Percutaneous Coronary Interventions in Nonagenarians: In-Hospital Mortality and Outcome at One Year Follow-up

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ABSTRACT

Background: Limited information is available regarding outcome of very elderly patients referred for percutaneous coronary intervention (PCI).
Purpose: This study aimed to assess acute and intermediate term clinical outcomes among nonagenarians.
Methods: The study included 32 consecutive nonagenarian patients undergoing PCI between January 2001 to August 2006. There were 6 (19%) patients admitted with acute ST-segment elevation myocardial infarction (STEMI), 10 (31%) patients with non-STEMI, and 16 (50%) patients with unstable angina pectoris. Receiver-operator characteristic curve (ROC) analysis was done to define the relationship between heart rate, blood pressure, left ventricle ejection fraction, serum creatinine level, and mortality.
Results: Results: Immediate procedure success was achieved in 28 (88%) patients. Cumulative mortality at hospital discharge was 3(9%), at 6 months it was 6 (19%) and remained 6(19%) at 1 year follow-up.
Conclusion: Hypotension and low ejection fraction correlated with in-hospital mortality and worst clinical outcome. Procedural success does not appear to decline in nonagenarians.

Introduction

Coronary artery disease is a leading cause of mortality and morbidity in the elderly.[1] Structural and functional changes in the cardiovascular system with aging and higher comorbidities makes them more prone to unfavorable outcome.[1] The elderly are the fastest growing segment of the population in the United States. Octogenarians (age >80 years) will increase from the current proportion of 1 in 35 to more than 1 in 12 by the year 2050.[2–4] Currently, over 5 million Americans are >85 years of age and by 2050 that number is projected to be 19 million.[4,5] A necropsy study of patients 90 years of age and over revealed that 70% of subjects had one or more coronary vessels occluded.[6] It has been shown that elderly patients benefit more from emergency percutaneous coronary intervention (PCI) rather than from thrombolytics in acute ST-segment elevation myocardial infarction (STEMI).[1] The morbidity and mortality of coronary artery bypass surgery may be prohibitive in the very elderly; resulting in many patients being referred for PCI.[7–9] In general, increasing age is associated with increased procedural complexity and complications.

Despite the significant burden of illness posed by coronary artery disease in the elderly population, use of PCI remains limited when compared with younger individuals.[10] This may reflect a valid perception among physicians treating these patients that diagnostic and interventional coronary procedures are associated with greater risk in the elderly. Prior studies have suggested that age is an independent predictor of adverse outcome following percutaneous coronary transluminal angioplasty.[11–12] However, fewer data are available regarding the outcome of the very elderly referred for PCI in the current era of improved techniques, devices, and pharmacotherapy. Furthermore, it remains unclear whether age itself or the associated comorbidities are independent risk factors for adverse outcome. PCI in the elderly can be effectively utilized to improve symptom control. Much of these data are derived from studies of patients <90 years old.

The present study is aimed at evaluating clinical outcomes and characteristics of nonagenarians undergoing PCI. This study reviews the morbidity and mortality among nonagenarian patients undergoing PCI at our regional medical center.

Methods

Patient Population

We performed a retrospective analysis using the St. Joseph's Regional Medical Center medical and electronic records, for the period of January 2001 to August 2006. The outcome of 32 consecutive patients, aged ≥90 years who underwent PCI at our hospital was carefully reviewed and evaluated. A total of 6 patients were admitted because of acute ST-segment

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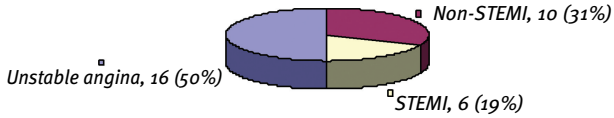

Figure 1. Clinical presentation of 32 nonagenarian patients.

elevation myocardial infarction (STEMI); 2 of them were in cardiogenic shock at the time of PCI, 10 patients had non-STEMI, and 16 patients had severe unstable angina pectoris (Figure 1). Detailed demographic, clinical, angiographic, procedural data, in-hospital, 6 month, and 1 year clinical outcomes were obtained.

