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Association between baseline characteristics and clinical outcomes among the elderly undergoing PCI – retrospective cohort study

Wyniki rewaskularyzacji za pomocą przezskórnej interwencji wieńcowej u pacjentów w wieku podeszłym oraz charakterystyka zwężeń w tętnicach wieńcowych w tej populacji – retrospektywne badanie kohortowe

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Abstract

Introduction and Objective. Percutaneous coronary intervention (PCI) is the method of choice for the treatment of coronary artery disease or acute coronary syndromes, but clinicians often refrain from performing it on elderly and/or frail patients. The aimed of the study was to determine the feasibility of PCI in the elderly, and define characteristics of significant stenoses and clinical outcomes of those procedures.

Materials and method. A retrospective analysis was conducted on a total of 150 patients aged ≥70 years, who were admitted and underwent PCI between November 2020 – December.2021. Also investgated was the impact of patients' baseline characteristics, such as: gender, body mass index (BMI) or comorbidities: hyperlipidaemia, hypertension, diabetes, etc. on clinical outcomes of PCI performed in the elderly.

Results. The mean age was 77.5 ± 7.1 years, 65.33% were male. The average BMI was 27.5 ± 4.3, 92.00% had a history of HT. The majority of patients (n=84) were treated for acute coronary syndromes (ACS). The mean length of stents implanted in one procedure was 31mm. The TIMI 3 flow was achieved in 94.67% of cases. Combined intra-procedural and in-hospital mortality was 2.67%.

Conclusions. Complex PCI may be successfully and safely performed among elderly patients who frequently suffer from severe myocardial ischemia and carry a substantial comorbidity burden. Age itself cannot warrant disqualification from interventional management of coronary artery disease. Gender and BMI are potential factors that influence clinical outcomes.

Key words

PCI, the elderly, mortality, CAD, frailty, clinical outcomes

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Streszczenie

Wprowadzenie i cel pracy. Przezskórna interwencja wieńcowa (PCI) to metoda z wyboru w leczeniu ostrych zespołów wieńcowych i choroby wieńcowej. Tymczasem osoby w wieku podeszłym, ze zwiększonym ryzykiem zespołu kruchości, są często pomijane w kwalifikacji do tej inwazyjnej formy leczenia. Nasze badanie służy ocenie wyników zastosowania PCI w tej populacji oraz określeniu cech istotnych zwężeń obserwowanych u tych pacjentów.

Materiał i metody. Przeprowadziliśmy retrospektywną analizę wyników leczenia za pomocą PCI populacji 150 pacjentów w wieku ≥ 70 lat hospitalizowanych w naszym ośrodku od listopada 2020 do grudnia 2021 roku. Zbadaliśmy również, jak wpływają na te wyniki czynniki takie jak płeć, BMI czy obciążenia określone przy przyjęciu do szpitala, takie jak zaburzenia lipidowe, nadciśnienie tętnicze lub cukrzyca.

Wyniki. W badanej populacji średnia wieku wynosiła 77,5 ± 7,1 roku; 65,33% pacjentów stanowili mężczyźni. Średnie BMI miało wartość 27,5 ± 4,3; przy czym 92,00% pacjentów miało nadciśnienie. Większość pacjentów (n = 84) przeszła PCI z powodu ostrych zespołów wieńcowych, a średnia długość stentów wynosiła 31 mm. Skuteczność procedury oceniona jako 3 w skali TIMI została osiągnięta w 94,67% przypadków. Śmiertelność pacjentów łącznie w trakcie procedury oraz do wypisu ze szpitala wyniosła 2,67%.

Wnioski. PCI jest inwazyjną metodą leczenia ostrych zespołów wieńcowych i przewlekłej choroby wieńcowej, która z powodzeniem może być stosowana u osób w wieku podeszłym, u których występuje zwiększone ryzyko zespołu kruchości. Sam wiek nie może powodować dyskwalifikacji pacjentów, a płeć i BMI są czynnikami mającymi wpływ na wyniki leczenia, dlatego je również należy wziąć pod uwagę, kierując osoby w wieku podeszłym na leczenie za pomocą PCI.

Słowa kluczowe

przeskórna interwencja wieńcowa, osoby w wieku podeszłym, śmiertelność, choroba wieńcowa, zespół kruchości, wyniki leczenia

INTRODUCTION AND OBJECTIVE

The ageing population and increasing life expectancy result in an increasing number of elderly people suffering from cardiovascular diseases, including coronary artery disease (CAD), which is the most common cause of death in this group of patients. Approximately 30% of seniors suffer from its symptomatic form [1]. In addition to the increasingly optimized pharmacological treatment, coronary revascularization (PCI) is considered an effective therapy to alleviate symptoms and improve prognosis in patients with CAD, regardless of age [2].

