Metabolic Syndrome Is Associated With Venous Thromboembolism in the Korean Population

Moon Ju Jang, Won-il Choi, Soo-Mee Bang, Taeseung Lee, Yeo-Kyeoung Kim, Walter Ageno, Doyeun Oh

Background—The metabolic syndrome (MS) is a known risk factor for arterial thromboembolism. Preliminary reports have also suggested the association between MS and venous thromboembolism (VTE).

Methods and Results—In this case–control study, we investigated the association between MS and VTE in Korean patients. Patients with objectively diagnosed VTE and healthy control subjects underwent clinical assessment for the presence of MS according to the National Cholesterol Education Adult Treatment Panel III criteria modified with body mass index (WHO Asian Pacific Perspective, 2000). The presence of known risk factors for VTE was ascertained. Patients with VTE secondary to cancer were excluded. The prevalence of MS was compared between VTE group and controls. Two hundred eight VTE patients and 300 controls were assessed. VTE was idiopathic in 91 patients and secondary to a known risk factor in 117. The prevalence of MS was significantly higher in VTE patients (47.6%) than in controls (37.7%) (OR: 1.50; 95% CI: 1.05 to 2.15, $P=0.026$). After adjusting for age, sex, and smoking status, metabolic MS remained independently associated with VTE (OR: 1.56; 95% CI: 1.07 to 2.27, $P=0.020$). In the subgroup analysis, MS was also independently associated with idiopathic VTE (OR: 1.71; 95% CI: 1.04 to 2.81, $P=0.033$), but not with secondary VTE (OR: 1.43; 95% CI: 0.91 to 2.99, $P=0.121$). Multivariate analysis demonstrated that high BMI (OR: 1.70, 95% CI: 1.01 to 2.87), decreased HDL cholesterol (OR: 1.99, 95% CI: 1.17 to 3.39), and elevated fasting glucose levels (OR: 2.31; 95% CI: 1.35 to 3.94) were associated with idiopathic VTE.

Conclusion—MS is associated with VTE and in particular with idiopathic VTE in the Korean population. **(*Arterioscler Thromb Vasc Biol*. 2009;29:311-315.)**

Key Words: venous thromboembolism metabolic syndrome

Venous thromboembolism (VTE) and arterial thrombosis are usually considered as distinct disease entities because of their different anatomic location, risk factors, clinical presentation, and modalities for prevention and treatment. However, several recent studies have elucidated the association between VTE and atherosclerosis. The most important basis for this association is that VTE and atherosclerosis may share common risk factors including obesity, diabetes, hypertension, and hyperlipidemia.[1,2] A number of studies have consistently demonstrated that idiopathic VTE is associated with an increased risk of subsequent cardiovascular events[3,4] and that patients with idiopathic VTE have an increased prevalence of asymptomatic atherosclerotic lesions.[5]

The metabolic syndrome is a cluster of risk factors for atherosclerosis, including abdominal obesity, hypertension, insulin resistance, dyslipidemia with high triglycerides, and low high-density lipoprotein (HDL) cholesterol. A few recent studies have suggested that the metabolic syndrome may also be a risk factor for VTE in whites.[6–8]

The incidence of VTE in the Asian population has been generally found to be lower than in whites, but it appears to be rapidly increasing,[9–11] possibly because of the widespread adoption of a westernized lifestyle which also results in an increasing prevalence of the metabolic syndrome. Although the metabolic syndrome has become an important health concern in Asian countries, as much as it is in Western countries, the association between the metabolic syndrome and VTE has never been studied in Asian populations. To address this issue, we carried out a case–control study to investigate the association between the metabolic syndrome and VTE in a Korean population.

Received January 7, 2009; revision accepted January 15, 2009.