Left ventricular ejection fraction (LVEF) was determined in each patient by left ventricle (LV) cine or by echocardiography just prior to or following the procedure. Follow-up was made by outpatient clinic or telephone calls and chart documentations of major adverse cardiac events (MACE) were recorded. If contact information was unavailable or phone number was not listed, then those patients were excluded.

PCI Procedures and Adjunctive Therapy

Informed consent before the catheterization procedure was obtained from all patients. Experienced interventional cardiologists performed every PCI procedure, both during routine day hours, or overnight hours. All interventional cardiologists had met the All interventional cardiologist had met the american college of cardiology/ american heart association procedural volume guidelines. procedural volume guidelines.[13] Coronary angioplasty and stent implantation were performed using standard percutaneous techniques via the femoral artery approach.

Patients presenting with STEMI received primary PCI as a part of reperfusion therapy. None of the patients who presented with STEMI received thrombolytics. Each operator relied on his or her own visual estimation or upon other objective measurements, such as quantitative coronary analysis to assess PCI results. All patients received unfractionated heparin intravenously during the procedure (50–70 units/kg bolus) and adjusted to an activated clotting time of 250 to 300 seconds during the intervention. Glycoprotein (GP) IIb/IIIa antagonist medications were given before initial balloon inflation at the discretion of the operator in case of large thrombus burden. After the procedure, all patients received aspirin (81 mg once daily) and clopidogril (300 mg loading dose orally followed by 75 mg daily) for at least 9 months for drug-eluting stents and 6 weeks for bare-metal stents, followed by aspirin alone at 81 mg daily.

Study Endpoints and Definitions

Procedural success was defined as an angiographic residual stenosis <30% by visual estimate or with optimized angiographic flow (thrombolysis in myocardial infarction [TIMI] flow grade 3). A major adverse cardiac event included any of the following: death, post PCI acute myocardial infarction, need for urgent repeat revascularization (repeat PCI or emergent coronary artery bypass graft), or major bleeding. Outcomes were recorded for above endpoints during hospitalization, at 6 months and throughout 1 year follow-up. Acute STEMI was defined as the presence of typical chest pains and accompanying symptoms for a duration of at least 20 minutes but less than 12 hours in the presence of ST-segment elevation $\geq$1 mm in at least two contiguous leads or new or undetermined duration of left bundle branch block. The diagnosis of post PCI myocardial infarction during follow-up was based on recurrent chest pains accompanied by elevation of the cardiac enzymes levels to at least 2.5 times the upper limit of normal for the hospital laboratory and/or new ST-segment elevation. TIMI criteria[14] for major bleeding was used, defined as intracranial hemorrhage or a >5 gm/dL of decrease in the hemoglobin concentration or a >15% absolute decrease in hematocrit. Renal insufficiency was defined as creatinine value $\geq$1.4 mg/dL. Cardiogenic shock was defined as a systolic blood pressure of <90 mm Hg for at least 30 minutes or the need for supportive measures to maintain a systolic blood pressure of 90 mm Hg and end-organ hypoperfusion (cool extremities or a urine output of <30 mL per h, and a heart rate of 60 beats per min).

Statistical Methods

All categorical data were analyzed by either Fisher's exact test (for 2×2 cross tabulation) or χ^2 test for trends (for $2 \times n$ cross tabulation). Continuous data were tested for fit-to-normality by the D'Agostino-Pearson omnibus normality test. Data, which were normally distributed, were compared by a parametric method (unpaired t test); non-normally distributed data were compared with a Mann-Whitney test. For normally distributed data, mean$\pm$SD, 95% confidence interval (CI) are given; and for non-normally distributed data we used median and interquartile ranges (IQR).

The relationship between mortality and blood pressure (both systolic and diastolic) was assessed by receiver-operator characteristic curve (ROC) analysis. Area under the curves (AUCs) and resultant P values were used to estimate the strength of association of systolic blood pressure (SBP) and diastolic blood pressure (DBP) with mortality.

Confounding variables were, by protocol, defined as those baseline characteristics (other than major covariates) which demonstrated a difference between in-hospital survivors and nonsurvivors at a level of $P < .2$. None achieved that level and so were not considered for adjustment. For major covariates, that is, presenting systolic and diastolic blood pressure, ejection fraction, and creatinine levels, α was set at 0.05, thus $P < .05$ was considered to be statistically significant.

