UMass Chan MEDICAL SCHOOL

Repairs Of Small AAAs (<5.5 cm) Are Justified By Many Evidence Based Reasons: What Are These Reasons And What Are The Downsides

Jessica Simons, MD MPH

11.20.24

VEITH SYMPOSIUM Connecting The Vascular Community

Disclosures

- none

The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm

Elliot L. Chaikof, MD, PhD,[a] Ronald L. Dalman, MD,[b] Mark K. Eskandari, MD,[c] Benjamin M. Jackson, MD,[d] W. Anthony Lee, MD,[e] M. Ashraf Mansour, MD,[f] Tara M. Mastracci, MD,[g] Matthew Mell, MD,[h] M. Hassan Murad, MD, MPH,[i] Louis L. Nguyen, MD, MBA, MPH,[j] Gustavo S. Oderich, MD,[k] Madhukar S. Patel, MD, MBA, ScM,[a,l] Marc L. Schermerhorn, MD, MPH,[a] and Benjamin W. Starnes, MD,[f] *Boston, Mass; Palo Alto, Calif; Chicago, Ill; Philadelphia, Pa; Boca Raton, Fla; Grand Rapids, Mich; London, United Kingdom; Rochester, Minn; and Seattle, Wash*

Repair of AAA is indicated for:

- Women at a diameter threshold of 5cm
- Men at a diameter threshold of 5.5cm

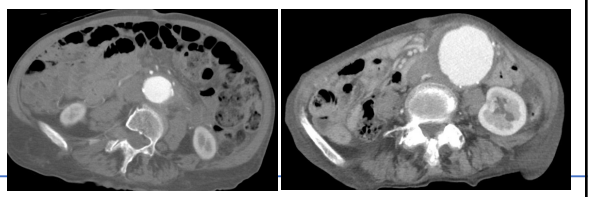
What about smaller AAA?

In patients with a small aneurysm (4.0 cm to 5.4 cm) who will require chemotherapy, radiation therapy, or solid organ transplantation, we suggest a shared decision-making approach to decide about treatment options.	
Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

We suggest elective repair for the patient who presents with a saccular aneurysm.	
Level of recommendation	2 (Weak)
Quality of evidence	C (Low)

Aortic diameter is not a perfect predictor

- We've all seen small AAA that rupture and large AAA that haven't



4cm, contained rupture

7.8cm, intact

Evidence

- Published in 1998
- 10% of rAAA were <5cm

Rupture in small abdominal aortic aneurysms

Stephen C. Nicholls, MD, Jon B. Gardner, MD, Mark H. Meissner, MD, and Kaj H. Johansen, MD, PhD, *Seattle, Wash*

Background: The decision of whether to repair small abdominal aortic aneurysms (AAAs), which are those that are less than 5 cm in diameter, remains controversial. ***Methods:*** We describe 161 consecutive patients who were seen at a single urban hospital with ruptured AAAs (rAAAs) and in whom aneurysm size was measured with ultrasound scanning, or rarely computed tomography, en route to the operating room. Eleven patients (6.8%) had AAAs that measured less than 5.0 cm. This group was compared with 150 patients who had rAAAs that were more than 5 cm. ***Results:*** The mortality rates were similar in both of the groups—70% for small rAAAs versus 66% for large rAAAs. No significant differences were seen between the patients with small and large ruptured aneurysms with respect to the prevalence rates of hypertension (60% vs 50%) or of cardiac disease (20% vs 22%). However, the prevalence rate of obstructive lung disease was significantly different (64% vs 25%; $P = .02$) as was the rate of diabetes (28% vs 3%; $P = .004$). Five aneurysms were measured at exactly 5 cm. This suggests that approximately 10% of all aneurysms that rupture in this series do so at 5 cm or less. ***Conclusion:*** In view of the safety of elective repair as compared with the prohibitive risk associated with aneurysm rupture, patients who are at good risk with small AAA (between 4 and 5 cm) should be considered for elective aneurysm resection. For unclear reasons, obstructive lung disease and diabetes are associated with a significantly greater risk for rupture of small AAA. Patients with these risk factors should be given special consideration. (J Vasc Surg 1998;28:884-8.)

