Risk Factors to Predict Neurologic Complications After Endovascular Treatment of Unruptured Paraclinoid Aneurysms

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■ OBJECTIVE: **Unruptured paraclinoid aneurysms are often asymptomatic, and endovascular coiling is the main treatment. However, endovascular treatment of these lesions still leads to neurologic complications. We aimed to identify predictors of neurologic complications in these lesions.**

■ METHODS: **We retrospectively analyzed patients with unruptured paraclinoid aneurysms who were treated with endovascular coiling between January 2014 and December 2015. A neurologic complication was defined as any transient or permanent increase in the modified Rankin Scale score after aneurysm embolization. Univariate and multivariate logistic regression analyses were performed to assess the risk factors of neurologic complications.**

■ RESULTS: **Of the 443 unruptured paraclinoid aneurysms that were included in this study, the incidence of neurologic complications was 5.2%. Neurologic complications were highly correlated with hypertension (odds ratio [OR], 3.147; 95% confidence interval [CI], 1.217–8.138; $P = 0.018$), cerebral ischemic comorbidities (OR, 3.396; 95% CI, 1.378–8.374; $P = 0.008$), and aneurysm size (OR, 7.714; 95% CI, 1.784–31.635; $P < 0.001$), and irregular shape (OR, 3.157; 95% CI, 1.239–8.043; $P = 0.016$) in the univariate analysis. Cerebral ischemic comorbidities (OR, 2.837, 95% CI, 1.070–7.523; $P = 0.036$) and aneurysm size as dichotomous variables (OR, 7.557; 95% CI, 2.975–19.198; $P < 0.001$) were strongly correlated with neurologic complications in the final adjusted multivariate logistic analysis.**

■ CONCLUSIONS: **Unruptured paraclinoid aneurysms after endovascular treatments had 5.2% of neurologic complications. Cerebral ischemic comorbidities and aneurysm size were predictors of neurologic complications.**

INTRODUCTION

Paraclinoid aneurysms can be defined as intracranial aneurysms that arise from a segment of the internal carotid artery between the roof of the cavernous sinus and the origin of the posterior communicating artery.[1,2] Because of the proximity of the aneurysm to the base of the skull, surgical clipping of paraclinoid aneurysms remains a challenge. Endovascular treatment is now the first-line treatment for unruptured paraclinoid aneurysms in most cases.[3-6] Lower morbidity and mortality with satisfying anatomic results have been shown after endovascular treatment compared with those after surgical management.[7,8] Most unruptured paraclinoid aneurysms are asymptomatic and identified incidently.[9,10] However, neurologic complications are encountered during endovascular treatment.[11] During the last few decades, innovative endovascular treatment including surface-modified coiling, balloon-assisted coiling, stent-assisted coiling, flow diversion, and flow disruption have been used to facilitate coiling.[12,13] However, the risk factors affecting the occurrence of neurologic complications have not been systematically analyzed in a large series of patients with unruptured paraclinoid aneurysms.

Therefore, we collected data on a large series of patients with unruptured paraclinoid aneurysms who were treated with

Key words
- Complication
- Endovascular
- Follow-up study
- Unruptured intracranial aneurysm

Abbreviations and Acronyms
CI: Confidence interval
mRS: Modified Rankin Scale
OR: Odds ratio
RS: Raymond Scale

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endovascular embolization to analyze the incidence of neurologic complications and their associated risk factors.

METHODS

Study Design and Ethics

We retrospectively reviewed the clinical data of patients with unruptured intracranial aneurysms who were consecutively treated with endovascular coiling between January 1, 2014 and December 31, 2015. A neurovascular team made the treatment decisions using interdisciplinary approaches. The results of the International Study of Unruptured Intracranial Aneurysms and Unruptured Cerebral Aneurysm Study of Japan served as frameworks for management decisions.[14-16] Data on age; sex; history of hypertension, diabetes mellitus, hyperlipidemia, smoking, and alcohol use; aneurysm size; wide neck; modalities of treatment; Raymond Scale (RS); and modified Rankin Scale (mRS) were collected for included patients. Clinical follow-up was supplemented with telephone interviews scheduled at 1 and 6 months after endovascular treatment and annually thereafter. The neurologic status of the patients was measured with mRS at the follow-up assessments. At least 1 digital subtraction angiography examination was performed during follow-up to evaluate imaging outcomes.

