

Prevalence of Asymptomatic Carotid Stenosis in Korea Based on Health Screening Population

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We attempted to investigate the prevalence and risk factors of carotid artery stenosis in Korea. Twenty thousand seven hundred twelve individuals who underwent carotid artery ultrasonography for health screening between March 2005 and March 2010 were retrospectively evaluated. The population was divided into four groups, according to the degree of stenosis, as Group A, below 29%; Group B, 30% to 49%; Group C, 50% to 74%; Group D, above 75%. The medical records of the individuals were investigated, and Fisher's exact test, chi-square tests, Kruskal-Wallis tests and a binary logistic regression model were used for statistical analysis. The prevalence of carotid stenosis was Group B, 5.5%; Group C, 0.9%; Group D, 0.1%. Old age, male gender, hypertension, diabetes mellitus and ischemic heart disease were significantly higher in Groups C and D ($P = 0.001$, 0.001 , 0.001 , 0.048 , and 0.001 , respectively). Among the males aged over 65 yr, the prevalence of carotid stenosis $\geq 50\%$ and $\geq 30\%$ were 4.0% and 18.2%, respectively. Asymptomatic carotid stenosis is not uncommon in Korea. Carotid ultrasonography is necessary for people with above-listed risk factors.

Key Words: Carotid arteries; Stenosis; Prevalence

INTRODUCTION

Internal carotid artery (ICA) atherosclerotic stenosis is responsible for a significant proportion of transient ischemic attacks (TIA) and approximately 30% of ischemic strokes (1). Population-based epidemiological studies using ultrasound have shown that the prevalence of asymptomatic carotid artery stenosis (CAS) $\geq 50\%$ varies between 4% and 8% in adults (2). The annual risk of ipsilateral neurologic deficits for asymptomatic CAS was published in several studies (2-8).

The screening of individuals with asymptomatic significant CAS is important to find the patients who need serial surveillance, medication, intervention or surgery. In Korea, however, the prevalence of CAS in the asymptomatic people has not been reported. The role of screening depends on the incidence of the disease in the population, and the subpopulation in which the screening has a cost-effective benefit must be identified.

In this study, we attempted to investigate the prevalence of asymptomatic CAS in Korea, and we wanted to identify the risk factors of CAS. We investigated the prevalence of CAS according to the subpopulation with a combination of risk factors.

MATERIALS AND METHODS

Twenty thousand seven hundred twelve neurologically asymptomatic people underwent carotid artery duplex ultrasound for

health screening between March 2005 and March 2010. We excluded the individuals with history of cerebrovascular accident or symptoms indicating TIA. The individuals' characteristics and degrees of CAS were retrospectively evaluated. The population was divided into four groups according to the degree of CAS with using real-time B-mode high resolution ultrasonography as group A, below 29% of CAS; Group B, 30% to 49% of CAS; Group C, 50% to 74% of CAS; Group D, above 75% of CAS. The medical records of all the individuals were investigated.

Duplex ultrasound was performed by radiologists or registered vascular technologists. And the carotid artery diameter was measured on a longitudinal and transverse view of the proximal ICA and carotid bifurcation on both sides. The intima-media thickness (IMT), the rate of diameter reduction and the peak systolic velocity in the internal carotid artery (just distal to the carotid bifurcation) were measured. The degrees of CAS were measured by the rate of diameter reduction according to the European Carotid Surgery Trial (ECST) method. Ultrasonography scanner equipped with 9-to-4-MHz linear-array transducer and a 5-MHz pulsed Doppler (SIEMENS, Antares, Germany) or a 10-MHz linear-array transducer and a 4.4-MHz pulsed Doppler (GE, LOGIQ 9, Waukesha, WI, USA) were used for duplex ultrasound.

