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Improved short and long term survival associated with percutaneous coronary intervention in the elderly patients with acute coronary syndrome

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Abstract

Background: Percutaneous coronary intervention (PCI) are increasingly used in daily clinical practice in elderly patients with acute coronary syndrome (ACS) despite limited evidence. The purpose of this study was to assess the impact of PCI on short and long term survivals in a large cohort of elderly patients with ACS from a “real world”.

Methods: We enrolled 491 patients aged ≥ 70 years admitted to our institution with ACS from 2006 to 2012. Effect of PCI on short and long term survival was evaluated in both overall and a propensity score-matched cohort.

Results: The mean age of the overall cohort is 83 ± 6 years. Among them, 285 were treated with PCI, whereas 206 were not. Patients treated with PCI were younger (82 ± 5 vs. 85 ± 6), more males (67% vs. 46%), with lower heart rate (77 ± 22 vs. 84 ± 21), higher eGFR (58 ± 20 vs. 47 ± 23), and less with heart failure (29% vs. 15%) (all $p < 0.001$). In both overall and propensity-matched population, improved survival was associated with PCI-treatment at 1 and 3 years ($p < 0.001$ for all comparisons). Furthermore, by using multivariate Cox proportional-hazards regression model following factors were identified as independent predictors of 3-year all-cause mortality: age (HR 1.08, 95% CI 1.00–1.16), heart rate (HR 1.02, 95% CI 1.01–1.03), eGFR (HR 3.07, 95% CI 1.63–5.77), malignancy (HR 2.03, 95% CI 1.27–4.57), prior CABG (HR 2.033, 95% CI 1.27–4.57), medication with statin (HR 0.40, 95% CI 0.19–0.86) in PCI group, whereas age (HR 1.08, 95% CI 1.03–1.13), heart rate (HR 1.01, 95% CI 1.01–1.02), hypertension (HR 1.87, 95% CI 1.01–3.49) and using of ACEI/ARB (HR 0.46, 95% CI 0.28–0.76) in non-PCI group.

Conclusions: In elderly ACS patients, PCI-treatment was associated with improved 1 and 3-year survival and PCI-treated patients had different prognostic profile compared to those without PCI treatment.

Keywords: Acute coronary syndrome, Percutaneous coronary intervention, Elderly, Short and long outcome

Background

The general population is gradually ageing worldwide, and cardiovascular diseases are still leading cause of morbidity and mortality in the elderly people. Advanced age is associated with an increased incidence of acute coronary syndromes (ACS) requiring urgent angiography [1]. The current ACS guidelines do not distinguish between elderly and younger patients [2–4] despite studies

of percutaneous coronary intervention (PCI) in elderly population are limited. As a matter of fact, elderly adults have been largely underrepresented or excluded from most of the randomized controlled trials assessing an invasive versus conservative approach in ACS [5, 6]. Therefore, in daily clinical practice, interventional cardiologists are often reluctant to undertake PCI in very elderly individuals due to the perception of poor outcome owing to the high prevalence of associated comorbidities [2, 7–9]. However, during recent years, there were studies from registries or hospital cohort that indicated beneficial effect of PCI on outcome in octogenarians presenting with ACS [10–13]. Recently, the 1st randomized trial in elderly

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patients with non-ST segment elevation myocardial infarction (NSTEMI) and unstable angina pectoris demonstrated that an invasive strategy with PCI or coronary artery bypass grafting (CABG) is superior to a conservative strategy in the reduction of composite events [14]. However, this study was underpowered to assess survival. The purpose of the present study was to assess any associations between PCI and all-cause mortality (both short and long term) in a large cohort of elderly patients with ACS from a “real world”, and explore the predictors of 3-year all-cause mortality in patients treated with different strategies.

