

Safety and Efficacy of Cardiac Catheterization in Nonagenarians

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Abstract

- **Objective:** The elderly comprise the fastest growing segment of the U.S. population, but data on cardiac catheterization in this age-group are scarce. We present a series of 191 nonagenarians who underwent cardiac catheterization at our institution.
- **Methods:** Retrospective data were collected for 191 nonagenarians who underwent cardiac catheterizations from 1994 to 2006. Variables were defined per the National Cardiovascular Network (NCN) data registry recommendations.
- **Results:** The mean age of the study group was 91.4 ± 1 years, and 65% of the patients were women. Diabetes, hypertension, peripheral vascular disease, and smoking were present in 18%, 87%, 35%, and 27% of patients, respectively. At presentation, 79% had acute coronary syndrome (56% with unstable angina and 23% with acute myocardial infarction) and 48% had multivessel disease. Percutaneous coronary intervention (PCI) was performed in 122 patients (135 vessels) with coronary stents used in 74%. Angiographic success was achieved in 90.6% of cases. There were 45 documented in-hospital complications (4 deaths, 2 Q wave myocardial infarctions, 3 strokes, 9 cases of renal failure, and 27 vascular complications) and 29 deaths at 1-year follow-up.
- **Conclusion:** Most nonagenarians have a high-risk profile, but cardiac catheterization and PCI can be an acceptable option in selected patients.

The elderly are a growing segment of the U.S. population and account for a third of all cardiovascular event-related deaths [1]. However, limited data are available about the utilization, safety, and efficacy of cardiac catheterization in this age-group as they are often excluded from clinical trials. The initial American Heart Association/American College of Cardiology guidelines on mortality risk following percutaneous coronary intervention (PCI) noted that the very elderly constitute a special patient population with worse outcomes [2]. Recent progress in addressing the adverse lesions, diffuse disease, and comorbid conditions

in very elderly patients is believed to have significantly improved PCI outcomes in this patient population. A study by Klein and colleagues that evaluated the risks and outcomes of PCI using American College of Cardiology–National Cardiovascular Data Registry (ACC-NCDR) data from 8828 octogenarian patients reported good success rates and acceptable mortality [3]. Angiographic success was obtained in 93% of PCIs performed, with an overall in-hospital mortality of 3.7%. We report the outcomes of 191 nonagenarians who underwent cardiac catheterization at our institution over the past 11 years. The goal of this study was to analyze the current experience in nonagenarians undergoing cardiac catheterization and to better understand the outcomes in this unique patient group in clinical practice.

Methods

Data Collection

The study was performed in a 608-bed hospital that performs an average of 6000 cardiac catheterizations annually. We performed a retrospective chart review of all nonagenarians who underwent cardiac catheterization between 1994 and 2006 ($n = 191$). The patients were identified by procedure ICD-9-CM codes associated with cardiac catheterization (37.22 and 37.33). Patients who underwent peripheral vascular procedures were not included. Data were obtained regarding demographics (age, sex, race), risk factors (eg, smoking, diabetes, hypertension), medical history (prior coronary disease, ejection fraction), PCI indications, PCI presentations, angiographic findings, and outcomes (in-hospital and 1-year follow-up). Follow-up data were obtained for a mean period of 14 months for all patients discharged alive. None of the patients was readmitted for a repeat catheterization for a failed procedure. Patients who underwent multiple catheterizations over the study period did so as part of a staged intervention strategy; thus, these were counted as separate procedures. We obtained approval from the institutional review board of St. John Hospital and Medical Center to collect and publish the data.

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Table 1. Patient Characteristics ($n = 191$)

Mean age \pm SD, yr	91.4 \pm 1
Female sex, n (%)	124 (65)
Caucasian, n (%)	175 (94)
Smoking (current/former), n (%)	70 (27)
Past medical history, n (%)	
Hypertension	166 (87)
Diabetes mellitus	35 (18)
Dyslipidemia	105 (55)
Renal failure	30 (16)
Atherosclerotic disease	140 (73)
Congestive heart failure	58 (30)
Past surgical history, n (%)	
Cardiac catheterization	95 (50)
Coronary artery bypass grafting	19 (10)

SD = standard deviation.

