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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

# Complete versus culprit-only revascularization in non-ST-segment elevation myocardial infarction and multivessel coronary artery disease

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**SUMMARY**

**Introduction/Objective** The optimal percutaneous coronary intervention (PCI) in patients with non-ST-elevated myocardial infarction (NSTEMI) and multivessel coronary artery disease (CAD) is still not clear. The aim of our study was to examine intrahospital and long-term major adverse cardiovascular and cerebrovascular events (MACCE) in this group of patients.

**Methods** This retrospective study included 225 patients with NSTEMI and multivessel CAD treated with PCI at the Institute of Cardiovascular Diseases of Vojvodina. Three groups were formed: complete one-stage PCI; complete multi-stage PCI, and culprit-only PCI. We analyzed intrahospital and one-year follow-up MACCE and mortality after three years in all three groups.

**Results** Complete one-stage PCI was performed in 112 (49.8%), complete multi-stage PCI in 70 (31.3%), and culprit-only PCI in 43 (19.1%) patients. Patients with multi-stage complete PCI had the lowest mortality in comparison with one-stage and culprit-only PCI, both intrahospital (0% *vs*. 0.9% and 20.9%, respectively, $p < 0.0005$) and after one year (0% *vs*. 2.7% and 30.2%, respectively, $p < 0.0005$) and three years (4.3% *vs*. 5.4% and 32.6%, respectively, $p < 0.0005$). There was no significant difference in other MACCE between the groups, both intrahospital and after one year.

**Conclusion** In our study, multi-stage PCI significantly reduces intrahospital, one-year and three-year follow-up mortality in patients with NSTEMI and multivessel CAD.

**Keywords:** non-ST-elevated myocardial infarction; multivessel coronary artery disease; percutaneous coronary intervention; major adverse cardiovascular and cerebrovascular events; mortality

## INTRODUCTION

The annual incidence of acute coronary syndrome (ACS) remains high and 70% of patients present as non-ST-elevated myocardial infarction (NSTEMI) and unstable angina pectoris [1]. Intrahospital mortality of patients with NSTEMI ranges 4–6% [2, 3]. Although the 30-day mortality in NSTEMI is lower than in ST segment elevation myocardial infarction (STEMI) and it ranges 3–5% [4], in long-term follow-up, patients with NSTEMI have a poorer prognosis in terms of one-year mortality of about 6%, reinfarction, and the need for repeated revascularization [1, 4]. Patients with NSTEMI are more likely to have multivessel coronary artery disease (CAD), which is associated with poorer clinical outcome [5].

The optimal therapeutic approach in patients with NSTEMI and multivessel CAD is less clear than in patients with STEMI or chronic CAD. In particular, with regard to percutaneous coronary intervention (PCI), there is a lack of randomized, prospective studies comparing revascularization of the infarct artery alone with complete revascularization of all blood vessels with hemodynamically significant stenosis [6, 7].

The aim of our study was to examine the in-hospital and long-term outcomes in terms of major adverse cardiovascular and cerebrovascular events (MACCE) in patients with NSTEMI and multivessel CAD, using three different revascularization strategies: PCI of the infarct artery alone, single-staged PCI and multi-staged PCI of all coronary arteries with hemodynamically significant stenosis.

## METHODS

This retrospective observational study included 225 patients ≥ 18 years old, 160 (71.1%) male, with NSTEMI and significant multivessel CAD treated with PCI, admitted to the Institute of Cardiovascular Diseases of Vojvodina (ICVDV) from January 2011 to December 2017. The data was obtained from the ICVDV information system.

NSTEMI was defined according to the European Society of Cardiology fourth universal definition of myocardial infarction [8]. The definition of hemodynamically significant multivessel CAD involved stenosis of two or more large coronary arteries ≥ 75% [9].

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Patients who had previously undergone surgical revascularization of the myocardium, single-vessel CAD and chronic total occlusion verified by angiography, failed PCI of the infarct artery, candidates for surgical revascularization based on angiography, and patients who presented with cardiogenic shock were excluded from the study.

