

# Percutaneous Coronary Intervention in Nonagenarians: Prevalence, Indications, Vascular Approach and Mortality at 3 Months

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## Abstract

**Background:** Percutaneous coronary intervention (PCI) in nonagenarians has been shown to be feasible, with a high success rate. However, there is paucity of data regarding the prevalence, vascular access, procedural data and mortality after PCI in this population.

**Methods:** All patients aged 90 and older referred to our institution from 2004 to 2014 for coronary angiogram were included in our retrospective study. Clinical and procedural data including vascular access and 3-month mortality rates were obtained for all patients.

**Results:** A total of 26696 PCI were performed over the last 11 years, of which 177 PCI (0.66%) were realized in 167 nonagenarians. The prevalence of PCI in nonagenarians increased from 0.17% in 2004 to 1.22% in 2014. In this population, with an age of  $92 \pm 2$  years and 51.4% of males, 76 (43%) PCI were performed in the setting of ST-elevation myocardial infarction, and 89 (50%) of the procedures were non-ST elevation myocardial infarction or unstable angina. Transradial approach (TRA) was used in 76 (43%) and transfemoral approach (TFA) in 101 (57%) procedures. Comparing TRA to TFA, the total fluoroscopic time and contrast volume was similar between the two groups. Overall complications, including cardiogenic shock, iatrogenic coronary dissection, perforation or no reflow phenomenon occurred in 22 of 177 procedures (12.4%). Overall survival rate was 92.8% at 3 months.

**Conclusion:** The majority of the procedures was performed in acute coronary syndrome clinical setting. TRA and TFA were comparable in terms of fluoroscopic time and contrast volume. Overall procedural success rate was high and complication rates were low.

**Keywords:** Nonagenarian; Percutaneous coronary intervention; Vascular access; Mortality

## Introduction

Elderly population is growing in industrialized countries and cardiovascular diseases represent their first cause of morbidity and mortality [1]. Also, a non-negligible proportion of these patients is still autonomous. Therefore, cardiologists are more frequently confronted with management decisions involving elderly population, including nonagenarians. This frail subgroup of patients is often characterized by cardiovascular atypical symptoms and more comorbidities. Age is not a contraindication to perform coronary angiography and percutaneous coronary intervention (PCI). The first reported PCI series involving octogenarians was published in 1996 [2]. Later on, Cohen et al. showed that long-term outcome after PCI of octogenarian population was similar to the general population [3]. A recent publication by From et al. reported a series of PCI in nonagenarians and demonstrated that PCI was feasible and might provide benefits when clear indications were present [4]. However, what was true 10 years ago is all the more so today: randomized controlled trials of acute coronary syndrome continue to exclude or underrepresent very old patients [5].

In this study, we evaluated retrospectively 11 years of PCI practice in nonagenarian patients in a high volume center. We examined the prevalence, indications, vascular approach, safety, complications and mortality rates at 3 months.

## Methods

### Population

This is a single center cohort study performed at the Montreal Heart Institute, Montreal, Quebec, Canada, a reference center for cardiovascular disease management. From January 2004 to December

2014, all patients aged 90 and older referred to our institution for coronary angiography and PCI were included in our analysis. Data was extracted retrospectively and each angioplasty was reviewed in detail regarding: indications for PCI, vascular access site, fluoroscopic time and total volume of contrast media. Cardiogenic shock was defined as prolonged systolic blood pressure < 90 mm Hg, the need for inotropes or use of intra-aortic balloon pump. Vascular complications and 3-month mortality rate data were collected. This study was approved by the local ethics committee.

### Procedures

All the procedures were performed according to current international guidelines. Transradial approach (TRA) or transfemoral approach (TFA) was performed at the discretion of the operator. Barbeau test was systematically performed and had to be normal before the use of TRA. At the end of the PCI and after sheath removal from radial artery, a wrist compression device was used (TR Band, Terumo Medical Corporation, Somerset, NJ, United States). Manual compression was performed when TFA was realized, if closure devices

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seemed unsafe to use. PCI success was defined as final TIMI 3 flow and <30% residual diameter stenosis in the culprit artery. Volume of contrast media and total fluoroscopy time during PCI were collected to compare TRA versus TFA.