To identify the risk factors of CAS, univariate analysis with Fisher's exact test, chi-square tests, Kruskal-Wallis tests and multivariate analysis with a binary logistic regression model was conducted using the individuals' demographics (age, gender) and

the clinical variables (hypertension, diabetes mellitus, ischemic heart disease, total cholesterol, HDL-cholesterol, LDL-cholesterol, HbA-1c). A total of 8,622 (41.6%) people did not provide information about their exact current status of smoking, so the history of smoking was excluded from the risk factor analysis. According to the subgroups with a combination of risk factors, we calculated the prevalence of CAS.

Ethics statement

This study was reviewed and approved by the institutional review board of the Samsung Medical Center (No. 2011-03-005). The board exempted informed consent because it was a retrospective study.

RESULTS

Table 1 demonstrates demographic and clinical characteristics of the study population. The mean age of the population was 55.1 yr (range: 18 to 91 yr) and 83% were male. The prevalence of CAS according to the degree of stenosis is shown in Table 2. The prevalence of CAS was 5.5% in Group B, 0.9% in Group C and 0.1% in Group D. The prevalence of CAS over 50% was 1% among the entire study population.

On univariate analysis (Table 3), CAS was more common in people aged over 65 yr ($P < 0.001$), males ($P < 0.001$), people with hypertension ($P < 0.001$), people with diabetes mellitus ($P < 0.001$) and people with ischemic heart disease ($P < 0.001$). The total

Table 1. The characteristics of the 20,712 study population

Characteristics	Findings
Mean age (yr) (range)	55.1 ± 9.0 (18-91)
Gender, male (%)	17,182 (83)
Hypertension (%)	6,281 (30.3)
Diabetes mellitus (%)	2,444 (11.8)
Cholesterolemia (%)	5,513 (26.6)
Ischemic heart disease (%)	1,106 (5.3)
Body mass index (BMI) (kg/m ²)	24.4 ± 2.6
Fasting blood sugar (FBS) (mg/dL)	97.4 ± 20.8
Total cholesterol (mg/dL)	193.7 ± 33.0
LDL-cholesterol (mg/dL)	128.6 ± 29.8
HDL-cholesterol (mg/dL)	53.6 ± 13.3
HbA1c (%)	5.6 ± 0.75

Table 3. Univariate analysis for the risk factors of carotid artery stenosis

Variables	Group A (< 30%)	Group B (30%-49%)	Group C (50%-74%)	Group D (75% ≤)	P value
Age (yr)	54	61	65	62	< 0.001*
Male (%)	15,984 (82.5)	1,015 (88.8)	167 (91.8)	16 (88.2)	< 0.001†
Hypertension (%)	5,579 (28.9)	590 (51.6)	102 (56)	10 (52.6)	< 0.001‡
Diabetes mellitus (%)	2,139 (11.0)	257 (22.5)	44 (24.2)	4 (21.1)	< 0.001†
Ischemic heart disease (%)	911 (4.7)	163 (14.3)	27 (14.8)	5 (26.3)	< 0.001†
TC (mg/dL)	192	188	184	188	0.003*
LDL-C (mg/dL)	125	124	117	124	0.042*
HDL-C (mg/dL)	51	49	49	50	0.001*

*Kruskal-Wallis; †Fisher's exact; ‡Chi-square. TC, total cholesterol; LDL-C, LDL-cholesterol; HDL-C, HDL-cholesterol.

cholesterol ($P = 0.003$) and LDL-cholesterol ($P = 0.042$) levels were higher in the people with CAS, and the HDL-cholesterol ($P = 0.001$) level was lower in the people with CAS.

On multivariate analysis (Table 4), the risk factors for CAS more than 50% were old age (OR, 1.11; 95% CI, 1.10-1.13), male gender (OR, 3.46; 95% CI, 2.12-5.66), hypertension (OR, 1.69; 95% CI, 1.25-2.28), diabetes mellitus (OR, 1.41; 95% CI, 1.00-1.99) and ischemic heart disease (OR, 1.93; 95% CI, 1.29-2.87).