The study was approved by the ethics committee of the Beijing Tiantan Hospital. In addition, informed consent was obtained from all patients for participation in the study.

Study Population

Patients were included if they had an unruptured intracranial aneurysm located in the ophthalmic segment of the carotid artery and underwent endovascular treatment.

Patients were excluded if they had a fusiform, dissected, and infectious intracranial aneurysm; we also excluded patients without digital subtraction angiography follow-up, those with aneurysms that were not located in the ophthalmic artery segment, and those who did not undergo endovascular treatment.

Definitions of Neurologic Complications and Other Parameters

Neurologic complications, including transient or permanent neurologic deficits and death, were defined as changes in neurologic status (increase in mRS score) after endovascular treatment.[11] Neurologic deficits were considered transient if they resolved within 1 month. Permanent neurologic deficits and death were evaluated at 1 month. Transient or permanent neurologic deficits were defined as an mRS score of 2–5. An mRS score of 6 indicated death. When the preoperative mRS score was >1, neurologic deficits were defined as any increase in mRS score.

The following variables were potential predictors or confounders:

1) Patient-specific characteristics: age (years); sex (male/female); and history of hypertension (yes/no), smoking (yes/no), alcohol use (yes/no), hyperlipidemia (yes/no), diabetes mellitus (yes/no), cerebral ischemic comorbidities (transient ischemic attack, cerebral infarction, or cerebral vascular stenosis; yes/no).
2) Aneurysm-specific characteristics: size (mm), wide neck (neck >4 mm or dome/neck ratio <1.5; yes/no),[17] multiplicity (yes/no), and irregular shape (yes/no).
3) Procedure-specific characteristics: modality of treatment (stent-assisted coiling/other type of coiling) and RS (the degree of aneurysm occlusion was defined based on the 3-point RS: RS1 indicated complete occlusion, RS2 indicated residual neck, and RS3 indicated residual aneurysm).[18]

Statistics

Statistical analysis was performed using SPSS 19.0 for Windows (IBM Corp., Armonk, New York, USA) under the direction of a statistician. Variables are expressed as mean ± standard deviation and number of patients (%), as appropriate. For univariate analysis, a Student t test or Mann-Whitney U test for continuous variables, and χ^2 test or Fisher exact test for categorical variables were used. A binary logistic regression analysis to calculate odds ratios (OR) and 95% confidence intervals (CI) was used. Age; sex; history of hypertension, hyperlipidemia, diabetes, smoking, and alcohol use; aneurysm size, neck, irregular shape, and multiplicity; modalities of treatment; and RS were included in the univariate analysis. A backward, stepwise, multivariate logistic regression analysis was performed using variables with P value <0.10 in the univariate analysis, and an adjusted multivariate logistic regression analysis was performed using all datasets. All P values <0.05 were considered statistically significant.

RESULTS

Study Population

Between January 1, 2014 and December 31, 2015, data on 764 patients with an unruptured intracranial aneurysm who underwent endovascular treatment were recorded in the Information System for Clinical Medicine and Imaging. After the exclusion criteria were applied (Figure 1), 443 patients were analyzed. Table 1 shows the baseline characteristics of the study population, which was divided according to the presence or absence of neurologic complications.

Incidence of Neurologic Complications

Among the neurologic complications that occurred, 23 were ischemic or hemorrhagic events, including 21 ischemic complications and 2 hemorrhagic complications, which led to 19 transient neurologic complications and 4 permanent neurologic complications.

The incidence of neurologic complication was 5.2% (95% CI, 4.2%–6.3%). Patients with hypertension (7.9%), stroke (12.3%), aneurysm size (≥7 mm, 14.4%), irregular shape (12.1%), complete embolization (RS 1, 25.0%), and balloon-assisted coiling (12.5%) had a higher incidence of neurologic complications than those who did not (Table 2).