The percentage of the elderly among patients undergoing PCI is constantly increasing [3]; however, due to multiple comorbidities, this group tends to be under-represented in clinical trials. Even though the elderly undergoing PCI are at a higher risk of procedural complications, they may benefit more from this treatment as they often present with a greater ischemic burden than younger patients [4]. An important issue in elderly patients treated with coronary angioplasty is the quality of revascularization achieved. While the immediate success rate of PCI is comparable to that achieved in younger age groups [5], revascularization in the elderly is much less likely to be complete. Incomplete revascularization is associated with a risk of recurrence and poorer long-term prognosis [6].

There is growing awareness that disease-laden patients may be an important indicator of unfavourable PCI outcomes, but to date, there is insufficient evidence to fully support this thesis. These patients may also have fraitly syndrome (FS), which is associated with a higher risk of cardiovascular events [7], whereas the relationship between FS and the prognosis of patients with CAD after PCI remains unclear. It has been identified as a factor that directly increases the overall risk of mortality, not only peri-operative mortality [8]; however, whether FS increases the risk of death in patients undergoing PCI in those over 70 years of age still remains unknown.

The aim of the study was to determine the procedural characteristics and clinical outcomes in a cohort of patients undergoing PCI, aged 70 years or more, hospitalized in a tertiary care centre in Warsaw, Poland, and to investigate whether the outcomes were associated with the patients' baseline characteristics.

MATERIALS AND METHOD

Study design. This was an investigator-initiated, retrospective, observational cohort, single-centre study conducted between November 2020 – December 2021 at the 1st Chair and Department of Cardiology, Medical University of Warsaw, Poland. All methods were carried out in accordance with current guidelines and regulations.

Selection of participants. Patients ≥70 years of age, diagnosed with acute or chronic coronary syndrome requiring coronary angioplasty procedure, were included in the analysis. Haemodynamically-significant stenosis was defined as narrowing of ≥50% of the vessel diameter, and assessed in all patients by coronary radiography, in some cases confirmed in intravascular ultrasonography (IVUS) or optical coherence tomography (OCT). Performance of angioplasty, as recommended by the ESC guidelines [9], depended on the choice of the interventional cardiologist for acute coronary syndrome, or depended on the decision of the Heart Group for Elective Procedures, and provided informed patient consent. Exclusion criteria were: <70 years of age, no BMI provided.

Clinical data collection and handling. The following data were collected from the registry and database of patients undergoing coronary angiography and PCIs in the haemodynamics laboratory during the index hospitalization: demographics (age, gender), patients' dimensions (height, weight), BMI, New York Heart Association (NYHA) class of heart failure, Canadian Cardiovascular Society Angina Grading Scale (CCS), timing of admission and angioplasty procedure, comorbidities, left ventricle ejection fraction (EF), haemoglobin (HGB) level, chronic myocardial infarction (MI) characteristics (obstructed coronary vessels, type of MI – non-ST elevation MI [NSTEMI], ST elevation MI [STEMI]), presence of chronic total occlusions (CTOs) procedural characteristics (bifurcation lesions, coronary vessel included into angioplasty, number, length, and type of stent – bare metal stent, drug-eluting stent [DES], pre- and post-dilatation applied, number of balloons, maximal pressure used, fluoroscopy exposure, contrast volume), personal history of the patient for cardiovascular and cardiocerebral conditions and procedures.

Samples for laboratory tests were collected at admission and during hospitalization until discharge, depending on the length of hospitalization and the patient›s general condition. Analysis of the tests was performed according to standard procedures in the unit where coronary angiography and PCI were performed. Analyses stratified according to gender and BMI (as an important factor underlying cachexia and frailty), as well as age of ≥80, hypertension and anaemia were pre-defined in the study.

Treatment. All patients underwent coronarography and PCI via femoral, radial, subclavian, or carotid access. The procedures were performed by an interventional cardiologist in a hybrid operating room. All patients continued their indicated treatment by the treating physician before admission, and received standard treatment after, according to the guidelines. Patients without indications for anticoagulant therapy received dual antiplatelet therapy (acetylsalicylic acid [ASA] and clopidogrel) for 3–6 months, followed by lifelong treatment with ASA treatment. Patients with indications for oral anti-coagulation continued with their treatment. Other drugs were continued at the discretion of the treating physician, according to the individual comorbidities, such as heart failure treatment, diabetes mellitus treatment, diuretics.

