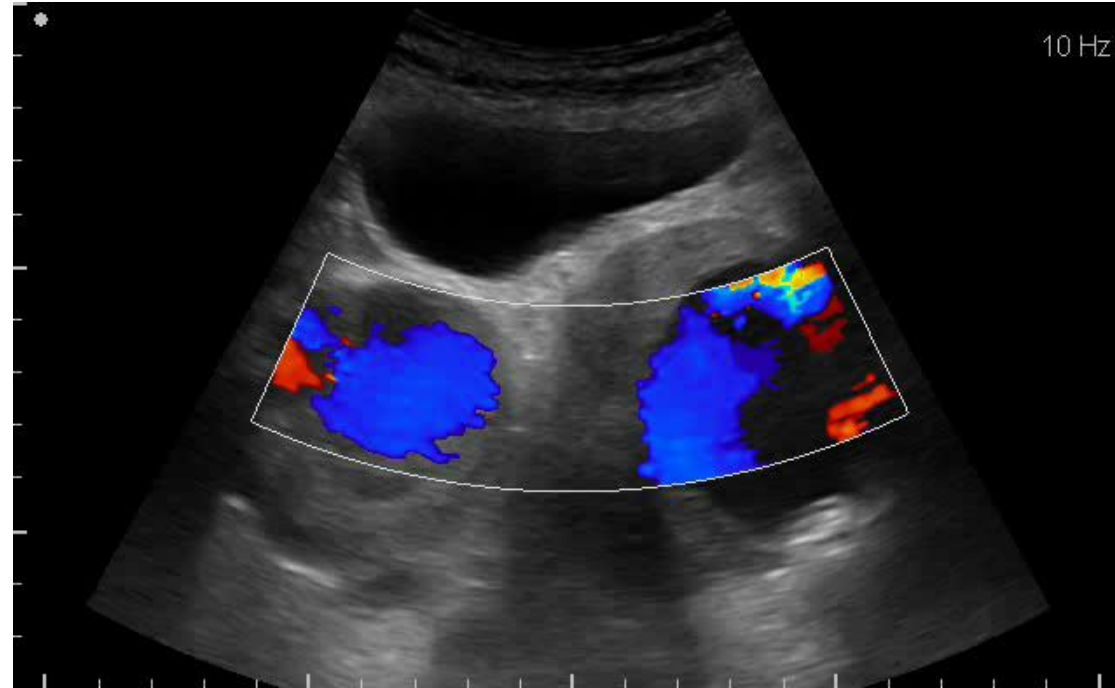


AAA: postoperative Kontrollen



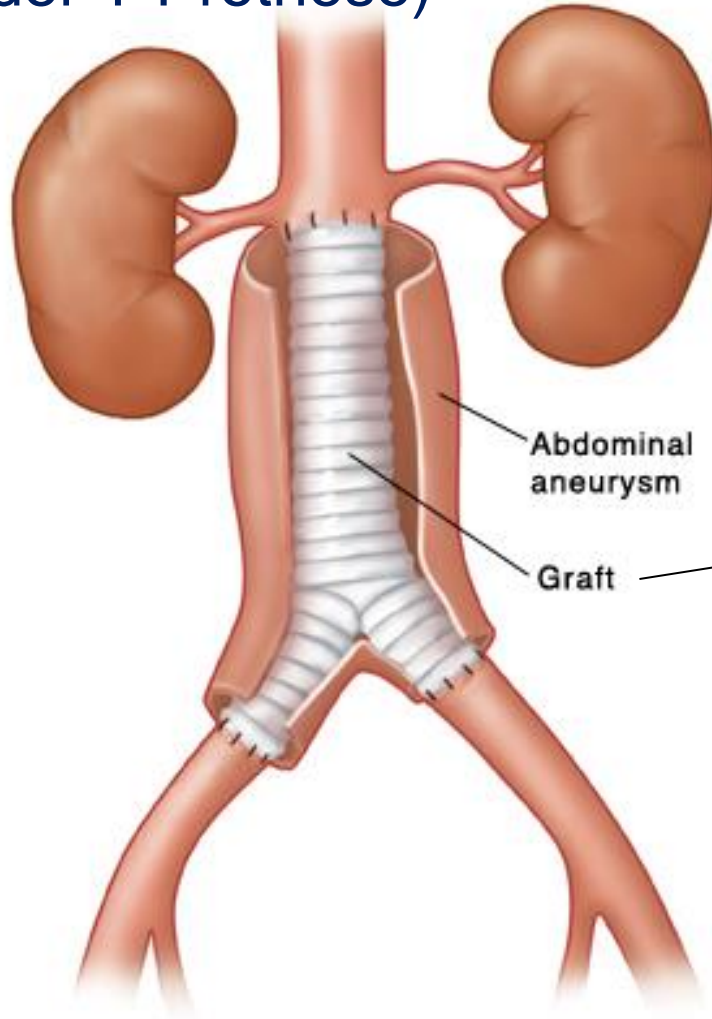
Angiologie

Spitalzentrum Biel

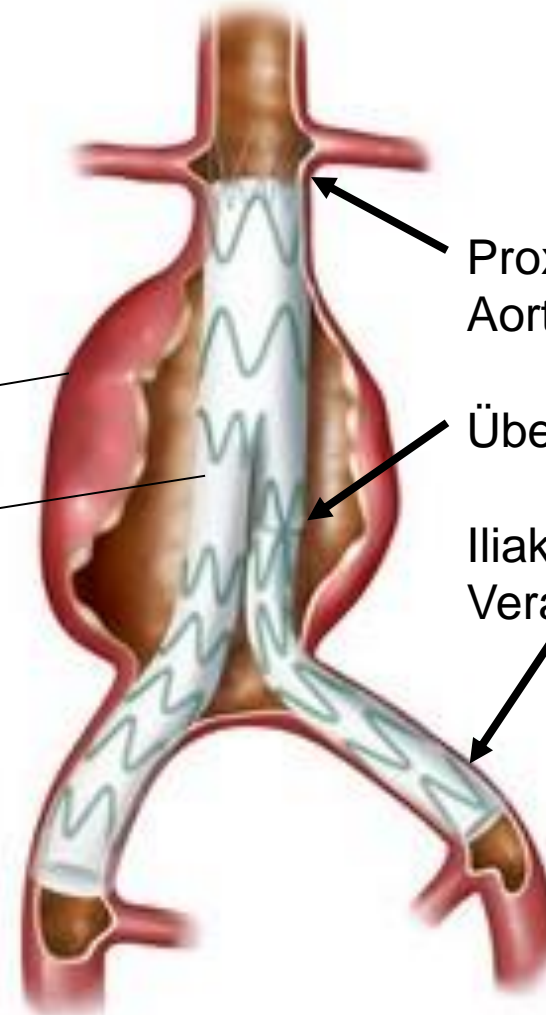
andreas.erdmann@szb-chb.ch

Therapie des infrarenalen AAA

Offene AAA-Chirurgie
(Rohr- oder Y-Prothese)



EVAR*
(aorto-bi-iliakaler beschichteter Stent)



* EVAR = Endovascular Aneurysm Repair

Kontrollen nach offener Operation

Table 6.1. Long-term complications after open abdominal aortic aneurysm repair, and their incidence within 5 and 10–15 years.

Complication	Estimated frequency during 5 year follow up	Estimated frequency during 10 year follow up
Para-anastomotic aneurysm formation	1%	12% (15 years)
Limb occlusion	1%	5% (15 years)
Incisional hernia	5–12%	5–21%
Graft infection	0.5–5%	
Secondary aorto-enteric fistula	<1%	

- Verlaufskontrolle mittels Duplex-Sonographie (oder CT-Angiographie) alle 5 Jahre

Recommendation 85

In all patients after open repair for abdominal aortic aneurysm, imaging follow up of the aorta and peripheral arteries may be considered every five years

