

Outcomes of Nonagenarians Who Undergo Percutaneous Coronary Intervention With Drug-Eluting Stents

Michael S. Lee,* MD, Raymond Zimmer, MD, Antonio Pessequeiro, MD, Daniel Jurewitz, MD, and Jonathan Tobis, MD

Background: Age is an important predictor of mortality after percutaneous coronary intervention (PCI). The safety and efficacy of PCI with drug-eluting stents (DES) in nonagenarians have not been extensively studied. **Methods:** A retrospective analysis of 889 consecutive patients identified 28 (3.1%) nonagenarians who underwent PCI with DES from May 2003 to December 2005 at our institution. **Results:** The mean age was 92 ± 2 years, 39% were male, and 4% were diabetic. Sirolimus-eluting stents were used in 79%. A mean of 1.5 ± 0.9 stents/patient were implanted with a total stent length of 31 ± 20 mm. Twenty-nine percent presented with unstable angina and 39% with myocardial infarction. The angiographic success rate obtained was 100%. The 30-day mortality rate was 21%. The 6 patients who died within 30 days included 3 patients who had cardiogenic shock and one patient with critical aortic stenosis who died due to complications during percutaneous aortic valvuloplasty. The cumulative survival rate for all nonagenarians at 1 year and 3 years was $68 \pm 9\%$ and $61 \pm 9\%$. When the four patients who were in extremis on presentation were excluded, there were no in-hospital deaths, the 30-day mortality was 8%, and the 1 year and 3 year survival rate was $79 \pm 8\%$ and $71 \pm 9\%$ for the nonagenarians. No patient had definite stent thrombosis. **Conclusions:** The majority of the nonagenarians who underwent PCI with DES presented with acute coronary syndrome. Percutaneous coronary intervention with DES was safe in nonagenarians as there were no in-hospital deaths and acceptable 3-year survival rates when patients who were in extremis on presentation were excluded. The high-risk profile of these patients and the expected attrition of nonagenarians may contribute to their mortality rates. © 2008 Wiley-Liss, Inc.

Key words: drug-eluting stent; percutaneous coronary intervention; nonagenarians

INTRODUCTION

Drug-eluting stents (DES) have significantly decreased the incidence of in-stent restenosis and the need for target vessel revascularization [1,2]. Moreno et al. reported on the results of 26 nonagenarians who underwent PCI in the pre-DES era [3]. With the continued aging of the population, nonagenarians constitute an increasingly significant percentage of the elderly population. While some studies have examined PCI in octogenarians and elderly patients in general with both bare metal stents and DES, there is a paucity of data analyzing the use of DES specifically in nonagenarians. In this retrospective study, we present our data on 28 nonagenarians who underwent PCI with DES.

METHODS

From April 2003 to December 2005, 28 out of 889 patients (3.1%) who underwent PCI with DES—sirolimus-eluting stent (Cypher, Cordis/Johnson and John-

son, Warren, NJ) or paclitaxel-eluting stent (Taxus, Boston Scientific, Natick, MA)—at the UCLA Medical Center were nonagenarians. The Institutional Review Board approved the use of the database review for this study.

Definitions

Angiographic success was defined as revascularization in the target lesion with Thrombolysis In Myocar-

Division of Cardiology, David Geffen School of Medicine, University of California, Los Angeles, California

*Correspondence to: Dr. Michael S. Lee, UCLA Medical Center, Adult Cardiac Catheterization Laboratory, 10833 Le Conte Avenue, Rm BL-394 CHS, Los Angeles, CA 90095-171715.
E-mail: mslee@mednet.ucla.edu

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dial Infarction flow grade 2 or 3 and <30% residual stenosis on angiography. In-stent restenosis was defined as a stenosis of >50% located within the stent or within 5 mm of the stent edges. The World Health Organization and American College of Cardiology/American Heart Association definition of myocardial infarction was used [4]. Two of the three criteria were required for the diagnosis of myocardial infarction: ischemic chest pain, significant electrocardiographic changes, or an elevated biochemical marker such as creatine kinase-MB or troponin. Myocardial infarction was further divided into ST-segment-elevation myocardial infarction if the admission electrocardiogram showed ≥ 1 mm ST-segment elevation in ≥ 2 contiguous leads, or non-ST-elevation myocardial infarction if ST-segment elevations were not present on the admission electrocardiogram. Major adverse cardiac events were defined as death, myocardial infarction, or target vessel revascularization.