From the Department of Internal Medicine (M.J.J., D.O.), College of Medicine, Pochon CHA University, Sungnam, Korea; the Department of Internal Medicine (W.C.), College of Medicine, Keymyung University, Daegu, Korea; the Department of Internal Medicine (S.-M.), Seoul National University Bundang Hospital, Sungnam, Korea; the Department of Vascular Surgery (T.L.), Seoul National University Bundang Hospital, Sungnam, Korea; the Department of Internal Medicine (Y.-K.K.), College of Medicine, Chonnam National University, Kwangju, Korea; and the Department of Clinical Medicine (W.A.), University of Insubria, Varese, Italy.

Correspondence to Doyeun Oh, Department of Internal Medicine, College of Medicine, Pochon CHA University, Sungnam, Korea. E-mail dohl@cha.ac.kr or Walter Ageno, U.O. Medicinal Ospedale di Circolo, Vale Borri 57, 21100 Varese, Italy. E-mail agewal@yahoo.com

Arterioscler Thromb Vasc Biol **is available at http://atvb.ahajournals.org** **DOI: 10.1161/ATVBAHA.109.184085**

Table 1. Baseline Characteristics

	Total VTE (n=208)	*P* Values*	Idiopathic VTE (n=91)	*P* Values*	Secondary VTE (n=117)	*P* Values*	Controls (n=300)
Mean age, years (SD)	58.1 (16.2)	0.900	56.5 (15.7)	0.332	59.3 (16.5)	0.542	58.3 (13.0)
Male sex, n (%)	91 (43.8)	0.649	44 (48.4)	0.278	47 (40.2)	0.825	125 (41.7)
Family history of VTE, n (%)	4 (1.9)	0.028	1 (1.1)	0.233	3 (2.6)	0.022	0 (0.0)
Smokers, n (%)	57 (27.4)	0.088	26 (28.6)	0.117	31 (26.5)	0.238	62 (20.7)
Mean systolic BP, mm Hg (SD)	129.8 (20.5)	0.002	129.5 (19.0)	0.023	130.1 (21.7)	0.013	124.5 (16.5)
Mean diastolic BP, mm Hg (SD)	79.7 (12.1)	0.330	79.5 (11.8)	0.354	79.9 (12.4)	0.506	80.7 (10.9)
Mean TG, mg/dL^{-1} (SD)	140.8 (78.4)	0.955	153.5 (85.7)	0.281	130.9 (71.1)	0.297	141.2 (97.6)
Mean HDL, mg/dL^{-1} (SD)	47.3 (15.3)	0.001	46.2 (14.0)	0.001	48.2 (16.3)	0.002	53.5 (13.2)
Mean glucose, mg/dL^{-1} (SD)	124.8 (73.3)	0.001	118.9 (38.9)	0.001	129.3 (91.4)	0.001	103.8 (24.6)
Mean BMI, kg/m^{-2} (SD)	24.4 (5.1)	0.035	24.4 (3.6)	0.048	24.5 (6.0)	0.131	23.6 (3.2)
DM (%)	33 (15.9)	0.114	8 (8.8)	0.567	25 (21.4)	0.012	34 (11.3)
HTN (%)	82 (39.4)	0.005	31 (34.1)	0.235	51 (43.6)	0.002	82 (27.3)
Antilipidemic therapy with statins (%)	24 (11.5)	0.161	11 (12.1)	0.204	13 (11.1)	0.252	23 (7.7)
Antihypertensive therapy (%)	59 (28.4)	0.147	22 (24.2)	0.777	37 (31.6)	0.061	68 (22.7)

**P* value as the total VTE group, idiopathic VTE group, and secondary VTE group compared with control group.
BMI indicates body mass index; DVT, deep vein thrombosis; HDL, high-density lipoprotein; SD, standard deviation.