The study protocol was approved by the Ethics Committee of the ICVDV.

Three groups were formed: the first group consisted of patients with one-stage revascularization of all blood vessels with hemodynamically significant stenosis, the second group consisted of patients with multi-stage PCI, with culprit artery being revascularized in the first act and subsequent revascularization of the remaining blood vessels with hemodynamically significant stenosis, and the third group consisted of patients in whom revascularization of culprit artery only was performed. Patients with a residual synergy between percutaneous coronary intervention with taxus and cardiac surgery (SYNTAX) score of 0 were defined as having undergone complete revascularization, and with a residual SYNTAX score > 0 as incomplete revascularization [10].

The method of revascularization depended on the decision of the interventional cardiologist during the procedure based on the type of lesion, suitability and feasibility of the intervention.

The use of anatomical or functional methods to assess the hemodynamic significance of the lesion, as well as the vascular approach, was at the discretion of the interventional cardiologist.

In the culprit-only group, we defined patients with poorer prognosis as those with residual SYNTAX score > 8 after the first intervention. In this group of patients, staged PCI was not planned for all the patients and the reasons for not performing PCI of the remaining significant lesions included the following: lesion not being suitable for PCI, stress test that did not indicate PCI of the remaining lesions, patients not being motivated for planned PCI or stress test, and death while awaiting intervention.

We examined intrahospital and the occurrence of MACCE one year after, which included death of cardiac origin, reinfarction, repeated revascularization, cardiac decompensation and stroke, as well as death of cardiac origin over a follow-up period of three years.

The following measures of the descriptive statistics were used: arithmetic mean, standard deviation, median, quartiles, frequencies, and percentages. The t-test for independent samples and the Mann–Whitney test were used to compare the mean values of the variables of the two populations. The correlation of categorical variables was examined using the $\chi^2$ test for contingency tables or using the Fisher test. Kaplan–Meier survival analysis was used to determine survival length. The influence of variables on survival was performed using Cox regression analysis.

Statistical analysis and data processing were done using the Statistical Package for Social Sciences – SPSS Statistics for Windows, Version 17.0 (SPSS Inc., Chicago, IL, USA), in which the significance limit was $p < 0.05$.

## RESULTS

The study included 225 patients with NSTEMI and multivessel CAD who were treated with PCI. The mean age of the patients was 62.8 ± 10.3 years.

There were 160 (71.1%) male patients, average age 61.3 ± 10.4 years, and 65 (28.9%) female patients, average age 66.5 ± 9.1 years, which showed to be statistically significant age difference ($p = 0.001$).

The first group, with complete one-stage PCI consisted of 112 (49.8%) patients; the second group, with complete multi-stage PCI, consisted of 70 (31.1%) patients, while the third group with culprit-only PCI consisted of 43 (19.1%) patients.

No significant difference between the groups in terms of demographic data, risk factors for the development of cardiovascular diseases, and previous diseases at admission was found, as shown in Table 1.

By analyzing laboratory parameters at admission, a statistically significant difference between the groups was found in terms of leukocyte count ($p = 0.01$) and neutrophil/lymphocyte ratio (NLR) ($p = 0.008$), as shown in Table 1.

In terms of clinical parameters analyzed at admission, the study groups were similar, and a statistically significant difference was found in terms of Killip class ($p = 0.045$) and cardiac arrest at admission ($p = 0.013$), as shown in Table 1.

During hospitalization, echocardiography was performed in all examined patients and a statistically significant difference in the left ventricular ejection fraction (LVEF) between the examined groups was found ($p = 0.005$), as shown in Table 1.

In terms of procedural characteristics, there was a significant difference between the groups in terms of the number of affected coronary arteries ($p < 0.0005$), culprit artery ($p = 0.008$), and the time elapsed from patient admission to PCI ($p = 0.002$), as shown in Table 2.