Stratification. The analyzed population was stratified based on nominal (1 – present, 2 – absent) variables: female gender, BMI ≥18.5 and <30, age ≥80, hypertension, anaemia. BMI cut-off points were selected according to the Pan American Health Organization (PAHO) and World Health Organization (WHO). The values < 18.5 and ≥ 30 were associated by some authors with increased risk of frailty syndrome[10]. The existence of statistically significant differences between subgroups were assessed in following parameters: lesion location, number of narrowed arteries, Thrombolysis in Myocardial Infarction Scale value of 3 (TIMI), treated arteries, bifurcation lesion treated, usage of DES stents, number of stents implanted, total length of stents implanted, pre-dilatation,

post-dilatation, number of STEMI infarction diagnoses, usage of non-compliant (NC) balloons, number of balloons used, mean maximum pressure used for angioplasty, fluoroscopy exposure, volume of contrast used, and unfractionated heparin dose.

Statistical analysis. A total of 150 patients were enrolled in the study to observe the difference between frailty index forms and cardiovascular and angioplasty outcomes. Statistical analysis was performed using IBM SPSS Statistics, version 27.0 (IBM, New York, USA). Nominal variables, including lesion location, presence of CTO, TIMI 3 achieved, treated arteries, bifurcation lesion treated, usage of DES, pre-dilataion, post-dilatation or NC balloons and STEMI diagnosis, were presented as number and percent, and compared using Chi-square test. Phi coefficient was also calculated. After stratification ordinal variables, such as number of narrowed arteries, number of stents implanted, number of balloons used, were dichotomized and compared using the Chi square test. The Shapiro-Wilk test was used to assess normal distribution of continuous variables, namely, the total length of stents implanted, mean maximum pressure used for angioplasty, fluoroscopy exposure, volume of contrast used, and unfractionated heparin dose. Continuous variables were compared using the Mann-Whitney U test, and presented as mean and SD. For those variables, confidence intervals (CI) were also calculated and a one-way ANOVA test performed. F-values obtained in this test was presented with CI.

RESULTS

A total of 150 patients with a mean age of 77.5 ± 7.1 years were analyzed. The study group included almost twice as many men (65.33%) as women. Mean BMI (27.5 ± 4.3) fell within the overweight range. The majority of the patients (56.00%) were treated for acute coronary syndromes (ACS). EF was reduced only in 24.11% of the analyzed population. Hypertension and hyperlipidaemia were the two most prevalent comorbidities present in 92.00% and 65.33% of patients, respectively. All basic characteristics of the study group are summarized in Table 1.

Procedural data and clinical outcomes. According to the results of coronarography haemodynamically-significant lesions were most frequently located in the left anterior descending artery (LAD) (62.00%), followed by right coronary artery (RCA) (52.00%), left circumflex artery (LCX) (32.67%), marginal branches (MG) (27.33%), diagonal branches (DG) (20.00%), and left main coronary artery (LM) (16.67%) (Fig. 1.). Coexistence of lesions in all included locations was detected only in one case, while one or two narrowed arteries constituted the most common configurations of lesions (32.00% each). At least one CTO was found in 22 patients (14.67%).

TIMI 3 was achieved in 94.7% of cases. The intra-procedural and in-hospital mortality reached 2.67%. Analysis revealed that 194 stents were used to treat the study population with 12.00% of the population not receiving a stent (the patients underwent only plain old balloon angioplasty [POBA]), the majority receiving only one stent (58.00%), and the rest (30.00%) receiving up to four stents. The distribution of lesions considered as culprit and treated with PCI was

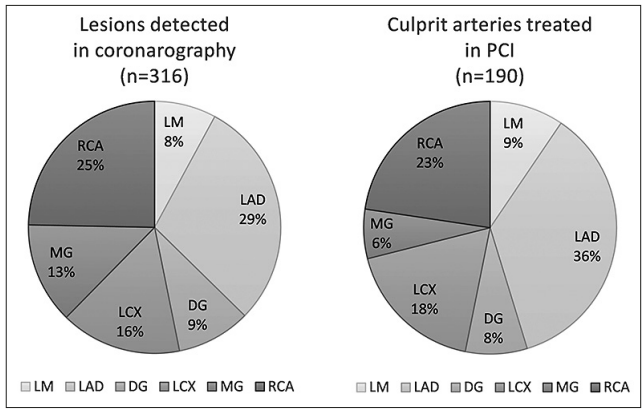

Figure 1. Comparison of distribution of lesions detected in coronarography with distribution of culprit arteries treated in PCI.
LM – left main coronary artery; LAD – left anterior descending artery; DG – diagonal branches; LCX – left circumflex artery; MG – marginal branches; RCA – right coronary artery; PCI – percutaneous coronary interventions

similar to the above-mentioned distribution of lesions detected in coronarography; however, here LM, where the least lesions were found, came just after the three main treated arteries – LAD, RCA and LCX (Fig. 1.).

