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Analysis of 45 early proposed geometric risk factors using a one data base of 108 cerebral aneurysms

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Introduction: The shape of cerebral aneurysms has a large impact on the blood flow in the vessel lumen and respectively on the mechanical signal acting on the aneurysmal wall. Several geometric parameters were proposed as aneurysm rupture risk parameters in the last years and tested in frames of different databases. We reviewed the literature for geometric risk parameters. All of these parameters proposed by different groups were tested with different data sets. We tested all these parameters with our data in order to proof the predictive validity of these parameters to discriminate the rupture status of the aneurysms.

Materials: Three-dimensional digital substraction angiography data of cerebral aneurysms were routinely acquired for treatment planning. Most of these image data were obtained at an isotropic spatial resolution of about 0.2 mm with a Siemens ARTIS device. The geometries of the vessels (47 ruptured and 61 unruptured aneurysms) were segmented and reconstructed in ZIB-amira. The literature review found 45 geometric parameters. The parameters were calculated using ZIB-amira and MatLab (Mathworks, USA). The validity of geometric risk parameters as a rupture indicator was proved by Kolmogorov-Smirnoff (KS) and Mann-Whitney U-test at a significance level of .05 using SPSS (IBM Inc., USA).

Results: 13 parameters show a significant difference between the ruptured an unruptured group using the U-test. From these U-test-significant parameters, only nine were significant using the KS-test. Four of the nine parameters describe the size of the neck (cross section area, equivalent diameter, perimeter, elliptical neck area). The other five quantify the smoothness of the aneurysm shape: (1) the ratio of the aneurysm volume to the volume of a sphere, which enclose the aneurysm surface, (2) non-sphericity index, (3) the isoperimetric ratio, (4) the Hausdorff distance between the dome surface and its spherical cap normalized by the spherical cap radius and (5) the standard deviation of the minimal distances of the surfaces also normalized by the spherical cap radius.
Conclusion: Using our database, only nine of earlier proposed and proved with different database parameters show a significant difference between ruptured and unruptured aneurysms with our data. This result shows an importance of the same cohort of data for validation of a newly proposed risk parameters. Ideally this data base should include data sets from different medical centers.