Patients and Methods

Study Population

The study was conducted between January 2006 and May 2008 by the Korean Deep Vein Thrombosis Working Party (KDVTWP). During this period, the 4 participating centers in KDVTWP enrolled consecutive Korean patients with recent (6 months) objective diagnosis of deep vein thrombosis (DVT) or pulmonary embolism (PE). VTE was defined as idiopathic or secondary depending on the presence or absence of any of the following risk factors: recent surgery (<3 months), recent trauma/fracture (<3 months), immobilization (>7 days), severe medical disease, pregnancy, use of oral contraceptives, and known hypercoagulable disease. VTE was classified as secondary if there was at least 1 of these risk factors. Patients with VTE secondary to known cancer were excluded from the study. The control group was selected among subjects visiting the Bundang CHA Health Promotion Center for periodic health examination. These were individuals who had no medical history of VTE or malignancy. The Institutional Review Board of Bundang CHA Hospital approved the research protocol and written informed consent was obtained from all participating individuals.

Methods

Data were recorded on computer-based case report form at each participating hospital and were submitted to a centralized coordinating center through a Korean DVT registry website (http://kdvt.chamc.co.kr). Patients' identities remain confidential because they are identified by unique numbers assigned by the study coordinating center. At regular intervals, data quality was monitored and documented electronically to detect inconsistencies or errors. The computer-based case report form comprised the following data of patients: age, sex, weight, height, body mass index (BMI), waist circumference, systolic and diastolic blood pressure, history of smoking, hypertension, diabetes mellitus, hyperlipidemia, current use of antihypertensive, antidiabetic drug and antilipidemic drugs, and laboratory results (serum fasting glucose, triglyceride, and HDL cholesterol).

The time interval between VTE event and physical measurement and blood collection had to be at least 6 months. Body weight was measured in light underwear by a precision scale to the nearest 0.5 kg, and body height was measured by a precision meter to the nearest 0.01 meter. BMI was calculated as body weight (kg) divided by the square of the height (m). The circumference of the waist was measured with a retractable steel tape, with the subject in the standing position, as described by Ashwell et al.[12] The waist measurement to be recorded was the smallest girth between the rib cage and the iliac crest. Blood pressure was measured in the right arm, with subject in the supine position after 10-minute rest by using a mercury sphygmomanometer of appropriate cuff size. Venous blood was drawn from an antecubital vein with plastic syringes after an overnight fast and was collected in polystyrene tubes and then glucose, HDL cholesterol, and triglycerides were determined in fresh plasma.

The presence of the metabolic syndrome in patients and controls was defined in accordance with the National Cholesterol Education Program (NCEP) Adults Treatment Panel III (ATP III) criteria[13] and modified with Asia–Pacific criteria for obesity based on BMI (≥25 kg/m^2) or waist circumference (≥90 cm for men, ≥80 cm for women).[14] BMI was used for participants with missing data on waist circumference to diagnose metabolic syndrome. In the presence of 3 or more of the following risk factors the metabolic syndrome was diagnosed: (1) elevated waist circumference: ≥90 cm in men, ≥80 cm in women, or BMI: ≥25 kg/m^2 in both sexes; (2) elevated triglycerides: ≥150 mg/dL or ongoing drug treatment for elevated triglycerides; (3) reduced HDL cholesterol: <40 mg/dL in men, <50 mg/dL in women or ongoing antilypidemic treatment; (4) elevated blood pressure: ≥130 mm Hg systolic blood pressure, ≥85 mm Hg diastolic blood pressure, or ongoing antihypertensive treatment; (5) elevated fasting glucose: ≥110 mg/dL or ongoing antidiabetic treatment.

Statistical Analysis

Statistical analyses were conducted by using SPSS 13.0. Differences between the group of VTE patients and controls were assessed using the Student *t* test. Categorical variables were compared using the chi-squared test. Logistic regression analyses were performed to select significant risk factor for VTE among components of metabolic syndrome. Multivariate analysis was performed to select independent risk factors for VTE among those clinical variables and components of metabolic syndrome using logistic regression analysis. Odds ratios and corresponding 95% confidence intervals were calculated. Statistical significance was determined to be $P<0.05$.

