What to do with thrombus in endografts?

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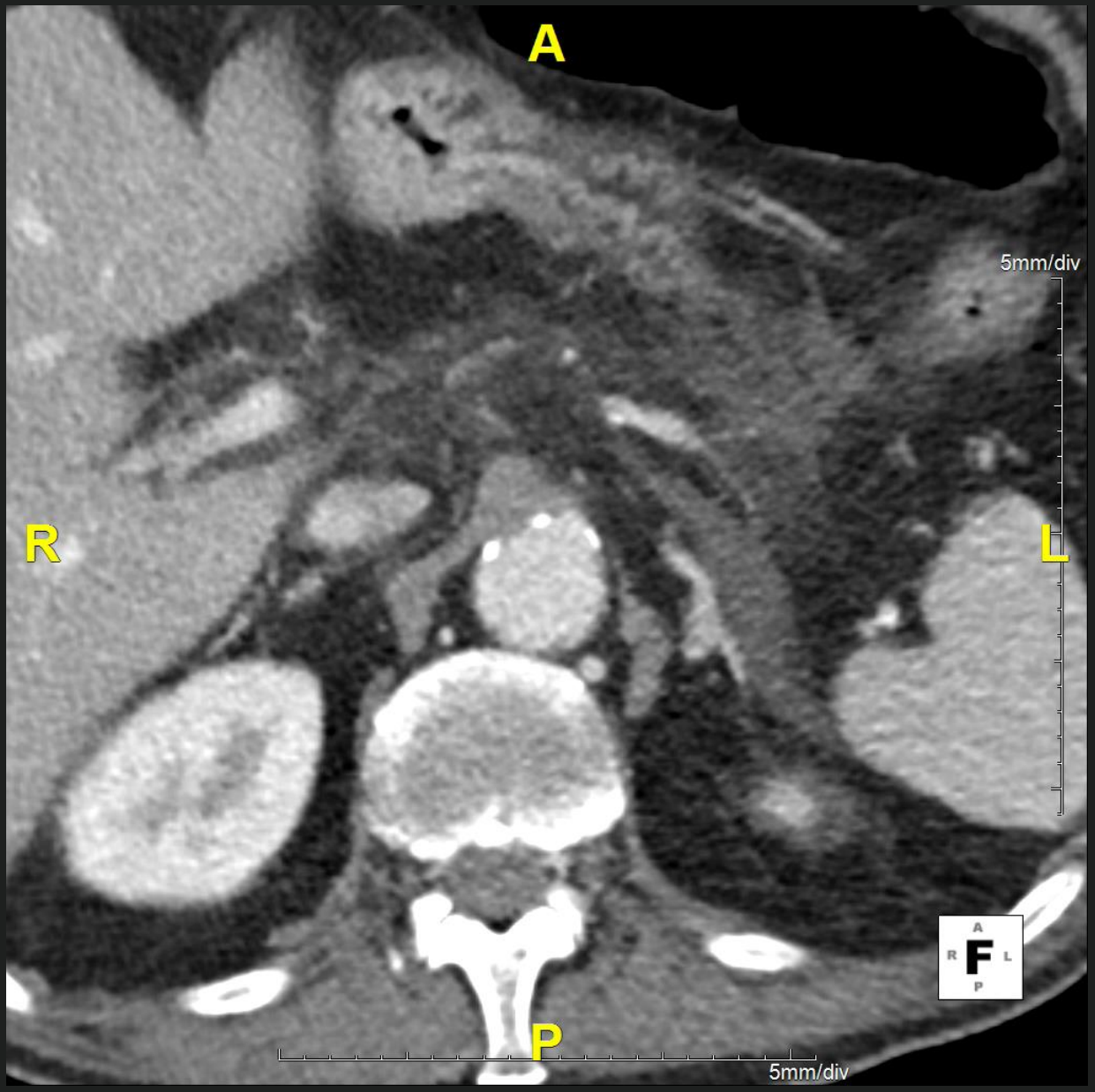
Disclosure of Interest

Speaker name: Barend Mees

- I do not have any potential conflict of interest

Patient 1

- 69 year old male
- 2013 EVAR (Cook Zenith 36-131, IBD L, 13-74 limb R)
- Antiplatelet agents
- Uncomplicated follow-up (US and Abdominal XR)
- 2017 CT Abdomen for pancreatitis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Patient 1

- 69 year old male
- 2013 EVAR (Cook Zenith 36-131, IBD L, 13-74 limb R)
- Antiplatelet agents
- Asymptomatic thrombus lining in main body EVAR

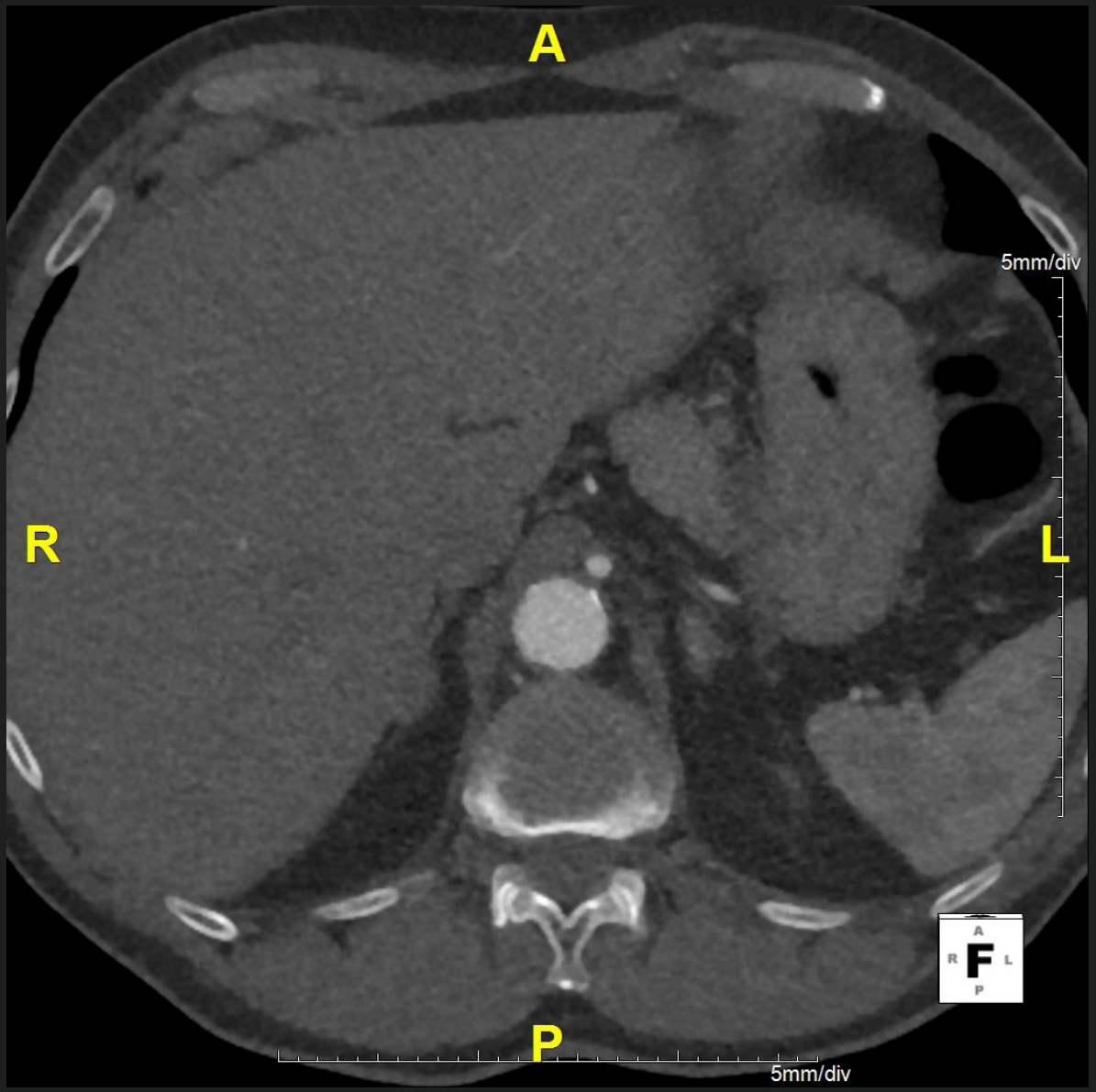
- What would you do?