NSTEMI was much more common than STEMI (62.16% and 37.84% of patients with MI, respectively). DESs were used in 88% of patients; mean combined length in one procedure – 30.9mm. Bifurcation lesions were treated in 15 patients (10%), which was less than the number of patients with diagnosed CTO (14.67%). Pre- and post-dilatation were applied in the great majority of performed procedures (93.33% and 72.00%, respectively). The PCI was performed with the use of up to three balloons in slightly more than a half of the analyzed patients (51.33%). Frequency of NC balloon usage reached 71.33% and mean value of maximal dilatation pressure used in one procedure was 19.1atm. Moreover, on average, one procedure led to 951.0mGy of fluoroscopy exposure, 205.3ml contrast injection, and required 8.1×10^3 units.

Stratification outcomes. Gender and BMI-stratified analyses of procedural and clinical data are represented in Table 2. Those two characteristics been proven to be associated with the highest number of differences in assessed parameters. When it comes to taking the remaining characteristics into consideration, there were no significant differences between patients with (n=138) and without hypertension; patients 80 years of age and older (n=50) had stenosis of LCX less frequently than the rest of study group (22.00% vs. 38.00%; p-value = 0.049); and patients with anaemia (n=60) underwent PCI with post-dilatation more often (81.7% vs. 65.6%; p-value = 0.031). There were no significant differences in the achievement of TIMI 3 score between the groups with and without FS-related characteristics mentioned above.

DISCUSSION

Discussion on the optimal qualification for interventional CAD treatment is ongoing, as is the balance between the risks and the benefits among the elderly undergoing coronary revascularization procedures [11]. There is evidence indicating that successful PCI treatment attenuates the risk of major adverse cardiovascular and cerebrovascular events, and improves the long-term clinical outcomes, at least in

Table 1. Basic characteristics

Characteristic	Studied group (n=150)
Age (years) mean ± SD	77.5 ± 7.1
Gender, n (%)	
Male	98 (65.33%)
Height (cm) mean ±SD	167.5 ± 9.1
Weight (kg) mean ±SD	77.5 ± 15.1
BMI mean ±SD	27.5 ± 4.3
Admission, n (%)	
Planned	66 (44.00%)
Urgent	84 (56.00%)
Reasons for admission, n (%)	
Acute myocardial infarction, unspecified	23 (15.33%)
Angina pectoris, unspecified	22(14.67%)
NSTEMI	14(9.33%)
EF, n (141 evaluated)	
50%-70%	82 (54.67%)
41%-49%	25 (16.67%)
≤40%	34 (22.67%)
HT, n (%)	138 (92.00%)
DM, n (%)	52 (34.67%)
SA/CAD, n (%)	92 (61.33%)
CCS, n (%) (65 evaluated)	
IV	0 (0.00%)
III/IV	3 (2.00%)
III	10 (6.67%)
II/III	7 (4.67%)
II	39 (26.00%)
I/II	0 (0.00%)
I	6 (4.00%)
HL, n (%)	98 (65.33%)
HF, n (%)	67(44.67%)
NYHA, n (%) (60 evaluated)	
IV	3 (2.00%)
III/IV	0 (0.00%)
III	6 (4.00%)
II/III	1 (0.67%)
II	31 (20.67%)
I/II	1 (0.67%)
I	18 (12.00%)
AF, n (%)	42 (28.00%)
Paroxysmal	25 (16.67%)
Permanent	11 (7.33%)
CKD, n (%)	30 (20.00%)
Dialysis, n (%)	1 (0.67%)
Stroke, n (%)	16 (10.67%)
TIA, n (%)	0 (%)
PAD, n (%)	10 (6.67%)
Carotid artery disease, n (%)	9 (6.00%)
Asthma, n (%)	2 (1.33%)
COPD, n (%)	7 (4.67%)
Impaired mobility, n (%)	
Full	138 (92.00%)
Wheelchair	4 (2.67%)
Bed	8 (5.33%)
Current smoker, n (%)	13 (8.67%)
Former smoker, n (%)	41 (27.33%)
Previous MI, n (%)	43 (28.67%)
Previous STEMI, n (%)	10 (6.67%)
Previous NSTEMI, n (%)	12 (8.00%)
Previous PCI, n (%)	54 (36.00%)
Artery treated in previous PCI, n (%)	
LM	4 (2.67%)
LAD	31 (20.67%)
DG	6 (4.00%)
LCX	17 (11.33%)
MG	6 (4.00%)
RCA	21 (14.00%)
HGB [g/dl], median (Q1, Q3)	12.95 (12.025, 14.1)
PLT [x10^3/mcL], median (Q1, Q3)	189.0 (154.0, 237.0)
Cardiac troponin T [µg/l], median (Q1, Q3)	0.2135 (0.025, 2.432)