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All calculations were made in Prism software (Graphpad Corp., San Diego, CA) on a personal computer platform using a Windows XP operating system.

Results

Baseline Characteristics

Baseline characteristics of nonagenarian patients undergoing PCI are listed in Table 1. Mean age is 91.5±1.5 years, 59% were females. Most of the patients were white. One-fourth of the patients had a history of hypertension, 22% had prior history of smoking, 19% had prior history of diabetes, 19% had hyperlipidemia, 34 % had peripheral arterial disease, and 38% had a family history of coronary heart disease. All patients were admitted via the emergency room. A total of 22% of patients presented with STEMI, 31% of patients presented with non-STEMI, and 47% with unstable angina. A total of 19% of patients had LVEF <40%. In the patients who were alive at time of hospital discharge, mean SBP was 148±30 mm Hg, compared to 106±27 mm Hg in the patients who died during the initial hospitalization (P = .008; Figure 2). Initial mean DBP of patients who were alive at time of hospital discharge was 76±10 mm Hg compared to 56±29 mm Hg (P = .009) for patients who died. Median heart rate was 75 beats/min (IQR: 66–85) in patients who were alive at hospital discharge compared to 83 beats/min (IQR: 67–96) in patients who died during initial hospitalization (P = .5). Mean ejection fraction was 51%±7% in patients who were alive at hospital discharge compared to 28%±9% who died (P<.001; Figure 3). Baseline median creatinine level was 1.1 mg/dL (IQR: 0.9–1.3) in patients alive at hospital discharge compared to 1.8 mg/dL (IQR: 1.1–2.7) in patients who died during initial hospitalization (P = .54). Two patients who were in cardiogenic shock at time of emergency PCI died during hospitalization.

Table 1. Demographic and Clinical Characteristics (n = 32)

Mean age (years)	91.5±1.5
Gender	
Female	19 (59)
Race	
White	19 (59)
African American	7 (22)
Hispanic	3 (9)
Asian	3 (9)
History	
Tobacco	7 (22)
Hypertension	8 (25)
Diabetes	6 (19)
Hyperlipidemia	6 (19)
CHD	7 (22)
CABG	4 (13)
Peripheral artery disease	11 (34)
Stroke	2 (6)
Family history of CHD	12 (38)
Presentation	
STEMI	7 (22)
Non-STEMI	10 (31)
Unstable angina	15 (47)
Heart rate, bpm	78±14
Systolic blood pressure, mm Hg	140±34
Diastolic blood pressure, mm Hg	72±17
LVEF<40%	6 (19)

Abbreviations: CABG, coronary artery bypass grafting; CHD, coronary heart disease; LVEF, left ventricular ejection fraction; STEMI, ST-segment elevation myocardial infarction.
Values are expressed as mean±SD or n (%).

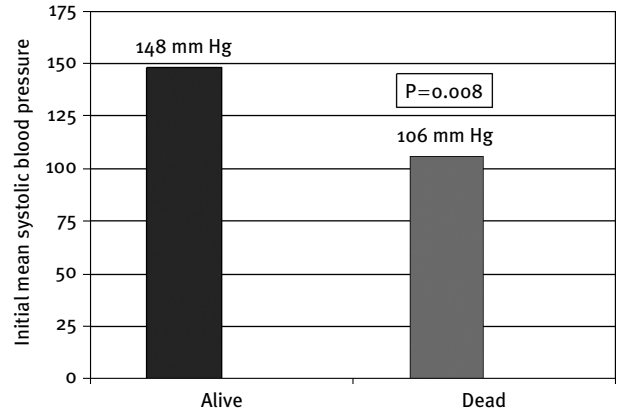

Figure 2. Initial mean systolic blood pressure comparing alive vs dead.