Variables

Variables were defined per the National Cardiovascular Network Data Standards Committee recommendations [4]. *Angiographic success* was considered achieved when a Thrombolysis in Myocardial Infarction flow grade of 2 or 3 and less than 50% of arterial diameter residual postintervention stenosis were obtained. *Baseline renal failure* was defined as a documented history of renal failure diagnosed and treated with medications, low-protein diet, or dialysis by a physician, or a baseline creatinine concentration of 2.0 mg/dL or greater. *Postprocedural renal failure* was defined as an increase in serum creatinine of 1 mg/dL or more or need for hemodialysis or peritoneal dialysis in a patient not requiring either prior to cardiac catheterization, at any time following coronary intervention. *Vascular complications* included the occurrence of any of the following: catheter entry arterial pseudoaneurysm; blood loss at the site of arterial or venous access or due to perforation of vessel; occlusion of the access artery requiring surgical repair; loss of distal pulse requiring therapy; and development of arteriovenous fistula at the femoral access site or arterial dissection. *Major blood loss* was defined as that requiring transfusion of blood products after the procedure.

Data Analysis

Data analysis was performed using SPSS, version 12.0 (Chicago, IL). Continuous variables were expressed as mean \pm standard deviation (SD), and discrete variables were expressed as percentages.

Results

The mean age of the study group ($n = 191$) was 91.4 ± 1 years

Table 2. Angiographic Details and Outcomes

Indication, n (%)	
Stable angina	41 (21)
Unstable angina	107 (56)
Acute MI/ NSTEMI	42 (23)
Mean \pm SD ejection fraction	48% \pm 15%
PCI performed, n (%)	122 (64)
Stent deployed	90 (74)
Angiographic success	91%
In-hospital complications, n (%)	
Q wave MI	2 (1)
Stroke	3 (2)
Renal failure	9 (5)
Major blood loss	18 (9)
Vascular	9 (5)
Death	4 (2)
Postdischarge mortality, n (%)	
1 mo	7 (4)
6 mo	11 (6)
1 yr	11 (6)

MI = myocardial infarction; NSTEMI = non-ST-segment myocardial infarction; PCI = percutaneous coronary intervention; SD = standard deviation.

(range, 90–97 years), and 65% of the patients were women (Table 1). Diabetes, hypertension, dyslipidemia, and smoking were present in 18%, 87%, 55%, and 27% of the patients, respectively. Half of the patients ($n = 95$) had undergone previous cardiac catheterizations (including 10% with coronary bypass grafting); 25% ($n = 48$) had a history of documented peripheral vascular disease; and 16 patients had a previous ischemic stroke. The mean ejection fraction was $48\% \pm 15\%$ in 170 patients in whom ejection was calculated by concurrent contrast left ventriculography (Table 2). Indications for performing cardiac catheterization were: stable angina, 41 (21%); unstable angina, 107 (56%); and acute myocardial infarction (MI)/non-ST elevation myocardial infarction (NSTEMI), 43 (23%). The femoral artery was used as the access site in 96% of patients and the radial artery was used in 4%. Multivessel disease was present in 48% ($n = 91$) of patients. Of the 191 patients who underwent catheterization, 122 (64%) underwent PCI. A total of 135 PCIs were performed, as several patients had the procedure performed on more than 1 vessel. Coronary stents were used in 74% of those undergoing PCI. Of the 41 nonagenarians who underwent cardiac catheterization following the introduction of drug-eluting stents in 2003, 24 received these stents as their PCI. Heparin was used in 134 patients undergoing catheterization, and glycoprotein IIb/IIIa inhibitors were used in 49 patients.

