Comparison of in-hospital and mid-term outcomes of percutaneous coronary intervention between patients aged over 65 and younger

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Abstract

Background and aim: Advanced age is known to be correlated with adverse outcomes in patients undergoing percutaneous coronary intervention (PCI). We compared the outcomes of PCI between patients over the age of 65 and those younger.

Methods: From a total of 5572 patients in the Tehran Heart Center PCI Registry,1318 (23.7%) persons > 65 years old (group I) were compared with 4254 patients ≤ 65 years of age (group II) in a two-year period (April 2003 to June 2005). PCI outcomes were classified into in-hospital and mid-term. The in-hospital outcomes comprised major adverse cardiac events (MACE); including non-fatal myocardial infarction (NFMI), cardiac death, and emergent coronary artery bypass grafting (CABG). The mid-term outcomes consisted of MACE, target vessel revascularization (TVR), and target lesion revascularization (TLR).

Results: Two patients in group I and 6 in group II suffered in-hospital MI (0.2 vs. 0.1%, p = 0.999). Both groups had the same rate of in-hospital death. With respect to the mid-term outcomes, a comparison between the two groups yielded the following results: NFMI: 2.2 vs. 1.0%, p < 0.001; CABG: 1.2 vs. 1.5%, p = 0.436; TVR: 2.0 vs. 2.6%, p = 0.205; TLR: 0.8 vs. 1.1%, p = 0.413; cardiac death: 1.4 vs. 0.3%, p < 0.001; and MACE: 4.3 vs. 3.5%, p = 0.199. The results, therefore, demonstrated that NFMI and cardiac death occurred more often in group I (> 65 years) at mid-term follow-up, whereas there were no statistically significant differences between the two groups in terms of TVR, TLR, CABG, and MACE.

Conclusion: The in-hospital outcomes were similar between the two groups. Those of advanced years (group I), however, had significantly higher NFMI and cardiac death rates than did the younger patients (group II) at mid-term follow-up.

Key words: percutaneous coronary intervention, mid-term outcomes, advanced age

Introduction

The recent advances in medical care and the resultant prolonged life expectancy have brought an increase in the number of older patients with coronary artery disease who require revascularization. In this regard, interventional cardiologists seem to favour the percutaneous approach as the treatment of choice in patients of advanced years [1]. There has been a whole host of research comparing the outcomes of percutaneous coronary intervention (PCI) in patients of different age groups [2], and investigators have taken a keen interest in delving into the differences between patients considered for PCI that are presumed to exert an impact on PCI outcomes: variables such as age [3], gender [4], obesity or waist circumference [5], consumption of statins [6], types of stents [7], and such known accepted risk factors as diabetes mellitus, hypertension, hyperlipidaemia, and smoking.

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Given that an in-depth understanding of the effects of the foregoing factors can help us predict the outcome of PCI more accurately and that advanced age is reputed to be an independent risk factor for adverse outcomes in candidates for PCI, it is regrettable that there is a paucity of data on the in-hospital and short-term outcomes of Iranian patients undergoing PCI with respect to their age. The present study, consequently, sought to investigate and compare the in-hospital and mid-term outcomes between two groups of patients (> 65 years old and ≤ 65 years old) treated with PCI in order to find out whether advanced age (> 65 years) could be considered a predisposing factor to non-fatal myocardial infarction (NFMI) and cardiac death in patients considered for PCI.

Methods

The study protocol was approved by the Ethics Committee of Tehran Heart Center according to the Declaration of Helsinki, revised in 2000.

This retrospective study was performed utilizing the PCI Registry of Tehran Heart Center. A registry of a single academic centre, the PCI Registry contains demographic, clinical and para-clinical features, risk factors, procedural details, and follow-up data.

A total of 5572 patients who underwent PCI at the centre between April 2003 and June 2005 were included and divided into two groups: group I was composed of 1318 patients over the age of 65, and group II was composed of 4254 patients ≤ 65 years old. There was a minimum period of nine months' follow-up after the intervention, and the outcomes of PCI were categorized as in-hospital and mid-term. These outcomes were compared between the two study groups.

The in-hospital outcome, defined as short-term MACE, consists of presence of cardiac death, non-fatal MI, and emergent coronary artery bypass grafting (CABG) within the hospitalization period, while the mid-term MACE consists of presence of cardiac death, NFMI, emergent coronary artery bypass grafting (CABG), target vessel revascularization (TVR), and target lesion revascularization (TLR) within the first nine months after PCI diagnosed by the cardiologist. The patients were clinically assessed at the 1st, 6th and 9th months and then annually up to 5 years after the PCI. After completion of the 9-month follow-up only the data of 340 cases were missing.