When clinical outcome was evaluated, intrahospital mortality in our study was 4.4%. Patients with culprit-only PCI had the highest intrahospital mortality (20.9%); intrahospital mortality among patients who underwent complete one-stage revascularization was 0.9%, while no intrahospital deaths were reported among patients who underwent complete multi-stage PCI, which represents a significant difference ($p < 0.0005$). Intrahospital outcome of the examined patients in terms of MACCE, including death, is shown in Table 3.

The rate of cumulative intrahospital MACCE including death was 9.8%, with the highest intrahospital MACCE in the group of patients with culprit-only revascularization (32.6%), followed by complete multi-stage revascularization (5.7%), and the lowest in the group of patients with complete one-stage revascularization (3.6%), which is a significant difference ($p < 0.0005$).

Cox's analysis for the occurrence of cumulative intrahospital MACCE, including death, has shown that the groups affected the occurrence of MACCE with a statistically significant difference (HR 0.387, 95% CI 0.208–0.720, $p = 0.003$), as presented in Table 4.

**Table 1.** Selected baseline and clinical characteristics at presentation in multivessel non-ST-elevated myocardial infarction patients

| Baseline characteristics | Complete single-stage PCI | Complete multi-stage PCI | Culprit-only PCI | p |
|---|---|---|---|---|
| Age, mean ± SD | 62.7 ± 10.2 | 61.4 ± 10.7 | 65.4 ± 9.8 | 0.137 |
| Male sex, n (%) | 83 (74.1) | 46 (65.7) | 31 (72.1) | 0.472 |
| Hypertension, n (%) | 87 (77.7) | 59 (84.3) | 33 (76.7) | 0.493 |
| Risk factors, n (%) | | | | |
| HLP | 57 (50.9) | 27 (38.6) | 14 (32.6) | 0.072 |
| DM | 30 (26.8) | 22 (31.4) | 14 (32.6) | 0.700 |
| Smoking | 50 (44.6) | 35 (50) | 18 (41.9) | 0.661 |
| Alcohol | 0 (0) | 1 (1.4) | 2 (4.7) | 0.077 |
| BMI > 30 kg/m$^2$, mean ± SD | 29 ± 15 | 29 ± 4 | 30 ± 6 | 0.718 |
| Disease history, n (%) | | | | |
| COPD | 8 (7.1) | 5 (7.1) | 2 (4.7) | 0.841 |
| CKI | 4 (3.6) | 3 (4.3) | 1 (2.3) | 0.861 |
| Previous MI | 17 (15.2) | 15 (21.4) | 14 (32.6) | 0.054 |
| Previous PCI | 16 (14.3) | 12 (17.1) | 6 (14) | 0.848 |
| Previous CVI | 7 (6.3) | 5 (7.1) | 4 (9.3) | 0.803 |
| Blood tests on admission | | | | |
| Troponin, med (range) (ng/l) | 48 (13–114) | 27 (1–47) | 42 (31.5–67.5) | 0.509 |
| Troponin max, med (range) (ng/l) | 122 (65–295) | 99.5 (51–286) | 75 (32–114) | 0.172 |
| CK MB, med (range) (U/l) | 33.5 (23–62) | 33.5 (27–75) | 26 (15.5–76.5) | 0.642 |
| Glucose, med (range) (μmol/l) | 7.6 (5.7–10.5) | 7.4 (6.1–14.1) | 6.5 (6.2–8.4) | 0.215 |
| ALT, med (range) (U/l) | 27 (19–35) | 28 (16–55) | 26 (15.5–35) | 0.596 |
| Creatinine, med (range) (μmol/l) | 102 (92–116) | 94.5 (85–105) | 97 (86–114.5) | 0.062 |
| Uric acid, mean ± SD (μmol/l) | 340 ± 92 | 329 ± 91 | 370 ± 106 | 0.079 |
| Total bilirubin, mean ± SD (μmol/l) | 12.3 ± 7.6 | 11 ± 5.6 | 12.6 ± 6.6 | 0.408 |
| LDL, mean ± SD (μmol/l) | 3.9 ± 1.1 | 3.7 ± 1 | 3.6 ± 1 | 0.384 |
| Triglycerides, med (range) (mg/dl) | 1.7 (1.2–2.4) | 1.6 (1.1–2.8) | 2.1 (1.4–2.4) | 0.930 |
| CRP, med (range) (mg/l) | 5.7 (2.8–23.2) | 8.3 (5.4–28.5) | 8.3 (3–21.2) | 0.296 |
| Hemoglobin, med (range) (g/l) | 143 (132–153) | 146.5 (138– 162) | 138 (120–144.5) | 0.098 |
| Leukocytes, med (range) (× 10$^9$/l) | 7.75 (6.5–9.8) | 9.05 (7.1–10.7) | 8.5 (7.75–11.2) | **0.01** |
| Neutrophil/lymphocyte ratio, med (range) | 2.3 (1.8–3.1) | 3.25 (2.5–5.5) | 2.8 (2.3–5.1) | **0.008** |
| Clinical parameters at admission | | | | |
| Systolic blood pressure, med (range) (mmHg) | 140 (130–160) | 140 (130–150) | 150 (142–165) | 0.148 |
| Diastolic blood pressure, med (range) (mmHg) | 82 (80–95) | 80 (70–90) | 90 (80–90) | 0.447 |
| Heart rate, med (range) (beats/min) | 85 (70–100) | 87 (80–105) | 75 (65–81) | 0.590 |
| Killip class | | | | 0.045 |
| I, n (%) | 93 (83) | 55 (78.6) | 26 (60.5) | |
| II, n (%) | 12 (10.7) | 9 (12.9) | 12 (27.9) | |
| III, n (%) | 7 (6.3) | 6 (8.6) | 5 (11.6) | |
| Cardiac arrest, n (%) | 0 (0) | 1 (1.4) | 3 (7) | **0.013** |
| GRACE score, med (range) | 121 (100–143) | 107 (92–129) | 115 (103–122) | 0.212 |
| Echocardiographic parameters | | | | |
| EF (%), mean ± SD | 53 ± 10 | 54 ± 8 | 48 ± 11 | **0.005** |
| High degree MR, n (%) | 0 (0) | 0 (0) | 2 (4.7) | 0.064 |

