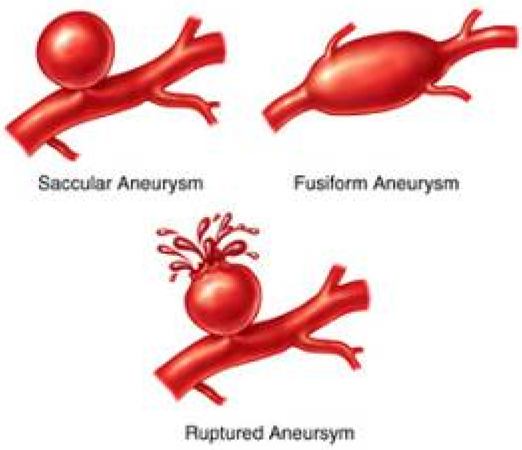
Small intracranial aneurysm



Definition

Small intracranial aneurysm size: < 7 mm

Small anterior circulation intracranial aneurysm

Small anterior circulation intracranial aneurysm

Of 26 studies, 5, 10, and 8 described the growth rate of aneurysms 3 mm and smaller, 5 mm and smaller, and 7 mm and smaller, respectively, whereas rupture rates were reported in 7, 11, and 13 studies for aneurysms 3 mm and smaller, 5 mm and smaller, and 7 mm and smaller, respectively. The annualized growth rate was less than 3% in all but 1 study for all 3 size categories. The annualized rupture rate was 0%, less than 0.5%, and less than 1% for the 3 size categories, respectively. Strength of evidence was very low quality for growth rates and low quality for rupture rates.

Poor-quality evidence suggests that small UIAs have low growth and rupture rates and very small UIAs have little or no risk for rupture [1)].

The annual rupture rate of small (3-4 mm) unruptured intracranial aneurysms (UIA) is 0.36% per year, however, the proportion of small ruptured aneurysms < 5 mm is 35%. This discrepancy is explained by the hypothesis that most acute subarachnoid hemorrhage (SAH) is from recently formed, unscreened aneurysms, but this hypothesis is without definitive proof.

Ikawa et al., aimed to clarify the actual number of screened, ruptured small aneurysms and risk factors for rupture.

The Unruptured Cerebral Aneurysm Study Japan, a project of the Japan Neurosurgical Society, was designed to clarify the natural course of UIAs. From January 2001 through March 2004, 6697 UIAs among 5720 patients were prospectively registered. At registration, 2839 patients (49.6%) had 3132 (46.8%) small UCAs of 3-4 mm. The registered, treated, and rupture numbers of these small aneurysms and the annual rupture rate were investigated. The rate was assessed per aneurysm. The characteristics of patients and aneurysms were compared to those of larger unruptured aneurysms (≥ 5 mm). Cumulative rates of SAH were estimated per aneurysm. Risk factors underwent univariate and multivariate analysis.

Treatment and rupture numbers of small UCAs were 1132 (37.1% of all treated aneurysms) and 23 (20.7% of all ruptured aneurysms), respectively. The registered, treated, rupture number, and annual rupture rates were 1658 (24.8%), 495 (16.2%), 11 (9.9%), and 0.30%, respectively, among 3-mm aneurysms, and 1474 (22.0%), 637 (20.9%), 12 (10.8%), and 0.45%, respectively, among 4-mm aneurysms. Multivariate risk-factor analysis revealed that a screening brain checkup (hazard ratio [HR] 4.1, 95% confidence interval [CI] 1.2-14.4), history of SAH (HR 10.8, 95% CI 2.3-51.1), uncontrolled hypertension (HR 5.2, 95% CI 1.8-15.3), and location on the anterior communicating artery (ACoA; HR 5.0, 95% CI 1.6-15.5) were independent predictors of rupture.

Although the annual rupture rate of small aneurysms was low, the actual number of ruptures was not low. Small aneurysms that ruptured during follow-up could be detected, screened, and managed based on each risk factor. Possible selection criteria for treating small UCAs include a history of SAH, uncontrolled hypertension, location on the ACoA, and young patients. Further large prospective and longitudinal trials are needed.Clinical trial registration no.: C000000418 (https://www.umin.ac.jp/ctr) [2].

From September 2000 to January, 2004, 540 aneurysms (446 patients) were registered. Four hundred forty-eight unruptured aneurysms <5 mm in size (374 patients) have been followed up for a mean of 41.0 months (1306.5 person-years) to date.

Sonobe et al., calculated the average annual rupture rate of small unruptured aneurysms and also investigated risk factors that contribute to rupture and enlargement of these aneurysms.

The average annual risks of rupture associated with small unruptured aneurysms were 0.54% overall, 0.34% for single aneurysms, and 0.95% for multiple aneurysms. Patient <50 years of age (P=0.046; hazard ratio, 5.23; 95% CI, 1.03 to 26.52), aneurysm diameter of >or=4.0 mm (P=0.023; hazard ratio, 5.86; 95% CI, 1.27 to 26.95), hypertension (P=0.023; hazard ratio, 7.93; 95% CI, 1.33 to 47.42), and aneurysm multiplicity (P=0.0048; hazard ratio, 4.87; 95% CI, 1.62 to 14.65) were found to be significant predictive factors for rupture of small aneurysms.