Results

Baseline Characteristics

Baseline characteristics of patients with VTE and controls are shown in Table 1. A total of 208 patients with VTE and 300

Table 2. Association Between the Metabolic Syndrome and VTE

	Prevalence of Metabolic Syndrome (%)	Unadjusted OR (CI)	*P* Values	Adjusted* OR (CI)	*P* Values
Total VTE	99/208 (47.6)	1.50 (1.05–2.15)	0.026	1.56 (1.07–2.27)	0.020
Idiopathic VTE	44/91 (48.4)	1.55 (0.97–2.49)	0.070	1.71 (1.04–2.81)	0.033
Secondary VTE	55/117 (47.0)	1.47 (0.95–2.26)	0.081	1.43 (0.91–2.99)	0.121
Controls	113/300 (37.7)				

*Adjusted by age, sex and smoke.
OR indicates odds ratio; CI, confidence interval; VTE, venous thromboembolism.

controls were enrolled in the study. Of VTE patients, 74 (35.6%), 66 (31.7%), and 68 (32.7%) patients were diagnosed as having isolated DVT, DVT with PE, and isolated PE, respectively. VTE was idiopathic in 91 patients and secondary to a known risk factor in 117. Among components of the metabolic syndrome, systolic blood pressure and serum glucose levels were significantly higher in patients with VTE and also in the subgroups of patients with idiopathic or secondary VTE than in controls. Also, mean HDL cholesterol levels were significantly lower in all VTE populations than in controls. Conversely, diastolic blood pressure and triglyceride levels were not statistically different among the groups. BMI was significantly higher both in patients with all VTE and idiopathic VTE than that in controls. At the time of study enrollment, 24 (11.5%) VTE patients and 23 (7.7%) controls were receiving therapy with statins, and 59 (28.4%) VTE patients and 68 (22.7%) controls were receiving therapy with antihypertensive drugs.

Prevalence of the Metabolic Syndrome

The prevalence of the metabolic syndrome was 47.6% in patients with VTE, 48.4% in patients with idiopathic VTE, 47.0% in patients with secondary VTE, and 37.7% in controls (Table 2). In multivariate analysis, after adjusting for age, sex, and smoking status in the comparison between idiopathic and secondary VTE and controls, the prevalence of the metabolic syndrome was significantly higher in VTE patients than in controls (OR: 1.56; 95% CI: 1.07 to 2.27) and in the subgroup of patients with idiopathic VTE than in controls (OR: 1.71; 95% CI: 1.04 to 2.81). There was no statistically significant difference between patients with secondary VTE and controls (OR: 1.43; 95% CI: 0.91 to 2.99).

Association Between the Individual Components of the Metabolic Syndrome and VTE

In univariate analysis, the prevalences of decreased HDL cholesterol levels and increased glucose levels were significantly more frequent in the population of VTE patients (OR: 2.30; 95% CI: 1.59 to 3.33, and OR: 3.04; 95% CI: 2.06 to 4.50), and in the populations of patients with idiopathic VTE (OR: 2.07; 95% CI: 1.28 to 3.36, and OR: 2.51; 95% CI: 1.52 to 4.17) or secondary VTE (OR: 2.49; 95% CI: 1.60 to 3.86, and OR: 3.52; 95% CI: 2.23 to 5.57) than in controls. The prevalence of high BMI was significantly more frequent in the population of patients with VTE (OR: 1.67; 95% CI: 1.16 to 2.41) than in controls. In multivariate analysis, after adjusting for components of the metabolic syndrome, age, sex, and smoking status, decreased HDL cholesterol levels, and increased glucose levels remained independently associated with total VTE (OR: 2.31; 95% CI: 1.54 to 3.47, and OR: 2.88; 95% CI:1.90 to 4.36, respectively), idiopathic VTE (OR: 1.99; 95% CI: 1.17 to 3.39, and OR: 2.31; 95% CI: 1.35 to 3.94, respectively), and secondary VTE (OR: 2.73; 95% CI: 2.14 to 5.80, and OR: 3.52; 95% CI: 2.16 to 5.80, respectively), whereas increased BMI was independently associated with total VTE (OR: 1.54; 95% CI: 1.03 to 2.29) and idiopathic VTE (OR: 1.70; 95% CI: 1.01 to 2.87), but not with secondary VTE (OR: 1.38; 95% CI: 0.84 to 2.26).