Class	Level	References
Ib	C	[549,548]

AAA: Postoperative Nachsorge

Recommendation 86		Changed	
Patients operated on for an abdominal aortic aneurysm should receive post-operative cardiovascular risk management including statin therapy, antiplatelet medication, and blood pressure control.			
Class	Level	References	ToE
I	B	Xiong <i>et al.</i> (2022), ²⁰⁷ Risum <i>et al.</i> (2021), ³³⁸ Khashram <i>et al.</i> (2017) ⁷⁰² Zhang <i>et al.</i> (2015), ⁷⁰³ Lindstrom <i>et al.</i> (2021) ⁷⁰⁵	

Statine: senken Mortalität um 35 % (RRR)

Wanhainen A et al., European Society for Vascular Surgery (ESVS) 2024 Clinical Practice Guidelines on the Management of Abdominal Aorto-Iliac Artery Aneurysms, European Journal of Vascular and Endovascular Surgery, <https://doi.org/10.1016/j.ejvs.2023.11.002>

Langzeit-Nachsorge nach E

Effektive Verlaufskontrolle mit Monitorisierung von:

- Diameter Aneurysma und -Hals
- Neue Aneurysmen
- Endoleak
- Graft-Thrombose
- Komplikationen im Zugangsbereich
- b/f/ch-EVAR: Permeabilität Seitenäste
- Stent-Migration
- Stent-Kinking/Stentbruch
- Infektionen

