3–14.8)	13.9 (12.7–15)	0.01
Hematocrit [%]	40 (37–44)	41 (38–44)	0.09
Glycemia on admission [mg/dL]	132.5 (107–192)	130 (105–179)	0.24
Glycated hemoglobin [%]	6.4 (5.8–7.6)	6.2 (5.6–8.0)	0.89

Data are shown as number (percentage) or mean (interquartile range). ACS — acute coronary syndrome; BMI — body mass index; CAD — coronary artery disease; CNS — central nervous system; HDL — high density lipoprotein; LDL — low density lipoprotein; LVEF — left ventricular ejection fraction; NSTEMI — non-ST-segment elevation myocardial infarction; PCI — percutaneous coronary intervention; STEMI — ST-segment elevation myocardial infarction; UA — unstable angina

Table 2. Diagnostic coronarography in patients with multivessel disease.

	Patients hospitalized due to ACS in centers with cardiac surgery on-site (CS group); n = 595	Patients hospitalized due to ACS in centers without cardiac surgery on-site (non-CS group); n = 4023	P
Vascular access in ACS during coronarography			< 0.001
Femoral	280 (47.1%)	613 (15.2%)	
Radial	313 (52.6%)	3375 (83.9%)	
Other	2 (0.3%)	35 (0.9%)	
Patients with a history of PCI			
Restenosis	10 (9.0%)	72 (12.5%)	0.30
Stent thrombosis	4 (3.6%)	12 (2.1%)	0.33
Bifurcation	7 (6.3%)	12 (2.1%)	0.01
Localization of significant stenosis in coronary arteries			
LM	0 (0%)	0 (0%)	1.0
LAD	595 (100%)	4023 (100%)	1.0
D	134 (22.5%)	582 (14.6%)	< 0.001
Cx	595 (100%)	4023 (100%)	1.0
OM	93 (15.6%)	708 (17.7%)	0.21
RCA	595 (100%)	4023 (100%)	1.0
Localization of culprit lesion in ACS			< 0.001
LM	5 (0.8%)	13 (0.3%)	
LAD	166 (27.9%)	1145 (28.5%)	
D	0 (0%)	24 (0.6%)	
Cx	75 (12.6%)	676 (16.8%)	
OM	3 (0.5%)	36 (0.9%)	
RCA	135 (22.7%)	1099 (27.4%)	
Unknown	211 (35.5%)	1020 (25.4%)	
Planned revascularization			0.054
No	66 (11.1%)	593 (14.8%)	
PCI	444 (74.6%)	2841 (71.0%)	
CABG	79 (13.3%)	503 (12.6%)	
CABG + PCI	6 (1.0%)	67 (1.7%)	

Data are shown as number (percentage). ACS — acute coronary syndrome; CABG — coronary artery bypass grafting; Cx — circumflex coronary artery; D — diagonal coronary artery; LAD — left anterior descending coronary artery; LM — left main coronary artery; OM — left marginal coronary artery; PCI — percutaneous coronary intervention; RCA — right coronary artery

(4.9% vs. 3.2%, p = 0.03) and RCA (40.8% vs. 31.5%, p < 0.001). Table 3 contains a comparison of PCI--revascularization in patients with ACS and MVD who were qualified for PCI treatment during primary hospitalization in centers with and without surgery on-site.

Complications during hospitalization in patients with ACS

Death from cardiovascular causes (7.6% vs. 4.6%, p = 0.002), reinfarction (1.1% vs. 0.1%, p < 0.001), hemorrhagic complications (6.4% vs. 1.6%, p < 0.001), necessity of blood transfusion (6.4% vs. 1.4%, p < 0.001), target vessel revascularization (1.8% vs. 0.4%, p < 0.001) and pulmonary edema (3.7% vs. 1.5%, p < 0.001) were more often observed in patients from the CS group. Adverse outcomes examined in patients hospitalized because of ACS with MVD are presented in Table 4.