BMI – body mass index; EF – ejection fraction; HT – hypertension; DM – diabetes mellitus; CAD – coronary artery disease; CCS – Canadian Cardiovascular Society; HL – hyperlipidaemia; HF – heart failure; NYHA – New York Heart Association; AF – atrial fibrillation; CKD – chronic kidney disease; TIA – transient ischemic attack; PAD – peripheral artery disease; COPD – chronic obstructive pulmonary disease; STEMI – ST elevation myocardial infarction; NSTEMI – non-ST elevation myocardial infarction; PCI – percutaneous coronary interventions; LM – left main coronary artery; LAD – left anterior descending artery; DG – diagonal branches; LCX – left circumflex artery; MG – marginal branches; RCA – right coronary artery; HGB – haemoglobin; PLT – platelet; Q1–25th percentile; Q3–75th percentile.
* percentage calculated for subgroup of patients in which given parameter was evaluated.

some subpopulations of elderly patients [12]. However, such patients still have significantly reduced odds of procedural success in comparison to non-elderly patients; thus, the question arises whether the benefits of successful PCI outweigh the increased risk of complications resulting from failed procedure. In this context, the outcome of patients in the current study, both in terms of intraprocedural and in-hospital mortality (2.67%) and TIMI score which was three in 94.67% of patients, might be considered favourable, underscoring the need for guideline-recommended use of PCI in the elderly. Such outcomes were observed, even though the average patient in the current study population was overweight, with HGB level at the lower limit of normal and had many cardiovascular risk factors (Tab. 1).

In the current study, LAD was the most common localization of lesions and the most frequently treated artery, in both instances followed by RCA and then LCX (Fig. 1). These proportions are in line with those reported in literature for the general population of patients undergoing PCI [13–15], showing that there is no specific distribution of stenosis or implanted stents in the elderly. LM, the least frequent localization of stenoses, was more frequently treated than DG or MG, but its physiological significance and prognostic impact well explain this observation. Implantation of no more than one stent was observed in 70% of patients, although patients with multi-vessel disease represented almost two-thirds of the analyzed group. Such an approach in which a lower number of stents is preferred may be one of the reasons why

satisfactory outcomes were achieved in those patients, as the reduced range and complexity of the intervention decreased the risk of complications [16, 17] consideration of paramount importance in the vulnerable elderly population. However, the combined length of stents per procedure was relatively long, mean fluoroscopy exposure was elevated, and mean contrast volume was high, which suggests that although a relatively low number of stents were implanted per procedure, those procedures remained difficult, time-consuming and laborious [18–20].

Considering the qualification for revascularization in the elderly, the fact should also be taken into consideration that a vast number of the elderly develop the frailty syndrome. Although there is general agreement on the occurrence of this syndrome and its importance in treatment planning, no consensus regarding its definition has been achieved to date. The WHO has suggested defining it as 'a clinically recognizable state in older people who have increased vulnerability, resulting from age-associated declines in physiological reserve and function across multiple organ systems, such that the ability to cope with everyday or acute stressors is compromised [21]'. The prevalence of frailty increases with age and equals 7% – 10% among people aged 65 years and older, and 20% – 40% in those aged 80 years and above [22].

In the current study, some factors commonly coexisting or directly related to the frailty syndrome were examined to check their association with the location of lesions in the coronary arteries, and the procedural outcomes of percutaneous coronary interventions (Tab. 2.). Patient gender is one of these factors. The majority of studies indicate that females are more likely to develop the frailty syndrome than males due to biological, social and behavioural factors. Interestingly, and in contrast, mortality in frail women is lower than in frail men [23]. In the current study, males were found to be more likely to present with lesions in LM than females (Tab. 2.). Other studies confirm this correlation[24] or indicate that LM disease is more common in men presenting with STEMI, but less common in men diagnosed with NSTEMI or unstable angina [25].

