The Epidemiological and Clinical Characteristics of Patients Admitted for Coronary Angiography to Evaluate Ischemic Heart Disease

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Background : Most of the known risk factors associated with ischemic heart disease are based on studies from Western countries; there is only limited information on Korean populations. This study was designed to analyze age related differences in epidemiologic and clinical characteristics in patients who were admitted for coronary angiography for the evaluation of ischemic heart disease.

Methods : As part of the multicenter KCAR (Korean Coronary Artery disease Registry) Study, the clinical data of 6,549 patients, who were evaluated at the cardiac catheterization laboratory by coronary angiography, at seven university hospitals in Korea from March 1999 to December 2005, were registered into the KCAR database and analyzed. All patients were divided into three groups according to age: age ≤40, age 41-70 and age ≥71. All demographic and coronary angiographic features were analyzed for the different groups.

Results : The demographic data showed that compared to the older patients young patients ≤40 had a higher prevalence of males and smokers, but a lower prevalence of hypertension, diabetes and prior history of stroke and myocardial infarction. For the lipid profiles, the younger patients had much higher levels of total cholesterol, triglycerides and LDL-cholesterol than the older groups; however, there was no difference in the HDL-cholesterol levels among the three age groups. The most common component of the metabolic syndrome was obesity (79%) in the younger patients and hypertension (92%) in the older patients. The most common reason for presentation was ST-segment elevated myocardial infarction in the younger patients and unstable angina in the older patients.

Conclusions : Ischemic heart disease in younger adults ≤40 had different demographic characteristics and clinical presentation than older patients.

Key Words : Ischemic heart disease, Epidemiologic study characteristics

INTRODUCTION

Age-linked epidemiology of disease generally differs in prevalence, incidence and severity at presentation. The causes and outcome of coronary artery disease differ by age[1]. Younger patients <40 with an acute myocardial infarction have different clinical characteristics and a different prognosis than older patients[2]. Patients older than 70 have been shown to be at risk for overt coronary artery disease and for exercise- induced silent ischemia based on age alone even when asymptomatic[3]. Many risk factors have been identified for the development of ischemic heart disease (IHD) in elderly patients. In addition, the prevalence of IHD has been closely associated with sociodemographic, biological, psychological, and behavioral risk factors[4]. To date there is only limited information available on the clinical characteristics of ischemic heart disease in different age groups in the Korean population.

The KCAR (Korean Coronary Artery disease Registry) Study is a registry study initiated in 1999 to investigate the clinical characteristics of IHD in Korea. The purpose of the present study was to assess the differences in epidemiology, clinical characteristics and treatment modalities for IHD in Koreans based on age.

MATERIALS AND METHODS

Subjects

This study was a prospective, multicenter registry-based study performed from March 1999 to December 2005. The KCAR (Korean Coronary Artery disease Registry) Study was initiated in 1999 to determine and record the clinical characteristics of ischemic heart disease in the Korean population. Nationwide, seven university hospitals in Korea (Yeungnam University Hospital, Daegu: Chungnam University Hospital, Daejeon: Kyunghee University Hospital, Seoul: Chungbuk University Hospital, Cheongju: Chonnam University Hospital, Gwangju: Hanrim University Hospital, Seoul: Donga University Hospital, Busan) participated in this study. Research coordinators registered all patients, evaluated at the cardiac catheterization laboratory for the purpose of assessment or treatment of ischemic heart disease. This registry included all consecutive patients who had coronary angiography with one of the following: 1) evidence of myocardial ischemia on exercise electrocardiography (ECG) and myocardial perfusion scanning ; 2) induced coronary spasm with the ergonovine or acetylcholine provocation test 3) clinical evidence of myocardial infarction based on clinical symptoms, cardiac enzymes and ECG. The different patient diagnoses included syndrome X, variant angina, stable angina, unstable angina, ST-elevated MI (STEMI), and non-ST elevated MI (NSTEMI). All diagnoses were determined by expert consensus after review of the available clinical data. Patients with atypical chest pain and normal angiographic findings, without evidence of myocardial ischemia, were excluded from this study. On the day after admission, a detailed medical history was obtained from subjects and doctors and study coordinators performed a physical examination. The physical examination included height and weight recorded according to standard methods; the body mass index was calculated by weight (kg)/height (m)^2. The total serum cholesterol and triglyceride levels were measured by enzymatic calorimetric testing after overnight fasting on the day after admission. The low-density lipoprotein cholesterol was calculated using the Friedewald formula. A coordinator at each hospital entered data collected from each institution into a standardized computerized database provided by the KCAR committee. The data coordinators attended meetings four times a year; at the meetings, the study protocol was reviewed and discussed. From March 1999 to December 2005, 6,549 patients were registered into the database. All patients were divided into three groups according to age: young patients, ≤ 40 (n=134), middle-aged patients, 41-70 (n=4451) and older patients, ≥ 71 (n=1778). We compared the baseline clinical characteristics and angiographic findings among these groups.

