Anatomic Predictors of Unruptured Anterior Communicating Artery Aneurysm Growth

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■ OBJECTIVE: **Anatomic variations of the anterior communicating artery (ACOM) complex have been shown to influence ACOM aneurysm morphology. It is not known whether these variations predispose unruptured ACOM aneurysms to grow over time.**

■ METHODS: **We retrospectively reviewed the course of patients with untreated, unruptured ACOM aneurysms monitored with serial imaging at our institution. The primary outcome of interest was aneurysm growth. Predictors of aneurysm growth were determined using a Cox proportional hazards model.**

■ RESULTS: **There were 81 patients with an unruptured ACOM aneurysm who were included in our study. Growth occurred in 9 (11.1%) patients, yielding a yearly growth rate of 2.8%. Aneurysms that grew were larger on initial detection than were those that remained stable in size (8.3 mm vs. 6.2 mm; $P = 0.031$). The ratio of the diameter of A1 segments was greater in patients with aneurysms that grew (2.1 vs. 1.4; $P = 0.003$), as was the frequency of patients with an A1 ratio >2.3 (25.0% vs. 6.6%; $P = 0.023$). Among aneurysms that grew, location at the A1—A2 junction was more common than origination solely from the ACOM (88.9% vs. 11.1%). When follow-up time was adjusted for, increasing aneurysm size (unit relative risk [RR] 1.25, 95% confidence interval [CI] 1.06—1.45; $P = 0.011$) and location at the A1—A2 junction (RR 6.15, 95% CI 1.12—114.49; $P = 0.035$) were significant predictors of aneurysm growth.**

■ CONCLUSIONS: **We identify several anatomic characteristics that may be associated with increased risk of ACOM aneurysm growth. These data could influence management strategies of unruptured ACOM aneurysms.**

INTRODUCTION

Growth of unruptured intracranial aneurysms (UIA) is considered to signify an increased risk of subsequent rupture.[1] Although the general risk factors for UIA growth have been identified,[1-4] data on location-specific predictors of growth are comparatively limited. Aneurysms arising from the anterior communicating artery (ACOM) complex often occur in tandem with a unilaterally hypoplastic A1 segment,[5-9] the hemodynamic effects of which have been suggested to drive aneurysm formation at this location.[10,11] Clinically, the presence of A1 segment hypoplasia has been correlated with ACOM aneurysm morphology.[12] It is not known whether this anatomic variant also predisposes unruptured ACOM aneurysms to grow over time. Knowledge of the effect of A1 segment hypoplasia on the propensity for growth could influence management strategies of unruptured ACOM aneurysms, particularly because this anatomic variant has also been associated with the incidence of infarction after subarachnoid hemorrhage.[7,13] We examined the incidence of growth in a cohort of patients with unruptured ACOM aneurysms in an attempt to identify clinical and anatomic predictors of growth specific for aneurysms of this location.

METHODS

Patient Selection

After approval from our Institutional Review Board, we retrospectively reviewed the clinical course of patients with unruptured saccular aneurysms arising from the ACOM monitored with serial

Key words
- Circle of Willis
- Growth
- Intracranial aneurysm

Abbreviations and Acronyms
ACOM: Anterior communicating artery
MRA: Magnetic resonance angiograpy
UIA: Unruptured intracranial aneurysm

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imaging. All patients had aneurysms at least 4 millimeters in size. In general, patients deemed to have a low risk of aneurysm rupture on the basis of aneurysm characteristics were observed, as were patients considered to be at high risk for experiencing complications from treatment. Aneurysm characteristics considered to represent low risk of rupture at our institution included small aneurysm size (<7 mm) and smooth or rounded morphology without lobulations or daughter sacs. In addition, although our approach is tailored to individual patients, our institutional tendency is to treat elderly patients (age >70) with observation whenever feasible. Patients who underwent treatment of their aneurysm shortly after discovery were excluded from the analysis aimed at identifying predictors of growth (n = 111), although the aneurysmal characteristics in this population were nevertheless recorded to allow comparison with aneurysms that were initially observed. Patients with a previously treated aneurysm that recurred (n = 5) were excluded, as were patients with an aneurysm associated with an arteriovenous malformation (n = 5).

Institutional Protocol for Monitoring Patients with Untreated Unruptured Aneurysm

In general, our usual protocol for serial imaging in patients with unruptured aneurysms treated conservatively is to obtain a follow-up study 6 to 12 months after initial discovery. If on initial follow-up the aneurysm appears unchanged, the interval of the subsequent studies (1, 3, or 5 years) is tailored to various patient-related and aneurysm-related factors. If feasible, magnetic resonance angiography (MRA) is the favored imaging modality for aneurysm follow-up.