Men were also found to have multiple stents implanted more frequently than women. Studies comparing gender and the number of implanted stents found no impact of gender on the number of implanted stents [26–28]; nevertheless, they evaluate individuals of all ages undergoing PCI treatment. The difference in the current study might result from the older age of the evaluated patients, and consistent with prior reports, males received longer stents during PCI [24]. It may be hypothesized that this could be the consequence of larger coronary vessels [29] and the development of longer lesions[24]. Further, male gender was also associated with a higher dose of radiation exposure during the procedure, due to the higher average mass of men [30].

BMI is another factor strongly correlating with the occurrence of the frailty syndrome. This variable shows a U-shaped incidence rate – the prevalence of frailty is higher in both underweight and overweight groups of people[31]. Based on this fact, individuals with BMI lower than 18.5 and greater than or equal to 30 were compared with those with BMI between 18.5–30. It is important to point out that most patients in the group with BMI<18.5 and BMI>30 were obese and had BMI higher than 30, whereas those with BMI lower than 18.5 constituted a very small part of this group. In the current study, the higher frailty risk group was found more frequently to have CTOs (Tab. 2). Obese people are certainly at a higher risk of cardiovascular disease [32], but the impact of BMI on developing CTOs has not yet been demonstrated in other studies. More research is needed to assess this dependence. Furthermore, patients with a BMI below 18.5 or above 30 were exposed to a higher fluoroscopy exposure. The higher radiation dose used in the PCI procedure is demanded in patients with a high BMI [33], which corresponds to the results of the current present study, since the majority of patients from this BMI-associated group were obese.

The prevalence of frailty increases with age. Numerous studies, according to the proportion of frail individuals, divide the study population into groups aged up to and above 80 years, showing the significant difference between the two groups in the prevalence of developing frailty syndrome [34]. However, in the current study there were no significant differences in procedural outcomes between groups aged 70–80 years and above 80 years of age. The only finding was that individuals aged between 70–80 are more likely to have a lesion in LCX than those above the age of 80. Other studies demonstrate that patients younger than 65 had lesions in LCX more frequently than patients above the age of 65 [35]. This might suggest that, in general, younger patients more often develop lesions in the LCX.

Frailty is very common in people with high blood pressure; although there is no definite correlation between hypertension and the frailty syndrome. There are studies both suggesting a relationship and denying the impact of hypertension on developing the frailty syndrome [36]. Hypertensive patients evaluated in the current study were found to be exposed to a higher radiation dose during the procedure. The coexistence of high blood pressure and obesity [37] may play a key role in explaining this fact (as mentioned previously, during procedures in obese patients, higher fluoroscopy doses are used). Also, hypertension itself as a cardiovascular risk factor might lead to the development of inflammation in the coronary arteries; thus, more complex procedures may be needed.

Some authors indicate a link between anaemia and the frailty syndrome. A low HGB level strongly correlates with the key symptoms of this syndrome, such as weakness or low physical endurance. However, a cause-and-effect correlation between anaemia and frailty cannot be unequivocally stated [38]. With exception of a lower use of post-dilatation in anaemic patients, there were no significant differences in procedural outcomes; however, no research is available to confirm this correlation.

In clinical practice in the geriatric population, there remains the dilemma of choice: invasive PCI management and evidence-based optimal medical therapy consisting of anti-platelet and anti-anginal drugs. In the population of people with an average age of 60 years, the extent of total major adverse cardiac and cerebrovascular events, including cardiac death, acute myocardial infarction, stroke, and repeated revascularization, there is no statistically difference between the treatment choices. However, PCI in the context of cardiac death and repeated revascularization alone, remains the better method with a lower incidence of the two events [39, 40]. Therapeutic approaches do not yield significant differences in exercise testing after AMI; however, in the myocardial perfusion single photon emission computed tomography, PCI has a lower rate of residual myocardial ischaemia and inducible ischaemia[41]. This translates into better symptom improvement in CCS and distant outcomes, and a lower risk

Table 2. Procedural characteristics stratified by selected baseline characteristics