Evidence

Rupture in small abdominal aortic aneurysms

Stephen C. Nicholls, MD, Jon B. Gardner, MD, Mark H. Meissner, MD, and Kaj H. Johansen, MD, PhD, *Seattle, Wash*

Background: The decision of whether to repair small abdominal aortic aneurysms (AAAs), which are those that are less than 5 cm in diameter, remains controversial.
Methods: We describe 161 consecutive patients who were seen at a single urban hospital

Conclusion: In view of the safety of elective repair as compared with the prohibitive risk associated with aneurysm rupture, patients who are at good risk with small AAA (between 4 and 5 cm) should be considered for elective aneurysm resection. For unclear reasons, obstructive lung disease and diabetes are associated with a significantly greater risk for rupture of small AAA. Patients with these risk factors should be given special consideration. (J Vasc Surg 1998;28:884-8.)

that approximately 10% of all aneurysms that rupture in this series do so at 5 cm or less.
Conclusion: In view of the safety of elective repair as compared with the prohibitive risk associated with aneurysm rupture, patients who are at good risk with small AAA (between 4 and 5 cm) should be considered for elective aneurysm resection. For unclear reasons, obstructive lung disease and diabetes are associated with a significantly greater risk for rupture of small AAA. Patients with these risk factors should be given special consideration. (J Vasc Surg 1998;28:884-8.)

UMass Chan MEDICAL SCHOOL

Evidence

Who Should We Operate On and How Do We Decide: Predicting Rupture and Survival in Patients with Aortic Aneurysm

Mark Fillinger, MD

- Other risk factors have also been shown to correlate with rupture risk

Table 1. Known Risk Factors for Aneurysm Rupture Apart from Diameter and Wall Stress, Demonstrating How They Can Be Displayed for an Actual Patient

Risk Factor	Your Information	Risk Relative to Average
Rate of growth	mm/year	NA
Gender	Female	Higher than average
Family history	None	Lower than average
Pulmonary disease/COPD	On meds	Higher than average
Hypertension history	Yes	Higher than average
Steroids	Not taking steroids	Average
Higher blood pressure	180/72 mm Hg	Higher than average
Today's blood pressure	168/70 mm Hg	Higher than average
Smoking	Current (within year)	Higher than average

UMass Chan MEDICAL SCHOOL

Fillinger M. Sem Vasc Surg 2007 Jun:20(2):121.

Evidence

Rupture Rates of Small Abdominal Aortic Aneurysms: A Systematic Review of the Literature

J.T. Powell [a,*], S.M. Gotensparre [a], M.J. Sweeting [b], L.C. Brown [a], F.G.R. Fowkes [c], S.G. Thompson [b]

- Measured rates of rupture for AAA 3.0-5.4cm
- Range: 0-1.61 ruptures per 100 person-years

Abstract *Background:* Small aneurysms of the abdominal aorta (3.0–5.5 cm in diameter) often are managed by regular surveillance, rather than surgery, because the risk of surgery is considered to outweigh the risk of aneurysm rupture. The risk of small aneurysm rupture is considered to be low. The purpose of this review is to summarise the reported estimates of small aneurysm rupture rates.
Methods and findings: We conducted a systematic review of the literature published before 2010 and identified 54 potentially eligible reports. Detailed review of these studies showed that both ascertainment of rupture, patient follow-up and causes of death were poorly reported: diagnostic criteria for rupture were never reported. There were only 14 studies from which rupture rates (as ruptures per 100 person-years) were available. These 14 published studies included 9779 patients (89% male) over the time period 1976–2006 but only 7 of these studies provided rupture rates specifically for the diameter range 3.0–5.5 cm, which ranged from 0 to 1.61 ruptures per 100 person-years.
Conclusions: Rupture rates of small abdominal aortic aneurysms would appear to be low, but most studies have been poorly reported and did not have clear ascertainment and diagnostic criteria for aneurysm rupture.

UMass Chan MEDICAL SCHOOL

Aortic diameter is not a perfect predictor

- Cardiac surgeons have studied the role for indexing diameter relative to patient size for asc/TAA:
  - Aortic size index (diameter/BSA)
  - Aortic height index (diameter in cm/height in m)
  - Cross-sectional area (in cm) to height (in m) ratio

Height (inches)	(m)	Aortic Size (cm) 3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
55	1.40	2.50	2.86	3.21	3.57	3.93	4.29	4.64	5.00	5.36	5.71
57	1.45	2.41	2.76	3.10	3.45	3.79	4.14	4.48	4.83	5.17	5.52
59	1.50	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00	5.33
61	1.55	2.26	2.58	2.90	3.23	3.55	3.87	4.19	4.52	4.84	5.16
63	1.60	2.19	2.50	2.81	3.13	3.44	3.75	4.06	4.38	4.69	5.00
65	1.65	2.12	2.42	2.73	3.03	3.33	3.64	3.94	4.24	4.55	4.85
67	1.70	2.06	2.35	2.65	2.94	3.24	3.53	3.82	4.12	4.41	4.71
69	1.75	2.00	2.29	2.57	2.86	3.14	3.43	3.71	4.00	4.29	4.57
71	1.80	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17	4.44
73	1.85	1.89	2.16	2.43	2.70	2.97	3.24	3.51	3.78	4.05	4.32
75	1.90	1.84	2.11	2.37	2.63	2.89	3.16	3.42	3.68	3.95	4.21
77	1.95	1.79	2.05	2.31	2.56	2.82	3.08	3.33	3.59	3.85	4.10
79	2.00	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
81	2.05	1.71	1.95	2.20	2.44	2.68	2.93	3.17	3.41	3.66	3.90

Light green area indicates low risk, yellow area indicates moderate risk, orange area indicates high risk, and red area indicates severe risk.