Patient II

- 71 year old male
- 2011 EVAR (Cook Zenith)
- Antiplatelet agents
- Aneurysm sac growth, never endoleaks detected, adequate seal proximally and distally
- 2015 EVAS relining for endotension

Patient II

- 71 year old male
- 2011 EVAR (Cook Zenith)
- Antiplatelet agents
- 6 weeks post EVAS relining for endotension
- R Buttock and thigh claudication, non invalidating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Patient II

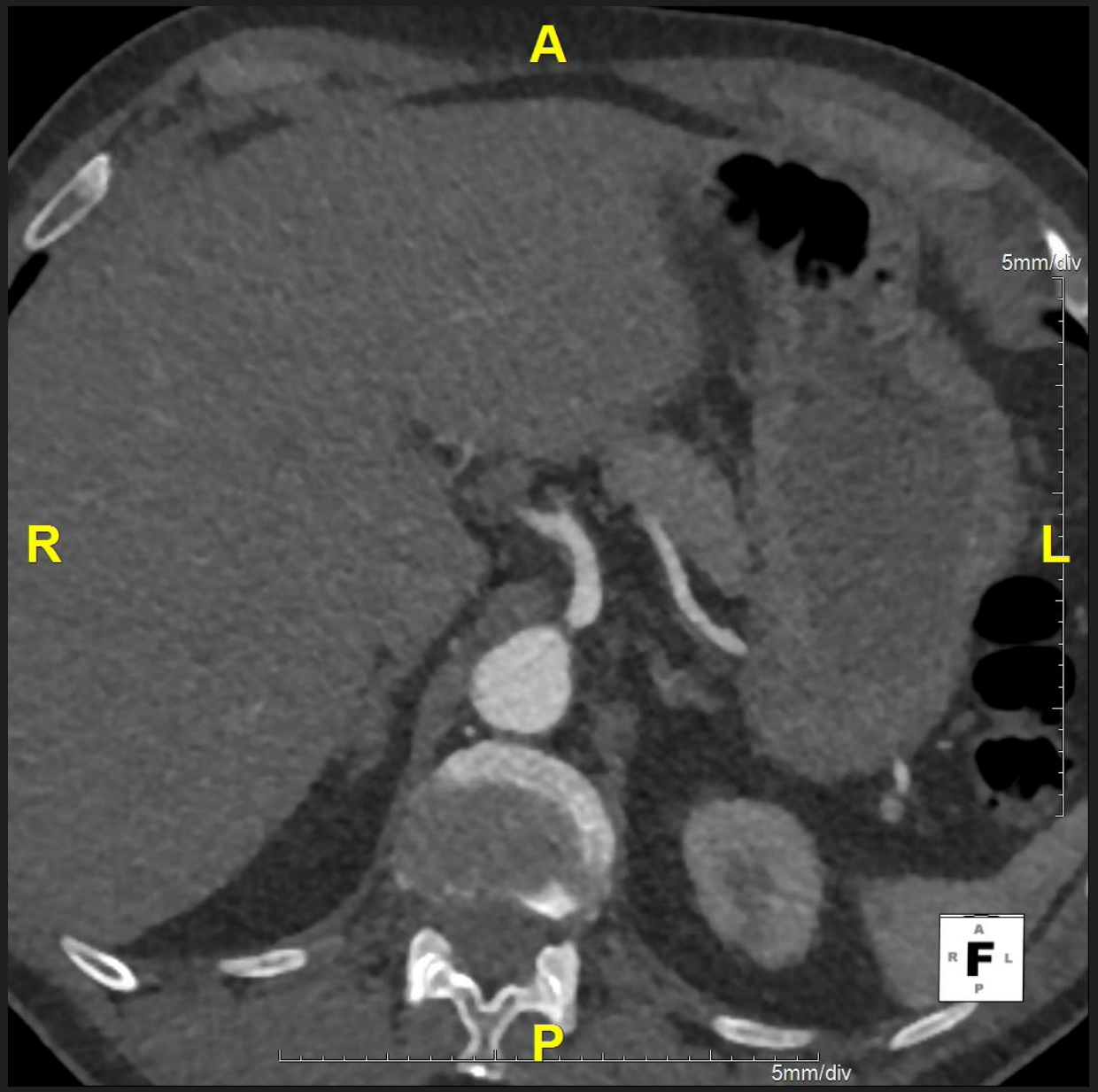
- 71 year old male
- 2011 EVAR (Cook Zenith)
- Antiplatelet agents
- 2015 6 weeks post EVAS relining for endotension
- R Buttock and thigh claudication, non invalidating
- Symptomatic thrombus lining R Nellix limb

- What do you do?

Patient II

- 71 year old male
- 2011 EVAR (Cook Zenith)
- Antiplatelet agents
- 2015 6 weeks post EVAS relining for endotension
- R Buttock and thigh claudication, non invalidating
- Symptomatic thrombus lining R Nellix limb

- 3 months later, no more symptoms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How often?

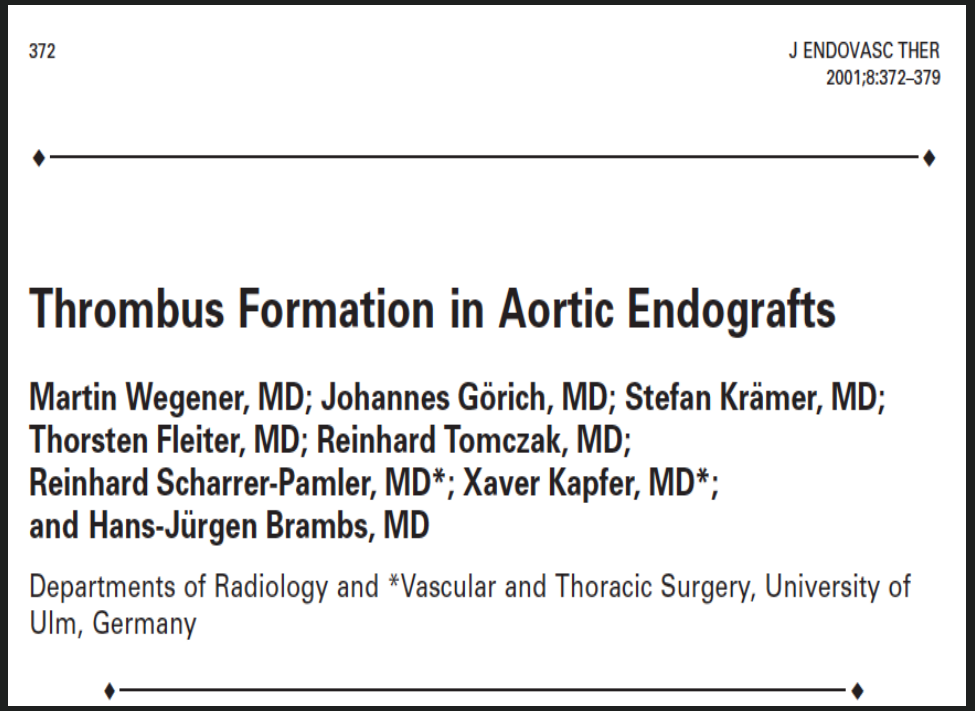
73 EVAR & 9 TEVAR patients

12 months mean follow-up

19 patients (23%; all EVAR) developed intragraft thrombus deposits

No limb occlusions/thrombotic complications

In 3 patients complete disappearance



372 J ENDOVASC THER 2001;8:372–379

Thrombus Formation in Aortic Endografts

Martin Wegener, MD; Johannes Görich, MD; Stefan Krämer, MD; Thorsten Fleiter, MD; Reinhard Tomczak, MD; Reinhard Scharrer-Pamler, MD*; Xaver Kapfer, MD*; and Hans-Jürgen Brambs, MD

Departments of Radiology and *Vascular and Thoracic Surgery, University of Ulm, Germany

What causes thrombus in endografts?