Percutaneous Coronary Intervention

Standard techniques for PCI were used. Intra-aortic balloon counterpulsation was used when clinically indicated, especially if severe left ventricular dysfunction was present. The choice of anticoagulation, use of glycoprotein IIb/IIIa antagonists, intravascular ultrasound (Boston Scientific Corp.), and the decision to use sirolimus-eluting stent or paclitaxel-eluting stent was left to the discretion of the operator. All patients received aspirin 325 mg/day indefinitely. Clopidogrel was continued for at least 6 months after a loading dose of 300 mg was given.

Follow Up

Patient data were collected retrospectively on a dedicated PCI database. Long-term data were obtained from medical records or telephone interview with the patient's physician. Repeat angiography was performed if clinically indicated because of recurrent ischemia or surveillance angiography after unprotected left main coronary artery stenting.

Statistical Analysis

Continuous data are expressed as mean \pm SD, and categorical variables are presented as frequency and percent. Survival curve was generated by the Kaplan-Meier method. Statistical analyses were performed using SAS, version 9.1 (SAS Institute, Cary, NC).

RESULTS

Baseline Patient Characteristics

The mean age was 92 ± 2 years, 39% were male, 4% had diabetes, 14% had chronic renal insufficiency

TABLE I. Baseline Patient Characteristics

| | |
|-------------------------------------------------------------------|-------------|
| Age (years) | 92 \pm 2 |
| Male gender (%) | 39 |
| Diabetes (%) | 4 |
| Hypertension (%) | 82 |
| Hypercholesterolemia (%) | 54 |
| Chronic renal insufficiency (Cr ≥ 1.5 mg/dL) (%) | 14 |
| Peripheral arterial disease (%) | 18 |
| Stroke (%) | 14 |
| Previous percutaneous coronary intervention (%) | 25 |
| Previous coronary artery bypass surgery (%) | 14 |
| Left ventricular dysfunction (ejection fraction $\leq 40\%$) (%) | 46 |
| Ejection fraction (%) | 42 \pm 15 |
| Medications | |
| Beta-blocker (%) | 46 |
| ACE inhibitor/ARB (%) | 39 |
| Calcium-channel blocker (%) | 11 |
| Statin (%) | 71 |
| Clinical presentation | |
| Angina pectoris/elective (%) | 32 |
| Unstable angina (%) | 29 |
| Myocardial infarction | |
| NSTEMI (%) | 32 |
| STEMI (%) | 7 |
| Cardiogenic shock (%) | 11 |

ACE, angiotensin converting enzyme; ARB, angiotensin receptor blocker; Cr, creatinine; NSTEMI, non-ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction.

(creatinine ≥ 1.5 mg/dL), 18% had peripheral arterial disease, 25% had previous PCI, and 14% had previous coronary artery bypass surgery (Table I). Left ventricular dysfunction (ejection fraction $\leq 40\%$) was present in 46% with a mean ejection fraction of $42 \pm 15\%$. Sixty-eight percent of patients presented with acute coronary syndrome (unstable angina 29%, non-ST-elevation myocardial infarction 32%, and ST-elevation myocardial infarction 7%). Three patients (11%) had cardiogenic shock.

Procedural Characteristics

Angiographic success was achieved in 100% (Table II). Sirolimus-eluting stents were used in 79% of cases, and paclitaxel-eluting stents in 21% of cases. The mean number of stents used per case was 1.5 ± 0.9 , and the mean stent length per case was 31 ± 20 mm. Multivessel PCI was performed in 39%.