UMass Chan MEDICAL SCHOOL

Zafar MA et al. JTCVS. May 2018:155(5):1938.

Evidence

Characteristics and outcomes of small abdominal aortic aneurysm rupture in the American College of Surgeons National Surgical Quality Improvement Program database

Kirthi S. Belamkonda, MSc,[1] Naeem Nassiri, MD,[1] Mehran M. Sadeghi, MD,[1] Yawei Zhang, PhD,[1] Raul J. Guzman, MD,[1] and Caleiua Ijad Ochoa Chaar, MD, MS, FACS,[1] New Haven, Conn

- NSQIP 2011-18
- 10.4% of rAAA were sub-guideline diameter (<5cm in women, <5.5cm in men)
- Aortic size index was significantly lower in the small rAAA group compared with the large rAAA group but this isn't the right comparison to answer the question at hand

ABSTRACT

Objective: The current guidelines recommend elective abdominal aortic aneurysm (AAA) repair at 5.5 cm for men and 5.0 cm for women. However, rupture can occur in patients with an aneurysm smaller than these size thresholds. In the present study, we investigated the proportion of AAAs that rupture at sizes less than elective operative thresholds and compared the outcomes of repair with those of aneurysms that had ruptured at a larger size. Our hypothesis was that the rupture of small AAAs carries mortality similar to that of rupture at larger sizes.

Methods. The American College of Surgeons National Surgical Quality Improvement Program targeted vascular files for open AAA repair and endovascular aneurysm repair (EVAR) were reviewed for all cases of ruptured AAAs (rAAAs) from 2011 to 2018. The patients were divided into two groups: those with small AAAs that had ruptured at a size less than the current size guidelines for elective repair and those with large AAAs that had ruptured at a size that had met the criteria for elective repair. Univariate analyses were conducted to compare the comorbidities and perioperative outcomes of infrarenal rAAA repair between the groups. Multivariable logistic regression was performed to examine the differences in mortality between small and large rAAAs after controlling for confounding variables.

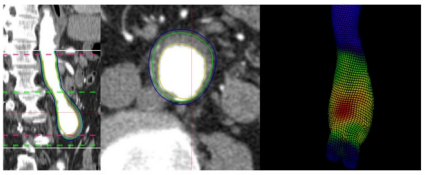
Results. Of the 902 rAAA repairs, 107 (10.4%) were small rAAAs. The proportion of small rAAAs did not significantly change during the study period ($P = .35$). The large rAAA group was more likely to have juxtarenal or suprarenal aneurysms compared with the small rAAA group (27% vs 10%; $P < .001$). A comparison of infrarenal rAAAs only demonstrated that the mean small rAAA (n = 141) diameter was 4.1 cm in the women and 4.5 cm in the men compared with the large rAAAs (n = 1055), with a mean diameter of 7.1 cm in women and 8.5 cm in men ($P < .01$ for the women; $P < .01$ for the men). The patients in the small rAAA group had had a significantly lower body mass index but were more likely to be African American and to have hypertension. The small rAAA group was more likely to present without hypotension and to have undergone EVAR. The repair of small rAAAs was associated with lower bleeding and mortality and a shorter mean operative time but with more readmissions. Multivariable regression analysis demonstrated that size was not associated with outcome after adjusting for other variables.

Conclusions: Of all AAA repairs classified as treating rupture, 10% were for patients with small AAAs. Patients with small rAAA were less likely to present with hypotension and were more likely to have undergone EVAR. Further research into sac morphology and more sensitive imaging modalities might help identify small rAAAs at high risk of rupture that would benefit from elective repair. (J Vasc Surg 2021;74:729-37.)

UMass Chan MEDICAL SCHOOL

Aortic diameter is not a perfect predictor

- Much work has sought to identify "at-risk" features
  - Finite element analysis for measuring peak wall stress



UMass Chan MEDICAL SCHOOL

From Singh TP et al. Eur Radiol 2023 Aug;33(8):5698-570.