Parameter	GENDER					
	Male (n=98)	Female (n=52)	F*	95% CI*	Phi**	p-value
			Lesion characteristics			
Lesion location, n (%)						
LM	19 (19.39%)	6 (11.54%)			0.100	0.220
LAD	62 (63.27%)	31 (59.62%)			0.036	0.661
DG	18 (18.37%)	12 (23.08%)			0.056	0.493
LCX	34 (34.69%)	15 (28.85%)			0.059	0.467
MG	31 (31.63%)	10 (19.23%)			0.132	0.105
RCA	49 (50.00%)	29 (55.77%)			0.055	0.501
CTO. n (%)	16 (16.33%)	6 (11.54%)			0.064	0.430
No. of arteries narrowed in one patient. n (%)					0.146	0.073
0-1	29 (29.59%)	23 (44.23%)				
>=2	69 (70.41%)	29 (55.77%)				
			PCI procedural outcomes			
TIMI 3. n (%)	93 (94.90%)	49 (94.23%)			0.014	0.863
Artery treated. n (%)						
LM	16 (16.33%)	2 (3.85%)			0.183	0.025
LAD	45 (45.92%)	23 (44.23%)			0.016	0.843
DG	10 (10.20%)	5 (9.62%)			0.009	0.909
LCX	25 (25.51%)	9 (17.31%)			0.093	0.253
MG	8 (8.16%)	4 (7.69%)			0.008	0.919
RCA	26 (26.53%)	17 (32.69%)			0.065	0.427
Bifurcation lesion treated. n (%)	11 (11.22%)	4 (7.69%)			0.056	0.493
DES. n (%)	89 (90.81%)	44 (84.62%)			0.093	0.254
No. of stents. n (%)					0.232	0.004
0-1	61 (62.24%)	44 (84.62%)				
2-4	37 (37.76%)	8 (15.38%)				
Combined length of implanted stents [mm]. mean ± SD	33.8 ± 22.9	25.3 ± 19.5	5.130	29.20 – 38.37 (Male); 19.90 – 30.76 (Female)		0.021
Predilatation. n (%)	92 (93.88%)	48 (92.31%)			0.030	0.714
Postdilatation. n (%)	72 (73.47%)	36 (69.23%)			0.045	0.582
STEMI. n (%)	15 (15.31%)	13 (25.00%)			0.118	0.147
NC balloons. n (%)	76 (77.55%)	31 (59.62%)			0.189	0.021
Max dilatation pressure [atm]. mean ± SD	19.2 ± 3.2	18.9 ± 3.7	0.323	18.56 – 19.83 (Male); 17.80 – 19.92 (Female)		0.745
No. of balloons. n (%)					0.121	0.139
0-3	46 (46.94%)	31 (59.62%)				
>=4	52 (53.06%)	21 (40.38%)				
Fluoroscopy exposure [mGy]. mean ± SD	1083.7 ± 759.3	696.1 ± 580.7	9.978	929.88 – 1237.56 (Male); 531.07 – 861.14 (Female)		<0.001
Contrast volume [ml]. mean ± SD	212.0 ± 88.7	192.3 ± 77.2	1.654	193.43 – 230.57 (Male); 169.68 – 215.00 (Female)		0.118
Heparin [x103 units]. mean ± SD	8.4 ± 2.5	7.5 ± 2.0	4.609	7.86 – 8.91 (Male); 6.88 – 8.06 (Female)		0.022

Parameter	BMI			
	≥18.5 and <30 (n=108)	<18.5 or ≥30 (n=42)		p-value
			Lesion characteristics	
Lesion location. n (%)				
LM	18 (16.67%)	7 (16.67%)	0.000	1.000

Table 2. Procedural characteristics stratified by selected baseline characteristics (continuation)

