European Journal of Internal Medicine 30 (2016) 37–42

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original Article

The association between mean platelet volume and cardiovascular risk factors

Nakarin Sansanayudh [a,*], Dittapol Muntham [b], Sukit Yamwong [c], Piyamitr Sritara [c], Tawatchai Akrawichien [d], Ammarin Thakkinstian [e]

[a] Cardiology Unit, Department of Internal Medicine, Phramongkutklao Hospital, Bangkok, Thailand
[b] Section for Clinical Epidemiology and Biostatistics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand
[c] Division of Cardiology, Department of Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Thailand
[d] Electricity Generating Authority of Thailand, Thailand
[e] Section for Clinical Epidemiology and Biostatistics, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

ARTICLE INFO

Article history:
Received 12 July 2015
Received in revised form 21 October 2015
Accepted 30 November 2015
Available online 6 January 2016

Keywords:
Mean platelet volume
Cardiovascular risk factors
Hypertension
Diabetes
Metabolic syndrome
Smoking

ABSTRACT

Background: Mean platelet volume (MPV) correlates with platelet activation and has recently emerged as a potential marker of cardiovascular diseases. Previous publications also suggest possible association between MPV and some cardiovascular risk factors but the evidences are still conflicting and inconclusive.
Objective: To study the association between MPV and cardiovascular risk factors.
Methods: This is a cross-sectional study using data from the second survey of the Electricity Generating Authority of Thailand (EGAT) cohort. All participants of the survey who had results of MPV were included. Exclusion criteria included subjects with known hematologic disease or subjects with hematocrit <30% or platelet count <140,000/mm^3. The details of cardiovascular risk factors were documented and the association between MPV and risk factors was analyzed using fractional polynomial regression analysis.
Results: There were 2727 subjects with MPV results. After excluding those who had hematologic disease, 2642 subjects were included for analysis. Univariate analysis revealed that gender, diabetes, serum triglyceride, hypertension, and prehypertension were associated with MPV. Hematocrit, platelet count and fasting plasma glucose were inversely correlated with MPV. After adjusting with other variables, the risk factors that remained significantly associated with MPV included female gender, diabetes, metabolic syndrome, serum triglyceride, hypertension, and prehypertension. Platelet count and hematocrit were found to have significant inverse correlation with MPV.
Conclusion: After adjusting for other cardiovascular risk factors, the independent factors remain associated with MPV included female gender, diabetes, metabolic syndrome, serum triglyceride, hypertension and prehypertension. MPV has significant, but inverse association with platelet count and hematocrit.

1. Background

Mean platelet volume (MPV) is a quantitative measurement of average size of platelets [1]. Larger platelets are metabolically and enzymatically more active and have higher homeostasis property than smaller platelets [2]. MPV correlates with platelet function and activation and has recently emerged as a potential marker of cardiovascular diseases.

Pooling results from previous publications suggested the association between MPV and coronary artery disease (CAD) [3], i.e., patients with CAD had significantly larger MPV compared to patients without CAD, and patients with high MPV also had higher chance of having CAD compared to patients with low MPV. The pathophysiologic mechanisms of the association can be explained by the direct effects of higher platelet activity in patients with high MPV. In addition, previous publications also found the associations between MPV and risk factors of cardiovascular disease (CVD), in which diabetes and metabolic syndromes were the most common risk factors that had been studied, but there was less evidence on other individual risks such as age, gender, smoking, dyslipidaemia, body mass index (BMI), and waist circumference. Among those evidences, effects of MPV on these cardiovascular risk factors were also inconclusive and the findings were inconsistent, which might be due to limitation of previous studies. Most studies had only small sample sizes and thus less power to detect the association which made them unable to adjust for the effects of other risk factors. Few large studies have been conducted in specific group of patients (e.g. obese, diabetes, pre-diabetes, etc.) and the results might not be able to be applied to a more general population.

* Corresponding author. Tel.: +66 23547600; fax: +66 26444755.
E-mail addresses: dr_nakarin@hotmail.com (N. Sansanayudh), dittapol.mun@mahidol.ac.th (D. Muntham), sukit.yam@mahidol.ac.th (S. Yamwong), piyamitr.sri@mahidol.ac.th (P. Sritara), Tawatchai.a@egat.co.th (T. Akrawichien), ammarin.tha@mahidol.ac.th (A. Thakkinstian).

http://dx.doi.org/10.1016/j.ejim.2015.11.028
0953-6205/

We therefore conducted this cross-sectional study based on a cohort study of healthy volunteers which aimed to assess the association between MPV and all traditional cardiovascular risk factors. Magnitude of MPV effects on these risks were then compared.

2. Methods

This is a cross-sectional study using data from the second survey of the Electricity Generating Authority of Thailand (EGAT) cohort that was conducted in 1997. The EGAT cohort is a prospective, ongoing cohort of middle-income workers. The cohort was started in 1985 by recruiting the employees of EGAT and had the survey follow up in 1997, 2002, 2007 and 2012. The cohort primarily aims to study risk factors and incidence of cardiovascular disease.

Participants in the cohort were included in this study if they had complete blood count (CBC) results. The exclusion criteria included known history of hematologic disease, hematocrit <30%, and platelet count <140,000/mm^3.