Evidence

- 210 pts with AAA 3-4.9cm
- 2-yr follow up
- Peak wall rupture index: aortic wall stress/aortic wall strength
- 43 pts repaired electively
- 2 pts repaired for rupture

Association between aortic peak wall stress and rupture index with abdominal aortic aneurysm–related events

Tejas P. Singh[1,2] · Joseph V. Moxon[1,3] · T. Christian Gasser[4] · Jason Jenkins[5] · Michael Bourke[6,7] · Benard Bourke[6] · Jonathan Golledge[1,2,3]

Abstract

Objective The aim of this study was to assess whether aortic peak wall stress (PWS) and peak wall rupture index (PWRI) were associated with the risk of abdominal aortic aneurysm (AAA) rupture or repair (defined as AAA events) among participants with small AAAs.

Methods PWS and PWRI were estimated from computed tomography angiography (CTA) scans of 210 participants with small AAAs (≥ 30 and ≤ 50 mm) prospectively recruited between 2002 and 2016 from two existing databases. Participants were followed for a median of 2.0 (inter-quartile range 1.9, 2.8) years to record the incidence of AAA events. The associations between PWS and PWRI with AAA events were assessed using Cox proportional hazard analyses. The ability of PWS and PWRI to reclassify the risk of AAA events compared to the initial AAA diameter was examined using net reclassification index (NRI) and classification and regression tree (CART) analysis.

Results After adjusting for other risk factors, one standard deviation increase in PWS (hazard ratio, HR, 1.56, 95% confidence intervals, CI 1.19, 2.06; $p = 0.001$) and PWRI (HR 1.74, 95% CI 1.29, 2.34; $p < 0.001$) were associated with significantly higher risks of AAA events. In the CART analysis, PWRI was identified as the best single predictor of AAA events at a cut-off value of > 0.562. PWRI, but not PWS, significantly improved the classification of risk of AAA events compared to the initial AAA diameter alone.

Conclusion PWS and PWRI predicted the risk of AAA events but only PWRI significantly improved the risk stratification compared to aortic diameter alone.

Key Points

- *Aortic diameter is an imperfect measure of abdominal aortic aneurysm (AAA) rupture risk.*
- *This observational study of 210 participants found that peak wall stress (PWS) and peak wall rupture index (PWRI) predicted the risk of aortic rupture or AAA repair.*
- *PWRI, but not PWS, significantly improved the risk stratification for AAA events compared to aortic diameter alone.*

UMass Chan MEDICAL SCHOOL

Evidence

- 210 pts with AAA 3-4.9cm
- 43 pts repaired electively
- 2 pts repaired for rupture

Association between aortic peak wall stress and rupture index with abdominal aortic aneurysm–related events

Tejas P. Singh[1,2] · Joseph V. Moxon[1,3] · T. Christian Gasser[4] · Jason Jenkins[5] · Michael Bourke[6,7] · Benard Bourke[6] · Jonathan Golledge[1,2,3]

Abstract

Objective The aim of this study was to assess whether aortic peak wall stress (PWS) and peak wall rupture index (PWRI) were associated with the risk of abdominal aortic aneurysm (AAA) rupture or repair (defined as AAA events) among participants with small AAAs.

Key Points

- *Aortic diameter is an imperfect measure of abdominal aortic aneurysm (AAA) rupture risk.*
- *This observational study of 210 participants found that peak wall stress (PWS) and peak wall rupture index (PWRI) predicted the risk of aortic rupture or AAA repair.*
- *PWRI, but not PWS, significantly improved the risk stratification for AAA events compared to aortic diameter alone.*

cut-off value of > 0.562. PWRI, but not PWS, significantly improved the classification of risk of AAA events compared to the initial AAA diameter alone.

Conclusion PWS and PWRI predicted the risk of AAA events but only PWRI significantly improved the risk stratification compared to aortic diameter alone.

Key Points

- *Aortic diameter is an imperfect measure of abdominal aortic aneurysm (AAA) rupture risk.*
- *This observational study of 210 participants found that peak wall stress (PWS) and peak wall rupture index (PWRI) predicted the risk of aortic rupture or AAA repair.*
- *PWRI, but not PWS, significantly improved the risk stratification for AAA events compared to aortic diameter alone.*

UMass Chan MEDICAL SCHOOL

CONCLUSION: Aortic diameter is not a perfect predictor

- 10% of rAAA have diameters below guideline threshold recommendations
- Evidence suggests there definitely could be better methods for assessing rupture risk
- Special circumstances: rapid growth, saccular morphology, planned chemo/XRT, organ transplant

Shared decision making could lead to repair at smaller diameters.

UMass Chan MEDICAL SCHOOL