### Statistical Analysis

Statistical analysis was performed using Graph Pad Prism 5. Continuous variables are expressed as mean ± standard deviation. Paired and unpaired samples t-test were used to analyze differences in continuous variables with normal distribution. Categorical variables are expressed as frequencies and percentage. Chi-square and Fisher exact test were used for the comparison of categorical variables. A p-value<0.05 was considered significant.

### Results

#### PCI Prevalence and demographics characteristics

26696 PCI were performed over the last 11 years in our institution and 177 PCI (0.66%) were realized in 167 nonagenarians. The prevalence of PCI in nonagenarians increased from 0.17% in 2004 to 1.22% in 2014 (Figure 1). In this population, mean age of 92 ± 2 years, 51.4% of male, previous coronary revascularization was present in 44 (24.9%), either PCI and / or CABG (Table 1).

#### Indication for PCI

Primary PCI for ST-elevation myocardial infarction (STEMI) was realized in 76 cases (43%). Urgent PCI for non ST elevation myocardial infarction (NSTEMI) and / or unstable angina represented 48 (27%) and 41 (23%) cases respectively. Elective PCI was performed only in 12 cases (7%) (Figure 2).

#### Procedural characteristics

The prevalence of TRA increased over the last 11 years (Figure 3). The TRA was used in 76 (43%) (right radial artery in 74 cases) and the TFA in 101 (57%) of the procedures. Bare metal stents (BMS) were more frequently implanted than drug eluting stents (DES): 82% versus 11% respectively (Table 2).

#### Procedural success and complications

Coronary procedural success was achieved in 166 procedures (93.7%). Access site complications were noted in 3 cases (1.7%) following PCI. Overall complications occurred in 19 of the procedures (11%) including cardiogenic shock (n=7), acute ventricular septal defect (n=1), iatrogenic coronary dissection (n=4), coronary perforation (n=2) or no reflow (n=5). Three-month mortality was 9% (15 patients). Amongst these 15 patients, 9 deaths (60%) occurred following a STEMI.

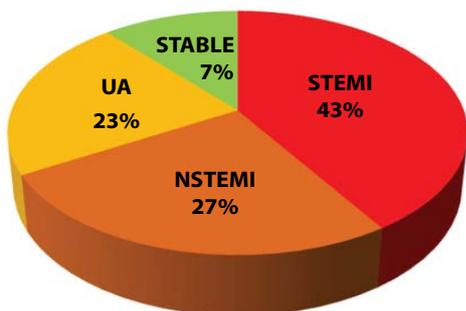


Figure 1: Clinical presentation.

Variable	Patients (n= 167)
Age, years	92 ± 2
Male gender, %	51.4
Diabetes, %	23.5
Hypertension, %	57.8
Hypercholesterolemia, %	61.9
Smoker or former smoker, %	15.1
Familial history of CAD, %	8
BMI, kg/m <sup>2</sup>	24.8 ± 4.5
Prior PCI, %	16
Prior CABG, %	14

BMI: Body Mass Index; CAD: Coronary Artery Disease; PCI: Percutaneous Coronary Intervention; CABG: Coronary Artery Bypass Grafting.

Table 1: Baseline clinical characteristics.

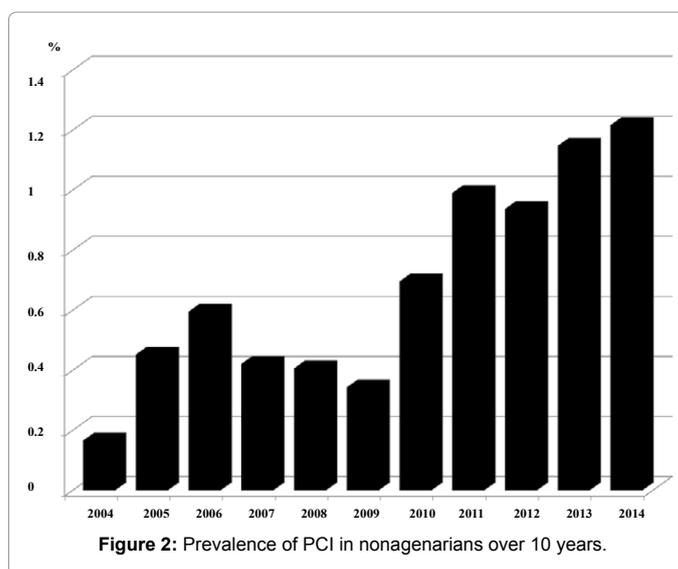


Figure 2: Prevalence of PCI in nonagenarians over 10 years.

