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Original article

Plateletcrit and red cell distribution width are independent predictors of the slow coronary flow phenomenon

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ABSTRACT

Background and purpose: Endothelial dysfunction may play a role in the pathogenesis of the slow coronary flow (SCF) phenomenon. A detailed examination of blood cellular components has not been performed for this condition. We investigated the relationship between SCF and whole blood cell counts.
Method: Records of 17,315 patients who underwent coronary angiography between January 2006 and December 2012 were evaluated retrospectively. A total of 146 patients with SCF were compared with 148 patients with normal coronary arteries according to demographic data, complete blood count, and biochemical parameters.
Results: The following parameters were significantly higher in SCF patients than in patients with normal coronary arteries: percentage of smokers (36.3% vs. 25%, $p = 0.036$), body mass index (26.69 ± 2.84 vs. 26.07 ± 3.15, $p = 0.049$), white blood cells (WBCs) ($7.52 \pm 1.43 \times 10^3$ mm^{-3} vs. $7.01 \pm 1.42 \times 10^3$ mm^{-3}, $p = 0.002$), red cell distribution width (RDW) ($13.68 \pm 1.42\%$ vs. $13.15 \pm 1.13\%$, $p < 0.001$), platelets ($250.29 \pm 50.96 \times 10^3$ mm^{-3} vs. $226.10 \pm 38.02 \times 10^3$ mm^{-3}, $p < 0.001$), plateletcrit (PCT) ($0.214 \pm 0.40\%$ vs. $0.184 \pm 0.29\%$, $p < 0.001$), mean platelet volume (8.63 ± 1.10 fL vs. 8.22 ± 0.83 fL, $p < 0.001$), platelet distribution width (PDW) ($16.58 \pm 0.76\%$ vs. $16.45 \pm 0.57\%$, $p = 0.028$), and neutrophils ($4.44 \pm 1.25 \times 10^3$ mm^{-3} vs. $4.12 \pm 1.24 \times 10^3$ mm^{-3}, $p = 0.029$). Positive PCT values [odds ratio (OR), 4.165; 95% confidence interval (CI), 2.493–6.959; $p < 0.001$) and RDW (OR, 1.304; 95% CI, 1.034–1.645; $p = 0.025$) were independent predictors of SCF.
Conclusion: Although within the normal range, the increased numbers of WBCs and neutrophils in patients with SCF suggest that SCF may be a subclinical inflammatory condition. Furthermore, increased RDW and PDW in SCF patients may cause microvascular blood flow resistance due to impaired cell deformability. The PCT provides reliable data regarding total platelet mass and may be a useful predictor of SCF.

Introduction

The slow coronary flow (SCF) phenomenon is seen on coronary angiography as a delayed opacification of distal vessels, suggesting increased resistance toward the distal coronary segments, in the absence of significant epicardial coronary stenosis. The etiopathogenesis of SCF is unknown, although several studies have shown that endothelial and microvascular dysfunction, inflammation, increased platelet activation, and homocysteine may play roles in this condition [1–7]. The clinical implications and outcomes of SCF are usually favorable, but it may be associated with adverse cardiac conditions such as recurrent angina pectoris, acute myocardial infarction, hypertension, and sudden cardiac death [8,9].

Microvascular flow resistance can result from changes in blood rheological properties. Patel et al. showed that increased red cell distribution width (RDW) was associated with impaired deformability of erythrocytes [10]. Variations and heterogeneity of blood cell shape are expressed by RDW for erythrocytes and

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platelet distribution width (PDW) for platelets; however, no such parameter is available for leucocytes. Cell distribution widths of platelets and erythrocytes have not been evaluated simultaneously in patients with the SCF phenomenon. In the present study, the relationships between cellular components of blood and the SCF phenomenon were investigated.

Methods

The angiographic records of 17,315 patients who underwent coronary angiography, due to anginal symptoms or positive treadmill exercise and scintigraphy tests, between January 2006 and December 2012 were evaluated retrospectively. The patient recruitment process is shown in Fig. 1. In the first stage, two cardiologists obtained the names and hospital record numbers (ID numbers) of patients with the SCF phenomenon (519 patients) and those with normal coronary arteries (765 patients) from the non-digital (paper) record files. In the second stage, two different cardiologists, who had no knowledge of the patients' coronary angiographic diagnoses, collected demographic data and biochemical and hematological laboratory results from a digital recording system (PC records). In the third stage, another two different cardiologists, without knowledge of the patients' angiographic data, assessed all patients and selected those for the study based on the exclusion criteria. Patients meeting any of the following criteria were excluded: acute coronary syndrome; hematological, oncological, or inflammatory disease; white blood cell (WBC) count >10,000 mm^{-3}; hemoglobin level <12 g/dL; valvular disease or a cardiac valve operation; anticoagulant therapy; ejection fraction <50%; renal insufficiency; liver or thyroid dysfunction; thrombocytopenia or thrombocytosis; and missing data. In the fourth stage, two experienced interventional cardiologists, who were unaware of the demographic and laboratory data, evaluated coronary angiographic images and calculated thrombolysis in myocardial infarction (TIMI) frame counts. A total of 70 patients with significant atherosclerotic plaque and coronary ectasia were excluded because these conditions are thought to be present in patients with a slow blood flow [11,12]. Finally, 146 patients with the SCF phenomenon and 148 patients with normal coronary arteries were included in the study.