PCI – percutaneous coronary intervention; HLP – hyperlipoproteinemia; DM – diabetes mellitus; BMI – body mass index; COPD – chronic obstructive pulmonary disease; CKI – chronic kidney insufficiency; MI – myocardial infarction; CVI – cerebrovascular insult; CK MB – MB isoenzyme creatine kinase; ALT – alanine transaminase; LDL – low-density lipoprotein; CRP – C-reactive protein; EF – ejection fraction; MR – mitral regurgitation

Kaplan–Meier analysis of survival has shown a significant difference in the occurrence of MACCE between the examined groups (p = 0.001), which is shown in Tables 5 and 6 and Figure 1.

The overall one-year mortality in our study was 16 (7.1%) and after three years it amounted to 23 (10.2%).

When MACCE after one year was analyzed, there was a statistically significant difference between the examined groups in terms of mortality (p < 0.0005), with the highest mortality among patients with culprit-only PCI (30.2%), followed by complete one-stage revascularization (2.7%), while there were no recorded deaths among patients in whom complete multi stage PCI was performed. There was no statistically significant difference in terms of other MACCE during the first year of follow-up, which is shown in Table 3.

In the three-year follow-up, a significant difference in mortality between the examined groups (p < 0.0005) was found, with the highest mortality among patients with culprit-only revascularization (32.6%); mortality in the group of patients with complete one-stage revascularization was 5.4%, and the lowest mortality was among patients with complete multi stage revascularization (4.3%).