- Patient-related factors
- Endograft-related factors
- Procedure-related factors

Aneurysm characteristics associated with endograft thrombus

From the Society for Vascular Surgery

Clinical outcome and morphologic determinants of mural thrombus in abdominal aortic endografts

Nelson F. G. Oliveira, MD,[a,b] Frederico M. Bastos Gonçalves, MD,[a,c] Sanne E. Hoeks, PhD,[a] Sander Ten Raa, MD, PhD,[a] Klass H. J. Ultee, MD,[a] Ellen Rouwet, MD, PhD,[a] Johanna M. Hendriks, MD, PhD,[a] and Hence J. M. Verhagen, MD, PhD,[a] *Rotterdam, The Netherlands, and Ponta Delgada, Azores and Lisbon, Portugal*

(J Vasc Surg 2015;61:1391-8.)

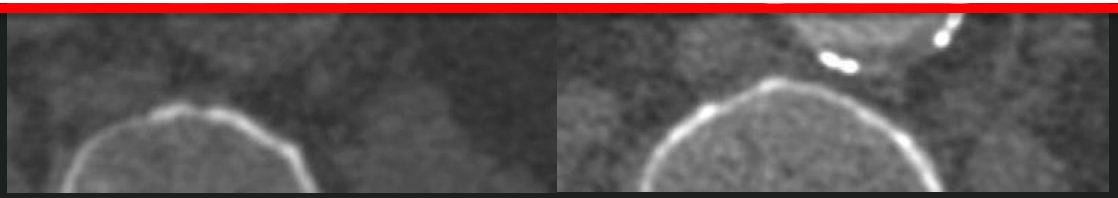
Aneurysm characteristics associated with endograft thrombus

- 68 EVAR patients with intragraft thrombus (414 overall cohort)
- Neck length < 15 mm (OR, 2.4; 95%CI, 1.3-4.2)
- Neck diameter > 30 mm (OR, 2.4; 95%CI, 1.3-4.6)

(J Vasc Surg 2015;61:1391-8.)

Preoperative thrombus load is associated with endograft thrombus

aneurysm neck thrombus progressively reduces over time and ultimately disappears. Moreover, in a significant proportion of our study group, thrombus reappeared intraluminally within the device during follow-up, similar to Houdini's famous "walking through a brick wall" illusion.



(J Vasc Surg 2015;61:1391-8.)

Preoperative thrombus load is associated with endograft thrombus

Incidence and Evolution of Mural Thrombus in Abdominal Aortic Endografts

Gaspar Mestres, Jordi Maeso, Valentin Fernandez, Nicolas Allegue, Ivan Constenla, and Manel Matas, Barcelona, Spain

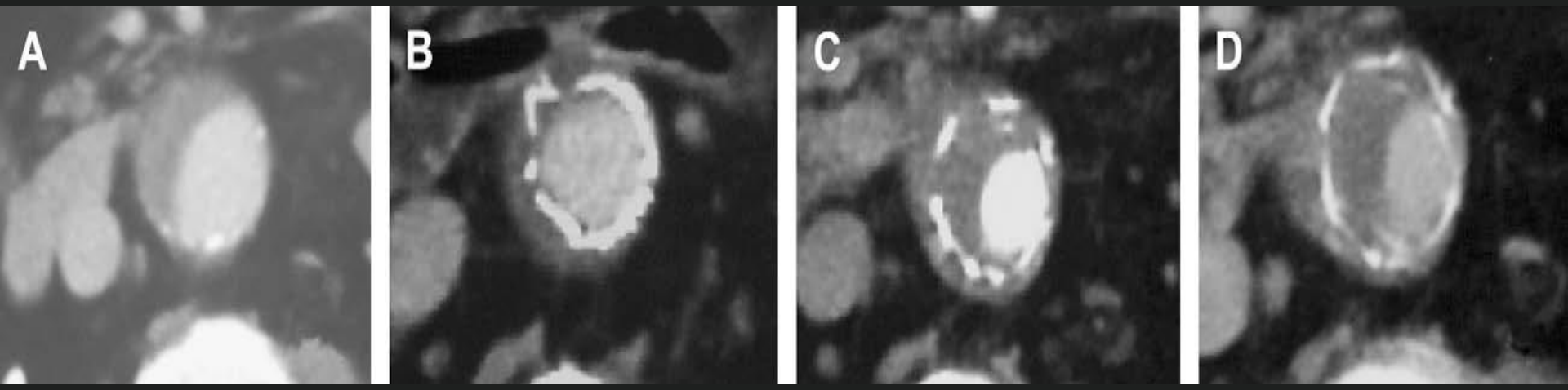
89 EVAR patients; 18 patients (24%) developed intragraft thrombus deposits

89% in first six months after EVAR, continuous increase in thrombus, no regression

Ann Vasc Surg 2009; 23: 627-633

Preoperative thrombus load is associated with endograft thrombus

- Lumen percentage of mural thrombus in native aorta (OR, 1.1; 95%CI, 1.02-1.11)



Ann Vasc Surg 2009; 23: 627-633

Patient-related factors that are NOT associated with endograft thrombus

- Age
- Smoking
- Malignancy
- Anticoagulation or antiplatelet therapy
- Coagulation disorders ?

Graft-related factors that are associated with endograft thrombus

- **Mural Thrombotic Deposits in Abdominal Aortic Endografts Are Common and Do Not Require Additional Treatment at Short-term and Midterm Follow-up**

Geert Maleux, MD, PhD, Marcel Koolen, MD, Sam Heye, MD, Birgit Heremans, MD, and André Nevelsteen, MD, PhD

33% from 187 Cook Zenith EVAR patients versus 17% from 71 Gore Excluder EVAR patients developed intragraft thrombus (P=0.038)

Polyester fabric (Endurant, Zenith, Talent) OR, 4.0; CI, 2.2-7.3

J Vasc Interv Radiol 2008; 19:1558–1562

Polyester-coated devices are associated with higher incidence of endograft thrombus

- Thrombogenicity of Dacron bypass grafts is greater than of ePTFE
- Hemodynamic properties causing turbulent or low flow are more common in polyester-coated devices (longer body length, smaller limb diameter)

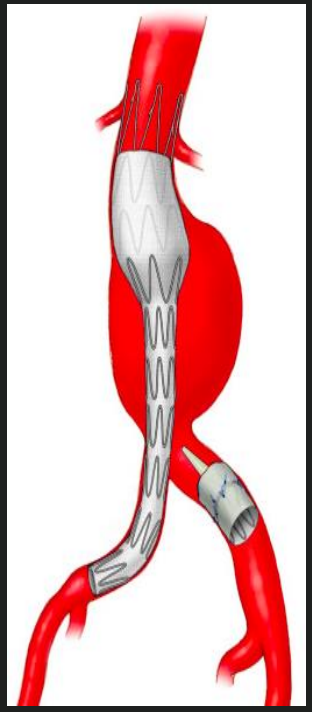
(J Vasc Surg 2015;61:1391-8.)

Ann Vasc Surg 2009; 23: 627-633

J Vasc Interv Radiol 2008; 19:1558–1562

Stentgraft configuration is associated with endograft thrombus

- Aorto-Uni-Iliac stentgraft (OR, 2.2; 95% CI, 1.9-5.5)
- In AUI devices large main body diameter and small outflow limb may cause flow deceleration and low flow regions inside main body leading to thrombus formation



(J Vasc Surg 2015;61:1391-8.)