Methods

Study population

This study consecutively included 491 patients aged ≥ 70 years and suffered from acute ACS at Sahlgrenska University Hospitals/Sahlgrenska, and Sahlgrenska University Hospitals /Östra affiliated with the University of Gothenburg from 2006 to 2012. Patients came directly from ambulance or were referred from cardiology and medical departments. ACS was classified as ST segment elevation myocardial infarction (STEMI), non-ST segment elevation myocardial infarction (NSTMI) or unstable angina (UA). Criteria for STEMI were ischemic symptoms lasting > 10 min and ST elevation in two contiguous leads or new left bundle branch block. NSTEMI and UA were defined by the presence of ST segment depression or T-wave abnormalities or ischemic symptoms with (NSTEMI) or without (UA) elevation of cardiac enzyme levels above the reference range. Treatment strategy was made at discretion of clinical decision by responsible cardiologist. All PCIs were performed at a joint PCI center for both hospitals. The study protocol was approved by the Human Ethical Committee at University of Gothenburg.

Data collection

The baseline demographic, medical history, clinical characteristics, comorbidities and medications were based on patients' electronic medical records and entered into a database. The Cockcroft-Gault formula was used to calculate the estimated glomerular filtration rate (eGFR) to assess renal function.

Follow up and end-points

All patients were followed from index hospitalization due to ACS for 3 years. The outcome measures for this study was 30-days, 1 and 3-year all-cause mortality. Mortality data during follow-up were obtained from the Death Registry of the National Board of Health and Welfare in Sweden.

Statistical analysis

Categorical variables are described as percentages and compared using chi-square test or Fisher exact test as appropriated. Continuous variables were described as mean \pm SD and compared using independent sample test. Cox proportional-hazard regression models were used to assess possible association between PCI and mortality, hazard ratios (HRs) and 95% confidence intervals (95% CIs) were presented. Estimates of the odd ratios (OR) and associated 95% confidence intervals (CI) were obtained from logistic regression models to identify factors associated with the usage of primary PCI.

To adjust for the bias inherent in treatment assignment, propensity score matching analysis with 1:1 nearest neighbor matching was employed. The propensity score is the propensity from 0 to 1 receive PCI treatment, given a set of known variables, and is used to adjust for potential selection bias, confounding and differences between the two groups in observational studies [15]. Variables used in developing the propensity score are presented in Table 1. After propensity score matching, the final cohort consisted of 296 matched patients, 148 in the PCI-treated and 148 in non-PCI-treated groups. Both the overall cohort and the PS-matched cohort were further analyzed by Cox proportional-hazard regression models.

A p value of < 0.05 was considered statistically significant. All statistical analyses were performed using SPSS 22 statistical software (SPSS, Inc., Chicago, Illinois).

Results

Clinical characteristics

The baseline characteristics are summarized in Table 1. In the overall cohort, the study population was aged around 83.2 ± 5.6 years. Among them, 285 (58%) patients had undergone PCI, whereas 206 were not. The numbers of elderly patients treated or not treated with PCI according to chronological age were illustrated in Fig. 1. In the PCI group, patients were significantly younger (81.6 ± 4.7 vs. 85.4 ± 6.0 , $p < 0.001$) and were often male (66.3% vs. 46.1%, $p < 0.001$). In PCI group, STEMI, NSTEMI and UA were 54, 35 and 12%, respectively whereas 13, 79 and 8% in non-PCI group. Furthermore, in PCI group patients had higher level of hemoglobin and eGFR whereas in non-PCI group patients had more comorbidities, including history of heart failure (29.1% vs. 15.4%, $p < 0.001$), hypertension (80.5% vs. 52.3%, $p < 0.001$) and stroke (24.8% vs. 10.5%, $p < 0.001$), compared with those in PCI group. Patients undergoing PCI were less frequently treated with diuretics (28.1% vs. 49.1%, $p < 0.001$), but more frequently received statins (49.1% vs. 29.1%, $p < 0.001$) and angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor antagonist (ARB) (48.1% vs. 36.4%, $p = 0.013$).

After propensity score matching, 296 patients remained including 148 in the PCI group and 148 in non-PCI group.

