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New insights into an old problem CHU Liège, APF

www.chuliege-imaa.be

Imaging alternatives in order to prevent rupture (volume vs diameter)

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with great help from

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Disclosure of Interest

T.Christian Gasser is

principal founder and

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Diameter risk criterion

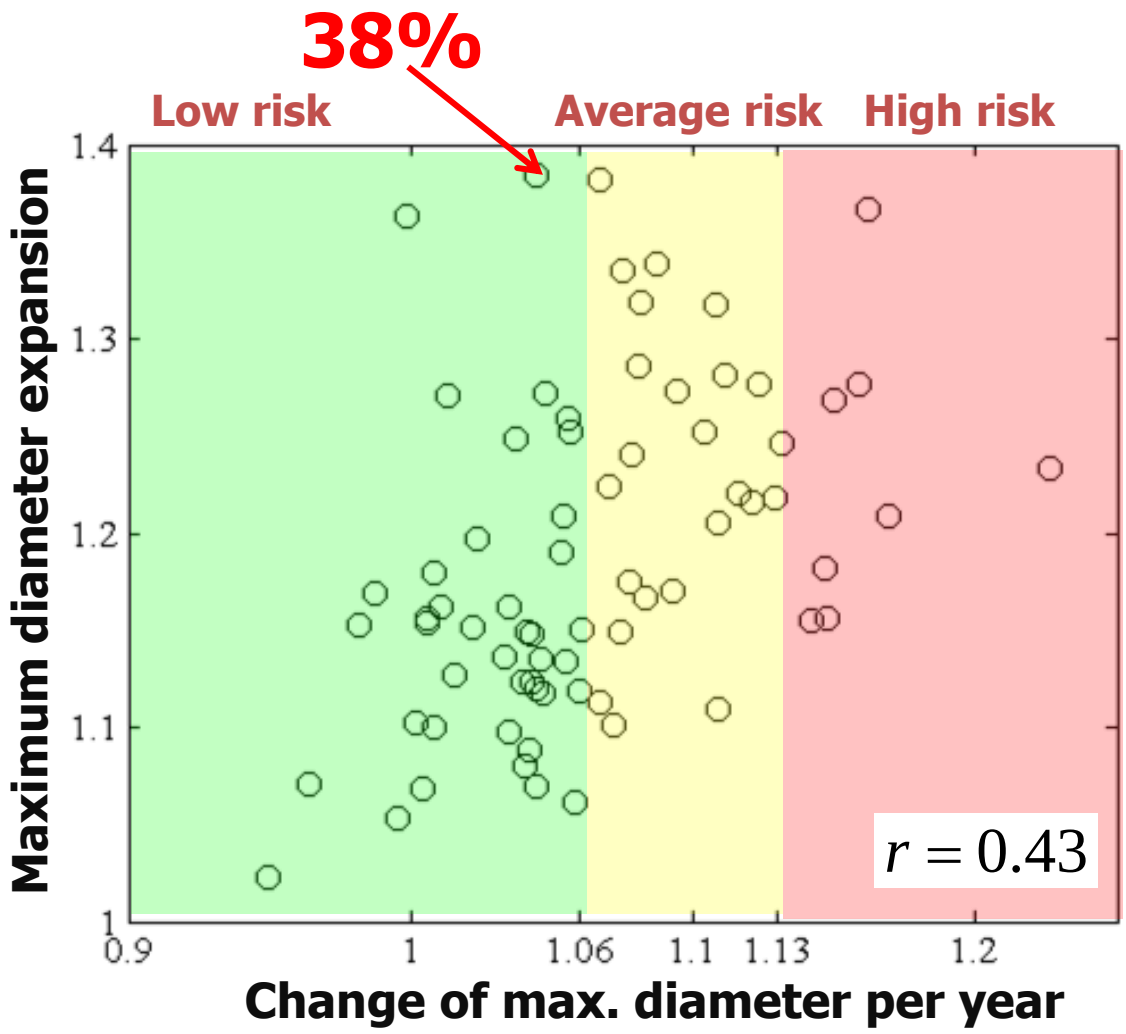
Based on a large number of interventions, a maximum transverse diameter of, on average, 55 mm appears to be the best indicator for elective AAA repair.