Ann Vasc Surg 2009; 23: 627-633

Stentgraft configuration is associated with endograft thrombus

The Significance of Endograft Geometry on the Incidence of Intraprosthetic Thrombus Deposits after Abdominal Endovascular Grafting

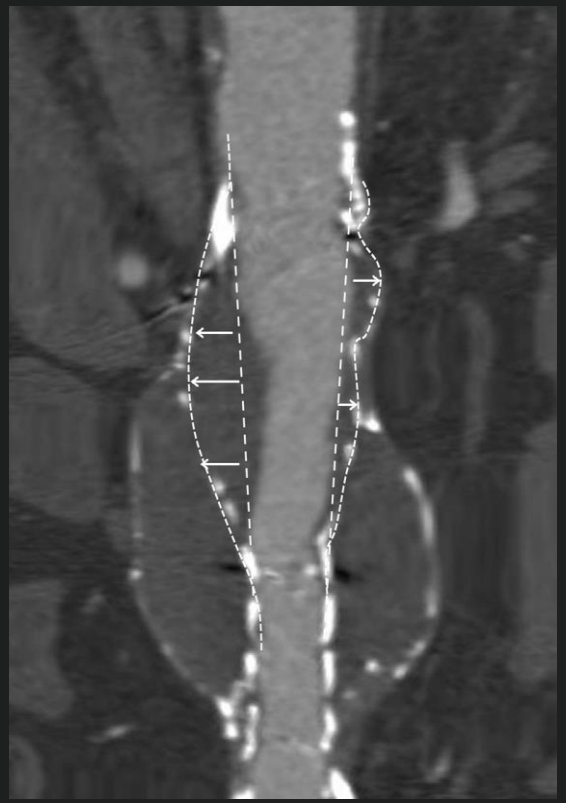
I.H. Wu [a], P.C. Liang [b], S.C. Huang [a], N.S. Chi [a], F.Y. Lin [c], S.S. Wang [a,*]

- 51 EVAR patients; 8 (16%) patients with thrombus in endograft
- Deposition of thrombus was mostly influenced by geometry of aortic stentgraft with wider main body diameter coupled with smaller limb grafts and longer main body graft.

Eur J Vasc Endovasc Surg (2009) **38**, 741–747

Stentgraft configuration is associated with endograft thrombus

- Barrel-like configuration of main body (> 50% increase in cross-sectional area) (OR, 6.9; 95% CI, 1.7-28.3)



(J Vasc Surg 2015;61:1391-8.)

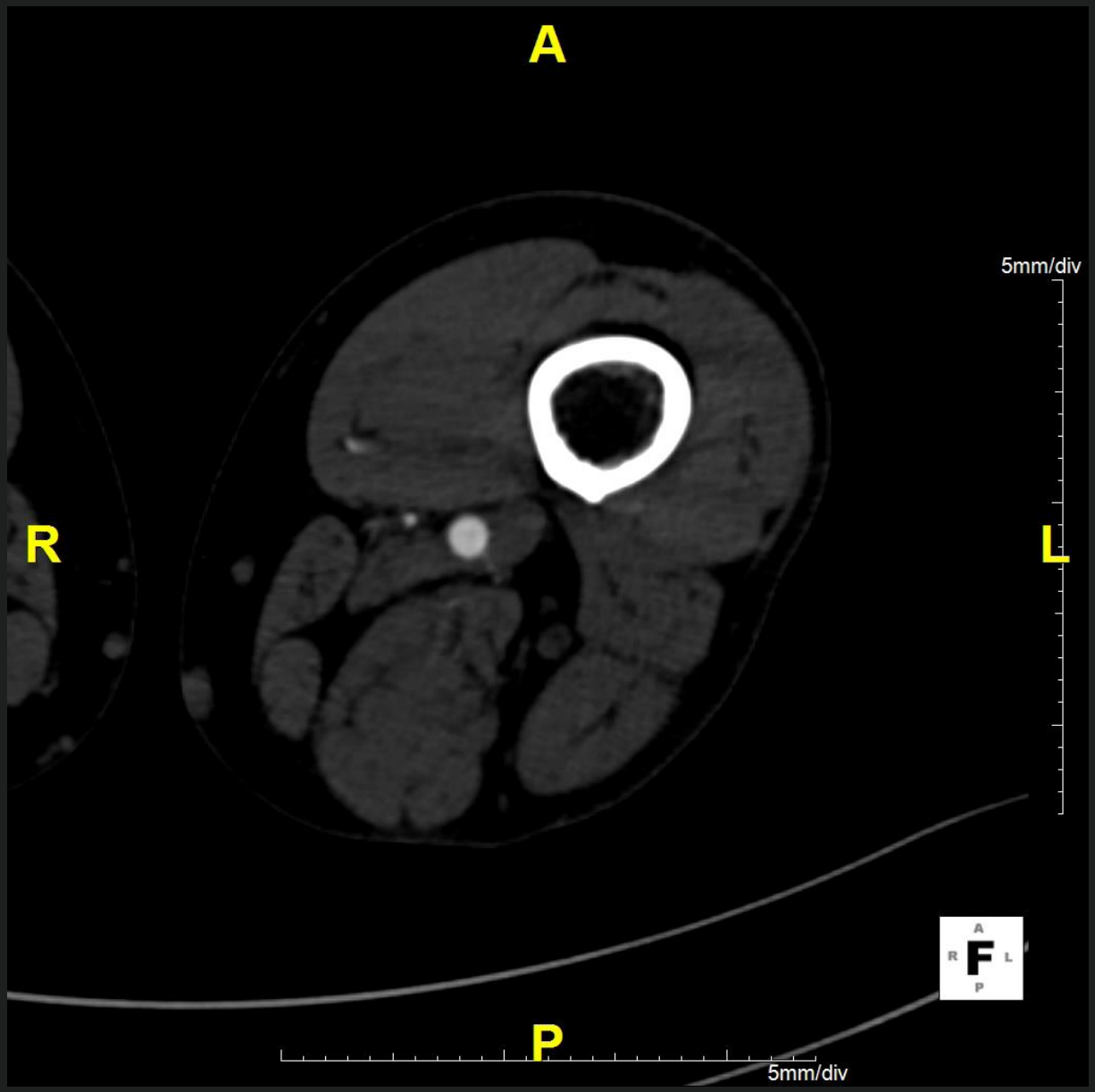
Stentgraft configuration is associated with endograft thrombus

- Bell-bottom iliac limb configuration
- 20% thrombus formation in iliac limbs >24 mm versus 8% in smaller iliac limbs
- No difference in main body endograft thrombus

(J Vasc Surg 2015;61:1391-8.)