Table 1 Demographic and clinical characteristics of all study patients

Variables	Overall cohort			Matched cohort		
	Non-PCI(n = 206)	PCI(n = 285)	P-value	Non-PCI(n = 148)	PCI(n = 148)	P-value
Demographics						
Age, year	85.4 ± 6.0	81.6 ± 4.7	< 0.001	83.4 ± 5.6	82.6 ± 4.6	0.143
Gender, male	95(46.1)	189(66.3)	< 0.001	85(57.4)	87(58.7)	0.906
Weight, kg	71.6 ± 14.3	74.3 ± 13.0	0.041	72.4 ± 14.6	73.6 ± 13.0	0.472
Height, cm	169.5 ± 9.9	171.3 ± 9.5	0.066	169.4 ± 9.0	170.7 ± 9.9	0.222
BMI, kg/m ²	24.6 ± 3.9	25.2 ± 3.8	0.096	25.0 ± 3.8	25.4 ± 4.0	0.387
Smoking	71(34.5)	136(47.7)	0.001	47(31.7)	68(45.9)	0.017
Clinical Characteristics						
STEMI	26(12.6)	154(54.0)	< 0.001	20(13.5)	76(51.3)	< 0.001
UNSTEMI	164(78.9)	95(35.4)	< 0.001	115(77.8)	59(39.9)	< 0.001
Unstable angina pectoris	17(8.3)	35(12.2)	0.181	14(9.5)	12(8.1)	0.838
Heart rate,bpm	83.9 ± 21.3	77.4 ± 22.1	0.001	81.9 ± 22.6	79.0 ± 20.6	0.247
Systolic BP, mmHg	144.4 ± 27.4	148.8 ± 26.3	0.083	145.6 ± 26.2	148.6 ± 26.6	0.332
Diastolic BP, mmHg	82.6 ± 15.4	84.3 ± 16.1	0.242	83.7 ± 15.3	84.1 ± 14.3	0.848
Laboratory findings						
Hemoglobin, g/L	128.7 ± 18.6	133.7 ± 15.9	0.003	130.1 ± 18.4	133.1 ± 15.7	0.128
eGFR, ml/min/1.73m ²	47.2 ± 23.1	58.1 ± 20.1	< 0.001	52.2 ± 23.7	56.5 ± 19.9	0.096
Creatinine, umol/L	119.3 ± 89.8	100.2 ± 56.2	0.005	112.7 ± 94.6	99.3 ± 36.8	0.108
Comorbidities						
Atrial fibrillation	46(22.3)	49(17.2)	0.166	34(23.0)	32(21.6)	0.889
History of heart failure	60(29.1)	44(15.4)	< 0.001	33(22.3)	35(23.6)	0.890
Hypertension	166(80.5)	149(52.3)	< 0.001	108(73.0)	99(66.9)	0.311
Diabetes	40(19.4)	55(19.3)	1.000	31(20.9)	35(23.6)	0.675
Hyperlipidaemia	36(17.5)	40(14.1)	0.376	27(18.2)	17(11.5)	0.141
Kidney disease	34(16.5)	51(17.9)	0.718	27(18.2)	24(16.2)	0.758
Pulmonary disease	31(15.0)	45(15.7)	0.900	20(13.5)	23(15.5)	0.742
Peripheral vascular disease	23(11.2)	20(7.0)	0.145	14(9.5)	15(10.1)	1.000
Anemia	25(12.1)	22(7.8)	0.120	13(9.7)	8(5.4)	0.366
Malignancies	15(7.3)	36(12.6)	0.071	13(8.9)	19(13.8)	0.349
Stroke	51(24.8)	30(10.5)	< 0.001	24(26.2)	23(15.5)	1.000
Prior CABG	24(11.6)	22(7.7)	0.159	17(11.5)	11(7.4)	0.321
Prior PCI	24(11.7)	34(11.9)	1.000	19(12.8)	12(8.1)	0.254
Prior valvar surgery	6(2.9)	2(0.7)	0.074	4(2.7)	1(0.7)	0.371
Pacemaker	14(6.8)	15(5.3)	0.562	8(5.4)	9(6.1)	1.000
Medications						
β-Blockers	128(62.1)	187(65.6)	0.446	99(66.9)	109(73.6)	0.252
Aspirin,	145(70.4)	188(65.9)	0.328	107(72.3)	104(70.3)	0.797
ACEI/ARB	75(36.4)	137(48.1)	0.013	63(42.6)	76(51.3)	0.162
diuretics,	101(49.1)	80(28.1)	< 0.001	62(41.8)	54(36.5)	0.405
Spironolactone	19(9.2)	21(7.4)	0.505	11(7.4)	17(11.5)	0.312
Statins	60(29.1)	141(49.5)	< 0.001	54(36.5)	68(45.9)	0.125
Digoxin	18(8.7)	18 (6.3)	0.381	14(9.5)	14(9.5)	1.000