During the survey in 1997, data from all participants were collected using self-administered questionnaires, which were consisted of general demographic data, risk/preventive behaviors, underlying disease, family history of illness, and use of medications. In addition, physical examination, electrocardiography, chest radiography, and blood tests were also performed at the survey camp sites. Anthropometric measurements were measured by trained nurses using a standard protocol [4]. Physical examination was performed by cardiologists. The completeness of each procedure, including the questionnaire, was checked at the end of the survey process for every participant. All participants were contacted and informed in advance to fast overnight for 12 h before receiving blood examinations including CBC, fasting plasma glucose (FPG), and lipid profile. The blood samples were transferred to a central laboratory for analysis. All samples were processed approximately 6–8 h after venupuncture. Previous publications found a substantial difference in MPV values measured by different analyzers [5,6]. Therefore, all blood samples for CBC in our study were collected in ethylenediaminetetraacetic acid (EDTA) tubes and were analyzed using a light scattering method by a single automated machine (Technicon H-1).

2.1. Risk factors and measurements

The details of cardiovascular risk factors (i.e., age, gender, BMI, waist circumference, waist-to-hip ratio, smoking, hypertension, diabetes, and metabolic syndrome) were collected at the survey camp.

Diabetes was diagnosed if the participants had history of diabetes, had fasting plasma glucose ≥126 mg/dL, or taking anti-diabetic medications. Pre-diabetes was defined as participants who were not diabetes but had fasting plasma glucose between 100 and 125 mg/dL.

Hypertension was diagnosed if the participants had history of hypertension, had systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg, or taking antihypertensive medications. Blood pressure (BP) was measured using automated BP machines (Omron ®) which were calibrated before the survey. BP measurement protocol followed the recommended standard. After resting for at least 5 min, BP was measured at least twice in each participant and the average between readings was used.

Metabolic syndrome was diagnosed using modified NCEP criteria [7]. The participants were classified as having metabolic syndrome if they had at least three of the following criteria: 1) waist circumference ≥ 80 cm in women or ≥90 cm in men; 2) FPG ≥ 100 mg/dL; 3) triglyceride ≥ 150 mg/dL; 4) HDL < 50 mg/dL in women or HDL < 40 mg/dL in men and 5) SPB ≥ 130 or DBP ≥ 85 mmHg.

Age in year was calculated by subtracting survey date with date of birth. BMI was calculated as weight (kg)/height (m^2), where weight and height were measured using the standard techniques. Smoking was collected by self-reporting, which categorized as smoking (i.e., current plus ex-smoke) and non-smoking.

Institutional Review Board approval was obtained from the Faculty of Medicine Ramathibodi Hospital, prior to the conduct of the study. All participants gave written informed consent before enrollment.

2.2. Statistical analysis

Data were described using mean ± standard deviation (SD) or median and range where appropriate for continuous data, and using frequency and percentage for categorical data. Mean MPVs were compared between risk factor groups using t-test or one-way analysis of variance, where appropriate.

A simple linear regression was performed by regress MPV on each individual categorical risk factor. The MPV was transformed to natural logarithm scale to meet linear regression assumption of approximated normality of residuals. For those continuous variables (i.e., age, BMI, total cholesterol, triglyceride, hematocrit, and platelet count), a fractional polynomial regression was applied because its relationship with log (MPV) was non-linear. Each continuous variable was fitted using a set of power of −2, −1, −0.5, 0, 0.5, 1, 2, 3; and the best fitting degree of 2 was selected. For instance, degrees of −2 and −2 with a scale of 10-years for age; 1 and 2 with scale 10 for BMI; 2 and 2 with scale 10 for hematocrit; 1 and 3 with scale 100 for platelet count, 0.5 and 2 with scale 100 for cholesterol; and −1 and 3 with scale 1000 for triglyceride. Those risk factors whose p values were less than 0.10 plus traditional cardiovascular risk factors (i.e., age, BMI, diabetes, hypertension, total cholesterol, and triglyceride) regardless of their p values from the univariate analysis were simultaneously considered in a multivariate fractional polynomial model. Normality of residual was then checked. All analyses were performed using STATA version 13 (Stata Corp., College Station, Texas, USA). A p-value of less than 0.05 was considered statistically significant.

3. Results

Among 2967 participants of EGAT 1997, 240 participants did not perform blood collections for laboratory analysis, thus they had no result of MPV and other laboratory parameters. These participants were excluded leaving 2727 participants included in our study. Of

Table 1
Baseline characteristics of the studied participants.

Characteristics	N = 2642
Age, years, mean (SD)	54.34 (4.90)
Sex, number (%)	
Male	1984 (75.1)
Female	658 (24.9)
Smoking, number (%)	560 (21.60)
Diabetes, number (%)	298 (11.28)
Hypertension, number (%)	1267 (47.96)
Metabolic syndrome, number (%)	892 (33.76)
Body weight, kg, mean (SD)	65.65 (10.46)
Height, cm, mean (SD)	162.70 (7.25)
BMI, kg/m^2, mean (SD)	24.76 (3.35)
Waist circumference, cm	88.00 (9.59)
Systolic blood pressure, mmHg, mean (SD)	135.76 (21.39)
Diastolic blood pressure, mmHg, mean (SD)	81.41 (13.11)
Total cholesterol, mg/dL, mean (SD)	239.51 (41.10)
Triglyceride, mg/dL, mean (SD)	135 (90)
HDL, mg/dL, mean (SD)	52.72 (11.10)
LDL, mg/dL, mean (SD)	155.85 (39.98)
Fasting blood glucose, mg/dL), mean (SD)	95.71 (28.93)
Creatinine, mg/dL, mean (SD)	1.15 (0.37)
Hematocrit, %, mean (SD)	44.88 (4.28)
White blood cell, 10^3 mg/dL, mean (SD)	7.16 (1.82)
Platelet count, 10^9/L, mean (SD)	255.44 (59.30)
MPV, fL, mean (SD)	7.24 (0.81)