Patient III

- 52 year old male
- Presents with ischemic limb L 2 years post-EVAR (Endurant, L limb 28 mm diameter)
- Antiplatelet agent
- No previous claudication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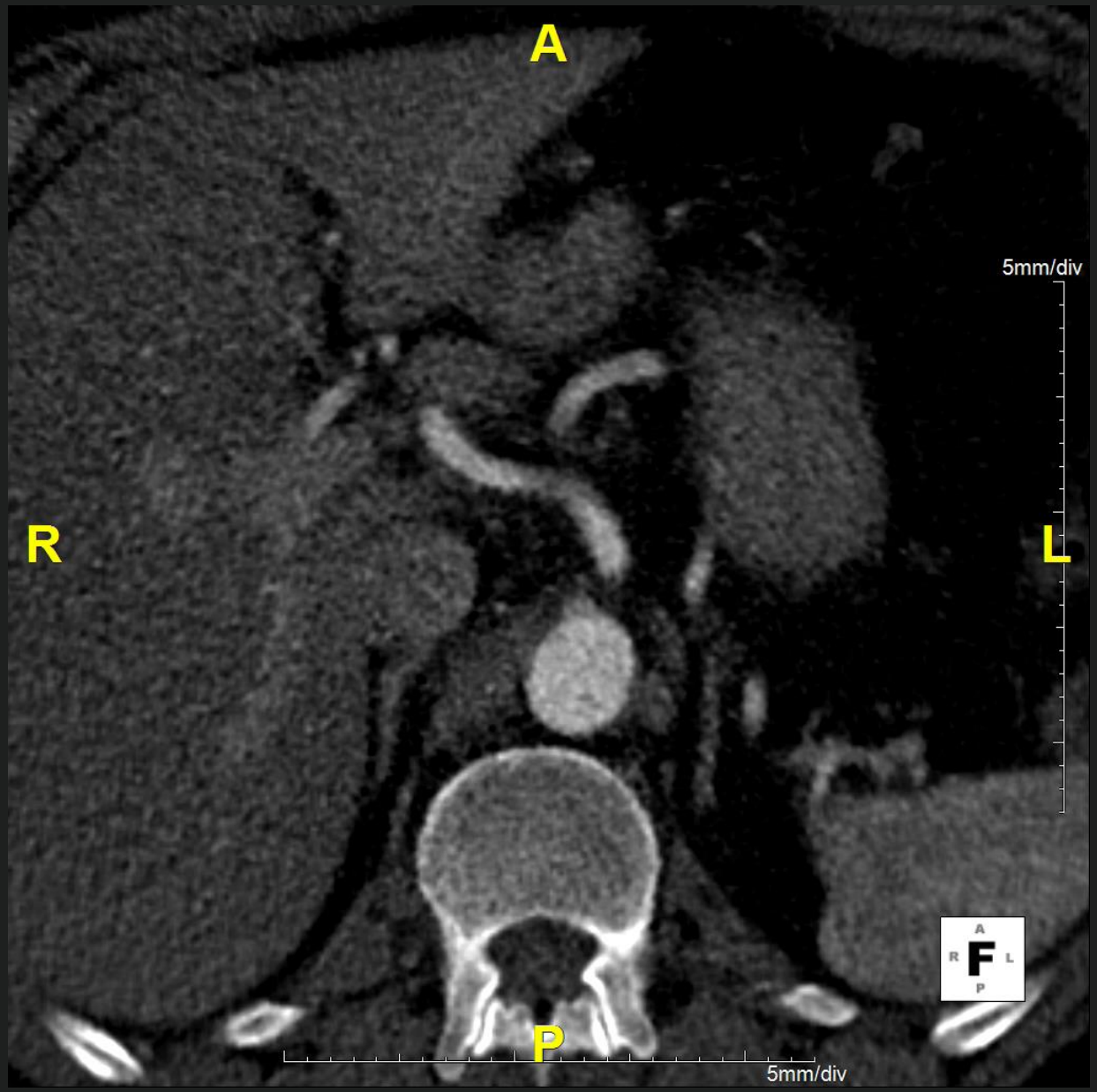
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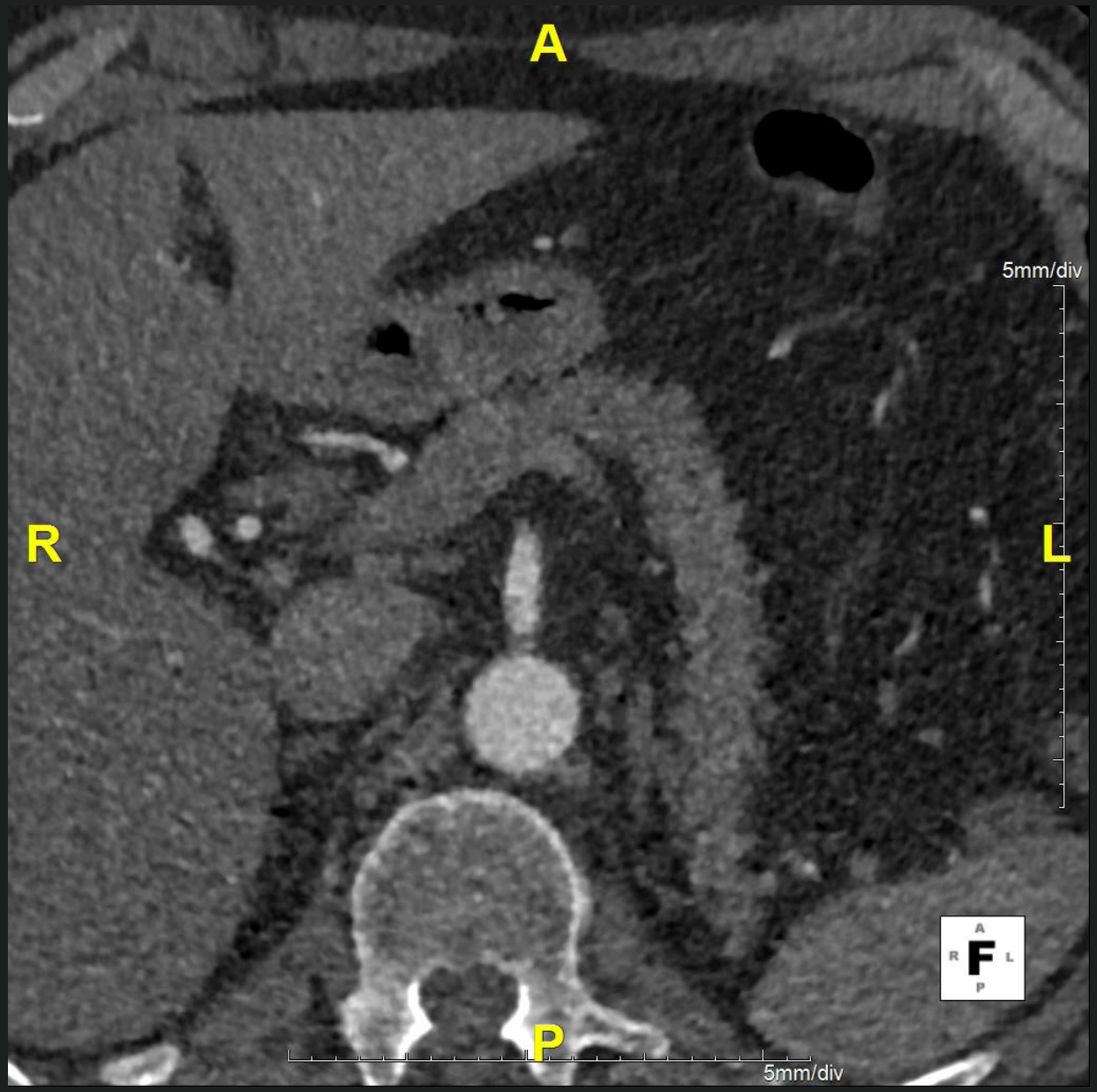
Patient III

- 52 year old male
- Presents with ischemic limb L 2 years post-EVAR (Endurant, L limb 28 mm diameter)
- Antiplatelet agent
- No previous claudication
- Symptomatic thrombus in iliac limb of EVAR
- What to do?

Patient III

- Thrombectomy and started on anticoagulation
- 2nd stage relining of L iliac 28 mm limb
- Possible to achieve sealing in distal CIA
- Percutaneous relining with Endurant 16-20-93 limb
- Switched back to antiplatelets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Stent g ated with

Thromboembo ith® Low Profile Endovascular inal Aneurysms

T. A. J. Urlings · A. C
Otterloo · D. Eefting ·

Table 1 Thromboembolic complications

Patient	Thrombus main body	Thrombus iliac limbs	Limb occlusion	Distal embolization
1/M/63	C	RN, LC	R(T), L(2x)(T)	Left PA(T)
2/F/73	C	RN	R	–
3/M/60	C	RC	L(T)	–
4/F/74*	–	–	–	–
5/M/86	C	RC, LC	–	–
6/M/80	C	–	R(T), L	–
7/M/78	C	–	–	–
8/M/79	N	RN	–	–
9/M/71	C	RN, LN	R(T)	Right PA
10/F/75	C	RN	–	–
11/M/82	–	–	–	–
12/M/65	N	–	–	–
13/M/76*	–	–	–	–
14/M/72	C	–	–	–
15/M/80	–	–	–	–
16/M/64	–	RN, LN	–	–
17/M/84	–	–	L	–

Patients with limb occlusion are given in bold

C circumferential, *N* noncircumferential, *L* left, *R* right, *T* thrombolytic therapy performed, *PA* popliteal artery