TVR was defined as ischaemia-driven repeat percutaneous intervention or bypass surgery of the target vessel. TLR was defined as ischaemia-driven repeat percutaneous intervention of the target lesion or bypass surgery of the target vessel [8].

Non-fatal MI event was defined as admission with data fulfilling ACC National Cardiovascular Data Registry diagnostic criteria followed by alive discharge from the hospital.

The clinical outcomes were obtained via clinical visits by cardiologists and/or research physicians. The subjects were followed by clinical and telephone interviews at the end of the 1st, 6th, and 9th month follow-up, and the data were then fed into the computerized database. The patients' baseline clinical angiographic, in-hospital outcomes, and/or procedural characteristics were obtained by research physicians and were subsequently entered into a computerized database by computer operators. Our PCI Registry contains the data on all the patients who have undergone PCI, and the data are routinely collected by cardiologists and trained general practitioners. The validity of all the data is checked by re--abstracting 10% of the entries of the patients and by re--entering 5% of the records of the patients.

Statistical analysis

The analyses were conducted using the SPSS package (SPSS Version 13; SPSS, Chicago, IL). Of the total of 5572 cases, 1318 (27%) patients were over 65 years of age. The baseline, procedural characteristics, and the clinical outcomes were compared between the two groups employing the chi-square test (and/or Fisher's exact test) for categorical variables and the unpaired t-test for continuous variables. Multivariable Cox regression model for comparing the 9-month MACE between the two groups in the presence of confounders was used. The association between age and outcomes in the final model was expressed as hazard ratio (HR) with 95% CI. A Kaplan-Meier time-to-event estimate was used to compare the log-rank test between the two groups. Statistical significance was considered as a p value < 0.05.

Results

The age range of the 5572 patients, enrolled between April 2003 and June 2005, was 14 to 93 years old. As age increased across the two study groups, so did the percentage of females (25.6% in group II vs. 38.3% in group I). Hypertension was the most prominent significant risk factor, and it was more frequent in the advanced-age group (34.2 vs. 51.4%, $p < 0.001$). Diabetes mellitus was not significantly associated with aging (Table 1). Group I was more likely to display a significant incidence of NFMI and cardiac death at 9-month follow-up than was group II (Table 3). In concordance with the global rates of average life expectancy, advanced age (older than 65 years) was an important predisposing factor to NFMI and cardiac death in our patients who were treated with PCI.

Angiographic characteristics

The elderly patients, as opposed to the younger ones, were more likely to have bare-metal stents implanted in the presence of a total occlusion in the left anterior

Table 1. Baseline clinical and demographic characteristics of patients (n = 5572)*

	Group I (n = 1318)	Group II (n = 4254)	p
Age	70.40 ± 4.26	52.04 ± 7.72	< 0.001
Male gender	813 (61.7)	3166 (74.4)	< 0.001
Hypertension	670 (51.4)	1444 (34.2)	0.001
Diabetes mellitus	310 (23.8)	933 (22.1)	0.205
Current smoker	113 (8.7)	999 (23.7)	0.001
Dyslipidaemia	599 (45.9)	2136 (50.6)	0.005
Family history	172 (13.3)	1167 (27.8)	< 0.001
Previous PCI	54 (4.1)	156 (3.7)	0.466
Previous CABG	52 (4.0)	113 (2.7)	0.015
Type of PCI			
Single Vessel	1038 (78.8)	3458 (81.3)	0.045
Multivessel	280 (21.2)	796 (18.7)	

* Data are expressed as mean ± SD or n (%)
Group I: patients > 65 years old, group II: patients ≤ 65 years old, CABG – coronary artery bypass grafting, PCI – percutaneous coronary intervention

Table 2. Procedural characteristics including treated vessels and angiographic success*