Definitions

Based on the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC) VII guidelines, hypertension was defined as known hypertension or a blood pressure (BP) $\geq 140/90$ mmHg[5]. The diagnosis of diabetes mellitus was based on fasting plasma glucose levels ≥ 126 mg per dL (7.0 mmol per L) or two-hour postprandial plasma glucose (2hrPPG) readings ≥ 200 mg per dL (11.1 mmol per L)[6]. The metabolic syndrome was defined according to a modification of the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III)[7]. Since the cutoff values for the definition of obesity in Asian populations have been revised, the criteria for the metabolic syndrome was modified[8]. The metabolic syndrome was diagnosed if three or more of the following were present: (a) Obesity defined by a body mass index >25 kg/m^2 (b) hypertriglyceridemia if the TG ≥ 150 mg/dL (c) low HDL-C : HDL-C<40 mg/dL in men or <50 mg/dL in women (d) hypertension as known hypertension or a BP $\geq$ 130/85 mmHg and (e) dysglycemia was defined as known diabetes (DM) or a fasting plasma glucose ≥ 110 mg/dL. Cardiac syndrome X was present in patients with typical exertional chest pain, a positive response to stress testing and normal coronary angiograms.

Table 1. Baseline clinical characteristics

Group	Age ≤40 (n=134)	Age 41–70 (n=4451)	Age ≥71 (n=1778)	p-value
Age.yrs	36.34±4.39	59.10±7.62	76.38±4.69	
Sex,male(%)	114 (85.1)	3068 (68.9)	891 (50.1)	<.001
DM(%)	10 (7.5)	1132 (25.4)	445 (25.0)	<.001
Hypertension(%)	41 (30.6)	2185 (49.1)	1017 (57.2)	<.001
Smoking(%)	78 (58.2)	1772 (39.8)	444 (25.0)	<.001
Family Hx(%)	12 (9.0)	145 (3.3)	27 (1.5)	<.001
CVA Hx(%)	0 (0)	178 (4.0)	104 (5.8)	<.001
Previous MI(%)	4 (3.0)	196 (4.4)	103 (5.8)	.042
Previous PCI/CABG(%)	5 (3.7)	352 (7.9)	149 (8.4)	.156

