Original Article

Short-Term Outcomes and Mid-term Follow-up After Coronary Angioplasty in Patients Younger Than 40 Years of Age

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Abstract

Background: *Stenting is currently the standard of care in percutaneous coronary intervention (PCI). Whether young patients remain at increased risk after PCI in the present stent era has not been investigated widely. We evaluated angiographic characteristics and short- and mid-term outcomes in patients younger than 40 years of age who underwent PCI.*

Methods: *From April 2003 to March 2005, prospective data were collected in 118 consecutive patients, who were less than 40 years of age and underwent PCI at our referral center. The PCI outcomes in these patients were compared to those in 354 patients, randomly selected from 2493 patients older than 40 years of age in our database. Follow-up was scheduled at 1 month, 5 months, and 9 months through clinic visits, telephone interviews, and reviewing hospital records.*

Results: *Patients<40 years of age were more often male (91.5% vs. 71.8%, P<0.001), current smokers (33.9% vs. 15.2 %, P<0.001), and had more family history of coronary artery disease (38.1% vs. 21.8%, P<0.001) and myocardial infarction (44.1 vs. 31.1, p=0.01), while diabetes mellitus (6.8% vs. 22.1%, P<0.001), hypertension (13.6% vs. 35.3%, P<0.001), and hyperlipidemia (34.7% vs. 44.8%, P=0.055) were less common in these patients. There were no significant differences between the two groups regarding vessel involvement, reference vessel diameter, stenosis rate (before and after procedure), and lesion characteristics, with an exception that angulated lesions were more common in the patients≤ 40 years of age (P<0.05). The young patients, who underwent PCI, presented more frequently with single-vessel disease (61% vs. 46%, P=0.01).The vessel and lesion sites of PCI and clinical success rates were similar in these age groups. Usage of stent was high and similar, and drug- eluting stent use was not significantly different between the two groups. With a high procedural success (94.9% vs. 91.8%), intra-hospital and late complications were very low and similar in both groups.*

Conclusion: *Percutaneous coronary intervention is a safe and effective procedure for young patients, and major adverse cardiac events are similar in young and older patients.*

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Keywords: *Percutaneous coronary intervention • Young patients • Major adverse cardiac events*

Introduction

Specific characteristics of the natural history and presentation of coronary artery disease (CAD) in young patients make the choice of effective therapy particularly challenging.[1,2] Many young patients present with myocardial infarction without previous angina,[3] and in some there may be a prothrombic tendency.[3,4] Moreover, the natural progression

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of atherosclerosis is accelerated in part due to a high prevalence of risk factors.[5-7] Prior literature emphasizes that cigarette smoking, cocaine use, diabetes, and dyslipidemia are prominent risk factors in the development of early atherosclerosis.[2,8-12] Suboptimal results have been reported regarding medical therapy[13] or coronary bypass surgery[7,14] for the treatment of CAD in patients younger than 40 years of age showing poor long-term results, with a high rate of new coronary surgery and myocardial infarction in patients who had previous saphenous vein bypass graft implantation.[14] Several studies have shown that percutaneous transluminal coronary angioplasty (PTCA) in young patients with CAD could be a safe and successful alternative to medical or surgical therapy.[15-26] However, most of these studies date back to mid 1990s. The introduction and refinement of techniques for the implantation of coronary stents[27-30] coupled with ongoing developments in stent, balloon, and catheter technology resulted in dramatic changes in practice during the mid-1990s. Coronary stenting is well known to have contributed to the decrease in the rate of restenosis and improvement of early and late outcome of percutaneous angioplasty from the first randomized clinical trials.[31-34] There is limited published data regarding the results of percutaneous coronary intervention (PCI) in patients younger than 40 years of age in the stent era. The aim of this study was first to determine whether there were age-related differences in early and late outcomes in patients undergoing PCI in the current stent era; and, second, because to our knowledge there were no published data on the epidemiology of Iranian patients with premature atherosclerosis who underwent PCI, we sought to investigate the likely epidemiologic differences among our study population with premature (<40 years of age) CAD undergoing PCI as a representative of the Iranian population.