During hospitalization, patients presenting with cardiogenic shock needed mechanical circulatory support. As Table 4 shows there were no statistical differences in the CS and non-CS group in using devices such as intra-aortic balloon counter pulsation (1.2% vs. 0.7%, p = 0.18), percutaneous left ventricular assist device (0% vs. 0.02%,

Table 3. Percutaneous coronary intervention (PCI)-revascularization during primary hospitalization in patients with acute coronary syndrome (ACS).

PCI in ACS	Patients hospitalized due to ACS in centers with cardiac surgery on-site (CS group), n = 595	Patients hospitalized due to ACS in centers without cardiac surgery on-site (non-CS group), n = 4023	P
LM	4 (0.7%)	13 (0.3%)	0.20
LAD	238 (40.0%)	1372 (34.1%)	0.005
D	33 (5.6%)	93 (2.3%)	< 0.001
Cx	226 (38.0%)	1102 (27.4%)	< 0.001
OM	29 (4.9%)	128 (3.2%)	0.03
RCA	243 (40.8%)	1267 (31.5%)	< 0.001

Data are shown as number (percentage). Cx — circumflex coronary artery; D — diagonal coronary artery; LAD — left anterior descending coronary artery; LM — left main coronary artery; OM — left marginal coronary artery; RCA — right coronary artery

Table 4. Complications during hospitalization in patients with acute coronary syndrome.

	Patients hospitalized due to ACS in centers with cardiac surgery on-site (CS group), n = 595	Patients hospitalized due to ACS in centers without cardiac surgery on-site (non-CS group), n = 4023	P
Death from CV causes	45 (7.6%)	183 (4.6%)	0.002
Death from other causes	0 (0%)	7 (0.2%)	0.31
Reinfarction during same hospitalization	7 (1.1%)	5 (0.1%)	< 0.001
Transient ischemic attack	0 (0%)	3 (0.1%)	0.50
CNS stroke with neurological deficits	1 (0.2%)	6 (0.2%)	0.92
Free wall heart rupture	0 (0%)	5 (0.1%)	0.39
Acute ventricular septal defect	2 (0.3%)	7 (0.2%)	0.41
Acute mitral regurgitation	1 (0.2%)	16 (0.4%)	0.38
Hemorrhagic complications	38 (6.4%)	64 (1.6%)	< 0.001
Necessity of blood transfusion	38 (6.4%)	55 (1.4%)	< 0.001
SCA during hospitalization	24 (4.0%)	113 (2.8%)	0.11
Target vessel revascularization	11 (1.8%)	16 (0.4%)	< 0.001
Pulmonary edema	22 (3.7%)	58 (1.5%)	< 0.001
Cardiogenic shock	18 (3.0%)	112 (2.8%)	0.77
IABP	7 (1.2%)	27 (0.7%)	0.18
pLVAD	0 (0%)	1 (0.02%)	0.70
ECMO	0 (0%)	1 (0.02%)	0.70

Data are shown as number (percentage). CNS — central nervous system; CV — cardiovascular; ECMO — extracorporeal membrane oxygenation; IABP — intra-aortic balloon counterpulsation; pLVAD — percutaneous left ventricular assist device; SCA — sudden cardiac arrest

p = 0.7) and extracorporeal membrane oxygenation (0% vs. 0.02%, p = 0.7).

Discussion

Revascularization strategy in MVD patients is an ongoing debate and till today remains controversial [4]. Many randomized controlled trials were performed, as well as meta-analyses of randomized controlled trial [5–10]. Although many arguments (such as lower mortality, long-term survival, lower risk of recurrent revascularization) and actual guidelines appeal for CABG as a primary type of revascularization of MVD, there remains a high need of finding the most effective and safe approach of treating MVD patients in different scenarios.