* Only ultrasound follow-up

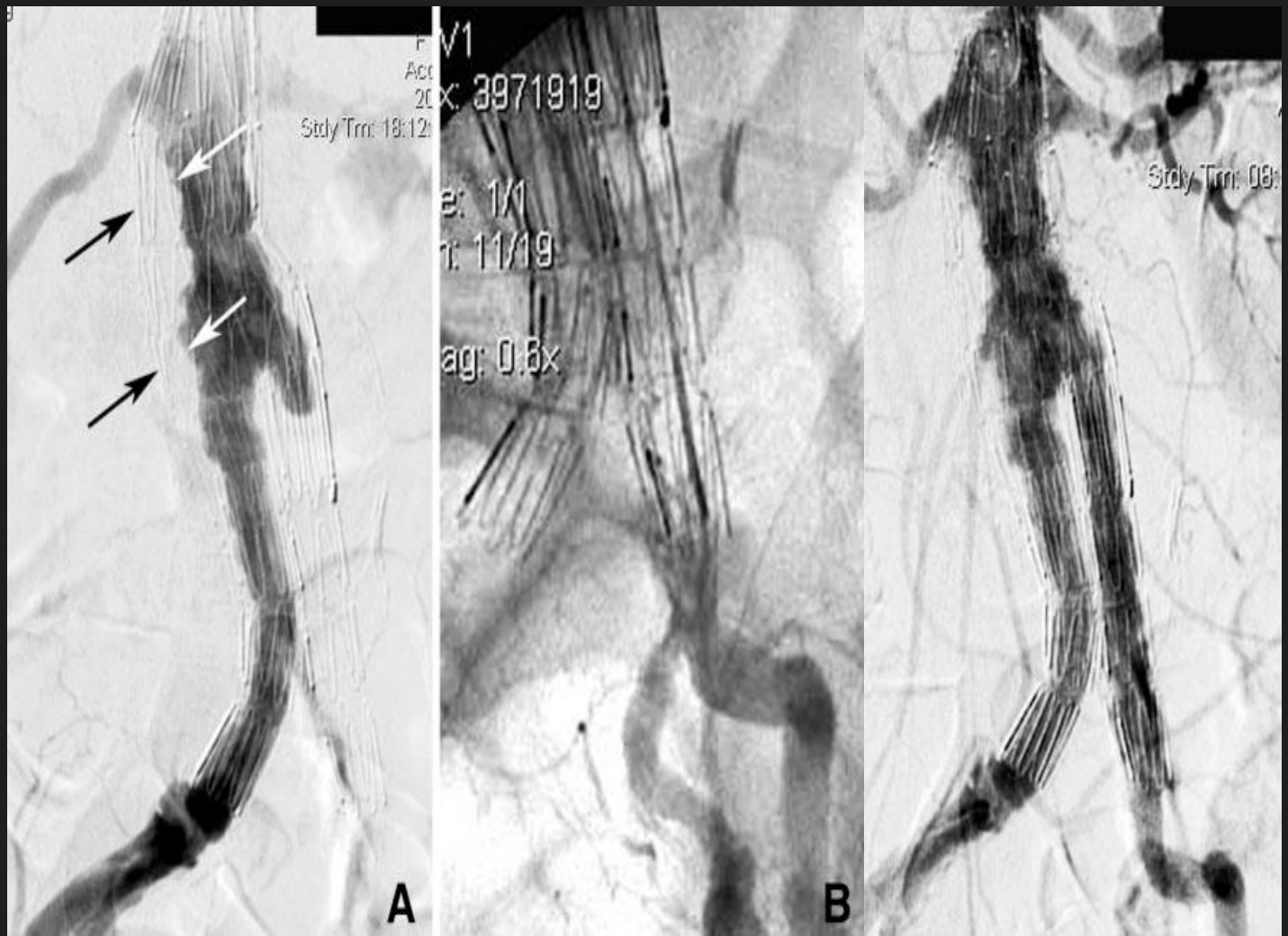
Procedure-related factors associated with endograft thrombus

Heparin-Induced Thrombocytopenia and Graft Thrombosis Following Endovascular Aneurysm Repair

Timothy A.M. Chuter, MD; Laura K. Pak, MD; Roy L. Gordon, MD; Linda M. Reilly, MD; and Louis M. Messina, MD

J ENDOVASC THER
2003;10:1087–1090

Heparin-Induced Thrombocytopenia causing endograft thrombosis



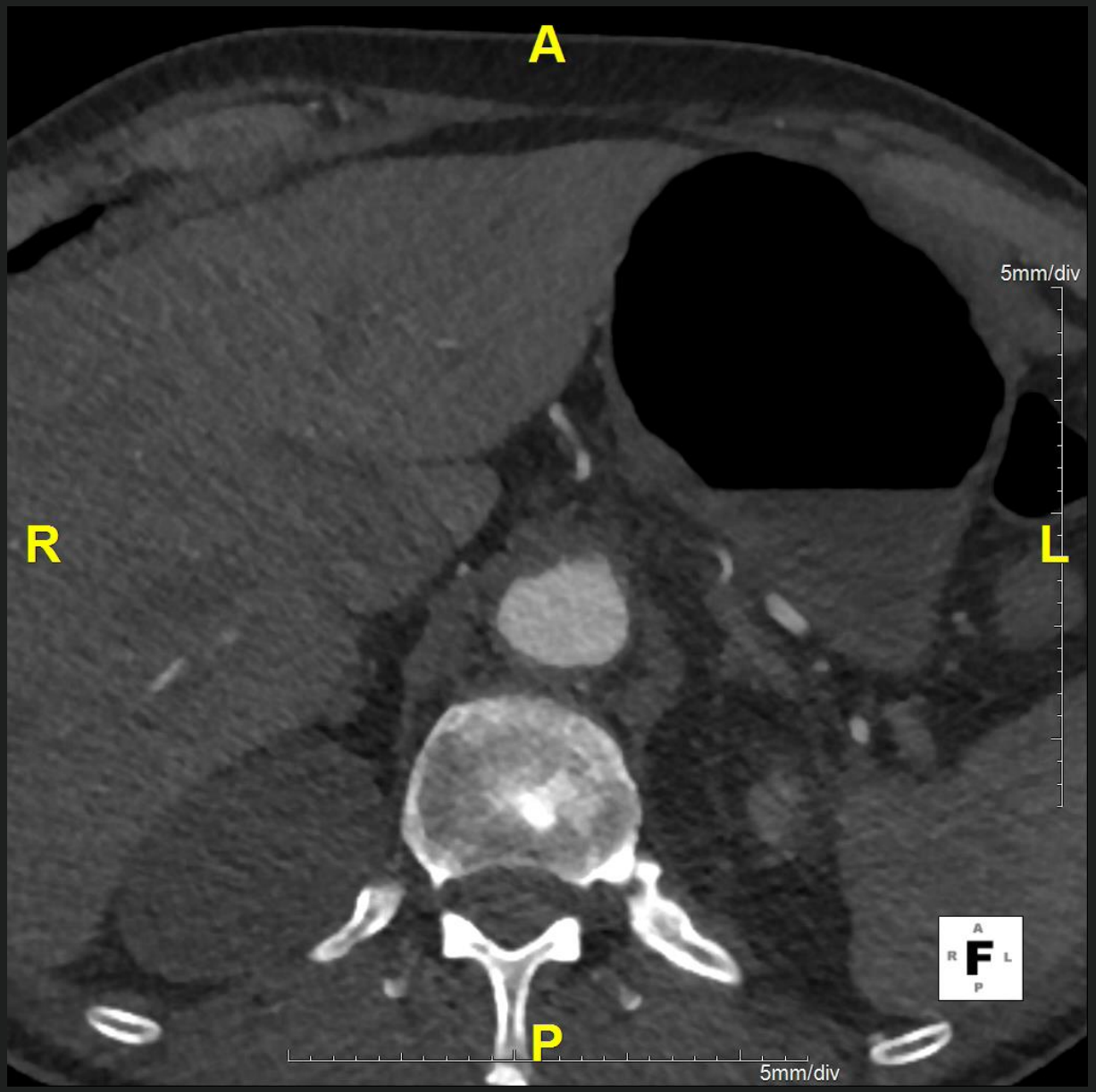
Procedure-related factors associated with endograft thrombus