BMI body mass index, **ADL** activities of daily living, **LV** left ventricular, **LA** left atrial, **RA**, right atrial, **MR**, mitral regurgitation, **AS** aortic valve stenosis, **TR** tricuspid regurgitation, **ACEI** angiotensin converting enzyme inhibitor, **ARB** angiotensin receptor blocker

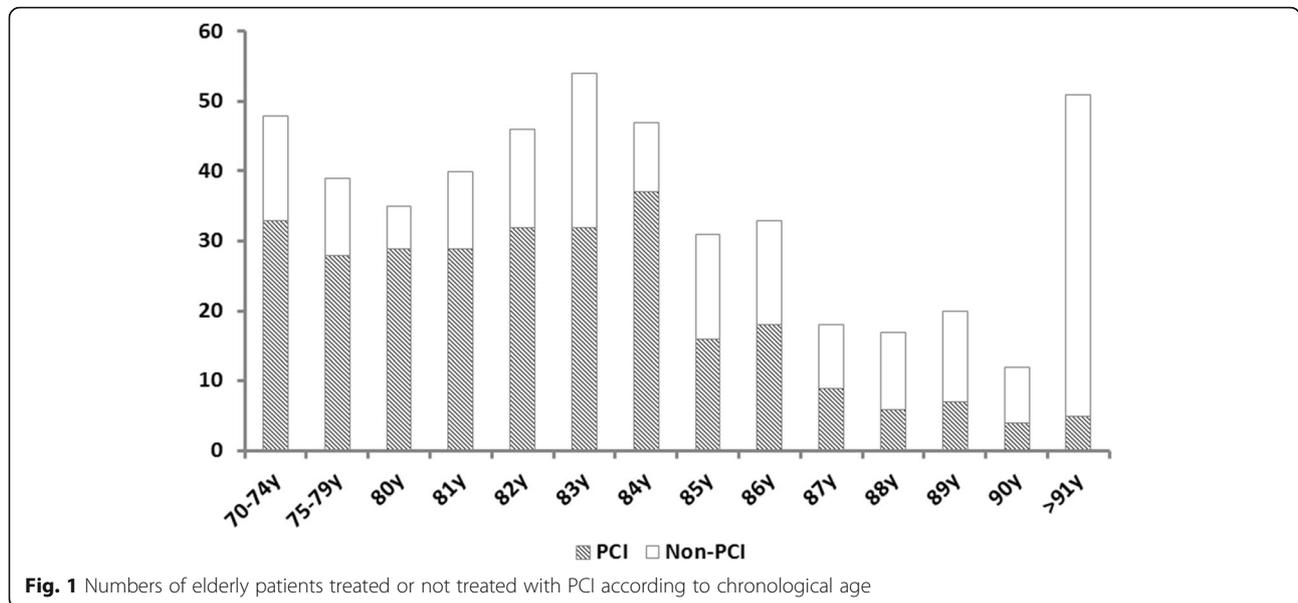


Fig. 1 Numbers of elderly patients treated or not treated with PCI according to chronological age

As illustrated in Fig. 2, propensity scores were nearly identically distributed.

Outcomes

In the overall cohort, patients in PCI group had better short and long term survival with all-cause mortality 7.4, 13, and 21.8% at 30 days, 1 and 3 years, respectively compared with 20.8, 39.3, 57.3% in non-PCI group (all $p < 0.001$). (Table 2 and Fig. 3).