Angiographic success was achieved in 90.6% interventions, with 45 documented complications (4 deaths, 2 Q wave MI, 3 strokes, 9 cases of renal failure, and 27 vascular complications). Three of the 4 patients who died had presented with cardiogenic shock complicating an acute coronary syndrome. The cause of death in these 3 patients included acute stroke with hemodynamic compromise in one (periprocedure), postprocedural Q wave MI in the second, and worsening renal failure with cardiac arrest in the third. The fourth patient was switched to comfort measures after suffering an ischemic stroke postprocedure. Two of the 3 strokes were determined to be of ischemic etiology following cardiac catheterization, and the cause of the other stroke could not be determined as the patient died periprocedure.

All patients discharged alive were followed for 1 year. There were 29 deaths: 7 at one month, 11 between 2 and 6 months, and 11 between 6 months and 1 year.

Discussion

The decision to proceed with a cardiac catheterization in nonagenarians is influenced by various factors. Significant noncardiac considerations include baseline mental status, nutritional status, and coexistent renal and vascular diseases. Also, life expectancy of nonagenarians (2.5 years for males and 3.5 years for females) plays a role when deciding whether to proceed with invasive diagnostic and therapeutic interventions. In this study, we report on a series of nonagenarians who underwent cardiac catheterization under all conditions—emergent, urgent, or elective—in order to better understand clinical outcomes and assess the risks and benefits of this invasive procedure in this unique patient population.

In our study, patients were more likely to be women, which is consistent with the overall higher life expectancy of females as compared with males. Women were also more likely to present with acute coronary syndrome and to experience vascular complications. Coronary stents were used as PCI in three-quarters of patients, and PCI had an acceptable angiographic success rate (91%). Our findings are consistent with those reported in earlier studies.

The ACC-NCDR study that evaluated in-hospital outcomes of 8828 octogenarians who underwent PCI [3] showed good success and acceptable risk with PCI, with the presence of acute or recent myocardial infarction, shock, renal insufficiency, diabetes, and low ejection fraction increasing the risk of in-hospital deaths. The mean age of the patients in the ACC-NCDR study was 83.7 ± 3 years, and the majority were women (53%). In this patient group, 22% had diabetes, 35% had heart failure, 55% presented with unstable angina, and the mean ejection fraction was $51\% \pm 7\%$. The reported in-hospital mortality was 3.7% (333/8288), with nonfatal complications reported at 2.15% for renal failure, 0.46% for

stroke, and 0.52% for Q wave myocardial infarction. Stents were placed in 75% of procedures, and angiography was considered successful in 93% of cases. Although we did not compare our data head to head with the data from this large multinational registry, the baseline characteristics and procedural outcomes were comparable in both these elderly population groups.

A recent retrospective analysis of 28 nonagenarians who underwent PCI with drug-eluting stents revealed acceptable outcomes during the in-hospital stay and a 3-year follow-up period [5]. The patient group's mean age was 92 ± 2 years and women comprised 61% of the group. Angiographic success was achieved in 100% patients. Of the 6 patients who died during their in-hospital stay, 3 had cardiogenic shock and 1 had critical aortic stenosis. Six of the surviving 22 patients died during the 1-year follow-up.

In a series of 28 nonagenarians (mean age, 92 ± 1 years, 46% female) who underwent PCI, angiographically successful results were obtained in 24 patients (92%), but the rate of in-hospital complications was high, with 5 deaths (19%), 1 nonfatal Q wave myocardial infarction, and 4 patients developing renal failure [6]. The authors concluded that in-hospital mortality is highest for patients who present with cardiogenic shock. In our study, 3 of the 4 patients who died presented with cardiogenic shock.

A recent study using data from the CRUSADE registry compared the baseline characteristics and in-hospital outcomes of 5557 patients older than 90 years with NSTEMI with those of a cohort aged 75 to 89 years [7]. The authors concluded that adherence to guideline recommended therapies was associated with decreased mortality in these age-groups.

Given the small number of patients and low mortality in our series, we were unable to derive independent predictors of mortality and the trends in their outcomes over the study period by multivariate analysis. However, to our knowledge, this is the largest case series reported for nonagenarians undergoing cardiac catheterization for all indications. We conclude that in spite of a higher risk factor profile in this patient population, cardiac catheterization and percutaneous interventions in carefully selected patients are associated with successful outcomes.

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