Transthoracic echocardiography (Vivid 7 Pro, GE, Horten, Norway) was performed with a 2.4 MHz phased array transducer. Left ventricular ejection fraction was estimated using Simpson's rule. Patients with arterial blood pressure >140/90 mmHg, as measured from the brachial artery, and those receiving antihypertensive therapy were considered to be hypertensive. Diabetes was defined by a fasting blood glucose >126 mg/dL or the use of antidiabetic drugs. Patients with total cholesterol >200 mg/dL, low density lipoprotein (LDL)-cholesterol >130 mg/dL, or triglycerides >150 mg/dL, and those using lipid-lowering drugs were considered to be hyperlipidemic. Past and current smokers were classified as smokers. This study was conducted with the approval of the local ethics committee.

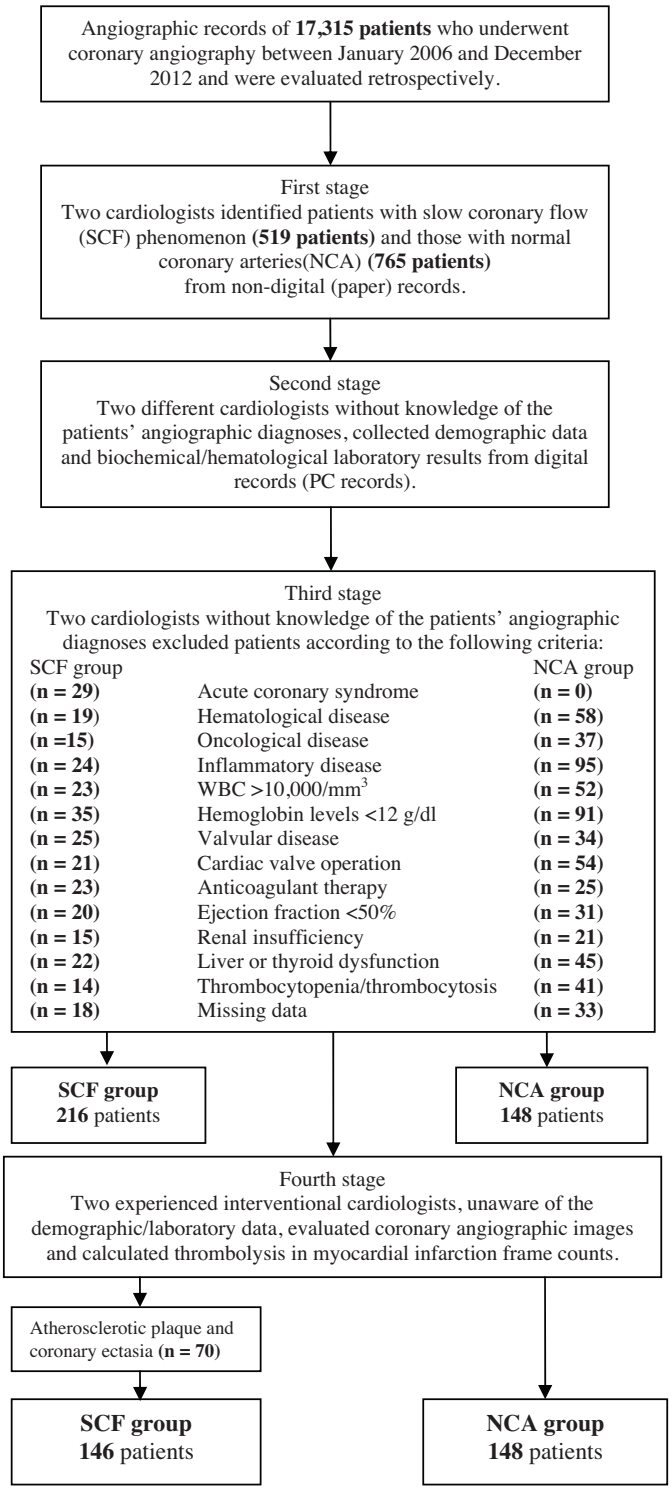

Fig. 1. Patients' recruitment diagram. WBC, white blood cell count.

Coronary angiography

Coronary angiography (Integris BH 5000; Philips, Amsterdam, the Netherlands) was performed via the femoral artery, using the standard Judkin's technique. The angiographic standard frame speed was 25 frames/s. Coronary angiography images of all patients included in the study were evaluated by two experienced interventional cardiologists who were unaware of the demographic and laboratory data. TIMI frame count values were calculated using the method of Gibson et al. [13].

Blood tests

Hematological parameters

Complete blood counts, performed using a Beckman Coulter LH 780 Analyzer (Miami, FL, USA), included 22 parameters: WBC count, 4.8×10^3 to 10.8×10^3 mm^{-3}; red blood cell count (RBC), 4.2×10^6 to 6.1×10^6 mm^{-3}; hemoglobin (HGB) concentration, 12–18 g/dL; hematocrit (HCT), 37–52%; mean cell volume (MCV), 80–99 fL; mean cell hemoglobin (MCH), 27–31 pg;