There were not many studies which compared the revascularization strategy (PCI vs. CABG) in MVD in units with and without cardiac surgery on-site [11, 12]. Furthermore, there is no medical data about such comparisons in cases of ACS in MVD patients.

This retrospective study was designed to analyse outcomes of ACS treatment in Polish patients with MVD in hospitals with and without CS on-site.

Firstly, patients admitted to hospitals with CS units on-site more often had a history of prior revascularization, and a lower level of hemoglobin and hematocrit. Furthermore, these patients more often suffered from kidney failure. Probably these factors directed the Heart Teams to refer for PCI as the revascularization treatment in ACS was a priority. Interestingly in a similar study reported by Ram et al. [13], the proportions of prior history of PCI in patients admitted to centers with and without CS on-site were lower, and thus CABG was chosen as a primary revascularization strategy [13].

Patients who were admitted to centers without CS on-site were more often active smokers and had higher levels of total cholesterol and LDL-fraction, which probably resulted from being undiagnosed or untreated before admission. Due to a lack of cardiac surgeons (perhaps vascular surgeons too) in hospitals, radial access was more often performed by hemodynamists in order to reduce the probability of vascular complications and enhance procedure safety. It can only be speculated that more complex coronary cases are performed in centers with CS on-site allowing fast bail-out surgery if required. Complex coronary cases far more often require femoral access enabling easy introduction of 7F and 8F guiding catheters to perform the procedure well. According to European Society of Cardiology guidelines and medical trials radial access should be preferred as it is associated with a significant risk reduction in bleeding, vascular complications, and mortality compared to femoral access [14, 15].

The present retrospective data shows that patients hospitalized in centers with CS on-site more often had in-hospital adverse outcomes as compared to patients hospitalized in centers lacking cardiac surgeon services. Importantly, the ratio of PCI in ACS patients with MVD were higher, which resulted in a higher prevalence of complications such as death from cardiovascular causes, reinfarction, target vessel revascularization and hemorrhagic complications. It may be speculated that it was caused by the more aggressive strategy of primary PCI during ACS, due to presence of cardiac surgeon backup.

Also, the decision-making process may differ between centers with and without CS-onsite. While in non-CS centers, the Heart Team most of decisions were not performed in the catheterization room and were postponed until a surgeon visit or call. That may have affected the decision process in favour of CABG. On the other hand, it may only be speculated that some patients initially referred for CABG in non-CS centers, were carefully assessed again in the target CS centers, and due to their increases of CABG complications the PCI was performed in the end.

It should be noted that patients admitted to CS centers had a higher comorbidity. These patients had a higher prevalence of renal failure (13.3% vs. 8.8%, $p < 0.001$) and more frequent had a history of coronary angioplasty (18.9% vs. 14.4%, $p = 0.005$). Which explains more in-hospital cardiac adverse events in these patients.

Limitations of the study

Firstly, the registry did not provide patient's long-term follow-up. Secondly, it did not show the patient's crossover between centers with or without CS. The data included in the registry relies on the survey filled out by doctors and nurses, and some of the important comorbidities may not have been recorded. Moreover, the MVD reporting is based on the visual estimation of CAD and Syntax score, which was not calculated in these patients. Furthermore, included in the analysis, were patients with MVD, but without left main coronary artery (LM) disease based on angiography. If the PCI had required to extended stenting from LAD or Cx to LM it was performed, although initially angiography had not presented the significant stenosis in LM. Finally, MVD could be underdiagnosed or overdiagnosed in challenging cases. All these limitations must be considered when drawing conclusions from our data.

Conclusions

In conclusion, the proportion of types of planned revascularization (PCI vs. CABG) of ACS in the centers with and without CS on-site remains at a very similar level. The safety of ACS treatment in MVD patients in centers without CS on site is non inferior to treatment of such patients in centers with CS on site in terms of in-hospital outcomes. The importance of the Heart Team in the process of decision making in the ACS treatment is invaluable and always should be considered if available.

Conflict of interest: None declared

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