Angiographic Characteristics and Procedural Variables

Angiographic findings and procedural data are shown in Table 2. Multivessel (≥2-vessel) coronary artery disease was observed in 70% of cases. Disease in the left anterior descending artery was noted in 40.6% of cases. No adjunctive thrombectomy device was used in any patients. Most of the patients (87.5%) needed only 1 stent; GP IIb/IIIa antagonists were used in 78% of cases; 7% of patients required an intra-aortic balloon pump. Procedural success was achieved in 88% of cases.

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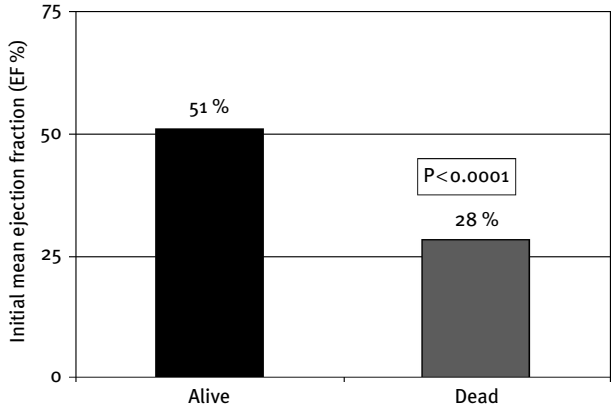

Figure 3. Initial mean ejection fraction comparing alive vs dead.

Table 2. Angiographic Characteristics and Procedural Variables (n = 32)

Multivessel disease	21 (70)
Treated Vessel	
Left anterior descending	13 (41)
Left circumflex	7 (22)
Right coronary	8 (25)
Other (SVGs)	2 (6)
Number of vessels treated	
1	11 (37)
≥2	19 (63)
Stents/patient	
0 stent	1 (3)
1 stent	11 (34)
≥2 stents	18 (56)
GP IIb/IIIa antagonists	25 (78)
Intra-aortic balloon pump	2 (6)
Adjunctive devices	1 (3)
Successful procedure	28 (88)

Abbreviations: SVG, sephaneous venous graft.
All values are n (%).

Outcome Data

At hospital discharge, MACE were 16% including death in 9% of patients. One patient had a major bleed requiring blood transfusion. Renal insufficiency was noted in one patient post PCI during initial hospitalization. Also one patient developed acute MI before hospital discharge. Cumulative mortality was 6(19%) at 6 months of follow-up. One patient required repeat revascularization due to recurrent chest pain at 6 months.

Table 3. In-Hospital and Cumulative 6 Months and 1 Year Outcomes (n = 32)

	In-Hospital Events	Post Hospitalization, 6 Months Outcome	Post Hospitalization, 1 Year Outcome
Death (%)	3 (9)	6 (19)	6 (19)
MACE (%)	5 (16)	7 (22)	7 (22)
Major bleed	1 (3)	0	0
Post PCI acute MI	1 (3)	0	0
Repeat revascularization	0	1 (3)	0
Cardiogenic shock	0	0	0
Renal insufficiency	1 (3)	0	0

Abbreviations: MACE, major adverse cardiovascular events; MI, myocardial infarction; PCI, percutaneous coronary intervention.
All values are n (%).

At 1 year follow-up cumulative mortality was 6(19%), as there were no further death observed during the remaining 6 months. None of the patients developed cardiogenic shock (Table 3). Cumulative mortality in the unstable angina group was 13%, in the non-STEMI group 20%, and 29% in the STEMI group after 6 months of follow-up and remained the same after 1 year of follow-up.

Receiver-operator characteristic curves (Figure 4) of the predicting value of blood pressure on in-hospital mortality yield AUC of 0.747 ($P = .063$) for DBP (Figure 4A) suggesting that there is no significant association between in-hospital mortality and DBP. However, SBP (Figure 4B) yield and AUC of 0.843 ($P = .01$), which indicates that SBP has some predictive value for in-hospital mortality. At a cut off of 116 mm Hg, SBP has a sensitivity of 92% (95% CI: 73.97–99.02) and a specificity of 66.67% (95% CI: 22.28–95.67).