Determination of Aneurysm Growth

The primary outcome of interest was evidence of aneurysmal growth seen on serial imaging studies. Growth was considered to be an increase of at least 1 millimeter in size in a single dimension. The determination of growth was based on the interpretation of the radiologist or neurosurgeon reviewing the images of each patient. Patients within our study underwent serial imaging with either MRA (n = 59), digital subtraction angiography (n = 12) or computed tomographic angiography (n = 10). The determination of growth was always based on a comparison of images of the same modality. The length of follow-up time, which was considered as the time interval between the first and last imaging study, was also recorded for each patient.

Covariates and Secondary Outcomes of Interest

Patient and aneurysm characteristics were recorded for each patient. Patient characteristics included age at the time of the first imaging study, sex, history of previous subarachnoid hemorrhage, hypertension, active smoking at the time of the first imaging study, a family history of intracranial aneurysms or subarachnoid hemorrhage, aspirin use during the time between first and last imaging study, and the presence of multiple aneurysms. We also collected information on the number of imaging studies performed on each patient. Anatomic characteristics included ACOM aneurysm size and morphology at initial discovery, location along the ACOM complex, and ratio of the diameter of A1 segments. Regarding aneurysm morphology, the subjective impression of a lobulated or irregular appearance, and the presence of aneurysmal daughter sacs, on review of initial imaging by the first author (L.R.) was noted. Regarding aneurysm location, a distinction was made between aneurysms arising from the ACOM proper versus those arising from the junction of the A1 and A2 segments (A1–A2 junction), as previously described (Figure 1).[14] The diameter of each A1 segment was measured for each patient, and the ratio of the diameter of the larger to the smaller A1 segment was calculated. The A1 ratio was considered as both a continuous and a categoric variable. Patients were dichotomized according to whether their A1 ratio was greater than 2.3. Patients with absence of an A1 segment were grouped with patients with an A1 ratio >2.3. The cut-off value of 2.3 was identified through the use of classification and regression tree analysis, which for a given independent continuous variable, in this case A1 ratio, determines the value above and below which the greatest differences in a dependent variable, in this case aneurysm growth, are observed.

Secondary outcomes of interest included aneurysm treatment and subarachnoid hemorrhage. For patients who experienced either of these events, the end of their follow-up time was considered to be the date of treatment or hemorrhage.

Statistical Analysis

Statistics for continuous variables were reported as a mean and standard deviation, with the exception of follow-up time, for

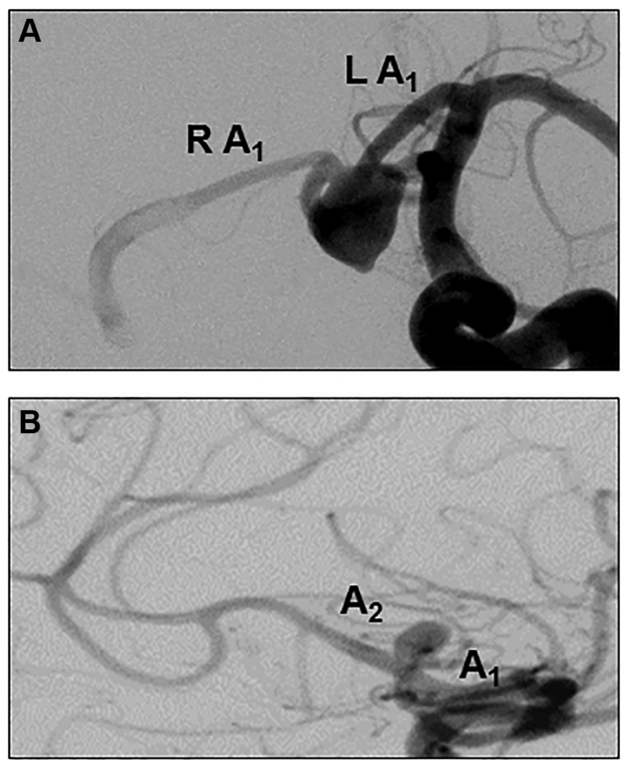

Figure 1. Representative digital subtraction angiographic images showing examples of anterior communicating artery (ACOM) and A1–A2 junction aneurysms. (**A**) Aneurysm arising from the ACOM. (**B**) Aneurysm arising from the A1–A2 junction.