In the matched population, no significant difference in all-cause mortality was observed in PCI group compared to non-PCI group at 30 days (9.5% vs.14.9%, $p = 0.186$). However, patients in PCI group had better survival at 1 and 3 year (16.2 and 29.1%, $p < 0.001$) compared to non-PCI group (31.8 and 48%, $p < 0.001$) (Fig. 3).

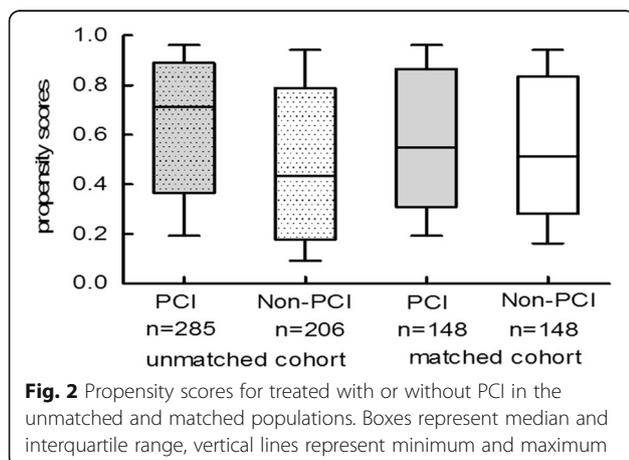


Fig. 2 Propensity scores for treated with or without PCI in the unmatched and matched populations. Boxes represent median and interquartile range, vertical lines represent minimum and maximum

Prognostic predictors of 3-year mortality

On the basis of the multivariate Cox proportional-hazards model following factors were identified as independent predictor of 3-year all-cause mortality: age (HR = 1.078, 95% CI 1.001–1.162, $p = 0.048$), heart rate (HR = 1.015, 95% CI 1.005–1.026, $p = 0.003$), eGFR ≤ 35 ml/min/1.73 m² (HR = 3.069, 95% CI 1.633–5.770, $p < 0.001$), history of malignancy (HR = 2.334, 95%CI 1.296–4.567, $p = 0.006$), prior CABG (HR = 3.247, 95% CI 1.381–7.638, $p = 0.007$), medication with statin (HR = 0.402, 95%CI 0.188–0.862, $p = 0.014$) in PCI group, while age (HR = 1.079, 95%CI 1.028–1.132, $p = 0.002$), heart rate (HR = 1.014, 95%CI 1.005–1.023, $p = 0.002$), history of hypertension (HR = 1.872, 95%CI 1.005–3.489, $p = 0.048$) and using of ACEI/ARB (HR = 0.461, 95%CI 0.279–0.761, $p = 0.002$) in non-PCI group (Table 3).

Factors associated with choice of PCI

The main determinants of choice of PCI were summarized in Table 4. Multivariable logistic regression analysis showed that age (OR 0.923, 95%CI 0.874–0.975, $p = 0.004$), male gender (OR 1.647, 95%CI 1.068–2.540, $p = 0.024$), lower heart rate (OR 0.900, 95%CI 0.981–0.999, $p = 0.032$), lower systolic blood pressure (OR 1.009, 95%CI 1.001–1.017, $p = 0.030$), without history of hypertension (OR 2.699, 95%CI 1.689–4.313, $p < 0.001$) and stroke (OR 2.425, 95%CI 1.389–4.233, $p = 0.002$) were the independent factors in favour of choice of PCI.

Discussions

Our results demonstrated that PCI was associated with better survival in both short and long terms in an elderly

Table 2 Association between PCI use and outcomes

Study group	Unmatched population					Matched population				
	Overall	Non-PCI (n = 206)	PCI (n = 285)	HR (95%CI)	P-value	Overall	Non-PCI (n = 148)	PCI (n = 148)	HR (95% CI)	P-value
	No events(%) IR(*100py)	No events(%) IR(*100py)	No events(%) IR(*100py)			No events(%) IR(*100py)	No events(%) IR(*100py)	No events(%) IR(*100py)		
30 days all- cause death	64 (13.0) 15.6	43 (20.8) 25.1	21 (7.4) 8.8	2.833 (1.681–4.773)	< 0.001	36 (12.2) 14.6	22 (14.9) 17.8	14 (9.5) 11.4	1.571 (0.804–3.071)	0.186
1 year all- cause death	118 (24.0) 24.0	81 (39.3) 39.3	37 (13.0) 13.0	3.393 (2.298–5.009)	< 0.001	71 (24.0) 24.0	47 (31.8) 31.8	24 (16.2) 16.2	2.062 (1.261–3.372)	0.004
3 year all- cause death	180 (36.7) 12.2	118 (57.3) 19.1	62 (21.8) 7.3	3.361 (2.468–4.578)	< 0.001	114 (38.5) 12.8	71 (48.0) 16.0	43 (29.1) 9.7	1.879 (1.286–2.745)	0.001