Discussion

Age related changes are most likely to be seen in the "oldest old" who have escaped cardiovascular pathology earlier in life. This group demonstrates the dual processes, often interacting, of biological aging of the cardiovascular system and age-related pathology. Hence recommendations derived

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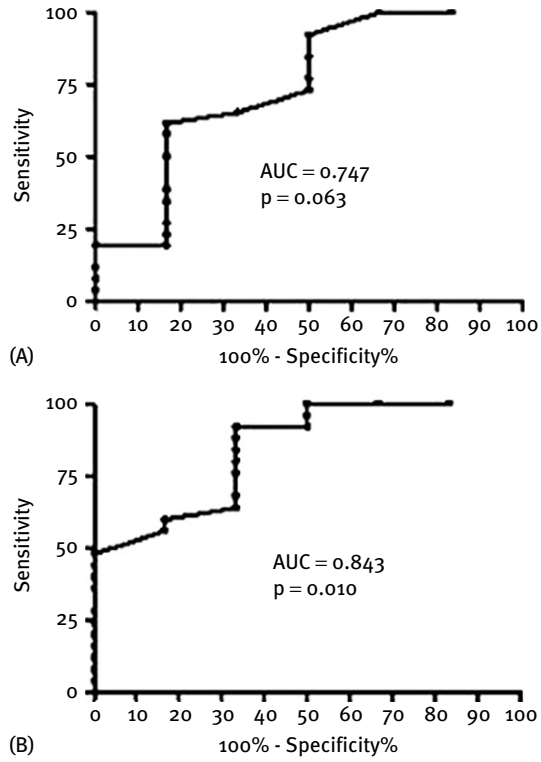

Figure 4. Receiver-operator characteristic curves (ROCs) of the predicting value of blood pressure on in-hospital mortality for DBP (A) and SBP (B).

from studies in "young old" (65–75 y) are not readily applicable to the "oldest old." Nonagenarians differ from "trial" patients of any age by virtue of their other comorbidities and clinical presentations. Unfortunately, elderly patients have been largely excluded from the randomized controlled trials of treatments of myocardial infarction. One of the most striking observations regarding age and procedural complications associated with coronary bypass surgery involves neurological injuries. Roach et al[15] found an incremental rise in complications after coronary bypass surgery along with age. The incidence of severe neurological events (fatal and nonfatal strokes, stupor, or coma) increased from 2% for patients aged 60 to 69 to 8% for patients age more than 80 years. Less severe neurological events (seizures or worsening of mental status) were also apparent for 8% of patients older than age 80. Reports from the national cardiovascular network database describes procedural success rate of 84% of percutaneous interventions and in-hospital moratality was 3.8% in octogenarians.[16] Cardiologists are not enthusiastic about taking nonagenarian patients to the cardiac catheterization laboratory, especially if it is not known if the procedure will be beneficial or prolong life. If the patients are going to die from associated comorbidities, then putting stents or doing PCI would be a waste of resources. In contrast, if nonagenarians, especially "young nonagenarians," undergo PCI and stenting, they would be spared another angioplasty or procedure.

The results of PCI in elderly patients were disappointing because of low success rates and frequent complications prior to the stenting era.[17–23] Factors related to poor outcome were frequent comorbidities including diabetes, renal insufficiency, prior stroke, and systolic and diastolic dysfunction.[17–21] A study by Hochman et al[24] showed that elderly patients with cardiogenic shock in a setting of acute myocardial infarction, undergoing PCI did not reduce 30 days overall mortality, however, the 6 month survival benefit was significant. Percutaneous coronary intervention with routine use of stents and antithrombotic drugs concomitantly have drastically changed the scope and results of PCI in elderly patients.[22,23] Considering the generally poor outcome in nonagenarians and lack of solid data concerning the prognostic benefit of primary PCI in nonagenarians, our study would raise concern about primary PCI in nonagenarians. Even though most of our patients had multivessel disease, only 1-vessel was treated in most patients, with acceptable outcomes.

In conclusion, in our study, we found low blood pressure and low ejection fraction correlating with in-hospital mortality and worst clinical outcome. Procedural success does not appear to decline in nonagenarians. These finding are pertinent because of the increasing population of the very elderly presenting with ischemic heart disease. Despite overall good procedural success rate, the in-hospital mortality differed significantly between patients with stable presentation vs unstable presentation.

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