Methods

Patient population

The study population comprised 118 consecutive patients younger than 40 years of age who underwent elective or urgent PCI at our institution between April 2003 and March 2005. During this period, angioplasty procedures were performed in the patients. The age cut off of 40 years was used to identify young adult patients based on formerly accepted nomenclature.[35-36] The outcome of young patients was compared to that of 354 randomly selected patients out of 2493 patients aged 40 or more. Informed consent was obtained from all the patients.

Procedure and data collection

Baseline data were obtained from a computerized database of prospectively recorded clinical and procedural information during the in-hospital period and at follow-up on standardized forms. Hypercholesterolemia was defined as a total cholesterol level>200 mg/dl, a low density lipoprotein cholesterol level>130 mg/dl, or receiving cholesterol lowering treatment by the patient at present or past history. Procedural success was defined as <30% residual diameter stenosis, and clinical success was defined as procedural success without hospital complications (death, Q wave myocardial infarction, or target vessel revascularization). Target vessel revascularization was defined as the revascularization of the vessel formerly treated by PCI during the index hospitalization by a repeat percutaneous intervention or bypass surgery. Emergency coronary artery bypass grafting (CABG) was defined as CABG performed within 24 hours after the index percutaneous procedure. For all the patients, 12-lead electrocardiography was obtained prior and following intervention to detect procedure-related ischemic changes and or the appearance of a new pathologic Q wave on the surface electrocardiogram. After the procedure, all the patients were checked for creatine kinase MB enzyme sampling at 8 and 16 hours (normal values to 35 IU/L). The diagnosis of non Q wave MI was considered as creatine kinase MB elevation>3 times normal values in the absence of new pathologic Q waves on electrocardiograms following intervention.

Patient follow-up

Follow-up response rate at 9 months was 83% for the young (n=98) and ≥40 years of age patients (n=294). Data of the early outcomes and occurrence of death, new non-fatal MI, need for CABG, subsequent need for repeat PCI, and occurrence of angina in both groups were recorded. Follow-up was scheduled at 1 month, 5 months, and 9 months through clinic visits or, if patients were unable to come to the clinics, through telephone interviews, mailing, and reviewing hospital records.

Statistical analysis

Early outcomes (in-hospital period) after PCI, including procedural success, occurrence of death and non-fatal MI, and emergency CABG were compared between the two groups. Mid-term outcomes at 9 months after PCI, including mortality, stroke, ischemia-driven TVR, non-fatal MI, and recurrence of angina were also compared between the groups. Statistical analyses were performed with SPSS soft ware version 11.5 statistical package. Continuous variables were expressed as mean±1SD and categorical data as percentage. Statistical analyses were completed on the categorical variables using a chi-square, and comparisons of the continuous variables between the two groups were performed with t-tests. A p value of <0.05 was judged significant.

Results

Baseline characteristics

The baseline characteristics of the patients are listed in Table 1. PCI was performed in 118 patients younger than 40 years of age (108 men and 10 women), with a mean age of 35.21±3.7 years (range, 21 to 39 years). The young patients were more likely to be current smokers and to have a positive family history for CAD while there a significantly higher incidence of hypertension, diabetes and hyperlipidemia in the older group. There were no significant differences between the two groups in terms of the presenting symptom. Mean left ventricular ejection fraction in the patients<40 years of age was 50.39±8.55 vs. 53.09±9.01 in patients≥40 years of age (P=0.02).

Procedural characteristics

The procedural characteristics are presented in Table 2. As age increased, the number of patients with 2- and 3-vessel disease rose and the number with single vessel disease decreased (P=0.03). The analysis involved the treatment of 606 lesions (465 in older and 141 in younger patients) in 472 patients. The left anterior descending artery was dilated in about 65% of the patients in both groups. Stent usage was high and around 90% in both groups. Various stent types were used in both patient populations; however, the number of stents per patient, stent diameter after inflation, stent length, and pre and post stenting diameter stenosis were similar between the two age groups.