	Group I (n = 1318)	Group II (n = 4254)	p
Pure-number of involved vessels in angiography			
Single	1126 (85.4)	3781 (88.9)	0.003
Double	183 (13.8)	450 (10.6)	
Triple (≥ 3)	10 (0.8)	23 (0.5)	
Location of lesions			
Ostial	70	222	0.587
LAD	840	2742	0.776
LCX	140	367	0.355
RCA	268	923	0.196
Stent type used (DES/ BMS)			
Single stent (n = 5222)	DES: 37.5 (%) BMS: 62.5 (%)	DES: 41.9 (%) BMS: 58.1 (%)	0.007
Double stents (n = 1086)	DES: 23.3 (%) BMS: 76.7 (%)	DES: 28.3 (%) BMS: 71.7 (%)	0.056
Triple stents (n = 176)	DES: 25.0 (%) BMS: 75.0 (%)	DES: 17.5 (%) BMS: 82.5 (%)	0.005
Quadruple stents (n = 29)	DES: 14.3 (%) BMS: 85.7 (%)	DES: 18.2 (%) BMS: 81.8 (%)	0.006
Successful PCI	1270 (96.4)	4121(96.9)	0.356
Unsuccessful because of failure to pass the guide wire	27 (2.0)	76 (1.8)	0.537
Unsuccessful because of failure to pass the balloon	5 (0.4)	10 (0.2)	0.368
Unsuccessful because of failure to pass the stent	2 (0.2)	3 (0.1)	0.339

* Data are expressed as n (%)
Group I: patients > 65 years old, group II: patients ≤ 65 years old, LAD – left anterior descending, LCX – left circumflex, RCA – right coronary artery, DES – drug-eluting stent, BMS – bare-metal stent

descending coronary artery (Table 2). Advanced age was not significantly correlated with a higher risk of post--angioplasty re-stenosis (Table 2). The prevalence of extensive arteriosclerosis (2 and ≥ 3 vessels) in group I was not more frequent than that in group II. The number of lesions and/or vessels attempted rose in tandem with

Table 3. Outcomes of in-hospital and 9 months' follow-up*

	Group I (n = 1318)	Group II (n = 4254)	p
In-hospital outcomes			
Cardiac death	7 (0.6)	17 (0.4)	0.524
Non-fatal MI	2 (0.2)	6 (0.1)	0.524
Emergency cardiac surgery	0 (0)	3 (0.1)	0.999
MACE	9 (0.7)	26 (0.6)	0.774
Outcomes of the 9 months' follow-up			
Cardiac death	17 (1.4)	11 (0.3)	< 0.001
Non-fatal MI	27 (2.2)	38 (1.0)	< 0.001
CABG	14 (1.2)	57 (1.5)	0.436
TVR	24 (2.0)	103 (2.6)	0.205
TLR	10 (0.8)	43 (1.1)	0.413
MACE	52 (4.3)	137 (3.5)	0.199

* Data are expressed as n (%)

Group I: patients > 65 years old, group II: patients ≤ 65 years old, MI – myocardial infarction, MACE – major adverse cardiac events, CABG – coronary artery bypass grafting, TVR – target vessel revascularization, TLR – target lesion revascularization

Table 4. Comparison of major adverse cardiac events (MACE) between two age-groups (> 65 vs. Ł 65 years) in the presence of confounders by multivariable analysis

Variables	Hazard ratio	95% CI	p
Age	1.333	0.950-1.871	0.096
Sex	0.927	0.656-1.310	0.667
FH	1.463	1.058-2.024	0.021
CS	1.290	0.892-1.866	0.175
HTN	0.824	0.591-1.149	0.253
HLP	0.905	0.666-1.229	0.523
DM	1.456	1.023-2.073	0.037
Previous PCI	1.982	1.009-3.893	0.047
Previous CABG	1.233	0.579-2.627	0.587

CI – confidence interval, FH – family history, CS – current smoking, HTN – hypertension, HLP – hyperlipidaemia, DM – diabetes mellitus, PCI – percutaneous coronary intervention, CABG – coronary artery bypass grafting

age; nonetheless, the use of stenting and IIb/IIIa-receptor antagonists was similar between the two study groups.

In-hospital outcomes

The overall procedural success of PCI was similar between the two groups (96.4 vs. 96.9%, p = 0.356). The unadjusted in-hospital incidence of death (0.6 vs. 0.4%) and NFMI (0.2 vs. 0.1%) was similar between the groups (Table 3).

Outcomes of 9 months' follow-up

After adjustment for potential confounders including sex, hypertension, diabetes, hyperlipidaemia, family history, smoking, previous PCI, and previous CABG, there was found no statistically significant difference in the 9-month follow-up of MACE between the two groups (HR = 1.333, 95% CI 0.950-1.071; p = 0.096) as shows in Table 4; indeed, there was no significant trend toward an increase of MACE-free cumulative survival rate in the elderly group compared with the younger group at 9-month follow-up, which is demonstrated in Figure 1 and Figure 2 (log-rank test, $\chi^2 = 1.676$, p = 0.196).