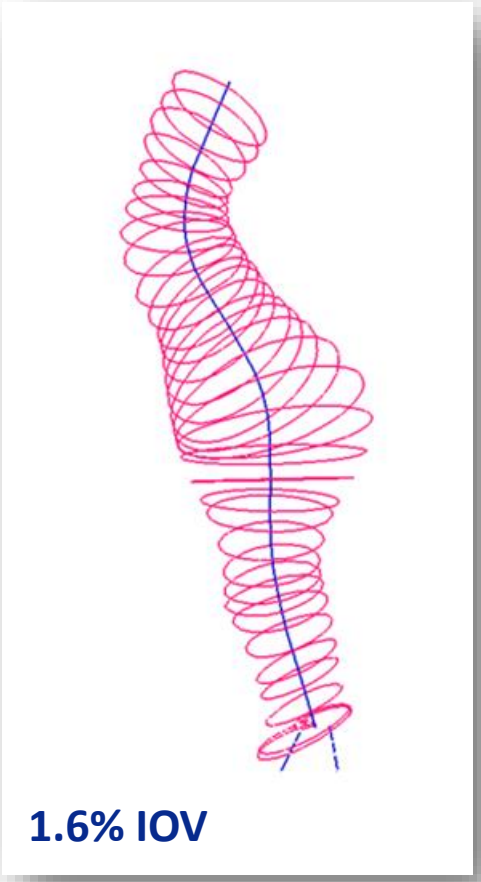
… but not for the individual patient!

AAA treatment is not optimal (NNT=10)

The UK Small Aneurysm Trial, Lancet 1998

Diameter follow-up

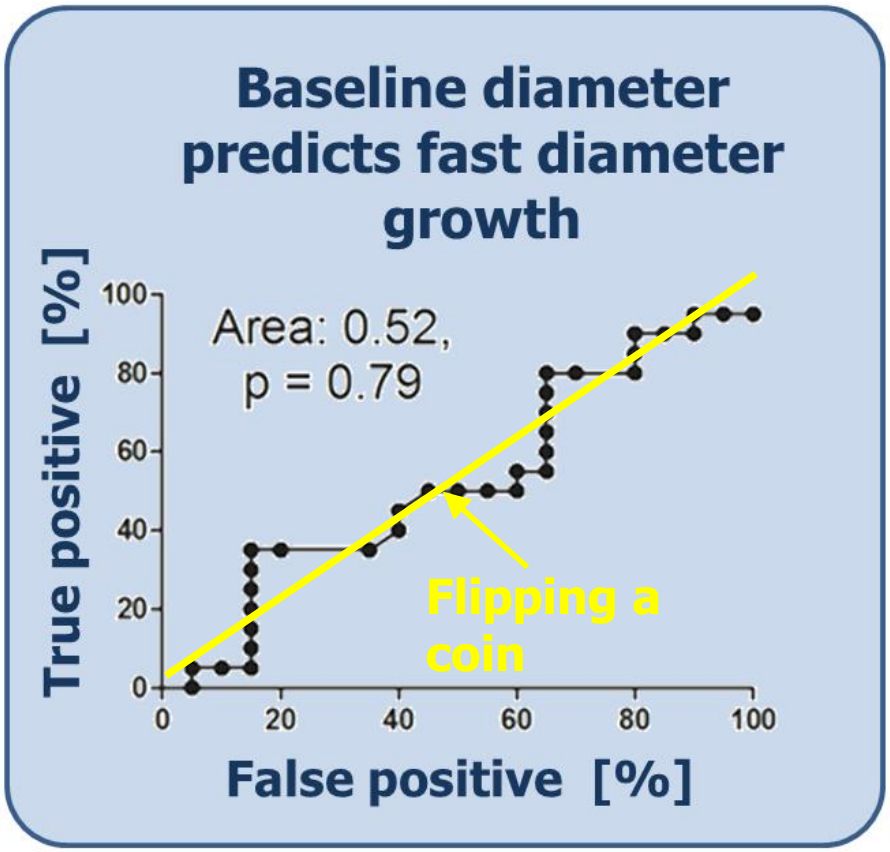




Follow up the max. diameter cannot measure max. growth

Martufi et al, J Vasc Surg, 2013

Diameter follow-up



41 patients

40-60mm diameter

Baseline diameter cannot predict expansion

Lindquist Liljeqvist et al, JVS 2016

What can be done better?

