The Effect of Eosinopenia on Mortality in Patients with Intracerebral Hemorrhage

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Introduction: Inflammation may determine the prognosis of intracerebral hemorrhage (ICH), which has high mortality and morbidity rates. Recent studies have increasingly demonstrated eosinopenia as a prognostic factor, particularly in bacteremia, chronic obstructive pulmonary disease, and myocardial and cerebral infarction. Nonetheless, its significance regarding the determination of prognosis in patients with ICH has not yet been clarified. *Materials and Methods:* Our study included 296 patients who presented to our clinic within 24 hours of the onset of symptoms and who were diagnosed with ICH between January 2008 and June 2016, along with 180 age- and sex-matched controls. During their hospitalization, 120 of these 296 patients died. Patients and controls were compared in terms of neutrophil count/percentage and eosinophil count/percentage; these were also compared between nonsurviving and surviving patients. The significance of eosinopenia in predicting mortality was also evaluated. *Results:* Patients had a significantly higher neutrophil count/percentage and a significantly lower eosinophil count/percentage than controls; these results were similar between nonsurviving and surviving patients ($P < .001$). Consequently, the patient group was divided into 4 subgroups depending on the presence of eosinopenia and/or neutrophilia. The mortality rate was highest (62%) in the group that had both eosinopenia and neutrophilia. Univariate and multivariate logistic regression analyses indicated that neutrophilia and eosinopenia were independent predictors of mortality in ICH ($P = .002$; $P = .004$) *Discussion:* These results indicate that eosinopenia can occur in patients with ICH and that although the mechanism

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is unclear, eosinopenia is closely associated with mortality in these patients, particularly when accompanied by neutrophilia. **Key Words:** Intracerebral hemorrhage—eosinopenia—neutrophilia—mortality.

Introduction

Intracerebral hemorrhage (ICH) constitutes 10%-15% of all cerebrovascular diseases. Within 30 days of ICH, the mortality rate varies between 32% and 52%.[1] Bleeding volume, age, the presence of intraventricular hemorrhage, and the infratentorial origin of hemorrhage, which are the components of the Hemphill Score and the Glasgow Coma Score (GCS), are important factors that determine prognosis in ICH patients. Furthermore, the prognosis can also be determined by the inflammatory response initiated after ICH, as inflammation plays a primary role in the progression of the brain injury.[2] Recent studies have shown that inflammatory parameters such as neutrophilia, neutrophil/lymphocyte ratio, platelet/lymphocyte ratio, and C-reactive protein (CRP) levels are important predictors of prognosis in cerebrovascular diseases such as cerebral infarction and ICH.[3-5] While these studies have mainly focused on neutrophil count and neutrophil/lymphocyte ratio, there is less information concerning the prognostic value of other white blood cell (WBC) types. Reduced eosinophil count (eosinopenia) is a strong prognostic factor in bacteremia, in chronic obstructive pulmonary disease, and possibly in myocardial and cerebral infarctions[6-9]; however, to our knowledge, no previous study has examined the relationship between eosinopenia and prognosis in ICH patients. Therefore, the present study aimed to determine the significance of eosinopenia in predicting prognosis in the acute phase in patients with ICH (Fig 1).

Materials and Methods

Study Population and Design

This study included 296 patients who presented to our clinic within 24 hours of the onset of symptoms and who were diagnosed with ICH between January 2008 and June 2016, together with 180 age- and sex-matched controls. The diagnosis of ICH was confirmed via patient history, neurological examination findings, identification of a hemorrhagic lesion by cranial magnetic resonance imaging or brain computed tomography (CT) sections, and ruling out other causes that may manifest with similar clinical and radiological findings. Of the 296 patients included in the study, 120 died during the 60-day hospitalization period. Study exclusion criteria were systemic inflammatory disease, hematological disease, cancer, severe liver disease, heart disease, or kidney failure, history of surgery/major trauma during the past month, fever at or above 37.5°C at the time of presentation, leukocytosis (WBC > 12000), presence of infection, or use of antibiotics or immunosuppressant drugs within the last 2 weeks. All venous blood samples were taken before surgery and within 2 hours after admission. The control group was composed of 180 individuals who were matched with the patient group in terms of age and sex, who did not have any uncontrolled systemic disease (diabetes, hypertension, cardiovascular disease), who presented to our clinic for reasons other than ICH between January 2008 and June 2016, and who provided blood samples.

The volume of bleeding in the ICH patients was calculated using the ABC/2 formula (ellipsoid).[10] Neutrophilia (increased neutrophil count) was defined as a proportion of neutrophils higher than 74.7% of the total WBCs, while eosinopenia was defined as the proportion of eosinophils lower than 0.3%. Diagnosis of infection was made when there was a known focus in the presence of fever, together with positive culture results (urine/blood/sputum) and imaging findings (ultrasonography or CT) supporting the diagnosis. The end points of the study were short-term mortality (within 60 days of hospitalization) and the presence of eosinopenia in the nonsurviving patients.

Parameters evaluated in the control group included age, sex, presence of diabetes and hypertension, neutrophil count/percentage, eosinophil count/percentage, and CRP levels.

This study was approved by the Ethics Committee of Cumhuriyet University. In this retrospective study, any missing patient data were retrieved by contacting patients or their relatives via telephone using the telephone numbers registered in the system.

Laboratory Analyses

A complete blood count, including platelet count, hemoglobin levels, and neutrophil and eosinophil count/percentage values, was performed with a BC-6800 analyzer (Mindray, Toshiba, Tokyo, Japan) using a Diagon kit (Sysmex, Kobe, Japan). CRP and glucose measurements were performed with an Image 800 analyzer (Beckman Coulter, Yokohama, Japan) using the accompanying manufacturer's kit via a fully automated nephelometric method.

Statistical Analysis

All data analyses were carried out using SPSS (version 22.0) software (SPSS Inc., Chicago, IL, USA). Descriptive statistics were expressed as means, standard deviations, medians, minimums, maximums, frequencies, and ratios.