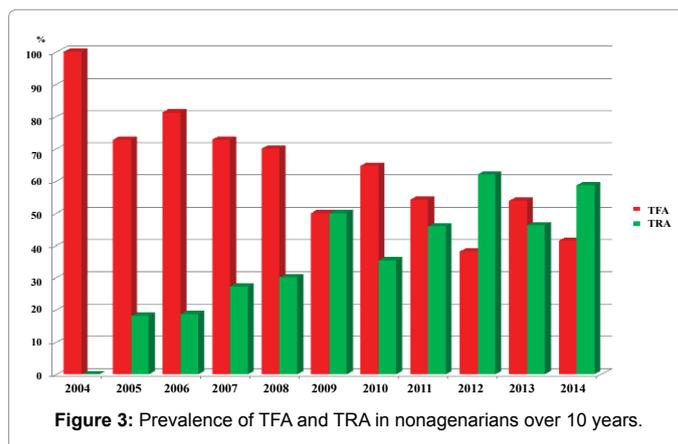


Figure 3: Prevalence of TFA and TRA in nonagenarians over 10 years.

#### TRA versus TFA

When comparing TRA to TFA, the total fluoroscopic time was not different: 14.4 ± 1 min vs 16 ± 1.1 min (p=0.26) respectively and the contrast volume did not differ between the two groups: 186 ± 6 ml vs 199 ± 8 ml (p=0.20). Coronary procedural success was achieved in 71 procedures (93%) via the TRA and in 95 procedures (94%) via the TFA (p=0.51) (Table 3). Reported access sites complications were 1 radial dissection, 1 radial hematoma and 1 femoral hematoma.

Procedural finding, n (%)	Procedures (n=177)
Radial approach	76 (43%)
Number of vessel coronary disease	
1	46 (26%)
2	43 (24%)
3	88 (50%)
Vessel treated	
Cx	16 (9%)
RCA	80 (45%)
LAD	67 (38%)
Left main	14 (8%)
Saphenous vein graft	9 (5%)
Predilation	149 (84%)
Rotablator use	6 (3.3%)
Coronary stenting	
Bare metal stent	145 (82%)
Drug eluting stent	20 (11%)
Balloon angioplasty	12 (7%)

Cx: Circumflex; RCA: Right Coronary Artery; LAD: Left Anterior Descending Artery

**Table 2:** Angiographic and procedural characteristics.

Variable	TRA (n = 76)	TFA (n = 101)	P
Contrast volume, ml	186 ± 6	199 ± 8	0.20
Fluoroscopic time, min	14.4 ± 1	16 ± 1.1	0.26
PCI success, n (%)	71 (93%)	95 (94%)	0.51

PCI, Percutaneous Coronary Intervention. Data are expressed as mean and standard deviation.

**Table 3:** Transradial vs transfemoral approach.

## Discussion

The main findings of this retrospective cohort are: 1) Prevalence of PCI in nonagenarians increased over the observation period of 11 years. 2) Urgent PCI was the most common indication to perform the procedure in the majority of cases. 3) TRA prevalence increased over the study period. 4) PCI success was achieved in the majority of cases. 5) Mortality at 3 months was low.

Current demographics in industrialized countries are reflected in the practice of interventional cardiology with an increase in the number of aging people addressed for coronary angiography and PCI [6]. The nonagenarians' paradox is represented by a growing population with a high prevalence of cardiovascular disease, more than the general population, but an underrepresentation in clinical trials and a lack of data regarding the best reperfusion strategy. In our series, there is a ten-fold increment of PCI in nonagenarian patients over the last 11 years. The prevalence increment could be explained by: 1) The possibility to perform coronary angiogram and PCI in safer conditions than previously. 2) Increment of aging population.