When the predictors of intrahospital cumulative MACCE, including death, were analyzed, the results of multivariate binary logistic regression showed that, except examined patient groups, intrahospital MACCE was simultaneously influenced by the following: infarcted blood vessel, time elapsed since patient admission to revascularization, cardiac arrest by type of pulseless electrical activity/asystole, and hyperlipoproteinemia, which is shown in Table 7. The Hosmer–Lemeshow test shows that this model is good (p = 0.888).

The results of our study showed that in the culprit-only group, residual SYNTAX score affects neither mortality nor cumulative MACCE, both intrahospital and after one year of follow-up, which is shown in Table 8.

## DISCUSSION

The prevalence of multivessel CAD in NSTEMI patients undergoing angiography is about 30–50% [11]. Higher

**Table 2.** Procedural characteristics of the patients with non-ST-elevated myocardial infarction and multivessel disease

| Procedural characteristics | Complete single-stage PCI | Complete multi-stage PCI | Culprit-only PCI | p |
|---|---|---|---|---|
| Number of affected coronary arteries, n (%) | | | | **< 0.0005** |
| Two | 100 (89.3) | 53 (75.7) | 23 (53.5) | |
| Three | 12 (10.7) | 17 (24.3) | 20 (46.5) | |
| Culprit artery, n (%) | | | | **0.008** |
| Left main | 1 (0.9) | 0 (0) | 4 (9.3) | |
| Left anterior descending | 43 (38.4) | 36 (51.4) | 11 (25.6) | |
| Right coronary artery | 26 (23.2) | 16 (22.9) | 14 (32.6) | |
| Left circumflex | 41 (36.6) | 18 (25.7) | 14 (32.6) | |
| TIMI flow, pre-procedure, n (%) | | | | 0.285 |
| 0 | 11 (9.8) | 14 (20) | 5 (11.6) | |
| 1 | 19 (17) | 8 (11.4) | 5 (11.6) | |
| 2 | 49 (43.8) | 27 (38.6) | 24 (55.8) | |
| 3 | 33 (29.5) | 21 (30) | 9 (20.9) | |
| TIMI flow, post-procedure, n (%) | | | | 0.052 |
| 0 | 1 (0.9) | 1 (1.4) | 4 (9.3) | |
| 1 | 0 (0) | 0 (0) | 0 (0) | |
| 2 | 3 (2.7) | 1 (1.4) | 1 (2.3) | |
| 3 | 108 (96.4) | 68 (97.1) | 38 (88.4) | |
| Stent type, n (%) | | | | 0.171 |
| Bare metal | 44 (39.3) | 36 (51.4) | 19 (44.2) | |
| Drug eluted | 65 (58) | 31 (44.3) | 23 (53.5) | |
| Drug eluted + bare metal | 3 (2.7) | 3 (4.3) | 0 (0) | |
| Average stent length, med (range) | 19 (5.5–112) | 20.7 (5.3–70) | 20.4 (5.5–43) | 0.083 |
| Average stent diameter, med (range) | 2.75 (2.5–3.5) | 2.75 (2.5–3) | 2.75 (2.5–3.25) | 0.857 |
| Access site, n (%) | | | | 0.095 |
| Radial artery | 88 (78.6) | 45 (64.3) | 27 (62.8) | |
| Femoral artery | 24 (21.4) | 24 (34.3) | 16 (37.2) | |
| Time from admission to PCI | | | | **0.002** |
| < 24h, n (%) | 24 (21.4) | 30 (42.9) | 12 (27.9) | |
| 24–48 h, n (%) | 23 (20.5) | 20 (28.6) | 6 (14) | |
| 48–72 h, n (%) | 13 (11.6) | 2 (2.9) | 8 (18.6) | |
| > 72 h, n (%) | 52 (46.4) | 18 (25.7) | 17 (39.5) | |

PCI – percutaneous coronary intervention; TIMI – thrombolysis in myocardial infarction

