Regarding “Changes in aneurysm volume after endovascular repair of abdominal aortic aneurysm”

Jan D. Blankensteijn, MD, Utrecht, The Netherlands

In February 2001, at the XIII International Congress on Endovascular Interventions in Scottsdale, Ariz, the audience members of an interactive session on endotension were asked whether they used computed tomography angiography–derived volume measurements to follow their AAA endografts. Less than 5% replied that they do so. However, the subsequent question, whether one would want to use volume measurements, showed an overwhelming yes in more than 50% of the responders.

The appeal of volume measurements on one hand and the limitations of diameter measurements on the other are well recognized. At the same time, the implementation of a volume-based follow-up program after endovascular AAA repair apparently has posed insurmountable difficulties in most institutions. Only a few centers, including Stanford University Hospital and our institution, have managed to perform the time-consuming and expensive volume measurements on all of their patients for endovascular AAA repair at all follow-up intervals.

Although intuitively volume measurements are more sensitive to changes in aneurysm size than single-plane diameter measurements, none of the volume centers have been able to show superiority of volume assessment in terms of indicating inadequate exclusion or the need for reintervention, let alone in predicting rupture. This is largely because ruptures after endovascular AAA repair are extremely uncommon but also because these centers have based their clinical judgement and assessment of the need for reintervention on volume changes already. Evidently, such a protocol cannot be used to show the advantage of earlier detection of problems because these problems are infrequently allowed to continue until evident with diameter measurements, none of the volume centers have been able to show superiority of volume assessment in terms of indicating inadequate exclusion or the need for reintervention, let alone in predicting rupture. This is largely because ruptures after endovascular AAA repair are extremely uncommon but also because these centers have based their clinical judgement and assessment of the need for reintervention on volume changes already. Evidently, such a protocol cannot be used to show the advantage of earlier detection of problems because these problems are infrequently allowed to continue until evident with diameter measurements.

In this issue of the Journal of Vascular Surgery, Wolf et al have analyzed their volume follow-up series to test the hypothesis that changes in volume are a more sensitive marker of aneurysm exclusion than changes in maximal transverse diameter. There is a problem with this hypothesis. Between volume changes and aneurysm exclusion lie two steps: the relationship between volume/diameter and size change and the relationship between size change and aneurysm exclusion. The first relationship does not need proof. It is a mathematic law that volume changes are more pronounced than diameter changes when a body grows or shrinks in three dimensions. If our measuring tools were infinitely accurate, diameter assessment would suffice. The truth is that a large number of variables in the measuring process are responsible for us not being able to reproduce our measurements within 5% for one observer and within 10% for different observers, regardless of volume or diameter measurements. Volume measurements are more sensitive to size changes than diameter measurements because volume can easily alter by 20% while diameter changes remain within the reproducibility limits of 5% to 10%.

Another confusing topic is the logistic regression analysis the authors have used. It appears to indicate that volume is more closely associated with the presence of an endoleak than diameter. But at the same time the authors conclude that the association of volume and endoleak does not appear to be appreciably stronger than diameter. The P values of a logistic regression analysis are not appropriate to find the most sensitive quantification of size change, mainly because volume and transverse and orthogonal diameters are strongly colinear entities but also because the authors have used subjective and unsubstantiated cutoff values for significant diameter change (2 mm).
reproducibility coefficient of diameter measurements is more likely to be in the order of 10% (5 mm).

Finally, the authors have disregarded the nonlinear characteristics of the shrinking process by lumping together measurements at all follow-up intervals and comparing initial with latest measurements. Volume may well be more sensitive for aneurysm exclusion than diameter in the first year only. In Table II, they report −8.8% volume change \((P < .05)\), −4.7% orthogonal diameter change \((P < .01)\), and −5.9% transverse diameter change \((P < .001)\). At first glance, the lowest \(P\) value appears to be the most sensitive parameter, but a statistically significant difference between initial and latest average value does not translate into detectable or nondetectable size change. With a reproducibility coefficient of 5% for both diameter and volume, which is attainable for one observer, it is clear that the average volume change is well above the detection level whereas the diameter changes are barely or not. This is why series like these might report 65% shrinkage at 6 months by volume but only 30% by diameter.

In conclusion, I believe the authors have certainly addressed an important question: is volume a better indicator of adequate aneurysm exclusion? But they have failed to answer it. They are underestimating the true value of volume by using a visible endoleak as gold standard and by applying reproducibility thresholds for diameter change that are too low. The true value of volume measurements (as a better indicator of exclusion than diameter change or endoleak) could be shown if normalized curves of both diameter and volume of individual patients after endovascular AAA repair are evaluated and rated for exclusion and clinical consequences by observers blinded to the type of measurement.

REFERENCES


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Please see related article by Dr Yehuda G. Wolf et al on pages 305-9.