30-Day Results

The overall 30-day major adverse cardiac event rate, which was attributable solely to death, was 21%. All three patients who presented with cardiogenic shock died. Another patient with critical aortic stenosis and congestive heart failure died because of complications during percutaneous aortic valvuloplasty. If these four patients who were in extremis on presentation were excluded, in-hospital mortality was 0%, and the 30-day

TABLE II. Procedural Characteristics

| | |
|---------------------------------------|-----------|
| Angiographic success (%) | 100 |
| Sirolimus-eluting stent (%) | 79 |
| Paclitaxel-eluting stent (%) | 21 |
| Number of stents/patient | 1.5 ± 0.9 |
| Stent length (mm) | 31 ± 20 |
| Multivessel PCI (%) | 39 |
| Glycoprotein IIb/IIIa antagonists (%) | 21 |
| Intravascular ultrasound (%) | 4 |
| Intra-aortic balloon pump (%) | 11 |
| Target vessel | |
| Left main artery (%) | 18 |
| Left anterior descending artery (%) | 39 |
| Left circumflex artery (%) | 14 |
| Right coronary artery (%) | 25 |

PCI, percutaneous coronary intervention.

mortality rate was 8% (2/24). The 30-day mortality rate in all patients who presented with myocardial infarction was 36% compared with 12% in those without myocardial infarction ($P = 0.12$). No patient had definite stent thrombosis.

Follow-Up Results

In patients who were discharged and alive after 30 days, there were 6 deaths (3 from 31 days to 1 year and 3 after 1 year). In addition, two patients had myocardial infarction. One patient had myocardial infarction on day 140 but the stents were patent on coronary angiography. Another patient who underwent PCI for distal bifurcation disease of the left main coronary artery with the simultaneous kissing stent technique had myocardial infarction and target vessel revascularization for in-stent restenosis at the ostium of the left circumflex artery at day 915. She subsequently died on day 1,139 from congestive heart failure. The cumulative survival rate for all nonagenarians at 1 year and 3 years was $68 \pm 9\%$ and $61 \pm 9\%$, respectively, and $79 \pm 8\%$ and $71 \pm 9\%$ at 1 year and 3 years, respectively for the nonagenarians when the four patients who were in extremis on presentation were excluded (Fig. 1).

DISCUSSION

In this study of 28 nonagenarians who underwent percutaneous coronary intervention (PCI) with DES, the majority presented with acute coronary syndrome. PCI with DES was safe in nonagenarians as there were no in-hospital deaths and acceptable 3-year survival rates when patients who were in extremis on presentation were excluded. The high-risk profile of these patients and the expected attrition of nonagenarians (life expectancy in nonagenarians is 2.5 and 3.5 years for men and women, respectively) may contribute to their mortality

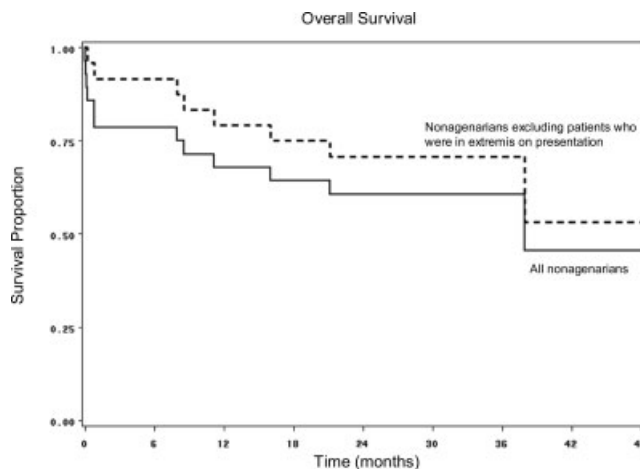


Fig. 1. Kaplan-Meier curves for survival proportion for all 28 nonagenarians and nonagenarians when the 4 patients who were in extremis on presentation were excluded.

rates. To our knowledge, this is the first study to analyze the use of DES in this patient population.

In the present study, the majority of the nonagenarians were female, which is consistent with the generally higher life expectancy of women compared with men. Nonagenarians also tended to have extensive cardiac disease (left ventricular dysfunction, multivessel disease, and critical aortic stenosis), with a significant rate of comorbidities including chronic renal failure and peripheral vascular disease. This is consistent with previous studies that have found similar comorbidities in octogenarians and elderly patients in general [3–16]. Similar to other studies in which elderly patients were more likely to present with an unstable clinical condition, such as acute coronary syndrome, acute heart failure and cardiogenic shock, 68% of our patients presented with an acute coronary syndrome, and 11% presented with cardiogenic shock [3,5–7].