DM, diabetes mellitus; HTN, CVA, cerebrovascular accident; MI, myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypsss graft; Hx, history.
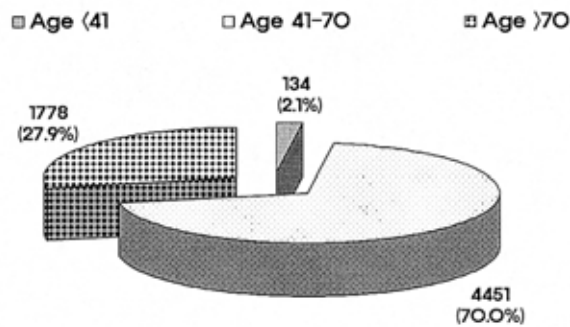
Figure 1. Age distribution of the study patients. About one third of the patients were older >70; patients <41 accounted for only 2.1%.
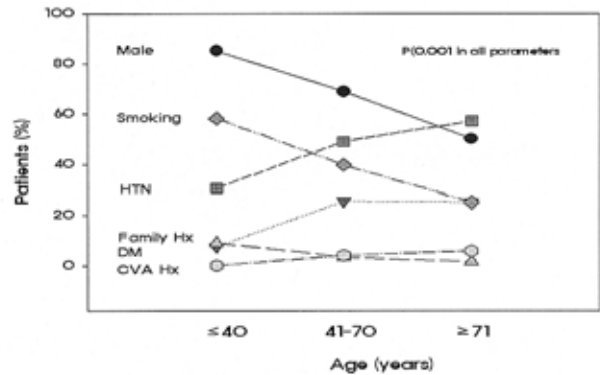

Figure 2. The prevalence of risk factors for ischemic heart disease. While younger patients showed a higher prevalence of male gender and smoking, older patients had a higher incidence of diabetes and hypertension. HTN, hypertension; DM, diabetes mellitus; CVA, cerebrovascular accident.

Statistical analysis

All data were described as means and standard deviation. To compare variables at three intervals, we performed one-way ANOVA and Scheffe's post-hoc test using the SPSS-PC 12.0 statistical package. A p-value less than 0.05 was considered significant.

RESULTS

Clinical characteristics

Of the 6,349 patients enrolled: 70% of the patients were in the 41–70 age group 2.1% in the ≤40 age group, and 27.9% in the ≥71 age group (Figure 1). The ≤40 age group had a higher number of males than the 41–70 and ≥71 age groups (85.1%, 68.9% and 50.1%, respectively, p<0.01). Furthermore, the 40 age group had a higher frequency of smoking and family history of ischemic heart disease than did the other groups (p<0.01, respectively). However, the over 41 age groups had a higher frequency of age-related risk factors such as diabetes mellitus, hypertension and stroke than did the ≤40 age group

(p<0.01, respectively) (Table 1) (Figure 2).

Lipid profiles and metabolic syndrome

Hypercholesterolemia defined as a serum total cholesterol 200 mg/dL or more was more common in the ≤40 age group than in the 41–70 and ≥71 age groups (49.4%, 37.3% and 31.5%, respectively, p<0.01). The levels of total cholesterol, triglycerides and LDL-C were significantly higher in younger patients than in the older patients. However, the HDL-C was not significantly different among the three groups (Table 2). To determine the frequency and contributing factors for the metabolic syndrome, all risk factors were identified and compared in the different groups; the metabolic syndrome for the total study population was identified in 55% of the ≤40, 66% of the 41–70 and 57% of the ≥71. The highest prevalence of the metabolic syndrome was in the middle age group (p<0.001) (Table 3). The frequency of contributing factors for the metabolic syndrome, according to age group was analyzed. In

**Table 2.** Lipid profiles and prevalence of hypercholesterolemia

Group	Age ≤40	Age 41-70	Age ≥71	p-value
T-CHO≥200	49.4%	37.3%	31.5%	<.001
T-CHO, mg/dL	198.68±55.41	189.42±40.75	181.57±38.15	<.001
TG, mg/dL	184.31±138.63	146.73±95.59	120.97±78.31	<.001
HDL-C, mg/dL	44.21±12.13	42.50±13.55	43.44±17.76	.164
LDL-C, mg/dL	127.81±53.89	119.49±37.76	115.62±36.01	.002

T-CHO, total cholesterol; TG, triglyceride; HDL-C, high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol

Table 3. Prevalence of the metabolic syndrome and each metabolic factor

Group	Age ≤40	Age 41-70	Age ≥71	p-value
BMI	25.75±3.89	25.14±3.08	23.89±3.37	<.001
Metabolic syndrome	55.0 %	65.5 %	57.3 %	<.001
Most common factor for metabolic syndrome	1, Obesity (79%) 2, HTN (79%) 3, HDL-C (67%) 4, Glucose (58%) 5, TG (46%)	1, HTN (90%) 2, Glucose (76%) 3, Obesity (72%) 4, HDL-C (71%) 5, TG (25%)	1, HTN (93%) 2, Glucose (80%) 3, HDL-C (77%) 4, Obesity (62%) 5, TG (18%)	

BMI, body mass index; HTN, hypertension, TG, triglyceride, HDL-C, low density lipoprotein cholesterol
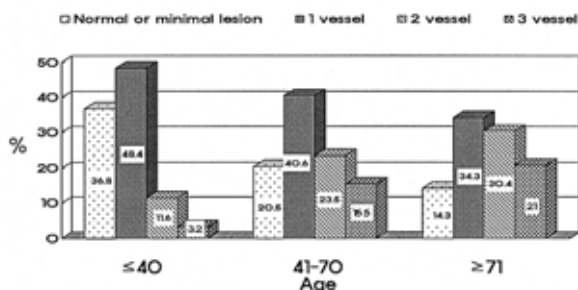
Figure 3. The distribution of the extent of coronary artery disease. Most of the younger patients showed minimal stenosis or significant stenosis in one vessel. Coronary atherosclerosis was extensive in older patients as revealed by the higher incidence of 2 or 3 vessel disease.
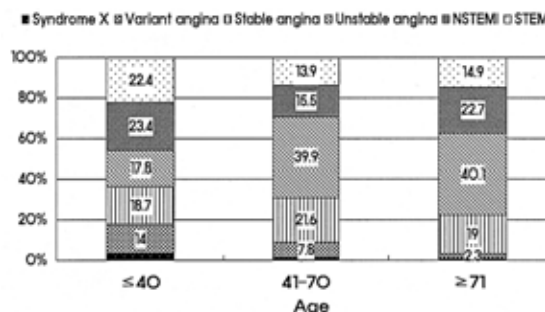

Figure 4. Distribution of clinical presentation of ischemic heart disease. Younger patients were more likely to present with myocardial infarction than older patients were. NSTEMI, non ST-segment elevated myocardial infarction; STEMI, ST-segment elevated myocardial infarction.

the ≤40 age group, obesity (79%) and hypertension (79%) were the most common contributing factors identified for the metabolic syndrome; hypertension and high fasting glucose were the most common contributing factors in the older age groups (Table 3).

Coronary angiographic findings, clinical presentation and treatment modalities

Coronary angiography showed normal or minimal stenosis in 37% and one vessel disease in 48% in the ≤40 age group. The prevalence of multivessel disease was dramatically increased with advancing age; 51% of the patients had more than two vessel disease in the ≥71 age group (Figure 3).

Young patients frequently presented with a myocardial infarction (MI), non-ST elevated MI (23%) and ST elevated MI (22%). However, older patients were most frequently admitted with unstable or stable angina (Figure 4). The treatment modalities were not different among the different age groups. About 13~ 14% of patients were treated by medication only. Percutaneous coronary intervention (PCI) was performed in more than 80% of the patients in each group. Coronary artery bypass graft surgery (CABG) was performed in 1.7% of all patients (Figure 5).
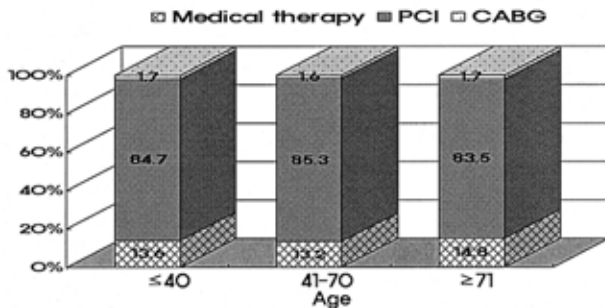
Figure 5. In-hospital management of significant coronary artery stenosis (≥=50 % diameter stenosis) by different ages (n=5150). The treatment strategies were similar for all age groups. About 84% of ischemic heart disease patients with significant stenosis of the coronary artery were treated with percutaneous coronary intervention. PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft surgery.