IR incidence rate, no./100 person-yr,HR, hazard ratio; P-value, Non-PCI vs. PCI

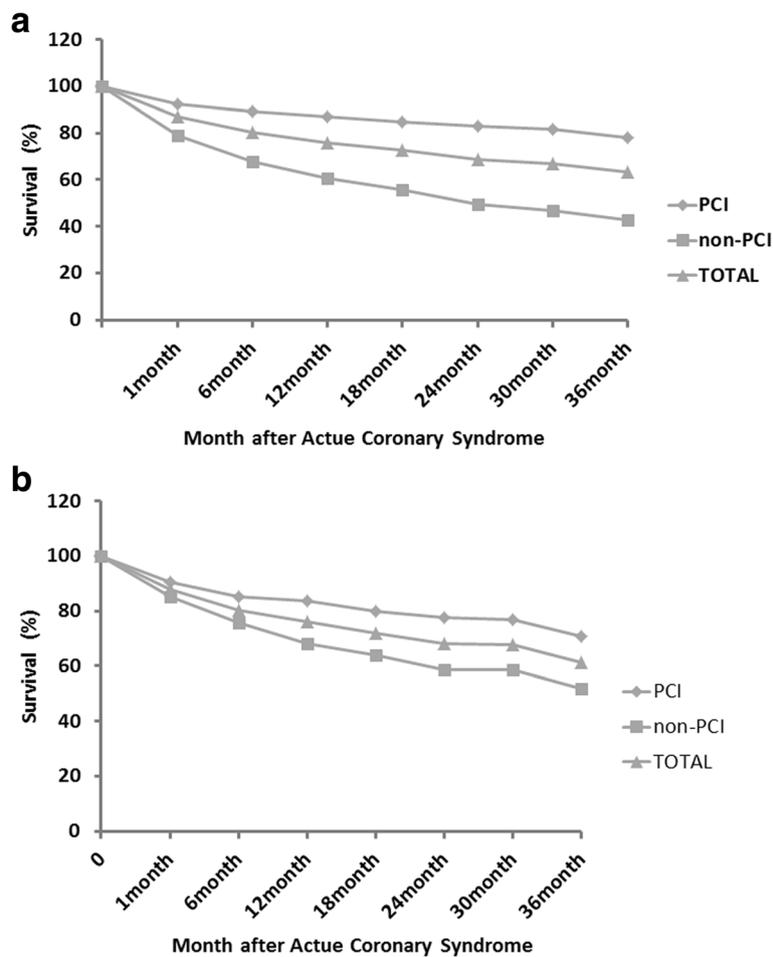


Fig. 3 Comparison of survival of elderly patients treated with or without PCI after acute coronary syndrome. **a:** overall cohort; **b:** the matched cohort

Table 3 Risk factors influencing 3-year all cause mortality of patient in two groups

