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Cardiac catheterisation in nonagenarians: Single center experience

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Abstract

Objective To explore the treatment, procedure related risks, and outcomes of patients older than 90 years of age undergoing cardiac catheterization. **Methods** We retrospectively studied 32 patients ≥ 90 years (93.0 ± 1.2 years) who underwent cardiac catheterisation in a tertiary specialist hospital (0.2% of 14,892 procedures during three years). The results were compared to a patient cohort younger than 90 years of age. **Results** Baseline characteristics revealed a higher prevalence of diabetes ($P < 0.001$), chronic obstructive pulmonary disease ($P < 0.04$), previous myocardial infarction ($P < 0.02$), and complex coronary anatomy (SYNTAX score 33 *vs.* 19) in nonagenarians. Patients < 90 years of age showed more hyperlipidemia ($P < 0.01$) and previous percutaneous coronary interventions ($P < 0.015$). Nonagenarians underwent coronary angiography more often for acute coronary syndrome (ACS) ($P < 0.003$), were presented more often in cardiogenic shock ($P < 0.003$), and were transferred faster to coronary angiography in cases of ACS ($P < 0.0001$). The observed in-hospital mortality rate (13% study group *vs.* 1% control group; $P < 0.003$) in nonagenarians was lower than the calculated rate of thrombolysis in myocardial infarction (TIMI) and global registry of acute cardiac events (GRACE) mortality and strongly influenced by the severity of clinical presentation and the presence of co-morbidities. **Conclusion** Despite the common scepticism that cardiac catheterisation exposes patients ≥ 90 years to an unwarranted risk, our data demonstrate an acceptable incidence of complications and mortality in this group of patients.

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Keywords: Nonagenarian; Acute coronary syndrome; Complications; Coronary angiography

1 Introduction

The mean life-expectancy has increased from 21 years in the 16th century[1] to 81.6 years of a newborn female in Germany in the year 2006.[2] In the aging populations of modern western societies, patients 75 years or older account for about 30% of hospital admissions with acute myocardial infarction, and patients older than 80 years comprise the fastest growing segment of the U.S. population.[3] It is estimated by 2020, there will be 2.6 million nonagenarians in the U.S.[3] Nevertheless, only a minority of less than 10% of all patients enrolled into randomised clinical trials of acute myocardial infarction were over 75 years of age.[4,5] Several of these studies were performed in the pre-stent era, and were focused primarily on angiographic rather than clinical parameters.[4] The evidence becomes even weaker, if only patients older than 80 years were investigated,[4] and only little is known about the safety and efficacy of contemporary coronary catheterisation and percutaneous coronary intervention performed in nonagenarians.

The aim of this study was to determine the risk and frequency of adverse clinical events associated with coronary angiography and percutaneous coronary intervention in the stent era in patients equal to or older than 90 years of age.

2 Methods

2.1 Study population

During the study period, a total of 32 nonagenarians out of 14,892 consecutive patients undergoing cardiac catheterisation or percutaneous coronary intervention in our tertiary hospital were included in our study. All patients gave oral/written consent for cardiac catheterisation; the institutional committee on human research had approved the study protocol. There were no exclusion criteria.

2.2 Risk factors

The control group was established by collecting data on 100 patients, selected as a representative random sample, by

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picking every 180th patient of the entire study population. The following parameters were assessed: (1) Patient related factors: age, gender, arterial hypertension, peripheral artery disease, hyperlipidemia, atrial fibrillation, chronic obstructive pulmonary disease, previous myocardial infarction, previous percutaneous coronary intervention (PCI), previous coronary artery bypass graft (CABG), and cardiogenic shock (defined as systolic pressure < 90 mmHg for at least 30 minutes) (Table 1). (2) Procedure related factors: number of diseased epicardial arteries, location of the culprit lesion, type of treatment (PCI *vs.* CABG *vs.* medical therapy), ejection fraction (EF), emergency procedure, and SYNTAX score[6] (Table 2). (3) Complications: vascular complications (e.g., pseudo-aneurysm, arterio-venous fistula, peripheral ischemia), acute renal failure (defined as oliguria or anuria with a daily increase in serum creatinine of > 1 mg/dL, or need for hemodialysis at any time after the procedure), peri-procedural myocardial infarction (defined as troponin increase of more than three times the upper limit of normal), and in-hospital mortality (defined as death in the catheterization lab or during the post procedural hospital stay). (4) We calculated the following risk scores with the use of published methods: thrombolysis in myocardial infarction (TIMI),[7] and global registry of acute coronary events (GRACE).[8]