DISCUSSION

In this multicenter registry based study of 6,549 patients hospitalized for ischemic heart disease, we found age-related variations in epidemiologic characteristics and clinical presentation. This is the first large scale study evaluating the epidemiologic features of ischemic heart disease in the Korean population.

The age group of 65 and over is currently the fastest growing age group in Korea; ischemic heart disease is an age-related disease and its prevalence is increasing with the aging population. Race and socioeconomic status are also associated with the prevalence and clinical outcome of ischemic heart disease[9]. The risk factors associated with atherosclerotic disease are different in elderly patients when compared to younger patients[10]. However, currently we do not have sufficient data to assess the specific risk factors contributing to the development of ischemic heart disease in the Korean population. In this study, we analyzed epidemiologic and clinical data from patients with ischemic heart disease who were treated at seven Korean university hospitals.

We analyzed epidemiologic variables in three different age groups. For the younger patients we found a higher frequency of males than in the older patients; the gender differences equalized after 70, similar to the data from Western countries[11, 12]. The menopausal age of Korean women is on average 49[13]. This suggests that the antiatherogenic effects associated with female gender are no longer present by about 20 years after menopause. The smoking rate was 58% in the younger age group, and it dropped to 25% in the old patient group. Therefore, smoking is still a major risk factor for coronary artery disease in young Korean males. However, the older group showed a higher prevalence of age related diseases such as

hypertension and diabetes.

As for the lipid profiles, the younger patients had dyslipidemia more commonly than the older patients did. This may have been related to the higher incidence of obesity in the younger patients. This also suggests the possibility of a genetic predisposition related to the metabolic abnormalities observed in younger patients.

Recently, the clinical significance of the metabolic syndrome for the development of cardiovascular disease has been emphasized; the prevalence of metabolic components such as high blood sugar, obesity and hypertension are increasing in Korea. The incidence of the metabolic syndrome depends on the definition used[14, 15]. In this study, the definition introduced by the National Cholesterol Education Program (NCEP) Expert Panel was used[16]. The definition of obesity was modified according to the Asian criteria developed for the body mass index (BMI) ≥25 kg/m^2 [8]. It is well known that the prevalence of the metabolic syndrome, in the general population, varies based on race, gender and geographic region. The prevalence of the metabolic syndrome, in Korea, using the ATP III-BMI25 definition was reported to be 13%, based on Korean health data[17], which included 20.1% men and 23.9% women from the Korean nutritional health survey[18]. In this study, the prevalence of the different components of the metabolic syndrome differed by age group. For the less than 40 group, obesity was the most common contributing factor. However, for the older groups age-related factors such as hypertension and diabetes were the most frequent factors.

The angiographic severity of coronary artery disease appears to differ in younger patients compared to the older patients; the younger patients showed a preponderance of normal findings, minimal lesions or single-vessel disease. For the ≥71 age group there was a significantly higher prevalence of three-vessel disease, up to 21%.

Recently, with improvements in coronary intervention and surgical skills, treatment is available at any age. However, our data showed that older patients were less likely to undergo percutaneous coronary intervention or bypass surgery during their hospital admission[1, 19]; although the medical treatment options were similar for the different age groups. In routine clinical practice in Korea, about 84% of patients with ischemic heart disease and significant coronary artery stenosis have percutaneous coronary intervention.

The limitations of this study included the following: not all clinical parameters were routinely noted and the treating physician recorded most of the diagnostic criteria; since we intended to determine general patient patterns in Korea, site selection was not random.

In conclusion, the KCAR study provides important information on age-related trends in the epidemiologic characteristics of

ischemic heart disease in Korea. Coronary artery disease in younger adults showed different demographic characteristics and different clinical presentation compared to older patients.

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