- Timing of systemic heparinization

Patient IV

- 76 year old male
- Presents with sAAA, suitable for normal EVAR
- Antiplatelet agent
- Bifurcated EVAR, completion angio: occluded

- No heparin administered!
- Bilateral thrombectomy and endarterectomy CFA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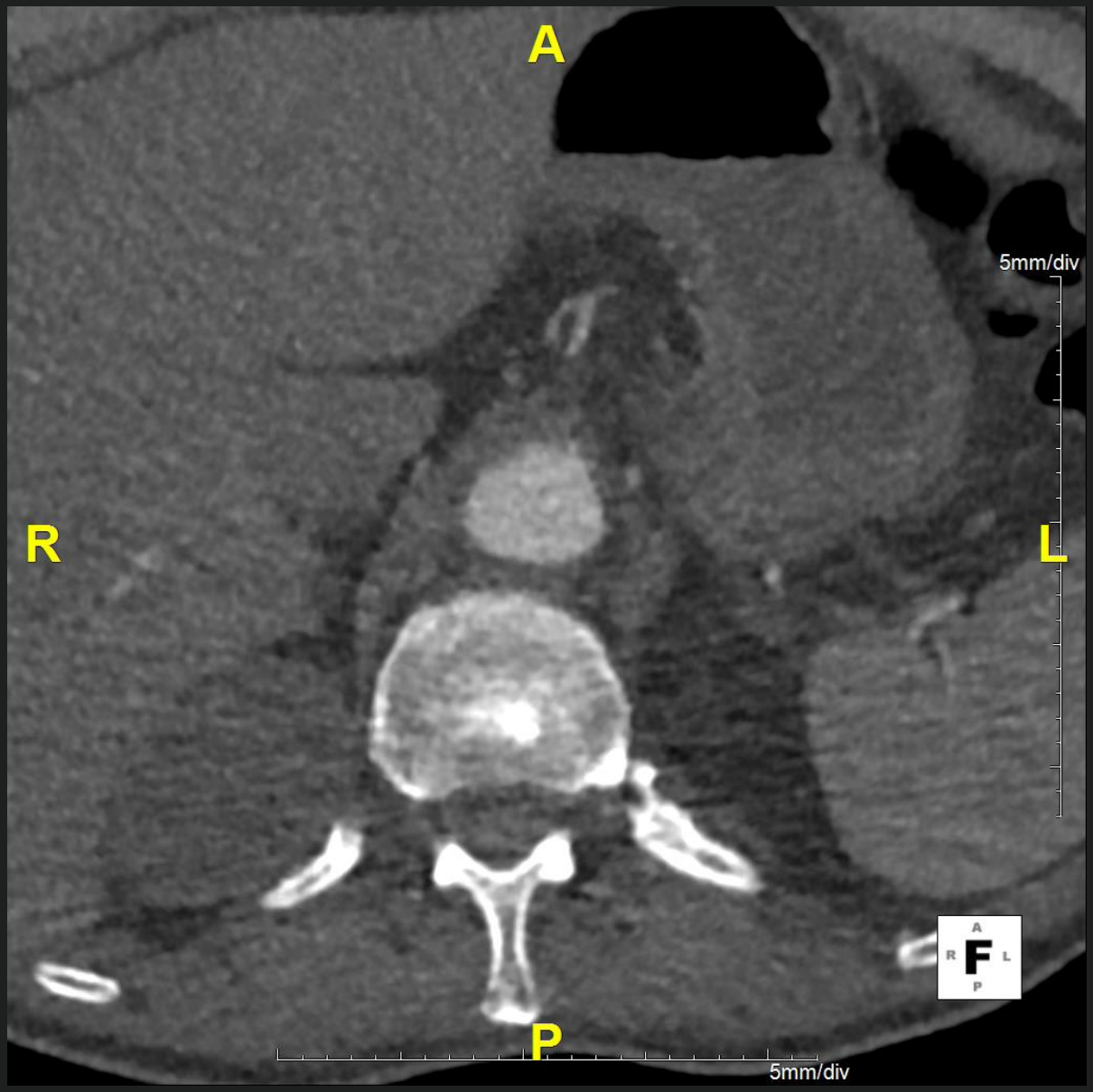
Patient IV

- Started on anticoagulation
- Two days later relining of main body
- Gore Excluder cuff 36-40 x2
- Switched back to antiplatelet therapy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Is mural thrombus in endograft associated with thrombo-embolic complications?

- NO

Eur J Vasc Endovasc Surg (2009) **38**, 741–747

Cardiovasc Intervent Radiol (2015) 38:600–605

Ann Vasc Surg 2009; 23: 627-633

(J Vasc Surg 2015;61:1391-8.)

J ENDOVASC THER
2001;8:372–379

Is mural thrombus in endografts a risk factor for limb occlusion?

- NO

Cardiovasc Intervent Radiol (2015) 38:600–605

J Vasc Interv Radiol 2008; 19:1558–1562

Eur J Vasc Endovasc Surg (2009) **38**, 741–747

(J Vasc Surg 2015;61:1391-8.)

J ENDOVASC THER
2001;8:372–379

- YES

Ann Vasc Surg 2009; 23: 627-633

Incidence and treatment results of Endurant endograft occlusion

Laura van Zeggeren, MD,[a] Frederico Bastos Gonçalves, MD,[b] Joost A. van Herwaarden, MD, PhD,[c] Herman J. A. Zandvoort, MD,[c] Debora A. B. Werson, MPA,[a] Jan-Albert Vos, MD, PhD,[d] Frans L. Moll, MD, PhD,[c] Hence J. Verhagen, MD, PhD,[b] and Jean-Paul P. M. de Vries, MD, PhD,[a]
Nieuwegein, Rotterdam, and Utrecht, The Netherlands

Predictive factors for limb occlusions after endovascular aneurysm repair

Elsa M. Faure, MD, Jean-Pierre Becquemin, MD, and Frédéric Cochennec, MD, on behalf of ENGAGE collaborators, *Créteil, France*

Predicting iliac limb occlusions after bifurcated aortic stent grafting: Anatomic and device-related causes

Alfio Carroccio, MD, Peter L. Faries, MD, Nicholas J. Morrissey, MD, Victoria Teodorescu, MD, James A. Burks, MD, Edwin C. Gravereaux, MD, Larry H. Hollier, MD, and Michael L. Marin, MD,
New York, NY

What are predictive factors for endograft limb occlusion?

- Landing zone in external iliac artery
- Small diameter endograft limbs
- Small diameter external iliac artery
- Kinking or stenosis of endograft limb
- Aneurysm diameter < 59 mm
- Correction of endoleak

Is there a role for anticoagulation as treatment of mural thrombus in endografts?

- Gut feeling (in analogy with mural thrombus in native aorta):