Discussion

The last two decades have seen the frequency distribution of patients treated with PCI broaden considerably. The fact that there has also been a substantial rise in the percentage of the elderly Iranian population renders an appropriate characterization of the use and efficacy of PCI in this age group vital.

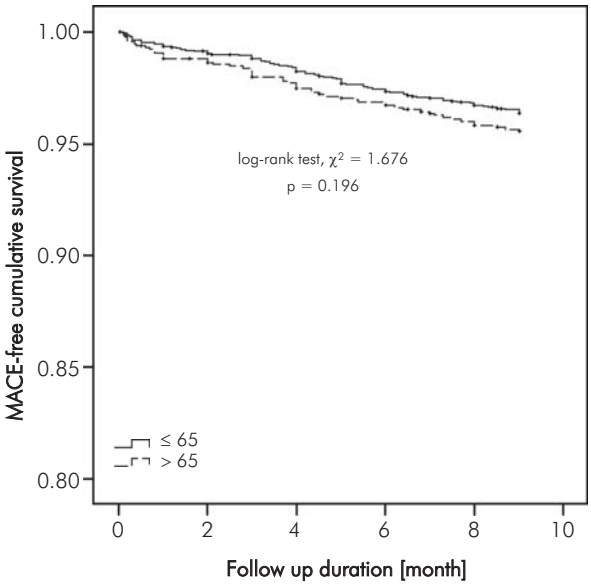

Figure 1. MACE-free cumulative survival between the two groups at 9-month follow-up

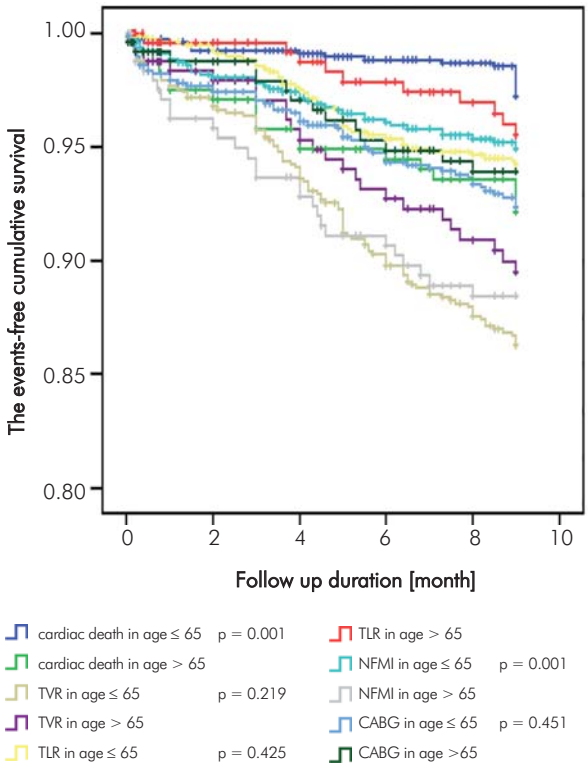

Figure 2. Event-free cumulative survival between the two groups at 9-month follow-up

Our overall results, drawn from 5572 patients who underwent PCI between 2003 and 2005 according to the Tehran Heart Center PCI Registry, demonstrated that the risk of in-hospital complications was almost equal in patients over and under 65 years of age.

However, we found a strong association between aging and post-PCI complications in the mid-term follow-up period. This finding is in contrast with that of the US National Heart, Lung, and Blood Institute Dynamic Registry (NHLBI) [9, 10], which reported earlier that there was no adequate evidence to suggest that advanced age could be allied with poorer survival in the year after PCI hospital discharge.

Procedural and in-hospital outcome

Our elderly subjects (> 65 years of age) at the time of PCI had more extensive cardiac and non-cardiac diseases than did our younger patients (≤ 65-years-old). The higher burden of atherosclerosis in the older patients was correlated with moderately more comprehensive revascularization attempted as well as more frequent dilation of stenosis in bypass grafts.

It is still controversial, however, whether in the presence of more complicated revascularization, older patients are more likely than younger ones to require novel adjunctive technologies such as stents and/or IIb/IIIa receptor antagonists. Given the differential clinical presentation and prevalence of co-morbid non-cardiac diseases despite comparatively similar treatment strategies, it is not surprising that advanced-age patients are predisposed to a higher incidence of in-hospital death, NFMI, and other complications.