Parameter	GENDER					
	Male (n=98)	Female (n=52)	F*	95% CI*	Phi**	p-value
LAD	67 (62.04%)	26 (61.90%)			0.001	0.988
DG	18 (16.67%)	12 (28.57%)			0.134	0.102
LCX	36 (33.33%)	13 (30.95%)			0.023	0.780
MG	33 (30.56%)	8 (19.05%)			0.116	0.156
RCA	55 (50.93%)	23 (54.76%)			0.034	0.673
CTO. n (%)	12 (11.11%)	10 (23.81%)			0.161	0.048
No. of arteries narrowed in one patient. n (%)					0.017	0.831
0–1	38 (35.19%)	14 (33.33%)				
>=2	70 (64.81%)	28 (66.67%)				
	PCI procedural outcomes					
TIMI 3. n (%)	102 (94.44%)	40 (95.24%)			0.016	0.846
Artery treated. n (%)						
LM	14 (12.96%)	4 (9.52%)			0.048	0.561
LAD	51 (47.22%)	17 (40.48%)			0.061	0.456
DG	9 (8.33%)	6 (14.29%)			0.089	0.275
LCX	27 (25.00%)	7 (16.67%)			0.089	0.274
MG	10 (9.25%)	2 (4.76%)			0.074	0.362
RCA	28 (25.93%)	13 (30.95%)			0.051	0.535
Bifurcation lesion treated. n (%)	13 (12.04%)	2 (4.76%)			0.109	0.182
DES. n (%)	98 (90.74%)	35 (83.33%)			0.105	0.199
No. of stents. n (%)					0.019	0.812
0–1	75 (69.44%)	30 (71.43%)				
2–4	33 (30.56%)	12 (28.57%)				
Combined length of implanted stents [mm]. mean ± SD	30.3 ± 19.4	32.3 ± 28.3	0.033	26.95 – 34.35 (BMI ≥18.5 and <30); 22.64 – 40.13 (BMI <18.5 or ≥30)		0.405
Predilatation. n (%)	103 (95.37%)	37 (88.10%)			0.131	0.109
Postdilatation. n (%)	82 (75.93%)	26 (61.90%)			0.140	0.086
STEMI. n (%)	21 (19.44%)	7 (16.67%)			0.032	0.695
NC balloons. n (%)	83 (76.85%)	24 (57.14%)			0.196	0.017
Max dilatation pressure [atm]. mean ± SD	19.2 ± 3.2	18.9 ± 3.7	0.158	18.53 – 19.77 (BMI ≥18.5 and <30); 17.72 – 20.08 (BMI <18.5 or ≥30)		0.920
No. of balloons. n (%)					0.017	0.839
0–3	56 (51.85%)	21 (50.00%)				
>=4	52 (48.15%)	21 (50.00%)				
Fluoroscopy exposure [mGy]. mean ± SD	846.5 ± 594.9	1218.5 ± 940.0	8.144	731.39 – 961.64 (BMI ≥18.5 and <30); 921.82 – 1515.21 (BMI <18.5 or ≥30)		0.034
Contrast volume [ml]. mean ± SD	206.4 ± 87.1	202.3 ± 81.0	0.065	188.96 – 223.90 (BMI ≥18.5 and <30); 176.07 – 228.55 (BMI <18.5 or ≥30)		0.893
Heparin [x103 units]. mean ± SD	7.6 ± 2.3	9.2 ± 2.2	13.488	7.161 – 8.091 (BMI ≥18.5 and <30); 8.496 – 9.929 (BMI <18.5 or ≥30)		<0.001

CI – confidence interval; LM – left main coronary artery; LAD – left anterior descending artery; DG – diagonal branches; LCX – left circumflex artery; MG – marginal branches; RCA – right coronary artery; PCI – percutaneous coronary interventions; CTO – chronic total occlusion; TIMI – Thrombolysis in Myocardial Infarction; DES – drug eluting stent; MI – myocardial infarction; p-values lower than 0.05 are in bold.
* for continuous data; ** for categorical data

of complications. Most importantly for the patients themselves, PCI reduces the incidence of angina symptoms to a greater extent, and significantly improves the quality of life after an episode of AMI [42]. However, we should be aware of the potential, albeit small, risks of adverse effects associated with PCI, such as stent thrombosis, malapposition or failure that require additional interventions, and thus represent an additional burden to patients.

The results obtained in the current study on population with an average age of 77 years, can be extrapolated to an older population over the age of 80 years. In this population, it is important to rely on clinical data that suggest the best management for a given patient. Given the superior long--term outcomes of PCI and the lack of mortality differences between invasive and conservative management, PCI should be considered first, especially in patients with a BMI of less than 18.5 and greater than 30, where CTO is more common and the use of more balloons provides the desired results.

Additionally, the male population should lean towards more intensive stenting and ballooning of stenotic vessels. However, the two age groups are associated with greater peri-operative risk, where radiation doses and heparin unit counts are significantly higher. Operators should be cautious, as this can result in skin damage and malignancy due to the radiation received, or internal bleeding after high doses of heparin, especially in at-risk patients [43].

Limitations of the study.

1) The relatively small sample size and single-centre registry.
2) The TIMI grade flow used to evaluate the procedural success was defined by each operator, and not confirmed by any independent core-laboratory [44].
3) Although consecutive patients were enrolled in the study, some bias cannot be excluded.
4) A part of the study group received PCI treatment via femoral access, which is associated with a higher risk and more frequent vascular complications compared to the radial access[45]. The differences in approach-related complications were not evaluated during the analysis.
5) The PCIs of included patients were performed by several different operators, which also might have affected the obtained results.

CONCLUSIONS

Complex PCI may be successfully and safely performed among elderly patients who frequently suffer from severe myocardial ischemia and carry a substantial comorbidity burden. Age itself cannot warrant disqualification from interventional management of coronary artery disease. Moreover, gender and BMI are potential factors that influence clinical outcomes of the elderly undergoing revascularization.

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