Biomechanical Rupture Risk Assessment BRRA

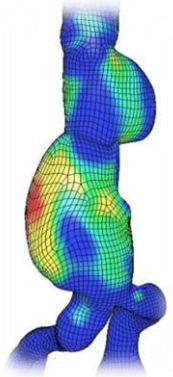
$$\text{Wall Rupture Index} = \frac{\text{Wall stress}}{\text{Wall strength}}$$

Biom. simulation integrated in the clinical workflow

Clinical problem

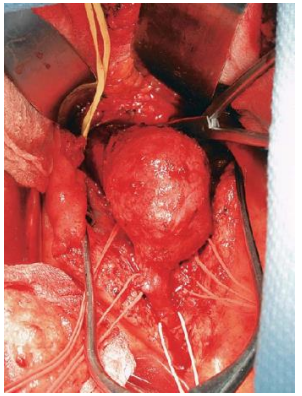
Computer model

Model prediction



PWRI

Clinical intervention



Gasser, AORTA 2016

BRRA - Validation

Biomechanical indices explain why….

… AAA rupture (retrospectively)

Fillinger et al, JVS 2002; Venkatas. et al, EJVES 2004; Heng et al, JVS 2008;
Maier et al, ABME 2010; Gasser et al, EJVES 2010/2014

… AAA rupture (quasi-prospectively)

Erhart et al, JEVT 2016, Siika et al (submitted)

…. AAA rupture at smaller diameters in females

Larsson, et al, JVS 2011; Gasser et al, EJVES 2014

Biomechanical risk locally correlates with …

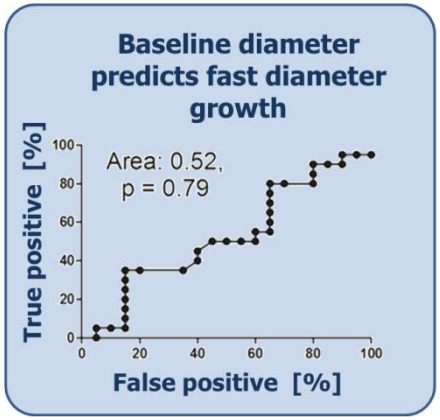
… wall patho-histology Hyhlik–Dürr et al, JEVT 2014
… FDG-uptake Nchimi et al. Circ Card Vasc Imag 2013
… site of rupture Erhart et al, JEVT, 2016, Siika et al (submitted)

Biomechanical stress influences growth rates

Martufi et al, JEVT 2016; Lindquist Liljeqvist et al, JVS 2016

What’s about volume?