Table 5 demonstrates the prevalence of CAS ≥ 50% according to the subpopulations with a combination of the risk factors. The prevalence of CAS ≥ 50% was 3.1% among the people aged over 65 yr, and it was 4.0% among males aged over 65 yr. It was 4.8% among males aged over 65 yr with hypertension, and it was 6.7% among males aged over 65 yr with hypertension and diabetes mellitus. It was 5.6% among males aged over 65 yr with hypertension, diabetes mellitus and ischemic heart disease. The prevalence of CAS ≥ 30% was 14.8%, 18.2%, 22.8%, 26.9% and 30.6% in each of the above subgroups, respectively.

DISCUSSION

The contribution of CAS to the overall stroke burden is difficult

Table 2. The prevalence of carotid artery stenosis

Degree of stenosis	No. (%)
Stenosis less than 50%	20,511 (99)
Group A (< 30%)	19,368 (93.5)
Group B (30%-49%)	1,143 (5.5)
Stenosis more than 50%	201 (1)
Group C (50%-74%)	182 (0.9)
Group D (≥ 75%)	19 (0.1)

Table 4. Multivariate analysis with binary logistic regression model for the risk factors of carotid artery stenosis (Stenosis < 50% vs 50% ≤ Stenosis)

Risk factors of carotid stenosis	P value	HR (95% C.I.)
Age > 65 yr old	0.001	1.11 (1.10-1.13)
Male	0.001	3.46 (2.12-5.66)
Hypertension	0.001	1.69 (1.25-2.28)
Diabetes mellitus	0.048	1.41 (1.00-1.99)
Ischemic heart disease	0.001	1.93 (1.29-2.87)
LDL-cholesterol	0.806	1.00 (1.00-1.00)
Cholesterolemia	0.156	1.25 (0.92-1.71)

Table 5. The incidence of carotid artery stenosis according to the subgroups

Subgroups	Group A (< 30%)	Group B (30%-49%)	Group C (50%-74%)	Group D (75% ≤)	Total
Overall					
No. (%)	19,368 (93.5)	1,143 (5.5)	182 (0.9)	19 (0.1)	20,712 (100)
Age > 65 yr old					
No. (%)	2,771 (85.1)	384 (11.7)	95 (2.9)	6 (0.2)	3,256 (100)
Age > 65 yr old, male					
No. (%)	1,838 (81.8)	320 (14.2)	86 (3.8)	4 (0.2)	2,248 (100)
Age > 65 yr old, male with hypertension					
No. (%)	817 (77.1)	191 (18.0)	51 (4.8)	-	1,059 (100)
Age > 65 yr old, male with hypertension and diabetes mellitus					
No. (%)	206 (73.0)	57 (20.2)	19 (6.7)	-	282 (100)
Age > 65 yr old, male with hypertension, diabetes mellitus and ischemic heart disease					
No. (%)	25 (69.4)	9 (25)	2 (5.6)	-	36 (100)

to approximate. Eighty-eight percent of strokes are ischemic, and 20% or fewer of these are due to large-artery stenosis (9-15). A subgroup of these has CAS, and CAS can be approached with endarterectomy or stenting. The screening of asymptomatic CAS followed by the best medical therapy or an invasive procedure is expected to reduce the risk of TIA and stroke in the general population.

The presence of CAS predisposes people to TIA and stroke, and the risk is correlated with the severity of CAS. For the people with 0 to 29% stenosis, TIA or stroke occurred in 2.1% each year. For the people with 30% to 74% stenosis, TIA or stroke occurred in 5.7%, and for the people with 75% to 100% stenosis, TIA or stroke occurred in 19.5% (16). O'Holleran reported that the 60% of the people with more than 75% stenosis had a stroke or TIA during 5 yr of follow-up (17). The reported risk of TIA or stroke in the people with asymptomatic CAS has varied, and the stroke risk depends on more than just the degree of carotid artery narrowing. Most studies consider stenosis of 50% or greater, or 60% or greater to be clinically important. In the randomized trials that have evaluated the role of carotid endarterectomy (CEA) in asymptomatic patients, the 5-yr risk of stroke in the individuals with CAS more than 60% was 11.0%-11.8% without performing CEA (18, 19).

