The Aortic Luminal Area is a Potential Marker of Increased Rupture Risk in Abdominal Aortic Aneurysms

Antti Siika (1), Moritz Lindquist Liljeqvist (1), Rebecka Hultgren (1), Christian Gasser (2), Joy Roy (1)
(1): Department of Molecular Medicine and Surgery, Karolinska Institutet and University Hospital (2): Department of Solid Mechanics, KTH Royal Institute of Technology

Introduction
Diameter is currently the only factor used to estimate rupture risk in abdominal aortic aneurysms (AAAs). Many large AAAs, however, do not rupture and a significant portion of small AAAs do. Our aim was to investigate if simple two-dimensional geometric measurements can improve rupture risk prediction in AAAs, and relate these measurements to biomechanical determinants of AAAs.

Methods
Thirty patients with ruptured AAAs (mean age was 77 ± 5 years and 23 were male) and 60 patients (mean age 60 ± 8 years, and 46 were male) with asymptomatic AAAs were included. At the location of the maximal diameter, the diameter, the luminal area and the vessel area were measured. Finite element analysis was used to compute 3D-geometric and biomechanical parameters of the asymptomatic AAAs, using A4 Clinics Software (VASCOPS GmbH, Graz, Austria). Patients were matched according to nearest-neighbour with an automatic-matching function.

Results
Analysis of all stable AAAs (n=60) and ruptured AAAs (n=30) showed that ruptured AAAs had a significantly larger diameter, 77 ± 15 mm vs. 62 ± 13 mm (p<0.01) and significantly larger luminal area 2281 ± 1964 mm² vs. 1059 ± 674 mm² (p<0.01). In order to control for diameter as a confounder, two diameter-matched groups, one with ruptured AAAs (n=28) and one with stable AAAs (n=15) were formed (74 ± 12 mm vs 73 ± 11, p = .67). Diameter-matched ruptured AAAs had a larger luminal area (1954 ± 1254 mm² vs. 1120 ± 623 mm², p = .02) and a lower relative ILT area (55 ± 24 % vs 68 ± 24%, p=.03). In multivariate regression of 60 asymptomatic AAAs, including the maximal diameter, the luminal area explained the largest amount of variance in the biomechanical rupture risk parameters, followed by the ILT-area.

Conclusions
We demonstrate that the luminal area is increased in ruptured AAAs compared to stable AAAs. Further, we show that this finding may, in part, be explained by a correlation between luminal area and biomechanical rupture risk parameters.

Karolinska Institutet
Antti Siika, MD
antti.siika@ki.se
Department of Molecular Medicine and Surgery

STAR – Stockholm Aneurysm Research Group

Fig 1. 3D-models of AAAs from 4 patients. Colors indicate luminal diameter (left) and von Mises stress (right)

Fig 2. Distribution of 2D-geometric indices in diameter-matched ruptured and asymptomatic AAAs.