Motivation/Objective



Diameter cannot predict AAA growth

Diameter growth is erratic Brady et al, Circulation, 2004

Volume has previously been discussed Kitagawa et al, JVS 2013

(i) Explore the volume as growth predictor

(ii) Explore the relation between PWRRI and growth

Lindquist Liljeqvist et al, JVS 2016

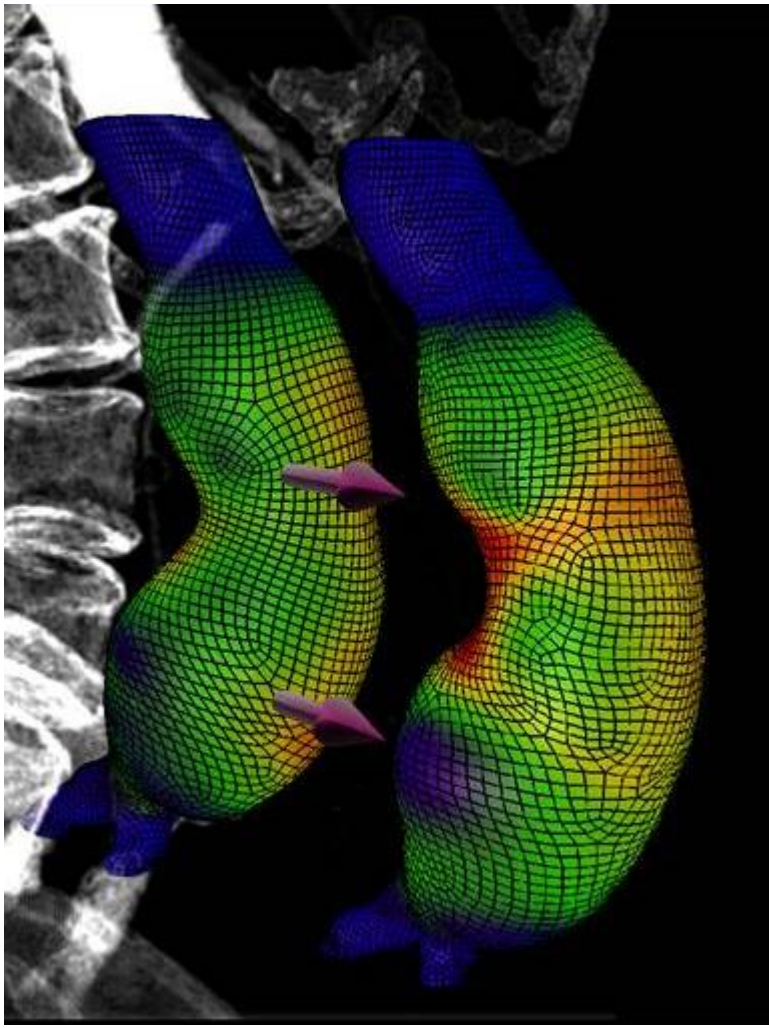
Method

Cohort

CTA from 41 patients,
9 females and 32 males,
40-60mm diameter,
8-17 month

Data analysis

AAA reconstruction and FEM
Annual rates of diameter, volume, PWS, and PWRI
Spearman's rank correlation
ROC analysis

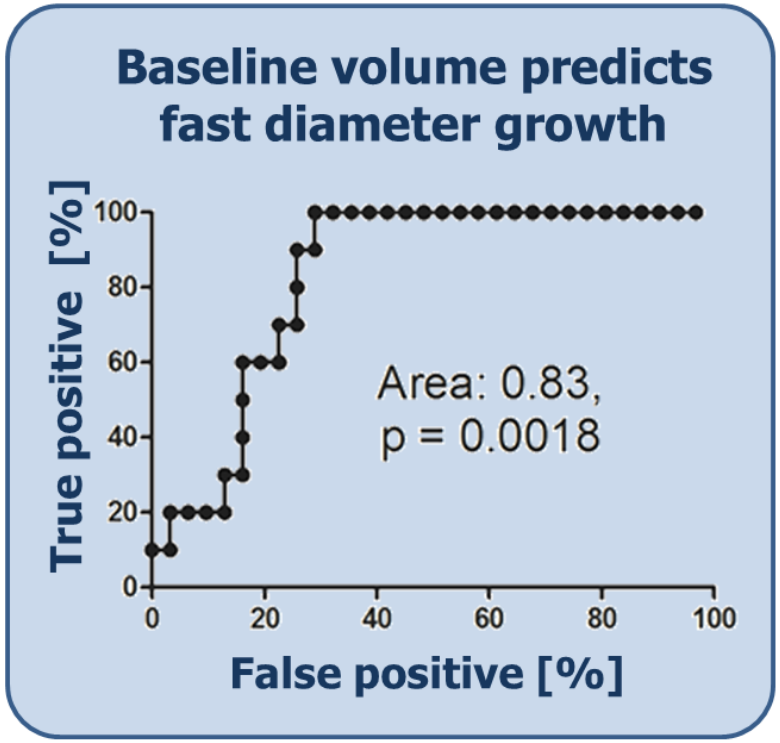


Lindquist Liljeqvist et al, JVS 2016

Results

Median volume growth: 17cm^3 (12%)

Median diameter growth: 3.1mm (12%)



Baseline volume could predict volume growth

Lindquist Liljeqvist et al, JVS 2016

Results

Volume growth correlated with predicted biomechanical risk of rupture

Absolute volume growth versus PWS/PWRI in all cases

P=0.036/0.035

Absolute volume growth versus PWS/PWRI in 'larger' cases

P=0.018/0.0001

Lindquist Liljeqvist et al, JVS 2016

Conclusions

Baseline volume, but not baseline diameter can predict growth and increase of biomechanical risk of rupture in a cohort of clinical interest

Volume measurements in AAA surveillance have several advantages over diameter measurements and their clinical value should be investigated further