YES

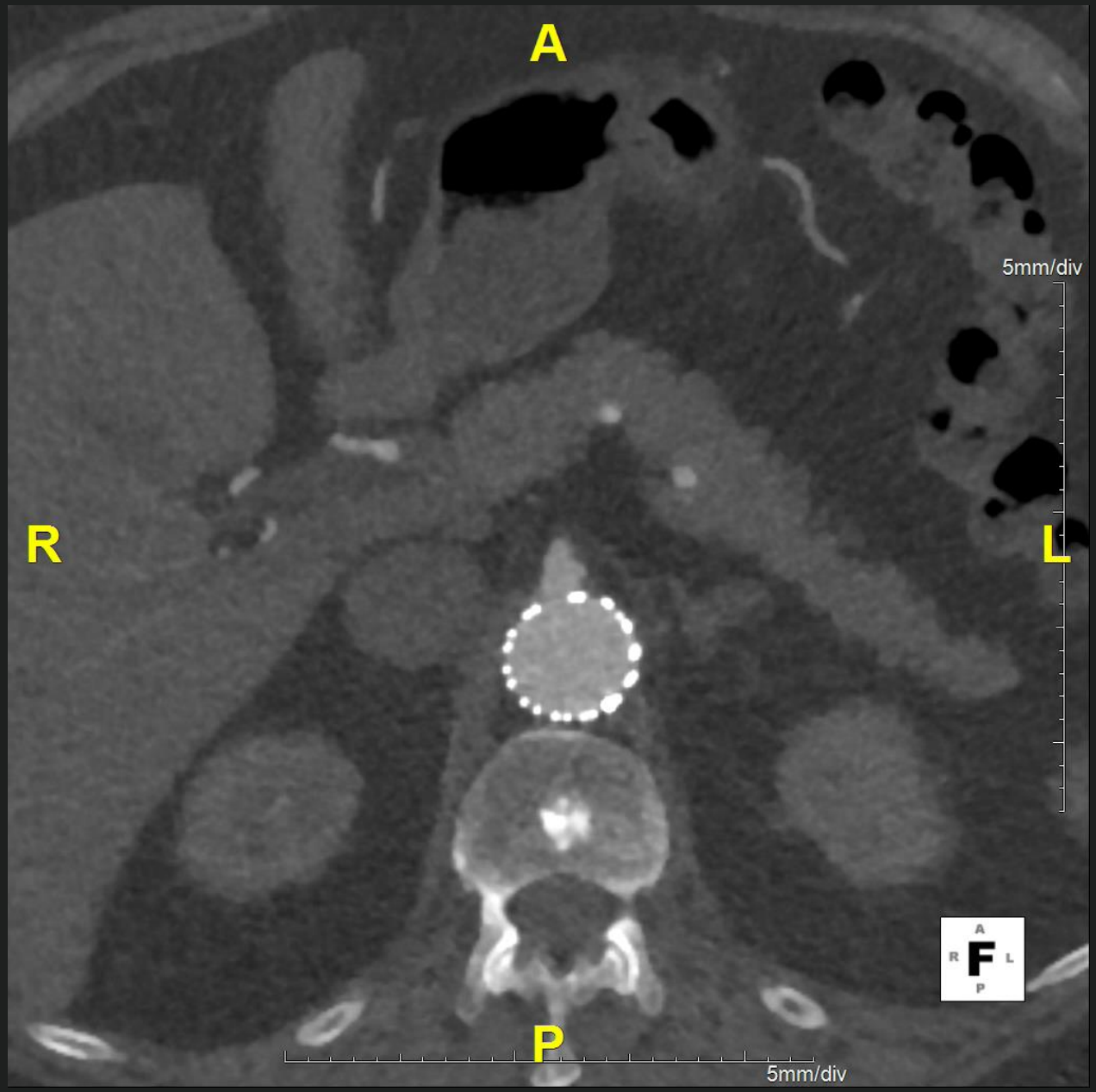
Is there a role for anticoagulation as treatment of mural thrombus in endografts?

- Evidence:

NO

Patient V

- 71 year old male
- 2013 EVAR (Endurant)
- Antiplatelet agents
- Type IA endoleak due to neck dilation
- 2015 FEVAR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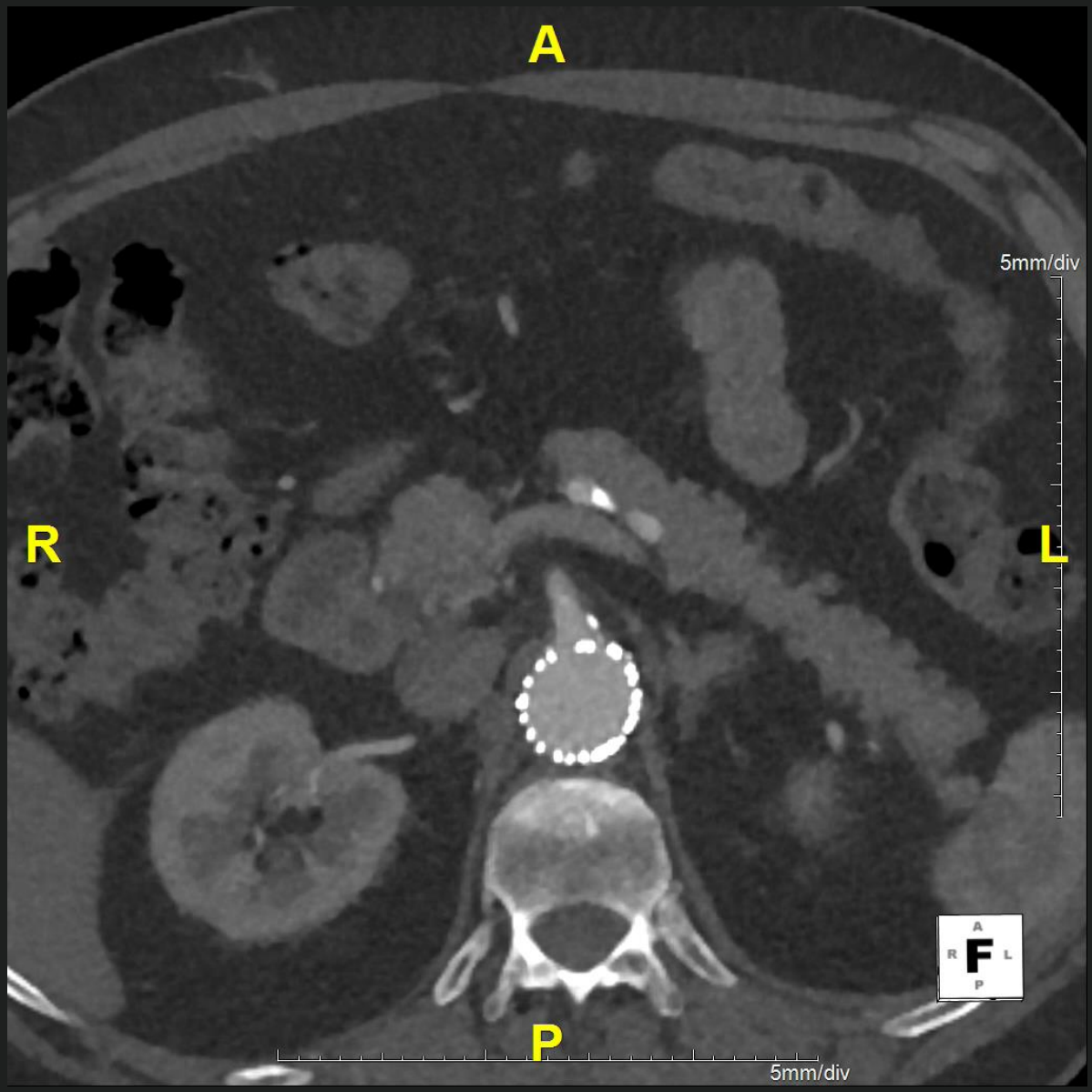
Patient V

- 71 year old male
- 2013 EVAR (Endurant)
- Antiplatelet agents
- Type IA endoleak due to neck dilation
- 2015 FEVAR
- Asymptomatic thrombus lining R limb

- What do you do?

Patient V

- 71 year old male
- 2013 EVAR (Endurant)
- Antiplatelet agents
- 2015 FEVAR
- Asymptomatic thrombus lining R limb
- Developed atrial fibrillation and started on oral anticoagulation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Mural thrombus in endografts

- Reported incidence is 11-33%
- Majority develops in first year post EVAR
- Risk factors are aneurysm-related (neck, thrombus), graft-related (configuration, fabric) and possibly patient-related (check for coagulation disorders)

Mural thrombus in endografts

- Rarely leads to thromboembolic events or endograft occlusion
- Thrombus lining in main body may be less harmful than in iliac limb
- If asymptomatic, no treatment advised, consider CTA follow-up

Mural thrombus in endografts

- If limb kinking, stenosis or outflow limitations, treatment is advised to prevent occlusion
- If symptomatic (claudication), anticoagulation or endograft relining may be considered
- If symptomatic (thromboembolic), endograft relining is advised
- Consider endograft relining with less thrombogenic device


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THANK YOU