The outcomes of the present study do not tally with those in the study by Batchelor et al. [11], who reported that the in-hospital risks for octogenarians undergoing PCI were considerably higher than those of younger patients and that the difference was fundamentally secondary to a higher prevalence of co-morbidities. It is worthy of note that other investigations of less favourable procedural outcomes examined in older and elderly populations have also pointed to adverse baseline characteristics [12, 13]. The discrepancies between our results and theirs could be attributable to the differences in the age of the subjects. It is important to note that the incidence of death, NFMI, and emergency CABG among PCI-treated patients has consistently fallen since the initial use of PCI in 1977 and that a cutback in adverse events has been detected among all patient age groups.

In the current study, the rates of angiographic success (almost all attempted lesions successfully treated) were high among both younger (≤ 65 years of age: 96.9%) and older (> 65 years old: 96.4%) patients. These rates show a noticeable rise in comparison with those in the 1985–1986 NHLBI Dynamic Registry with corresponding rates of 83% in patients aged < 65 years, 81% in patients between 65 and 74 years old, and 80% in patients ≥ 75

years of age [10]. The rates of emergency CABG were also notably lower than those in the NHLBI Dynamic Registry. The trend implies that newer technologies, as well as stents, have been beneficial to all age groups and that the higher risk of complications at mid-term follow--up, which continues among PCI-treated older subjects, is most likely the result of differential presenting profiles, both cardiac and non-cardiac in nature. The higher risk status of older and elderly patients, resulting from generally poorer health, is concordant with reports of longer lengths of hospital stay and admission site complications and infections among patients treated with PCI [14, 15].

Post-discharge outcome

There is a great deal of research in the existing literature reporting overall poorer procedural and in--hospital outcomes among older and/or elderly PCI--treated patients; be that as it may, there is a dearth of recent data on mid- to long-term results. Among 2,534 patients treated electively with stents, Abizaid et al. [16] recently discovered that aging could be an independent predictor of late death but not a predictor of TLR. Alfonso et al. [17] also discovered advanced age to be correlated with higher follow-up mortality rates despite a similar incidence of restenosis. Similarly, among 21,516 patients treated with percutaneous transluminal coronary angioplasty (PTCA) between 1980 and 1996, Taddei et al. [18] discovered that while aging had an independent effect on early and late survival after PTCA, it had a small effect on Q-wave MI.

The results of the present study indicated a strong positive relationship between aging and 9 months' mortality rates; nevertheless, our finding that the post-hospital discharge risk of cardiac death and NFMI after PCI was fundamentally unrelated to patients' age stands in sharp contrast to the foregoing investigations. So how can we explain this difference? One explanation may be the exclusion of subjects who had in-hospital deaths when measuring late deaths. Advanced age was not linked with an overall poorer in-hospital outcome, as well as lower rates of cardiac death and NFMI in our series, but the removal of in-hospital deaths precludes the 'double-counting' of deaths in the late (9 months') follow-up rates. Furthermore, we compared 9 months' cardiac death rates in terms of age with long--term probabilities of death in the US population reported in 1999 and discovered fundamentally dissimilar trends. In brief, aging is a potent predictor of risk of death; and despite having significant coronary artery disease, which necessitates coronary revascularization, elderly patients frequently have various other co-morbid statuses, and an important number of those who die do so as a direct consequence of non--cardiac reasons [19].

It is also posited that the crucial purpose of PCI in patients of all ages with obstructive coronary artery disease is to alleviate symptoms rather than increase the length of life. Hence, coronary revascularization researchers who intend to explore the long-term effect of aging on cardiac death should inquire into age-expected background rates of mortality and the often high competing risks of death of non-cardiac sources. Our analysis is not in line with a report from Singh et al. [20], who reported that long-term mortality rates among patients over 79 years old with primary angioplasty were significantly higher, whereas the long-term prognosis was not different from the age- and sex-adjusted mortality rates following successful angioplasty in the general population.

Conclusion

Although recent technological advances allow the treatment of more complex diseases in sicker patients, there remains a significant incremental risk of major adverse clinical events in older patients treated with PCI. In this retrospective study, in-hospital complications were not significantly different between our two groups of patients (group I: $>$ 65 years of age; group II: $\leq$ 65 years old). In contrast, however, the risk of cardiac death and NFMI in group I was higher than that of group II in the 9 months' follow-up period after PCI.

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