Coronary angiography was interpreted visually on site by each operator. Percutaneous coronary revascularisation procedures were performed using conventional methods at operator's discretion.

2.3 Statistical analysis

Mean ± SD were calculated for continuous variables, and frequencies were measured for categorical variables. Differences between groups were analysed using the Student *t*-test for continuous variables, while, in case of categorical variables, group differences were examined by chi-square test or Fischer exact test, as appropriate. A probability value of $P < 0.05$ was considered to be statistically significant.

3 Results

3.1 Clinical characteristics

Within three years, 32 patients equal or older than 90 years of age underwent coronary angiography or PCI in our institution, accounting for 0.2% of a total of 14,892 patients. Nonagenarians were more likely to have other co-morbidities (e.g., diabetes mellitus, chronic obstructive pulmonary disease, and hypertension), but were less likely to have high levels of serum cholesterol than the control group (Table 1). About 45% of our study population had a previous history of myocardial infarction, PCI, or coronary artery bypass grafting.

3.2 Angiografic characteristics

Multivessel disease was more frequent in nonagenarians compared to the control-group (58% *vs.* 44%, $P = 0.01$); the majority (84%) of nonagenarians had at least one coronary artery stenosis and the mean SYNTAX score was significantly higher in this group of patients (33 *vs.* 19; $P = 0.04$). Left ventricular systolic function was well preserved in both cohorts, although the left ventricular ejection fraction was slightly lower in nonagenarians (51% *vs.* 57%; $P = 0.1$) (Table 2). The most frequent indication for coronary angiography in the study group was acute coronary syndrome (85%). The non-

Table 1. Clinical characteristics.

Demographic data	Nonagenarian group ($n = 32$)	Patients < 90 years ($n = 100$)	*P*-Value
Female gender	16 (50%)	36 (36%)	0.2
Age (year, mean ± SD)	93 ± 1.2	63 ± 11	< 0.001
Arterial hypertension	29 (91%)	74 (74%)	0.05
Hyperlipidemia	7 (22%)	48 (48%)	< 0.01
Diabetes	20 (63%)	18 (18%)	< 0.001
Oral medication	2 (10%)	6 (6%)	
Insulin	10 (50%)	4 (4%)	
Diet	8 (40%)	8 (8%)	
Atrial fibrillation	6 (19%)	14 (14%)	0.6
COPD	5 (16%)	4 (4%)	0.04
Peripheral artery disease	3 (10%)	4 (4%)	0.4
Previous myocardial Infarction	13 (40%)	18 (18%)	0.02
Previous PCI	1 (3%)	22 (22%)	0.015
Previous CABG	1 (3%)	14 (14%)	0.1

CABG: coronary artery bypass graft; COPD: chronic obstructive pulmonary disease; PCI: percutaneous coronary intervention.

Table 2. Angiographic characteristics.

Angiographic data	Nonagenarian group (n = 32)	Patients < 90 years (n = 100)	*P*-Value
No. of epicardial arteries diseased			
None	5 (16%)	29 (29%)	0.2
1 vessel	8 (25%)	27 (27%)	1
2 vessels	6 (19%)	28 (28%)	0.4
3 vessels	13 (40%)	16 (16%)	0.006
LMCA	0 (0%)	0 (0%)	1
LV-Ejection fraction (%)			
Mean ± SD	51 ± 18	57 ± 14	0.3
Range	19–85	20–88	
Location of culprit lesion in ACS			
RCA	10 (32%)	19 (19%)	0.2
LCX	10 (32%)	12 (12%)	0.03
LAD	7 (23%)	15 (15%)	0.4
Bypass graft	0 (0%)	4 (7%)	0.6
SYNTAX score			
Mean ± SD	33 ± 1.2	19 ± 5.2	0.04
Type of treatment in ACS			
Medical only	11 (34%)	36 (36%)	1
Urgent PCI	13 (40%)	52 (52%)	0.3
Urgent Surgery	8 (25%)	12 (12%)	0.09