Discussion

This is the first study to demonstrate an association between the metabolic syndrome and VTE in an Asian population. In particular, patients with idiopathic VTE, but not with secondary VTE had a significantly higher prevalence of the metabolic syndrome than healthy control subjects. Among the components of metabolic syndrome, high BMI, decreased HDL cholesterol levels, and increased glucose levels were independently associated with idiopathic VTE.

The results of the present study are consistent with the results of previous studies conducted in white populations. The association between the metabolic syndrome and VTE was suggested for the first time by Ageno et al.[8] Two subsequent case–control studies[6,7] showed similar findings. Ageno et al observed a significantly greater prevalence of the

Table 3. Univariate Analysis Examining the Components of the Metabolic Syndrome

	Total VTE (n=208)	OR (95% CI)	Idiopathic VTE (n=91)	OR (95% CI)	Secondary VTE (n=117)	OR (95% CI)	Controls (n=300)
BMI ≥25 kg/m^2, n (%)	90 (43.3)	1.67 (1.16–2.41)	43 (47.3)	1.44 (0.90–2.31)	47 (40.2)	1.47 (0.95–2.29)	94 (31.3)
BP ≥130/85 mm Hg, n (%)	112 (53.8)	1.34 (0.94–1.91)	50 (54.9)	1.38 (0.86–2.20)	62 (53.0)	1.27 (0.83–1.95)	141 (47.0)
TG ≥150 mg/dL, n (%)	67 (32.2)	1.07 (0.73–1.57)	38 (41.8)	1.62 (1.00–2.63)	29 (24.8)	0.75 (0.46–1.21)	92 (30.7)
HDL cholesterol <40/50 mg/dL, n (%)	99 (47.6)	2.30 (1.59–3.33)	41 (45.1)	2.07 (1.28–3.36)	58 (49.6)	2.49 (1.60–3.86)	85 (28.3)
Glucose ≥110 mg/dL, n (%)	92 (44.2)	3.04 (2.06–4.50)	36 (39.6)	2.51 (1.52–4.17)	56 (47.9)	3.52 (2.23–5.57)	62 (20.7)

OR indicates odds ratio; CI, confidence interval; VTE, venous thromboembolism; BMI, body mass index; BP, blood pressure; TG, triglycerides; HDL, high-density lipoprotein.

Table 4. Multivariate Analysis Examining the Components of the Metabolic Syndrome

	Total VTE	OR (95% CI)	Idiopathic VTE	OR (95% CI)	Secondary VTE	OR (95% CI)	Controls
Mean age, years (SD)	58.1 (16.2)	0.99 (0.98–1.00)	56.5 (15.7)	0.99 (0.97–1.01)	59.3 (16.5)	0.78 (0.44–1.40)	58.3 (13.0)
Male sex, n (%)	91 (43.8)	0.95 (0.59–1.52)	44 (48.4)	1.19 (0.65–2.20)	47 (40.2)	0.99 (0.97−1.01)	125 (41.7)
Smokers, n (%)	57 (27.4)	1.64 (0.97–2.75)	26 (28.6)	1.32 (0.67–2.58)	31 (26.5)	1.82 (0.96–3.45)	62 (20.7)
BMI ≥25 kg/m^2, n (%)	90 (43.3)	1.54 (1.03–2.29)	43 (47.3)	1.70 (1.01–2.87)	47 (40.2)	1.38 (0.84–2.26)	94 (31.3)
BP ≥130/85 mm Hg, n (%)	112 (53.8)	1.17 (0.79–1.73)	50 (54.9)	1.19 (0.72–1.99)	62 (53.0)	1.23 (0.76–1.99)	141 (47.0)
TG ≥150 mg/dL, n (%)	67 (32.2)	0.75 (0.49–1.15)	38 (41.8)	1.13 (0.66–1.94)	29 (24.8)	0.50 (0.29–0.87)	92 (30.7)
HDL cholesterol <40/50 mg/dL, n (%)	99 (47.6)	2.31 (1.54–3.47)	41 (45.1)	1.99 (1.17–3.39)	58 (49.6)	2.73 (2.14–5.80)	85 (28.3)
Glucose ≥110 mg/dL, n (%)	92 (44.2)	2.88 (1.90–4.36)	36 (39.6)	2.31 (1.35–3.94)	56 (47.9)	3.52 (2.16–5.80)	62 (20.7)