PCIs were realized in emergency in 93% of cases while only 7% were scheduled electively. Elective PCI, although rare 11 years ago, seems to be more frequent now due to enhancement of techniques and systematic angiography before trans-catheter aortic valve implantation. Urgent procedures were also predominant in other series studying PCI in nonagenarians: 92% [7], 81.5% [8] and 82% [9]. Despite the fact that primary PCI represents the best reperfusion therapy for STEMI patients, it concerns a minority of nonagenarians admitted for acute coronary syndrome. A conservative strategy is often adopted in hospitalized nonagenarian patients. Indeed, the rate of invasive management by primary PCI for STEMI was only 16.9% in a large national registry [10]. Numerous cohort studies suggested

performing primary PCI in this population [11-14]. Recently, a large prospective registry on primary PCI compared demographics, angiographic data and outcome of nonagenarians (mean age = 92.9) with non-nonagenarian patients (mean age = 61.7). This study showed that PCI was feasible with a high success rate despite a higher short-term mortality in nonagenarians [15,16].

Large randomized controlled trials comparing TRA versus TFA in younger patients could be extended and also recommended to nonagenarians because of lower bleeding complications. A randomized trial compared TRA (n = 152) versus TFA (n = 155) in patients older than 75 years of age [17]. In this study, fluoroscopy time and amount of contrast agent were not different between the two strategies. Conversion of TRA to TFA was evaluated at 9%. The rate of post procedural complications through TFA was found to be higher and thus the authors suggested to favor TRA. There is no randomized, prospective trial which compares TRA versus TFA in nonagenarians. Indeed, interventional cardiologists may feel uncomfortable with -TRA because of arterial stiffness and tortuosity, which are often present in aged and/or hypertensive patients. An experimental study has shown that elastin content is involved in the development of aneurysmal dilatation and tortuosity caused by marked decrease in longitudinal traction [18]. The overall elastin content decreases in the arterial wall of normal aging patients [19]. However, TRA, especially via the right radial artery, is feasible in the majority of cases, as reported in previous studies and in the present one. Some particular situations should be highlighted: left main management and patient in shock. In our study, left main was involved in 8 patients and was unprotected in 6 cases. All procedures were performed via TFA. The PCI was successfully achieved in 6 of them and was complicated in 2 patients: we reported 1 electro-mechanical dissociation pre-dilation and 1 cardiogenic shock on presentation. In such situations, TFA should be preferred for technical facilities and complication management.

In this very aged population, half of the patients had 3 vessels disease. Pre-dilation was performed in the majority of cases to optimize stent deployment. As a consequence of calcified coronary stenosis, the rate of rotational atherectomy was high (3.3%), superior to the rate reported in some European Union countries [20]. BMS implantation was significantly higher than DES implantation. This is particularly true in the context of primary PCI, when medical history is unknown and bleeding complications can occur. The use of BMS in nonagenarians was recommended by the NINETY study [8]. Other current studies have reported a high success rate of PCI similar to the 94% of our series.

Because of the frailty of nonagenarians and the risk provided by coronary angiography and PCI, the patients are generally carefully selected. However, chest pain regression, symptom improvement, ischemic recurrence reduction and improvement in quality of life can easily be achieved by PCI [7]. Post PCI short term mortality was low in our series (7.2% at three months) considering the fragility of these patients. This trend was consistent with the rate of 10% observed in other current series, in which risk factors associated with post PCI mortality are well described (left ventricular systolic dysfunction, diabetes, renal injury) and similar in nonagenarians except for the frequency [21,22]. The mean short term death rate of most of the current series regarding PCI in nonagenarians was 14% and one third of these studies concerned primary PCI during STEMI [23].

## Limitations

This is a single center study and data were collected retrospectively. Therefore, some data regarding medical therapy, left ventricular

ejection fraction and mortality at one year are lacking. The prevalence and outcome of nonagenarian patients admitted for acute coronary syndrome treated medically or by surgery are not available. History of dementia and cerebrovascular events were not reported in our series. Unfortunately, frailty was not evaluated and patients admitted for PCI are probably highly selected. There was no difference in terms of rate of vascular complications between TRA and TFA, probably due to the small sample size.

## Conclusion

Nonagenarian patients represent a growing section of our patients. Prevalence of PCI in this population has increased over the last 11 years. While most of the procedures were realized in an emergency setting, it has been demonstrated that PCI is safe and associated with a high success rate. Radial approach should be preferred because radiation and contrast level are similar when compared to femoral approach. The short term mortality rate was low and comparable to the general population.

## Conflict of Interest

The authors have no conflicts of interest to declare.

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