ACS: acute coronary syndrome; LAD: left anterior descending artery; LCX: left circumflex coronary artery; LMCA: left main coronary artery; LV: left ventricle; RCA: right coronary artery; SYNTAX: synergy between Percutaneous Coronary Intervention with Taxus and cardiac surgery; PCI: percutaneous coronary intervention.

Table 3. Indications for coronary angiography.

	Nonagenarian group	Patients < 90 years	*P*-Value
Emergency (ACS)	27 (85%)	15 (15%)	0.0001
Elective	5 (16%)	85 (85%)	
Cardiogenic shock	5 (16%)	2 (2%)	0.003
PCI in ACS			
Immediate (< 24 hours)	16 (59%)	4 (24%)	0.05
Delayed	11 (41%)	11 (76%)	
Risk scores, mean ± SD			
TIMI	10 ± 3.1	4 ± 2	0.04
GRACE	165 ± 13	131 ± 21	0.07

ACS: acute coronary syndrome; GRACE: global registry of acute cardiac events; PCI: percutaneous coronary intervention; TIMI: thrombolysis in myocardial infarction.

agenarians were more likely to have evidence of hemodynamic compromise on presentation (cardiogenic shock 16% *vs*. 2%, $P = 0.003$). Nonagenarians diagnosed to have acute coronary syndrome were transferred significantly faster to our tertiary PCI center compared to the younger control-group (Table 3). Complex lesions, which required at least one long (≥ 20 mm) or multiple stents (≥ 2 stents), were present in 47% of the nonagenarians. All patients undergoing PCI received one or more stents. No drug eluting stents were used.

3.3 Complications

As compared to the control-group, the mortality among nonagenarians was significantly higher (13% *vs*. 1%, $P = 0.003$) (Table 4). Four patients of the nonagenarian-group died during hospital stay: two due to cardiogenic shock because of severely depressed left ventricular function, one due to prolonged cardiac low output after emergency coronary artery bypass grafting, and one patient with non-ST-elevation myocardial infarction (NSTEMI) died because of refractory ventricular fibrillation during PCI. The incidence of relevant complications was relatively low in both groups (Table 4).

Analysis of the selected risk scores showed significantly higher values for TIMI in ST-elevation myocardial infarction (STEMI) patients (10 points = 35.9% estimated mortality in the nonagenarian group *vs*. 4 points = 7.3% estimated mortality in the control group, $P = 0.04$), whereas GRACE score values showed only a trend for higher values in very old unstable angina/NSTEMI patients (165 points = 28% inhospital mortality in the nonagenarian group *vs*.131 points = 4% in-hospital mortality in the control group; $P = 0.07$). However, the estimated risk of both scoring models was much higher than the observed risk of mortality in the nonagenarian group (32% estimated, 13% observed).

Table 4. In-hospital complications.

	Nonagenarian group (n = 32)		Patients < 90 years (n = 100)		*P*-Value
	Diagnostic catheterization	PCI	Diagnostic catheterization	PCI	
	(n = 7)	(n = 25)	(n = 59)	(n = 41)	
Death	2 (6%)	2 (6%)	0 (0%)	1 (1%)	0.01
Renal failure	0 (0%)	1 (3%)	1 (1%)	1 (1%)	0.5
Periprocedural MI	3 (9%)	5 (16%)	11 (11%)	18 (18%)	0.8
Access-related complications	1 (3%)	0 (0%)	1 (1%)	4 (4%)	0.7

MI: myocardial infarction; PCI: percutaneous coronary intervention.