OR indicates odds ratio; CI, confidence interval; VTE, venous thromboembolism; BMI, body mass index; BP, blood pressure; TG, triglycerides; HDL, high-density lipoprotein.

metabolic syndrome in patients with idiopathic DVT than in those with secondary DVT and in matched controls. The prevalence of the metabolic syndrome in our study and in the Italian study are quite similar: 48.4% and 50.5%, respectively, in the population of patients with idiopathic VTE and 37.7% and 34.6%, respectively, in controls. Conversely, the prevalence of the metabolic syndrome in patients with secondary VTE was higher in our study (47.0%) than in the Italian study (27%). In the study by Ay et al, the prevalence of the metabolic syndrome was lower both in cases and controls as compared to our study, but the association between the metabolic syndrome and recurrent VTE was statistically significant.[6] These discrepant prevalences of metabolic syndrome among studies are attributed to variable sample sizes and different definition of metabolic syndrome among studies. Finally, Ambrosetti et al have shown in an observational case–control study that the presence of the metabolic syndrome significantly increased the risk of VTE after acute cardiac events.[7] The multiple adjusted odds ratio of the 4 case–control studies were quite similar, being 1.94 (95% CI: 1.04 to 3.63), 2.20 (95% CI: 1.10 to 4.30), and 2.38 (95% CI: 1.64 to 3.12), respectively in previous studies and 1.71 (95% CI: 1.04 to 2.81) in our study (Table 5). This is interesting given the different ethnicities of the studied populations. All previous case–control studies were conducted in whites, whereas our study was conducted in Asian patients only. The metabolic syndrome is an increasingly common disease both in Western Europe and in South Korea. On the other hand, it is usually conceived that the incidence of VTE is lower in the Asian population than in whites, although recent studies carried out in Asian patients undergoing major orthopedic surgery have shown that VTE rates at least for what concerns postsurgical VTE are quite similar.[15] Indeed, the prevalence of some risk factors such as inherited thrombophilia is clearly different between whites and Asians.[16,17] The metabolic syndrome may be a common risk factor for VTE in Asian and in whites and may at least partially explain the observed increase in the rate of VTE in Asian patients.[9,18] Among components of the metabolic syndrome, we found high BMI (OR 1.70; 95% CI: 1.01 to 2.87), decreased HDL cholesterol levels (OR: 1.99; 95% CI: 1.17 to 3.39), and increased glucose levels (OR: 2.31; 95% CI 1.35 to 3.94) to be independently associated with idiopathic VTE. Conversely, Ageno et al reported that waist circumference (OR 4.62; 95% CI: 2.06 to 10.38) and triglycerides (OR: 2.59; 95% CI: 1.27 to 5.29) were independently associated with idiopathic DVT.[8] Further research needs to elucidate potential ethnic differences in the role of other cardiovascular risk factors.

Recently, two similar population-based cohort studies aimed to clarify the nature of the association between atherosclerosis and VTE.[19,20] In these studies, the authors demonstrated that subclinical atherosclerosis itself is not a risk factor for VTE. Taken together, we may consider atherosclerosis as an additive factor rather than an independent risk factor for VTE possibly because of underlying biological links between atherosclerosis and VTE.