The tendency toward advancing coronary pathology with age has limited the use of stenting as an interventional modality in nonagenarians in the past. Nevertheless, procedural success rates for PCI in the elderly have been high despite a tendency towards more critical clinical presentation among older patients, and studies in which stenting was employed have shown similar results that are comparable to younger patients, reporting very high angiographic success rates [3–6]. A recent study of the effectiveness of PCI in the pre-DES era stents in 26 nonagenarians found that angiographically successful results were obtained in 92% of the patients, with bare metal stents being used in 81% of the patients [3]. Another study analyzing PCI with DES in octogenarians reported angiographic success rates that were similar to younger patients, though DES was not analyzed exclusively [5]. In the present

study, angiographic success was achieved in all of the patients, supporting the notion that PCI with DES is a technically feasible mode of intervention in nonagenarian patients despite their somewhat worse cardiac profile.

The 30-day major adverse cardiac event rate was 21% in our study, attributable solely to death, with a rate of 36% in patients presenting with myocardial infarction compared with 12% in those without myocardial infarction. The 21% event rate was observed in a population which included three patients who presented with cardiogenic shock and one patient who died from complications associated with aortic valvuloplasty, all of which were clinical complications and none of which were related to the use of DES. Previous studies have noted increasing in-hospital and short-term mortality and major adverse cardiac event rates with age, particularly in an emergent setting (i.e. presentation with acute coronary syndrome) [3,4,7]. Increasing age has also been demonstrated as an independent predictor of mortality in several studies of PCI in the elderly [5,9]. This is consistent with the higher rate of unstable clinical presentation in older patients. There were no in-hospital deaths, and the 30-day major adverse cardiac event rate was 8% when four patients who were in extremis on presentation were excluded. Similarly, Moreno et al. reported no in-hospital deaths after patients with cardiogenic shock and those in whom primary angioplasty was performed were excluded [3]. Furthermore, higher mortality rates on presentation with acute coronary syndrome have also been attributed to more severe clinical presentation in this age group [5,13,14]. This suggests that the clinical characteristics of nonagenarians are the primary contributors to both short-term and long-term mortality when it occurs, rather than intrinsic features of the stenting procedure.

The 1-year cumulative survival rate was (68 ± 9)% and the 3-year cumulative survival rate was (61 ± 9)%. The high death rate in our study is likely a reflection of the worsening clinical condition and comorbidities as well as the expected attrition in this age group. Only one patient underwent target vessel revascularization for in-stent restenosis on day 915. Some studies have previously demonstrated similar rates of death, restenosis, and repeat revascularization between elderly and younger patients, but in these studies the population group defined as elderly was often 65 years or older, and outcomes specific to stents and DES in particular have remained largely unstudied [5,13]. A recent study analyzing age-based clinical and angiographic outcomes following sirolimus-eluting stent implantation found no statistically significant differences in procedural success rate, complication rate,

or 7-month outcomes between young and elderly patients, where elderly was defined as being 65 or over [17]. Long-term outcomes in patients presenting with acute coronary syndrome have been mixed, though there is evidence for improved rates of restenosis and target vessel revascularization when bare metal stenting has been employed [18]. These benefits are likely to extend to DES as well in this population.

Our study is limited in being a single center retrospective study with a relatively low number of patients. However, the sample size is reflective of the generally low number of nonagenarians who undergo PCI. Also, repeat angiography in our study was done only if clinically indicated due to recurrent ischemia or as surveillance after unprotected left main coronary artery stenting. Therefore, the presence of clinically silent restenosis or other silent in-stent pathology was not assessed. A prospective study analyzing nonagenarian outcomes after stenting with DES, utilizing defined angiographic follow-up, would better evaluate the safety and efficacy of DES in this population.

CONCLUSION

The majority of the nonagenarians who underwent PCI with DES presented with an acute coronary syndrome. Percutaneous coronary intervention with DES was safe in nonagenarians. Excellent angiographic results were obtained with no in-hospital deaths, and the 3-year survival rate was acceptable, when patients who were in extremis on presentation were excluded. The high-risk profile of these patients and the expected attrition of nonagenarians may contribute to their mortality rates.

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