**Table 3.** Major adverse cardiovascular and cerebrovascular events

| Variable | Complete one-stage PCI | Complete multi-stage PCI | Culprit-only PCI | p |
|---|---|---|---|---|
| Intrahospital | | | | |
| Death, n (%) | 1 (0.9) | 0 (0) | 9 (20.9) | **< 0.0005** |
| Reinfarction, n (%) | 0 (0) | 0 (0) | 1 (2.3) | 0.119 |
| Repeated PCI, n (%) | 2 (1.8) | 4 (5.7) | 4 (9.3) | 0.104 |
| Cardiac decompensation, n (%) | 1 (0.9) | 1 (1.4) | 2 (4.7) | 0.275 |
| Stroke, n (%) | 0 (0) | 0 (0) | 1 (2.3) | 0.119 |
| One-year follow-up | | | | |
| Death, n (%) | 3 (2.7) | 0 (0) | 13 (30.2) | **< 0.0005** |
| Reinfarction, n (%) | 3 (2.7) | 2 (2.9) | 4 (9.3) | 0.143 |
| Angina pectoris, n (%) | 6 (5.4) | 6 (8.6) | 2 (4.7) | 0.610 |
| Heart failure, n (%) | 5 (4.5) | 4 (5.7) | 6 (14) | 0.098 |
| Stroke, n (%) | 1 (0.9) | 0 (0) | 2 (4.7) | 0.095 |
| Two-year follow-up | | | | |
| Death, n (%) | 4 (3.6) | 3 (4.3) | 13 (30.2) | **< 0.0005** |
| Three-year follow-up | | | | |
| Death, n (%) | 6 (5.4) | 3 (4.3) | 14 (32.6) | **< 0.0005** |

PCI – percutaneous coronary intervention

mortality in multivessel NSTEMI may be the result of different mechanisms, which include multiple vulnerable plaques and abnormalities in myocardial perfusion and contractility [9, 12]. Determining the culprit lesion can be challenging in NSTEMI and culprit-only PCI may result in unintentional treatment of a non-culprit lesion rather than a less apparent culprit plaque rupture or erosion [5, 13].

Our study shows a protective effect of complete multi stage PCI in multivessel NSTEMI compared to one stage complete PCI or culprit-only PCI with regard to occurrence of mortality both intrahospital (0% *vs.* 0.9% and 20.9%, respectively, $p < 0.0005$) and after one year (0% *vs.* 2.7% and 30.2%, respectively, $p < 0.0005$) and three years (4.3% *vs.* 5.4% and 32.6%, respectively, $p < 0.0005$), but with no significant impact regarding other MACCE.

According to the results of our study, patients who underwent complete multistage PCI had a lower risk of developing intrahospital MACCE by 62% compared to patients who underwent complete one-stage PCI, who had a 62% lower risk of developing intrahospital MACCE compared to patients who underwent culprit-only PCI (HR 0.387, 95% CI 0.208–0.720, $p = 0.003$).

There is a number of retrospective observational studies and registries that compared culprit-only with complete PCI in patients with multivessel NSTEMI with inconsistent results. According to the results of a large registry by Bauer et al. [14], no difference in intrahospital mortality was found between examined groups. When long term outcomes were analyzed, results of the TRANSLATE study failed to show statistically significant difference in mortality between examined groups during six months of the follow-up period [15]. In contrast to these results, registries conducted by Kim et al. [16] and Rathod et al. [17] showed better survival after one- and five-year follow-ups, respectively, of patients in whom complete revascularization was performed

The potential advantages of multivessel compared to culprit-only PCI include reduction of the myocardial territory at risk and improvement of myocardial function by increasing blood flow to the peri-infarct area, as described before [12]. This is how we explained

**Table 4.** Cox's analysis of intrahospital major adverse cardiovascular and cerebrovascular events

| | B | SE | Wald | df | Sig. | Exp (B) | 95% CI for Exp (B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Groups | -0.950 | 0.317 | 8.959 | 1 | 0.003 | 0.387 | 0.208 | 0.720 |