The results of our study corroborate the evidence that patients with VTE, especially patients with idiopathic VTE, should also be carefully assessed for their risk of atherosclerosis. Whether the detection of cardiovascular risk factors and the application of appropriate lifestyle changes and medications will reduce the risk of cardiovascular disease and recurrent VTE in this patient population will need to be carefully addressed in future studies.

Table 5. Summary of Clinical Studies About Association Between Metabolic Syndrome and VTE

		Prevalence of Metabolic Syndrome (%)		
Investigators	VTE Patients (No.)	Patients	Controls	Adjusted OR (95% CI)
Ageno et al[8]	93	47/93 (50.5)	37/107 (34.6)	1.94 (1.04–3.63)
Ay et al[6]	116	40/116 (35)	26/129 (20)	2.20 (1.10–4.30)
Ambrosetti et al[7]	86	44/86 (51)	29/95 (30)	2.38 (1.64–3.12)
Present study	208	99/208 (47.6)	113/300 (37.7)	1.56 (1.07–2.27)

MS indicates metabolic syndrome; OR, odds ratio; CI, confidence interval; VTE, venous thromboembolism.

This study has several limitations. First of all, control subjects were selected from a group of asymptomatic healthy individuals in whom the diagnosis of VTE was not excluded using objective methods. There is a possibility that a few patients with asymptomatic VTE were selected to represent control subjects. However, the likelihood of missing a number of asymptomatic VTE events to sufficiently interfere with our findings is extremely low. Second, we defined the metabolic syndrome in accordance with the NCEP ATP III criteria modified with the Asia–Pacific criteria for obesity based on BMI (≥25 kg/m2) or waist circumference (≥90 cm for men, ≥80 cm for women). Therefore, we should use caution when comparing our results with the results of previous studies that used the unmodified NCEP definition. Third, patients with idiopathic VTE were not completely investigated for the presence of occult malignancy in our study. Therefore we may have misclassified some patients with secondary risk factor for VTE as patients with idiopathic VTE. However, the influence on our results is likely low.

In conclusion, patients with idiopathic VTE have a significantly higher prevalence of the metabolic syndrome than healthy controls in the Korean population. The metabolic syndrome might play a pathogenetic role in idiopathic VTE.

Acknowledgments

This work was supported by the research fund from the Korean Ministry of Science and Technology (R01-2006-000-10654-0).

Disclosures

None.