Several population-based cohort and cross-sectional studies have examined the prevalence of CAS. The estimates of the prevalence of CAS from population-based studies have ranged from 0.5% to 8% (2, 11, 20-22). The prevalence of clinically important CAS (60% to 99%) is estimated to be about 1% in people aged over 65 yr (23). In our study, the prevalence of CAS more than 50% was 1% in the overall population. But with the combination of the risk factors, the prevalence was increased (Table 5). Especially in the male population aged over 65 yr, the prevalence of CAS more than 50% was 4%. The clinical importance of our study is that it is one of the first reports that have defined the prevalence of CAS in Korea based on a large population.

The CAS more than 50% is regarded as the indication for in-

tervention or surgery if it is accompanied by neurologic signs or symptoms or it shows an unfavorable morphology. If the degree of stenosis is less than 50%, then serial surveillance and medication are needed. As seen in the Table 5, the population who need serial surveillance and medication is high according to the combination of risk factors.

Medical therapy is recommended for the asymptomatic people with CAS less than 60%. Medical therapy can favorably alter the natural history of asymptomatic carotid disease. The role of aspirin or other antiplatelet agents in patients with asymptomatic carotid lesions has been established in several trials. The cut-off value of CAS that needs medical therapy has not been defined. But the high prevalence of CAS more than 30% was reported in our study, especially in the old male population. For example, in males aged over 65 yr, the incidence of CAS more than 30% was 18.2%. Medical therapy for these individuals with mild CAS can be expected to reduce the risk of cardiovascular events.

One of the purposes of carotid screening with duplex ultrasound is to find the population who are the potential candidates for surgical intervention. But the actual benefit of carotid screening followed by surgical intervention for the proper candidate has not been defined. Based on the results of our study, we calculated the benefit of carotid screening for the male population aged over 65 yr from the point of view of stroke prevention. The prevalence of CAS more than 50% was 4% in the males aged over 65 yr. In the 2004 Asymptomatic Carotid Surgery Trial (ACST), the 5-yr risk of stroke in the patients with CAS more than 60% was 11.8% without CEA. The relative risk reduction of CEA was 46% (19). From the data of the ACST, we regarded the 5-yr risk of stroke in the population with CAS more than 50% as roughly 10%, and the relative risk reduction of CEA as roughly 50%. With these suppositions, among the 1,000 males aged over 65 yr, carotid screening with duplex ultrasound can detect 40 patients with CAS more than 50%. Among them, 4 patients are potential victims of stroke within 5 yr. If CEA is performed in the proper can-

didates, then stroke can be prevented in 2 patients. Although this is not direct evidence of benefit of carotid screening with duplex ultrasound, it can be expected that carotid screening followed by CEA for the proper candidates can prevent at least 1 stroke per 1000 male population aged over 65 yr. There still is not direct evidence that screening adults with duplex ultrasound for asymptomatic CAS reduces fatal or nonfatal stroke (23). The actual benefit of carotid screening with duplex ultrasound and the cost-effectiveness must be defined in further studies.

This study was performed on the subjects who visited a tertiary medical center for routine health screening. So the subjects of this study may not be the real representatives of general Korean population. The study population may be biased by regional characteristics or socio-economic status. This is the limitation of this study.

In conclusion, asymptomatic CAS is not uncommon in Koreans. Carotid duplex ultrasound is necessary for people with risk factors such as male gender, old age, hypertension, diabetes and ischemic heart disease.

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AUTHOR SUMMARY

Prevalence of Asymptomatic Carotid Stenosis in Korea Based on Health Screening Population

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Carotid artery (CA) stenosis is responsible for a significant proportion of ischemic attacks in brain. In Korea, however, the prevalence of CA stenosis in the asymptomatic people has not been reported. We analyzed the health screening records of CA ultrasonography (20,712 cases) and found that the prevalence of CA stenosis > 50% was 1%. Old age, male gender, hypertension, diabetes mellitus and ischemic heart disease were significantly higher in CA stenosis group.