**Table 5.** Kaplan–Meier analysis of intrahospital major adverse cardiovascular and cerebrovascular events

| Groups | Mean | | | |
|---|---|---|---|---|
| | Estimate | Std. error | 95% CI | |
| | | | Lower bound | Upper bound |
| Culprit-only | 20.5 | 3.47 | 13.7 | 27.3 |
| One-stage complete | 24.14 | 1.82 | 20.56 | 27.72 |
| Multi-stage complete | 22.3 | 0.82 | 20.68 | 23.91 |
| Overall | 27.84 | 3.05 | 21.85 | 33.82 |

**Table 6.** Kaplan–Meier (logrank) analysis of intrahospital major adverse cardiovascular and cerebrovascular events (overall comparisons)

| Logrank (Mantel–Cox) | $\chi^2$ | df | Sig. |
|---|---|---|---|
| | 14.988 | 2 | 0.001 |

**Table 7.** Predictors of intrahospital cumulative major adverse cardiovascular and cerebrovascular events (multivariate binary logistic regression)

| Parameter | OR (95% CI) | p |
|---|---|---|
| Groups | 0.155 (0.063–0.378) | **< 0.0005** |
| Time to revascularization | 0.471 (0.278–0.797) | **0.005** |
| Culprit artery | 0.201 (0.082–0.490) | **< 0.0005** |
| Hyperlipoproteinemia | 0.208 (0.054–0.806) | **0.023** |
| Pulseless electrical activity/ asystole at admission | 0.135 (0.028–0.656) | **0.013** |

**Table 8.** Residual SYNTAX score as a predictor of intrahospital and one-year mortality and cumulative MACCE in the culprit-only group

| Mortality | Residual Syntax score | | p |
|---|---|---|---|
| | ≤ 8, n (%) | > 8, n (%) | |
| Intrahospital mortality | 5 (17.9) | 4 (26.7) | 0.696 |
| Intrahospital MACCE | 7 (25) | 7 (46.7) | 0.184 |
| One-year mortality | 8 (28.6) | 5 (33.3) | 0.742 |
| One-year MACCE | 12 (42.9) | 9 (60) | 0.347 |

MACCE – major adverse cardiovascular and cerebrovascular events

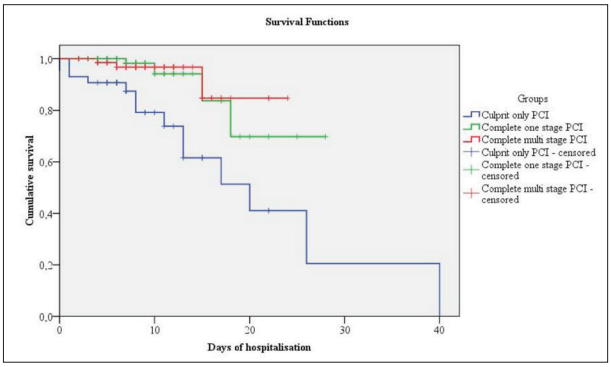


**Figure 1.** Kaplan–Meier analysis of intrahospital major adverse cardiovascular and cerebrovascular events;

PCI – percutaneous coronary intervention

significantly higher LVEF among patients with complete multi-stage PCI and one-stage PCI compared to culprit-only PCI, respectively (54 ± 8% and 53 ± 10% *vs.* 48 ± 11%, p = 0.005) in our study.

Most studies that compared complete with culprit-only revascularization excluded patients in whom complete multi-stage PCI was planned. SMILE was a randomized prospective trial which, after a one-year follow-up period, showed significant reduction of MACCE in patients with one-stage complete PCI in comparison with multi-stage PCI, mostly caused by a lower rate of repeated PCI, while it failed to show significant difference in reinfarction rate and mortality [18]. Recently, results of a small prospective study comparing total, staged, and fractional flow reserve-guided PCI were published in patients with NSTE-ACS and multivessel disease and they showed comparable effects between examined groups regarding the intrahospital and the six-month clinical follow-up mortality [19].