Variables	PCI			Non-PCI		
	HR	95%CI	p-value	HR	95%CI	p-value
Age, year	1.078	1.001–1.162	0.048	1.079	1.028–1.132	0.002
Gender, female	0.934	0.508–1.718	0.827	0.751	0.492–1.145	0.184
BMI, kg/m ²	0.941	0.874–1.013	0.103	0.972	0.923–1.023	0.280
Smoking	1.040	0.593–1.824	0.891	0.964	0.633–1.468	0.863
Heart rate,bpm	1.015	1.005–1.026	0.003	1.014	1.005–1.022	0.002
Systolic BP, mmHg	0.996	0.986–1.006	0.404	0.990	0.983–0.997	0.007
eGFR≤35 ml/min/1.73m ²	3.069	1.633–5.770	< 0.001	1.153	0.762–1.745	0.499
History of HF	1.261	0.665–2.391	0.478	1.338	0.866–2.068	0.190
Hypertension	1.464	0.820–2.614	0.198	1.872	1.005–3.489	0.048
Anemia	0.336	0.099–1.136	0.079	0.924	0.513–1.663	0.791
Malignancies	2.334	1.296–4.569	0.006	1.150	0.544–2.431	0.714
Stroke	0.739	0.306–1.787	0.502	1.050	0.655–1.683	0.839
Prior CABG	3.247	1.381–7.638	0.007	1.595	0.886–2.872	0.120
Prior PCI	0.639	0.242–1.686	0.366	0.779	0.362–1.677	0.524
β- Blockers	1.118	0.624–2.002	0.707	1.141	0.756–1.721	0.531
Aspirin	1.336	0.710–2.512	0.369	0.900	0.602–1.346	0.607
ACEI/ARB	1.211	0.645–2.276	0.551	0.461	0.279–0.761	0.002
Statin	0.402	0.188–0.862	0.014	0.995	0.524–1.889	0.989

cohort with ACS. Moreover, the prognostic factors of 3-year all-cause mortality between PCI and non-PCI group are different. Finally, the decision to proceed with PCI in the elderly ACS population was affected by the age, gender, blood pressure, heart rate, hypertension and stroke.

Older patients are often accompanied by more comorbidity and more spread atherosclerotic disease, PCI is therefore more challenging from the technical point of view. Recently, there were data indicating that PCI in elderly seems to be associated with good early and intermediate outcomes [11, 16]. Our results are in line with previous findings by

Table 4 Baseline characteristics related to the propensity using of PCI

Variables	Univariable			Multivariable		
	OR	(95%CI)	p	OR	(95%CI)	p
Age, year	0.870	0.837–0.905	< 0.001	0.923	0.874–0.975	0.004
Gender, female	2.300	1.592–3.323	< 0.001	1.647	1.068–2.540	0.024
Heart rate,bpm	0.986	0.977–0.994	0.001	0.900	0.981–0.999	0.032
Systolic BP, mmHg	1.007	1.000–1.013	0.055	1.009	1.001–1.017	0.030
eGFR, ml/min/1.73m ²	1.026	1.016–1.036	< 0.001	1.005	0.993–1.018	0.393
History of HF	2.251	1.450–3.945	< 0.001	1.142	0.666–1.957	0.630
Hypertension	3.788	2.498–5.743	< 0.001	2.699	1.689–4.313	< 0.001
Stroke	2.797	1.708–4.580	< 0.001	2.425	1.389–4.233	0.002
Malignancies	0.543	0.289–1.021	0.058	0.512	0.250–1.046	0.066
Prior CABG	1.576	0.858–2.897	0.143	1.847	0.873–3.908	0.109
Prior PCI	0.928	0.529–1.628	0.794	1.278	0.650–2.513	0.478
ACEI/ARB	0.618	0.429–0.893	0.010	1.006	0.619–1.635	0.980
Diuretic	2.465	1.692–3.590	< 0.001	1.489	0.936–2.368	0.093
Statin	0.420	0.287–0.614	< 0.001	0.725	0.423–1.242	0.242

showing that the elderly ACS patients can get benefit of PCI not only at 1-year but also 3-years. Recently a randomized study aimed to investigate whether elderly patients with NSTEMI or unstable angina would benefit from an early invasive strategy versus a conservative strategy and showed similar results as ours [14]. Although the mean age (85.4 years in non-PCI group and 81.6 years in PCI group) and sample size ($n = 491$) in our study are comparable to above-mentioned randomized study (84.7 in invasive strategy group and 84.9 in conservative strategy group) ($n = 457$), there are several differences: First, as inclusion, no patients with STEMI was included in randomized study. However STEMI is a large proportions of the total ACS patients included in our study. Second, as many other trials randomized study was subject to many exclusions such as cardiogenic shock, continuing bleeding problems, short life expectancy (such as chronic obstructive pulmonary disease, disseminated malignant disease, or others), and substantial mental disorder. This was not the case in our study. Therefore our study is more close to the “real world” of the clinical practice. Third, the invasive strategy in the randomized study included early coronary angiography with PCI and CABG, but in our study we assessed only association between PCI and the outcomes. Most important, above randomized study was underpowered to assess survival. Last, like most clinical trials and retrospective studies involving elderly patients they seldom have long-term results and the median follow-up in the randomized study is only 1.53 years.