References

1. Ageno W, Becattini C, Brighton T, Selby R, Kamphuisen PW. Cardiovascular risk factors and venous thromboembolism: a meta-analysis. *Circulation*. 2008;117:93–102.
2. Cushman M. Epidemiology and risk factors for venous thrombosis. *Semin Hematol*. 2007;44:62–69.
3. Prandoni P, Ghirarduzzi A, Prins MH, Pengo V, Davidson BL, Sorensen H, Pesavento R, Iotti M, Casiglia E, Iliceto S, Pagnan A, Lensing AW. Venous thromboembolism and the risk of subsequent symptomatic atherosclerosis. *J Thromb Haemost*. 2006;4:1891–1896.
4. Becattini C, Agnelli G, Prandoni P, Silingardi M, Salvi R, Taliani MR, Poggio R, Imberti D, Ageno W, Pogliani E, Porro F, Casazza F. A prospective study on cardiovascular events after acute pulmonary embolism. *Eur Heart J*. 2005;26:77–83.
5. Prandoni P, Bilora F, Marchiori A, Bernardi E, Petrobelli F, Lensing AW, Prins MH, Girolami A. An association between atherosclerosis and venous thrombosis. *N Engl J Med*. 2003;348:1435–1441.
6. Ay C, Tengler T, Vormittag R, Simanek R, Dorda W, Vukovich T, Pabinger I. Venous thromboembolism–a manifestation of the metabolic syndrome. *Haematologica*. 2007;92:374–380.
7. Ambrosetti M, Ageno W, Salerno M, Pedretti RF, Salerno-Uriarte JA. Metabolic syndrome as a risk factor for deep vein thrombosis after acute cardiac conditions. *Thromb Res*. 2007;120:815–818.
8. Ageno W, Prandoni P, Romualdi E, Ghirarduzzi A, Dentali F, Pesavento R, Crowther M, Venco A. The metabolic syndrome and the risk of venous thrombosis: a case-control study. *J Thromb Haemost*. 2006;4:1914–1918.
9. Sakon M, Maehara Y, Yoshikawa H, Akaza H. Incidence of venous thromboembolism following major abdominal surgery: a multi-center, prospective epidemiological study in Japan. *J Thromb Haemost*. 2006;4:581–586.
10. Lee LH, Gu KQ, Heng D. Deep vein thrombosis is not rare in Asia–the Singapore General Hospital experience. *Ann Acad Med Singapore*. 2002;31:761–764.
11. Kobayashi T, Nakamura M, Sakuma M, Yamada N, Sakon M, Fujita S, Seo N. Incidence of pulmonary thromboembolism (PTE) and new guidelines for PTE prophylaxis in Japan. *Clin Hemorheol Microcirc*. 2006;35:257–259.
12. Ashwell M, Chinn S, Stalley S, Garrow JS. Female fat distribution-a simple classification based on two circumference measurements. *Int J Obes*. 1982;6:143–152.
13. Executive Summary 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). *JAMA*. 2001;285:2486–2497.
14. Steering Committee of the WHO Western Pacific Region, IASO & IOTF. The Asia–Pacific perspective: redefining obesity and its treatment, Australia, 2000.
15. Piovella F, Wang CJ, Lu H, Lee K, Lee LH, Lee WC, Turpie AG, Gallus AS, Planes A, Passera R, Rouillon A. Deep-vein thrombosis rates after major orthopedic surgery in Asia. An epidemiological study based on postoperative screening with centrally adjudicated bilateral venography. *J Thromb Haemost*. 2005;3:2664–2670.
16. Miyata T, Kimura R, Kokubo Y, Sakata T. Genetic risk factors for deep vein thrombosis among Japanese: importance of protein S K196E mutation. *Int J Hematol*. 2006;83:217–223.
17. Jun ZJ, Ping T, Lei Y, Li L, Ming SY, Jing W. Prevalence of factor V Leiden and prothrombin G20210A mutations in Chinese patients with deep venous thrombosis and pulmonary embolism. *Clin Lab Haematol*. 2006;28:111–116.
18. Liew NC, Moissinac K, Gul Y. Postoperative venous thromboembolism in Asia: a critical appraisal of its incidence. *Asian J Surg*. 2003;26:154–158.
19. Reich LM, Folsom AR, Key NS, Boland LL, Heckbert SR, Rosamond WD, Cushman M. Prospective study of subclinical atherosclerosis as a risk factor for venous thromboembolism. *J Thromb Haemost*. 2006;4:1909–1913.
20. van der Hagen PB, Folsom AR, Jenny NS, Heckbert SR, O'Meara ES, Reich LM, Rosendaal FR, Cushman M. Subclinical atherosclerosis and the risk of future venous thrombosis in the Cardiovascular Health Study. *J Thromb Haemost*. 2006;4:1903–1908.

Arteriosclerosis, Thrombosis, and Vascular Biology

JOURNAL OF THE AMERICAN HEART ASSOCIATION

Metabolic Syndrome Is Associated With Venous Thromboembolism in the Korean Population

Moon Ju Jang, Won-il Choi, Soo-Mee Bang, Taeseung Lee, Yeo-Kyeoung Kim, Walter Ageno and Doyeun Oh

Arterioscler Thromb Vasc Biol. 2009;29:311-315
doi: 10.1161/ATVBAHA.109.184085
Arteriosclerosis, Thrombosis, and Vascular Biology is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 1079-5642. Online ISSN: 1524-4636