In previous studies comparing one-stage and multi-stage complete PCI in multivessel NSTEMI, it was hypothesized that a longer procedure duration, higher volume of contrast administered during the index procedure, possible complications (periprocedural myocardial infarction, procedure-related stroke, bleeding requiring transfusion, and contrast induced nephropathy requiring dialysis) could have an impact on higher rate of MACCE among patients with one-stage complete PCI at long-term follow-up [11, 17]. This could explain better long-term survival of patients with multi stage PCI compared to one-stage and culprit-only PCI in our study, but as this was a retrospective observational study, no valid data was available, so further research is needed.

Results of a multinational randomized COMPLETE trial of STEMI patients with multivessel CAD were recently published. This study showed that mortality of cardiovascular origin and reinfarction rate were lower among patients in whom complete revascularization was performed in comparison with culprit-only revascularization during three years of follow-up, regardless of performing complete revascularization during index procedure or as a planned multi-stage revascularization during 23 days [20]. If we were to transfer these results to NSTEMI patients, it would seem reasonable to consider interventions on non-infarct-related arteries in multiple acts, but further studies are needed.

## Limitations

Our study has several limitations that could affect the results. Firstly, this was a retrospective observational study conducted at a single hospital, which involved a relatively small number of patients. Secondly, definition of the type of lesion and the method of revascularization depended on the decision of the interventional cardiologist during the procedure and there was no standard approach. Finally, the groups were not fully balanced in terms of the number of patients in each individual group and the existence of a broad composite target event.

## CONCLUSION

In our study, in multivessel NSTEMI patients, complete multi-stage PCI is superior to complete one-stage and culprit-only PCI in terms of intrahospital and three-year follow-up mortality.

**Conflict of interest:** None declared.

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# Комплетна реваскуларизација насупрот реваскуларизацији само инфарктне артерије код инфаркта миокарда без елевације СТ сегмента и вишесудовне коронарне болести

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**САЖЕТАК**

**Увод/Циљ** Код болесника са инфарктом миокарда без елевације СТ сегмента (*NSTEMI*) и вишесудовном коронарном артеријском болешћу оптимални приступ перкутаном коронарном интервенцијом (ПКИ) још увек није јасан.
Циљ наше студије је био да се истражи појава интрахоспиталних и дугорочних нежељених кардиоваскуларних и цереброваскуларних догађаја (*MACCE*) у овој групи болесника.
**Методе** Ова ретроспективна студија је укључила 225 болесника са *NSTEMI* и вишесудовном коронарном артеријском болешћу код којих је учињена ПКИ на Институту за кардиоваскуларне болести Војводине. Формиране су три групе: комплетна ПКИ у једном акту, комплетна ПКИ у више актова и ПКИ само инфарктне артерије. Анализирали смо појаву *MACCE* интрахоспитално и после годину дана и морталитет после три године код све три групе болесника.
**Резултати** Комплетна ПКИ у једном акту урађена је код 112 (49,8%) болесника, у више актова код 70 (31,3%) и само инфарктне артерије код 43 (19,1%) болесника. Болесници са комплетном ПКИ у више актова имали су најмањи морталитет у поређењу са ПКИ у једном акту и ПКИ само инфарктне артерије интрахоспитално (0% насупрот 0,9% и 20,9%, $p < 0,0005$), после једне (0% насупрот 2,7% и 30,2%, $p < 0,0005$) и три године (4,3% насупрот 5,4% и 32,6%, $p < 0,0005$). Није било значајне разлике између група у погледу других *MACCE* интрахоспитално и после годину дана.
**Закључак** У нашем истраживању, ПКИ у више актова значајно смањује интрахоспитални морталитет после годину и три године код болесника са *NSTEMI* и вишесудовном коронарном артеријском болешћу.

**Кључне речи:** инфаркт миокарда без елевације СТ сегмента; вишесудовна коронарна болест; перкутана коронарна интервенција; велики нежељени кардиоваскуларни и цереброваскуларни догађаји; морталитет