

Assessment of Risk of Aneurysmal Rupture in Patients with Normotensives, Controlled Hypertension, and Uncontrolled Hypertension

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Background: The prevalence of hypertension in patients with intracranial aneurysms has been an increased concern, but it is not well understood if uncontrolled hypertension has impact on aneurysmal rupture. The aim of this study was to determine whether the risk of aneurysmal rupture is higher in uncontrolled hypertensive cohorts than in controlled hypertensive cohorts and normotensive cohorts. *Methods:* We retrospectively analyzed the records and angiographies of 456 patients with aneurysms who were treated at our center between June 2013 and June 2014. Three groups of patients were included in the study following the ESH-ESC (European Society of Hypertension-European Society of Cardiology) 2013 guidelines: normotensive group (n = 229), controlled hypertension group (n = 127), and uncontrolled hypertension group (n = 100). Paired comparisons of these 3 groups were analyzed with the Nemenyi test. Multivariate logistic regression analysis was used to exclude the impact of possible confounding factors. *Results:* The results of the univariate analysis showed that hypertension, smoking, and size of the aneurysms were significantly associated with intracranial aneurysmal rupture ($P < .05$). The multivariate logistic regression analysis containing clinical and aneurysmal characteristics showed that uncontrolled hypertension, smoking, and aneurysm size were statistically significant predictors of intracranial aneurysmal rupture ($P < .05$). The paired comparisons of 3 groups showed that the risk of rupture of intracranial aneurysms in the uncontrolled hypertension group was significantly greater than that in the normotensive group ($P < .05$) and in the controlled hypertension group ($P < .05$). *Conclusions:* Uncontrolled hypertension is associated with increased risk of rupture of intracranial aneurysms. Given that aneurysmal rupture is a potentially fatal—but preventable—complication, these findings are

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of clinical relevance. **Key Words:** Controlled—intracranial aneurysm—hypertension—rupture risk.

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Introduction

Intracranial aneurysms occur in up to 3% of the general population.¹ There has been an increase in the number of incidentally discovered unruptured intracranial aneurysms because imaging techniques have improved and people are living longer. Only a minority of aneurysms actually ruptures, but when rupture occurs, it results in morbidity and mortality of 25%-50%.² Previous studies have reported that the prevalence of hypertension in patients with aneurysms is between 45.0% and 45.2%.^{3,4} Systemic hypertension has long been considered a risk factor for aneurysmal rupture.⁵⁻⁸ However, many patients with a confirmed diagnosis of hypertension that is treated with antihypertensive drugs have normal blood pressure (BP), and this makes the findings of clinical studies conflicting.⁹⁻¹³ Until now, there are no published clinical studies evaluating the impact of uncontrolled BP on the risk of aneurysmal rupture in patients with hypertension and unruptured aneurysms. There are also few reports on BP management in hypertensive patients with unruptured aneurysms.

The aims of the present study were to determine whether the risk of aneurysmal rupture is higher in uncontrolled hypertensive cohorts than in controlled hypertensive cohorts and normotensive cohorts, and to provide guidance concerning BP management in hypertensive patients with unruptured aneurysms.

Materials and Methods

Ethics Statement

The study protocol had been approved by the Institutional Review Board of Beijing Tiantan Hospital. All patients had given written informed consent to participate, and the privacy of patients has been strictly protected.

Patient Selection

An uninterrupted clinical database that had been assembled in our institution from June 2013 to June 2014 was reviewed retrospectively to identify all 520 patients with aneurysms. This study included information about smoking and alcohol use, the incidence of diabetes mellitus, heart disease, and hypercholesterolemia. Smoking was defined as the patient's smoking at the time of diagnosis of the unruptured intracranial aneurysm or at the time of the interview. Excessive alcohol use was defined as greater than or equal to 18 U (i.e., ≥ 150 g) per week.¹⁴ A participant was said to have a heart disease if he or she had a myocardial infarction, angina pectoris, a coronary arterial bypass grafting, or percutaneous transluminal

coronary arterioplasty.¹⁵ All of the participating patients had already had conventional digital subtraction angiography imaging that included bilateral internal carotid arteries, bilateral external carotid arteries, and bilateral vertebral arteries, which allowed assessment of lesion location, maximal size, and number of aneurysms.

Exclusion Criteria

A total of 64 cases were excluded in this study. Patients who did not have regular office or clinic BP records were excluded. Cases of subarachnoid hemorrhage (SAH) caused by trauma, moyamoya, arteriovenous malformation, dural arteriovenous fistula, connective tissue disease, pregnancy-induced hypertension, arterial dissection, or of unknown etiology were excluded. Patients with incomplete clinical and imaging information were also excluded.

Hypertension Diagnosis and BP Measurement

According to the ESH-ESC (European Society of Hypertension-European Society of Cardiology) 2013 guidelines,¹⁶ hypertension was defined as an untreated systolic blood pressure (SBP) greater than or equal to 140 mmHg and/or diastolic blood pressure (DBP) greater than or equal to 90 mmHg in the sitting position on at least 3 different occasions ($\geq 130/80$ mmHg for diabetes or chronic kidney disease). Controlled hypertension group was defined as BP below 140/90 mmHg on 3 or fewer antihypertensive drugs for at least 2 months; uncontrolled hypertension group was defined as BP greater than or equal to 140/90 mmHg despite the use of greater than or equal to 3 antihypertensive agents for at least 2 months.¹⁷ Participants in the normal BP group had an SBP of less than 140 mmHg and a DBP of less than 90 mmHg ($<130/80$ mmHg for diabetes or chronic kidney disease). Office BP readings were measured by the physicians following a resting period of at least 5 minutes with the participant remaining in a seated position. An average of 3 consecutive measurements was taken at 5-minute intervals to determine the office SBP and DBP values.^{18,19} Study participants were at least 18 years of age.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS, Chicago, IL) was used to analyze the association between clinical and aneurysmal characteristics and rupture risk. Distributions of continuous variables and descriptive statistics (i.e., means, standard deviations, and 95% confidence intervals [CIs]) were generated. Student's *t*-tests were used

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