4 Discussion

The peri-procedural mortality risk of elderly patients undergoing elective PCI was reported to be two- to four-fold higher than those of younger patients due to the presence of co-morbidities, including peripheral vascular disease and more extensive coronary disease.[9–11] This difference may even be more pronounced in the setting of acute coronary syndrome.[11–13] Elderly patients in cardiogenic shock may not benefit from revascularisation to the same extent as their younger counterparts,[14] although data addressing all these issues are not available for patients older than 90 years. So there is a common scepticism, that invasive procedures in patients older than 90 years might offer more harm than good to the affected patients.

Nonagenarians in our series had substantially more co-morbidities and cardiac risk factors, including previous myocardial infarctions, diabetes, and hypertension. These findings are consistent with data from previous investigations reporting an increased occurrence of chronic renal failure, heart failure, low ejection fraction, and multivessel disease.[10,15–17] However, the prevalence of hyperlipidemia was significantly lower among patients older than 90 years. This is a common finding in very old populations and mainly due to malnutrition.[18,19] Although women are known to have a longer live expectancy we found no gender predominance in our series.

As risk factors in nonagenarians are more prevalent, we consequently encountered more extensive atherosclerosis with multi-vessel disease and complex lesions (58% with multi-vessel disease, 47% with complex/long lesions, and SYNTAX score 33), making PCI technically more challenging.[4,20] Nonagenarians in our series were sent to coronary angiography almost exclusively with the diagnosis of acute coronary syndrome, reflecting the previously mentioned scepticism about the use of elective invasive procedures in the very old. Interestingly, in case of acute coronary syndrome, nonagenarians were transferred much faster from the rural hospital to our PCI center as compared to patients < 90 years of age. This is in contrast with the findings of other authors, where patients older than 80 years are reported to get access to invasive procedures rather late.[11]

Several studies demonstrated a non-linear relation of mortality after elective coronary angiography and/or coronary intervention with age, ranging from about 0.5% for patients < 55 years old to about 5% for patients > 85 years old.[10] Previous multivariate logistic regression analyses in the literature revealed independent risk factors of in-hospital death for very old patients: cardiogenic shock, myocardial infarction without shock, left ventricular ejection fraction < 35%, renal insufficiency, age > 85 years and diabetes mellitus.[10,17,21,22] As approximately 85% of the nonagenarians in our series had one or more indicators of clinical instability or worse prognosis (acute MI, cardiogenic shock, diabetes), we found an in-hospital mortality rate of 13%. This is higher than in the national cardiovascular collaboration network[10] or a French registry[23] which reported a short term mortality of 3.8% and 3.4%, respectively. The vast majority of procedures in these two cohorts, however, were performed electively (no shock or acute MI). On the other hand, the mortality data of our study compared well to data in the Euro Heart Survey on coronary revascularisation. This survey showed an in-hospital mortality rate of 8% in patients older 75 years with STEMI treated by PCI.[24] In a myocardial infarction registry with more than 8000 octogenarians (mean age 84 years), in-hospital mortality following primary PCI was 14%.[15] Teplitsky *et al*.[17] reported in-hospital mortality rates of 26% in case of AMI in patients older than 85 years and 67% in case of cardiogenic shock. Interestingly, the observed mortality rates of our study group were substantially lower than the mortality rates predicted by the TIMI and GRACE-scores. This might be explained, at least in part, by the fact that in the patient cohort serving as the database for development of the aforementioned scoring systems, patients aged 90-years or more were not included.

Limitations of our study include a retrospective data analysis resulting in imbalances between the baseline characteristics of the study group and the control group. Secondly, the relatively small-sized population, and the fact that our study group was most probably a highly selected "healthier"

cohort of patients over 90 years of age and, therefore, not representative of the very-old patient population in general, represent additional limitations.

5 Conclusion

Cardiac catheterisation, including interventional procedures, is often felt to be contraindicated in patients older than 90 years of age. Our data demonstrates acceptable complication rates and in-hospital mortality so that, if indicated, these examinations should be performed in order to stratify and treat this group of patients. The introduction of new anti-thrombotic agents, together with the growing experience of interventional cardiology, may further improve the outcome of elderly patients. This rapidly expanding patient population should not be refused access to cardiac catheterisation based merely on their age.

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