The annual rupture rate associated with small unruptured aneurysms is quite low. Careful attention should be paid to the treatment indications for single-type unruptured aneurysms <5 mm. If the patient is <50 years of age, has hypertension, and multiple aneurysms with diameters of >or=4 mm, treatment should be considered to prevent future aneurysmal rupture [3].

Treatment

Small cerebral aneurysms are currently commonly treated non-invasively by flow diverter devices. These stents lead to thrombotic occlusion of the aneurysm soon after their placement. The purpose of this work is to model clotting into intracranial aneurysms with and without stents, using a non-

Newtonian of blood behavior, and to investigate the importance of stents to generate desired thrombus in intracranial aneurysms.

Method: The description of blood flow is made by the Boltzmann lattice equations, while thrombosis is modeled by the “fluid age” model. The lattice Boltzmann method is a computational technique for simulating fluid dynamics. The method is based on a mesoscopic approach, where the fluid is represented by a set of particles that move and interact on a grid. The model for blood coagulation is described by the lattice Boltzmann Method, and it doesn't take into account the complicated coagulation pathway, this main idea is developed using the model of residence time of blood: all fluid in the domain is assumed to be capable of clotting, given enough time. The fluid age is measured by a passive scalar using a transport equation, and the node coagulates if the fluid age increases enough. Three small aneurysms of different sizes and shapes with three stents of various porosities were used to test the ability of the model to predict thrombosis. The “occlusion rate” parameter is used to assess the effectiveness of the flow diverter device.

Results: For the large aspect ratio factor, the occlusion is: 91% for flow diverter devise with seven struts. For medium aspect ratio, a rate of 80% is achieved. An occlusion rate of slightly more than 30% is obtained for very small aneurysms with low aspect ratio. The Newtonian model underestimates the volume of thrombosis generated. The difference in the prediction of the thrombosis volume between the Newtonian and no-Newtonian Carreau-Yasuda models is approximately 10%.

Conclusion: The occlusion rate is proportional to the aspect ratio form factor. For the large and medium aspect ratio factors, the occlusion is satisfactory. Concerning very small aneurysms with low aspect ratio, aneurysm occlusion is low. This rate can be improved to almost complete occlusion if the flow diverter device is doubled. The generality of the model suggests its extensibility toward any other type of thrombosis (stenosis, thrombosis in aortic aneurysms) [4)].

Endovascular treatment of small intracranial aneurysms has historically been technically challenging and has been associated with high rates of complications and intraprocedural rupture.

A retrospective cohort study was performed to include all patients who underwent coiling of an intracranial aneurysm between 2005 and 2012. Small aneurysms were defined as any aneurysm 4.0 mm or smaller in all dimensions. The primary outcome was a composite outcome of the occurrence of an intraoperative aneurysm rupture or a perioperative thromboembolic event. The secondary outcome of interest was aneurysm recurrence.

483 patients were treated using endovascular techniques; 85 (17.6%) of these patients had small aneurysms. In the small aneurysm group, there was only one (1.2%) intraoperative rupture, three (3.5%) perioperative thromboembolic events, and 11 (12.9%) incidents of aneurysm recurrence. Both the primary and secondary outcomes of interest were similar in patients presenting with small or large aneurysms. Small aneurysm size was not a risk factor for either the composite primary outcome or aneurysm recurrence in multivariate analysis.

Treatment of small intracranial aneurysms via conventional endovascular coiling techniques is not inferior to endovascular treatment of larger aneurysms based on this single institution experience. While technically challenging, such aneurysms may be treated safely and effectively with acceptable rates of complications and recurrence [5)].

Small ruptured saccular intracranial aneurysm

Small ruptured saccular intracranial aneurysm.

Case series

retrospectively reviewed data for 62 small aneurysms (<3.99 mm) in 59 patients. Occlusion rates, complication rates, and coil packing densities were compared between subgroups based upon coil type and rupture status.

Results: Ruptured aneurysms predominated (67.7%). Aneurysms measured 2.99 ± 0.63 mm by 2.51 ± 0.61 mm with an aspect ratio of 1.21 ± 0.34 mm. Brands included Optima (Balt) (29%), MicroVention Hydrogel (24.2%), and Penumbra SMART (19.4%) coil systems. The average packing density was 34.3 ± 13.5 mm3. The occlusion rate was 100% in unruptured aneurysms; 84% utilized adjuvant devices. For ruptured aneurysms, complete occlusion or stable neck remnant was achieved in 88.6% while recanalization occurred in 11.4%. No rebleeding occurred. Average packing density (p = 0.919) and coil type (p = 0.056) did not impact occlusion. The aspect ratio was smaller in aneurysms with technical complications (p = 0.281), and aneurysm volume was significantly smaller in those with coil protrusion (p = 0.018). Complication rates did not differ between ruptured and unruptured aneurysms (22.6 vs. 15.8%, p = 0.308) or coil types (p = 0.830).

Conclusion: Despite advances in embolization devices, the coiling of small intracranial aneurysms is still scrutinized. High occlusion rates are achievable, especially in unruptured aneurysms, with coil type and packing density suggesting an association with complete occlusion. Technical complications may be influenced by aneurysm geometry. Advances in endovascular technologies have revolutionized small aneurysm treatment, with this series demonstrating excellent aneurysm occlusion, especially in unruptured aneurysms [6].

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