Comparison of the Prevalence of Ruptured and Unruptured Cerebral Aneurysms in a Poor Urban Minority Population

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Background: Most ruptured cerebral aneurysms are small (<7 mm). Evidence suggests low rupture rates for such lesions (<1% per year). Population studies demonstrate a prevalence rate of 3.2%. This study simultaneously estimates the prevalence of aneurysms in a single geographic population while reporting the observed rate of aneurysmal subarachnoid hemorrhage (aSAH) in the same geographic region composed of a poor urban minority demographic. *Methods:* This is an institutional review board-approved, Health Insurance Portability and Accountability Act of 1996-compliant retrospective study performed between 2005 and 2011 at a single center. Part 1 used the electronic medical record to identify all patients with a magnetic resonance angiography demonstrating a cerebral aneurysm. Part 2 used the electronic medical record to identify all patients from the same geographic area presenting with aSAH during the study period. *Results:* A total of 11,160 subjects had a magnetic resonance angiography from the study area. In this group, 422 intradural cerebral aneurysms were incidentally discovered. Ninety-one percent were less than 10 mm (mean 5.49, standard deviation 4.6). Twenty-one percent were aneurysms of the anterior communicating artery complex. Fourteen percent were of posterior communicating artery origin. A total of 237 patients had aSAH. Ninety-two percent of the aneurysms were less than 10 mm (mean 6 mm, standard deviation 3.2 mm). Both groups were composed of poor urban minority patients. *Conclusions:* The observed annual rate of rupture of small anterior circulation aneurysms in this study was .06%-.15% per year. The extrapolated population prevalence of such aneurysms (4.0%-1.5%) may explain the observed rate of rupture of these small aneurysms in a poor urban minority population.
Key Words: Aneurysm—socioeconomic status—epidemiology—subarachnoid hemorrhage.

Introduction

Unruptured cerebral aneurysms (UCAs) have a reported prevalence ranging from 1% to 7%[1-5] with an annual rupture incidence of 6-20 in 100,000 person-years.[6-15] Aneurysmal subarachnoid hemorrhage (aSAH) has an expected 30-day mortality approaching 50% and nearly 50% prevalence of neurological morbidity among survivors.[3,8,13,16,17] The reported morbidity and mortality from the treatment of UCA range from 3% to 20%, depending upon aneurysm complexity, patient age, and existing comorbidities.[5,6,12,15,18-24] Discovering a UCA presents an opportunity to decrease the associated morbidity, mortality, and cost by treating

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that lesion before its rupture.[25-27] This approach must be balanced against the potential complications and financial burden of treating an aneurysm that would have never ruptured.[28-30] Although a UCA may create patient anxiety, significant morbidity from a small aneurysm that has not ruptured would be atypical.[31,32]

In 1998, International Study of Unruptured Intracranial Aneurysms (ISUIA) investigators reported the 5-year cumulative rupture rate for aneurysms in the anterior circulation in patients with no previous subarachnoid hemorrhage (SAH) approximating nil in lesions smaller than 7 mm.[33] Chances of rupture increase to 2.5% in lesions of the posterior communicating artery or posterior cerebral circulation.[8,16,33-36] In 2012, the unruptured cerebral aneurysm study of Japan (UCAS) investigators reported their results from the study of 6697 incidental aneurysms and observed an annual rupture rate of .95% and an average aneurysm size of 5.7 mm.[1] There are several retrospective and prospective observational series of patients with aSAH caused by the rupture of lesions under 7 mm in size.[6,8,10,12,14,15]

The expected rupture rate of less than 1% per year of small UCAs from prospective trials and the 90% prevalence of small aneurysms in ruptured cohorts create a dilemma. Do low predicted rupture rates and the population prevalence of small UCA support the observed incidence of aSAH?[3,8,16] Population studies do not demonstrate sufficient prevalence of small UCA to support the numbers of observed ruptured small aneurysms at the rate of rupture reported by ISUIA and UCAS.[5,12,15,19,22]

The purpose of the present study was to analyze patients from a single geographic region to simultaneously compare the population prevalence of UCA and patients with ruptured aneurysms to elucidate the prevalence of incidental UCA and the prevalence of aSAH in the same population. This will test the hypothesis that the population prevalence of small UCA, and an expected rupture rate of less than 1% per year, will not support the observed rate of aSAH.

Methods

This is a retrospective cohort study in 2 parts performed according to Health Insurance Portability and Accountability Act of 1996 regulations with institutional review board approval at a single integrated urban health system. During the study period (2005-2011), the electronic medical record (EMR) was used to identify 2 patient cohorts. Cohort 1 consisted of all patients presenting for cerebral magnetic resonance angiography (MRA) to the hospital system and its affiliated imaging centers. Cohort 2 consisted of all patients presenting to the same health system with SAH. Patients with a self-reported zip code from the study area were included. For both groups, the EMR was used to obtain age, gender, race, ethnicity, and socioeconomic status data. For socioeconomic status data, a Z score was calculated from U.S. census data using methods described previously.[25,27] Incremental differences in the standard deviation (SD) of socioeconomic data from the state's population mean were used to describe subjects within the cohort.

For cohort 1, identification of UCA, the EMR was used to retrospectively identify patients who had cerebral MRA examinations from 2005 to 2011. The EMR was reviewed for patient demographics, and radiology reports were reviewed for mention of brain aneurysms. Indications for examinations were recorded. To identify incidentally discovered lesions, those patients with previously treated aneurysms and follow-up of known aneurysms were excluded. Cavernous or other extradural aneurysms were excluded. When the impression of the report included suggestion, uncertainty, or potential aneurysms, unblinded, board-certified neuroradiologists reviewed these exams. Uncertainty was resolved by generating additional reformatted images and group consensus. Parameters that were studied included the maximal aneurysm dimension and the associated parent vessel.

For cohort 2, the EMR was used to retrospectively identify patients who presented with SAH at the same urban tertiary referral center in a geographic area where there were no other centers treating cerebrovascular disease during the study period. Experienced specialists who perform at least 100 cerebrovascular procedures annually performed all procedures and aneurysm measurements. Cerebral angiogram reports were reviewed to determine if pathology was identified. If aneurysms were identified, 3-dimensional rotational angiography was reviewed and the maximum long-axis aneurysm dimension and vessel of origin were recorded. Measurements were reviewed and agreed upon by the neurovascular team at the time of the procedure. If multiple aneurysms were present, the index aneurysm was determined by the consensus of the senior authors based on blood pattern on admission computed tomography scan, size, morphology, and surgical appearance.

Population statistics from the 2010 census were used for the analysis. The population and demographics from the 2010 census are included in Table 1.[28] A total of 962,650 individuals 20 years of age and older were identified in the 2010 census. Subpopulations of the aggregate data were analyzed on a per zip code basis. Population demographics from the census were analyzed according to individual zip code regions. Observed numbers of MRA patients, positive MRA patients, SAH patients, and aSAH patients were recorded and compared to the expected population by zip code. These proportions were extrapolated to give sample and overall population numbers for each by zip code and in the aggregate and were used to estimate the expected SAH, aSAH, and overall aneurysm prevalence during the study period.

Results

For cohort 1 (unruptured aneurysm group), 15,773 subjects were identified as having an MRA during the study