Table 1. Baseline clinical characteristics*

	Age<40 years (n=118)	Age≥40 years (n=354)	P value
age (yr)	35±4	56±9	<0.001
Male	91.5	71.8	<0.001
LVEF	50±9	53±9	0.02
LVEF<40%	11.8	5.6	NS
Prior bypass surgery	0.9	2.8	NS
Prior PCI	2.6	6.2	NS
Previous MI	44.1	31.1	0.01
Multi vessel disease	39.4	54.3	0.01
Unstable angina	21.3	23.3	NS
Risk factors			
Hypertension	13.6	35.3	<0.001
Diabetes mellitus	6.8	22.1	<0.001
Hypercholesterolemia	34.7	44.8	0.05
Current smoking	33.9	15.2	<0.001
Family history	38.1	21.8	<0.001

*Data are presented as mean±SD or percentages

LVEF, Left ventricular ejection fraction; PCI, Percutaneous coronary intervention; MI, Myocardial infarction; NS, Non-significant

Table 2. Qualitative angiographic lesion characteristics*

	Age<40 years (n=141)	Age≥40 years (n=465)	P value
Use of stent	92.9	87.5	NS
DES stent	16.3	11.6	NS
Artery treated			
Left main	-	-	-
Left anterior descending	67.8	60.7	NS
Left circumflex	20.3	27.1	NS
Right coronary artery	19.5	28	NS
Saphenous vein graft	-	-	-
Lesion characteristic			
Ostial	2.5	5.4	NS
Proximal	35.6	39.3	NS
Long	54.2	54	NS
Diffuse (Length>20mm)	22.9	26	NS
Bifurcation	10.2	7.6	NS
Eccentric	18.6	22.3	NS
Angulated	0.8	5.9	0.02
Calcified	1.7	1.1	NS
Evidence of thrombus	2.5	2.3	NS
Total	13.6	13.8	NS
AHA/ACC type			
B2	18.2	25.6	NS
C	38.2	32.7	NS
Procedure type			
Primary	2.1	3.7	NS
Adhoc	13.5	8	NS
Elective	84.4	88.4	NS

* Data are presented as percentages

DES, Drug-eluting stent; AHA/ACC, American heart association/ American college of cardiology

Major adverse cardiac events (MACE) outcomes

Procedural successes as well as in-hospital and 9-month follow-up MACE are shown in Table 3. Procedural success was high and nearly equal in both age groups. In-hospital mortality was similar in the young and older patients (0% vs. 0.3%, P=0.56).At mid-term follow-up, there was a higher incidence of younger patients needing CABG after PCI (4.1% vs. 1.4%, P=0.09), but it did not reach statistical significance. Incidence of death, non-fatal MI, and ischemic-driven TVR at 9 months was not statistically different between the two age groups. Combined MACE rate at 9 months was low and similar in both age groups (5.1% vs. 6.5%).

Revascularization and angina recurrence

Ischemia-driven TVR and recurrence of angina at 9 months' follow-up can be seen in Table 4. Multivariable analysis was performed to identify independent predictors of the composite of MACE at 9 months. Variables entered were sex, stent usage, diabetes mellitus, smoking, prior MI, and lesion treated. There was no statistically significant difference noted with any variable.

Table 3. In-hospital outcomes*

	Age<40 years (n=118)	Age ≥40 years (n=354)	P value
Procedural success	112 (94.9)	325 (91.8)	0.26
Procedural complications	8 (6.8)	25 (7.1)	0.91
Elastic recoil	1 (0.8)	2 (0.6)	0.073
Side branch occlusion	1 (0.8)	7 (2)	0.41
Dissection	6 (5.1)	13 (3.7)	0.49
Access site complications	0	1 (0.3)	0.56
Clinical success	109 (92.4)	313 (88.4)	0.22
Death	0	1 (0.3)	0.56
Q Wave MI	0	1 (0.3)	0.56
Non Q wave MI	0	3 (1)	0.30
Emergency CABG	0	0	
MACE	0	6 (1.7)	0.344

*Data are presented as n (%)

MI, Myocardial infarction; CABG, Coronary artery bypass graft; MACE, Major adverse cardiac events; NS, Non-significant