Our data about 30-day, 1 and 3-year mortality are in line with the previous studies in elderly patients in whom 30 day mortality was reported to be 7 to 15% [17–19], and 15 to 21% of patients treated with conservative strategy [20, 21]. In our study, the 1-year mortality rate in octogenarian population is consistent with the German ALKK registry [16] in which all-cause mortality in patient 65–74 years was 10.1, and 20.4% in patients ≥ 75 undergoing PCI [22], and upon 1 year follow-up the mortality rate among the invasive group was lower compared with medically managed patients (11–20% vs. 19–30%) [23–26]. Long term data are relatively sparse, our 3-year mortality rates for elderly were comparable to previous studies in which 3-year all cause death in elderly patients with mean age of 88 years old treated with PCI were 33.3%, and treated with conservative management were 52.4% [27]. Taken all results together, our study extended previous observations by showing that PCI was associated with better survival in both short- and long- terms in an elderly cohort with ACS.

Previous studies showed that preoperative factors influencing mortality in elderly treated with invasive or conservative strategy are cardiogenic shock, previous cardiac surgery, renal failure, age, hypertension, heart rate and anemia [24, 28–33]. Moreover it is known that medication

use during PCI is related to success and less complications, for example, statin use may reduce complications and mortality after PCI [34], which was confirmed in this study. We find that age, heart rate, eGFR, malignance, history of prior CABG, using of statin were independent predictor of 3-year all-cause mortality in PCI group, whereas age, heart rate, systolic BP and using of ACEI/ARB were independent predictor of 3-year all-cause mortality in non-PCI group.

The decision to proceed with a PCI procedure in the elderly is influenced by numerous factors. Non-cardiac comorbidities include renal, cerebral, pulmonary and vascular disease [35] were often taken into account prior to decision making for PCI. There was a tendency to select intervention management in patients with a lower risk profile [1, 22, 36]. This is also reflected in our cohort of elderly patients. Although we cannot tell what factors led to these patients being selected for PCI, our study confirmed that the determinants for choosing PCI included younger age, male gender, lower heart rate, lower systolic BP, without history of hypertension and stroke.

Limitations and strengths

Despite our efforts in catching up as much information as possible in medical records, and despite PS adjustment, we cannot rule out potential confounding from unmeasured variables. Nevertheless, our data are encouraging and serve as the basis for randomized trials in the future. One of the main strengths is that all patients were included from our daily clinical practice, and therefore representative.

Conclusion

In elderly ACS patients, PCI-treatment was associated with improved 1 and 3-year survival and PCI-treated patients had different prognostic profile compared to those without PCI treatment.

Abbreviations

ACEI: angiotensin converting enzyme inhibitor; ACS: acute coronary syndromes; ARB: angiotensin receptor antagonist; BP: blood pressure; CABG: coronary artery bypass grafting; NSTEMI: non-ST segment elevation myocardial infarction; PCI: percutaneous coronary intervention; STEMI: ST segment elevation myocardial infarction; UA: unstable angina

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Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to them containing information that could compromise research participant privacy but are available from the corresponding author on reasonable request.

Authors' contributions

XJC contributed to the study design, statistical analyses, and preparation of the manuscript. SB and RS contributed to the data collection, data interpretation, and intellectual input into article. MF contributed to the concept and design of study and intellectual input into article. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study protocol was approved by the Human Ethical Committee at University of Gothenburg. All study participants provided written informed consent.

Competing interests

The authors declare that they have no competing interests.

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