Table 4. Clinical outcomes at follow-up*

	Age<40 years (n=98)	Age ≥40 years (n=294)	P value
Follow-up duration (mo)	10.09±3.89	10.10±3.69	0.99
Death	0	6 (2)	0.15
Non-fatal MI	1 (1)	4 (1.4)	0.79
CABG	4 (4.1)	4 (1.4)	0.09
Ischemia driven TVR	4 (4.1)	9 (3.1)	0.62
Recurrence of angina	2 (2)	5 (1.7)	0.50
MACE	5 (5.1)	19 (6.5)	0.62
Target lesion angioplasty	0	5 (1.7)	0.19
Re PCI	0	4 (1.4)	0.24

*Data are presented as n (%) or mean±SD

MI, Myocardial infarction; CABG, Coronary artery bypass grafting; TVR, Target vessel revascularization; MACE, Major adverse cardiac events; PCI, Percutaneous coronary intervention

Discussion

We studied a consecutive series of young patients (<40 years of age) to estimate the impact of age on the early- and mid-term outcomes after PCI in the current stent era. As the practice of PCI has evolved over the last decade, outcomes of patients undergoing PCI have improved and advanced age has been shown to be an independent predictive factor for mortality.[37] Most of these data predate stent usage. In our study, the patients≥40 years old showed a non-significant trend toward slight increase in intra-hospital mortality and the procedural success was high and comparable in the young and older patients. These results may indicate that the practice of interventional cardiology has been altered. Coronary stents are widely used, and catheters and techniques have been improved. Alternative devices for lesion-specific treatment and new adjunctive medical therapy are available. In line with previously published studies of young patients with coronary artery disease,[2,5,13,15-17] our results show a greater incidence of history of previous myocardial infarction, high prevalence of single vessel disease, and a frequent incidence of coronary risk factors such as cigarette smoking and family history of coronary artery disease. As is depicted in Table 5, our immediate results are in concordance with those of previous reports[5,15-17] and confirm the high success rate (>94%) and low major complication rates (0%) of PCI in young adults. Interestingly, in our study, a non-significant trend towards increased need for CABG following PCI in patients<40 years of age was observed.

Table5. Outcomes of formerly published data regarding coronary angioplasty in young patients

	Age (yr)	No of patients	Primary success
Stone et al. [5]	<35	71	95
Simpfendorfer et al. [15]	<35	33	94
Glazier et al. [16]	<35	23	91
Colasante et al. [18]	<35	57	81
Kofflard et al. [19]	<35	57	92
Webb et al. [17]	<40	148	90
Buffet et al. [20]	<40	140	86
Ellis et al. [21]	<40	86	90
Hara et al. [22]	<40	45	91
Araujo et al. [23]	<40	66	96
Mehan et al. [24]	<40	89	90
Palomo villada et al. [25]	<40	30	93.75
Singhaviranon et al. [26]	<40	30	89

* Numbers in [ ] are reference numbers

The reason why the young patients had an increased incidence of CABG may be due to the fact that they had high risk factor profiles and more aggressive coronary artery disease. Diabetes and smoking have been shown to be particularly associated with a heightened cardiovascular mortality and morbidity in young patients.[38-39] There are several limitations to our study. We report a single center experience, possibly limiting generality of our results despite the fact that our institution is a referral center. The study group is relatively small to make the definitive conclusions, and the sample size may limit mortality data to reach Statistical significance. However, the characteristics of patients and rate of stenting are comparable to other reports. As the majority of our patients were elective procedures, this low risk subset of patients may justify low mortality rates. Finally as with any observational study, uncontrolled confounding factors could have affected our analysis of differences in outcomes.

Conclusion

In the current stent era, PCI in young adults has a high likelihood of success, with low morbidity and very low

mortality rates. Mid term survival is very satisfactory. However, young patients should not be dismissed at low risk on the basis of age alone, and emphasis should be focused on early detection and screening of risk factors in this group. In addition, more studies are needed to investigate long term outcomes of PCI in young patients in the current stenting era.

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