Mit Duplex Ul

limitiert mit Du

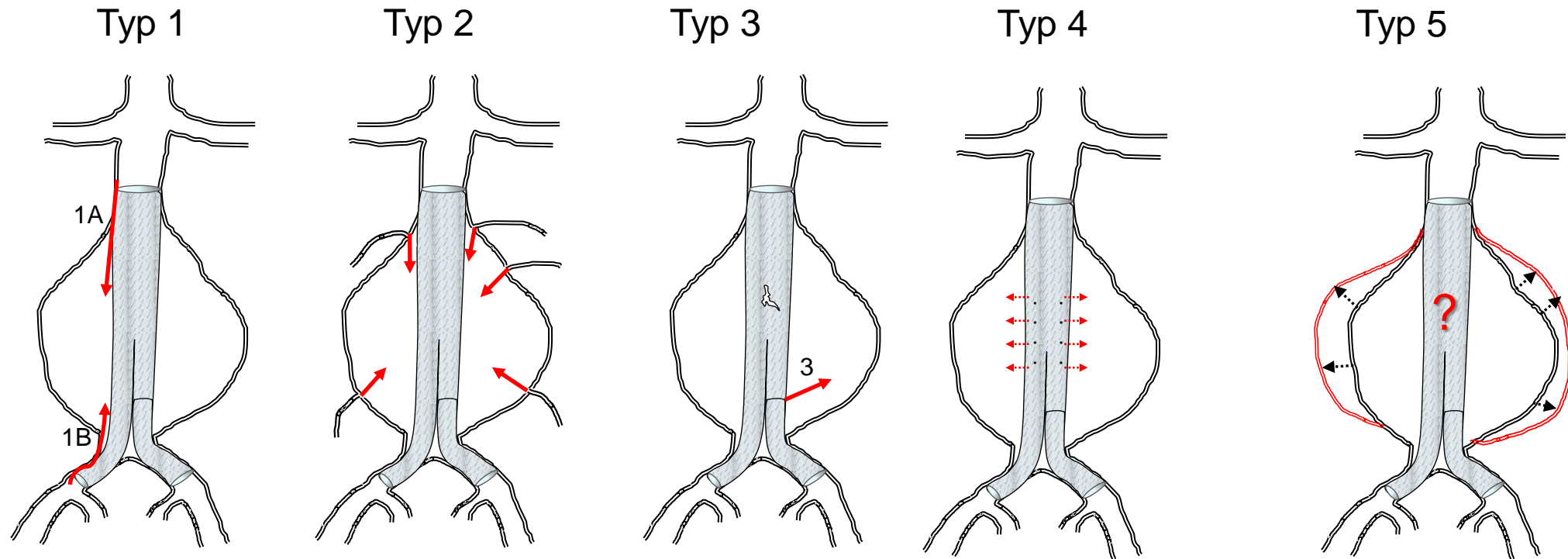
Recommendation 104 New			
Patients with compromised sealing zones* without visible endoleak after endovascular abdominal aortic aneurysm repair may be considered for intervention to improve the seal, primarily by endovascular means.			
Class	Level	References	ToE
IIb	C	Budtz-Lilly <i>et al.</i> (2023), ⁸⁰⁶ Bastos Gonçalves <i>et al.</i> (2013), ⁸²¹ Bastos Gonçalves <i>et al.</i> (2014), ⁸²² Baderkhan <i>et al.</i> (2018), ⁸²³ Geraedts <i>et al.</i> (2021) ⁸²⁴	

Recommendation 105 New			
For patients with a compromised proximal seal* after endovascular abdominal aortic aneurysm repair, proximal extension with fenestrated and branched devices should be considered in preference to other endovascular techniques.			
Class	Level	References	ToE
IIa	C	Doumenc <i>et al.</i> (2021), ⁷⁹⁸ Martin <i>et al.</i> (2014), ⁸⁰⁰ Wang <i>et al.</i> (2018), ⁸⁰² Dias <i>et al.</i> (2018), ⁸⁰³ Falkensammer <i>et al.</i> (2017), ⁸⁰⁴ Budtz-Lilly <i>et al.</i> (2023), ⁸⁰⁶ Perini <i>et al.</i> (2019), ⁸¹⁵ Juszczak <i>et al.</i> (2021) ⁸⁰⁷ Juszczak <i>et al.</i> (2020) ⁸²⁵	

* Inadequate seal (< 10 mm) or progressive neck dilatation.

Recommendation 106 New			
For selected patients with a compromised proximal seal* after endovascular abdominal aortic aneurysm repair, elective open conversion may be considered as an alternative to complex endovascular interventions, provided the surgical risk is acceptable.			
Class	Level	References	ToE
IIb	C	Doumenc <i>et al.</i> (2021), ⁷⁹⁸ Dias <i>et al.</i> (2018), ⁸⁰³ Scali <i>et al.</i> (2014), ⁸¹⁷ Arnaoutakis <i>et al.</i> (2019), ⁸¹⁸ Goudekting <i>et al.</i> (2019) ⁸¹⁹	

Verlauf nach EVAR : Endoleaks



NEJM 2008;358:491-501

Rev Med Suisse 2016 ; 12 : 2131-4

Partovi S, Staub D et al. *Br J Radiol* 2018;91:20180013

b/f-EVAR assoziierte Endoleaks

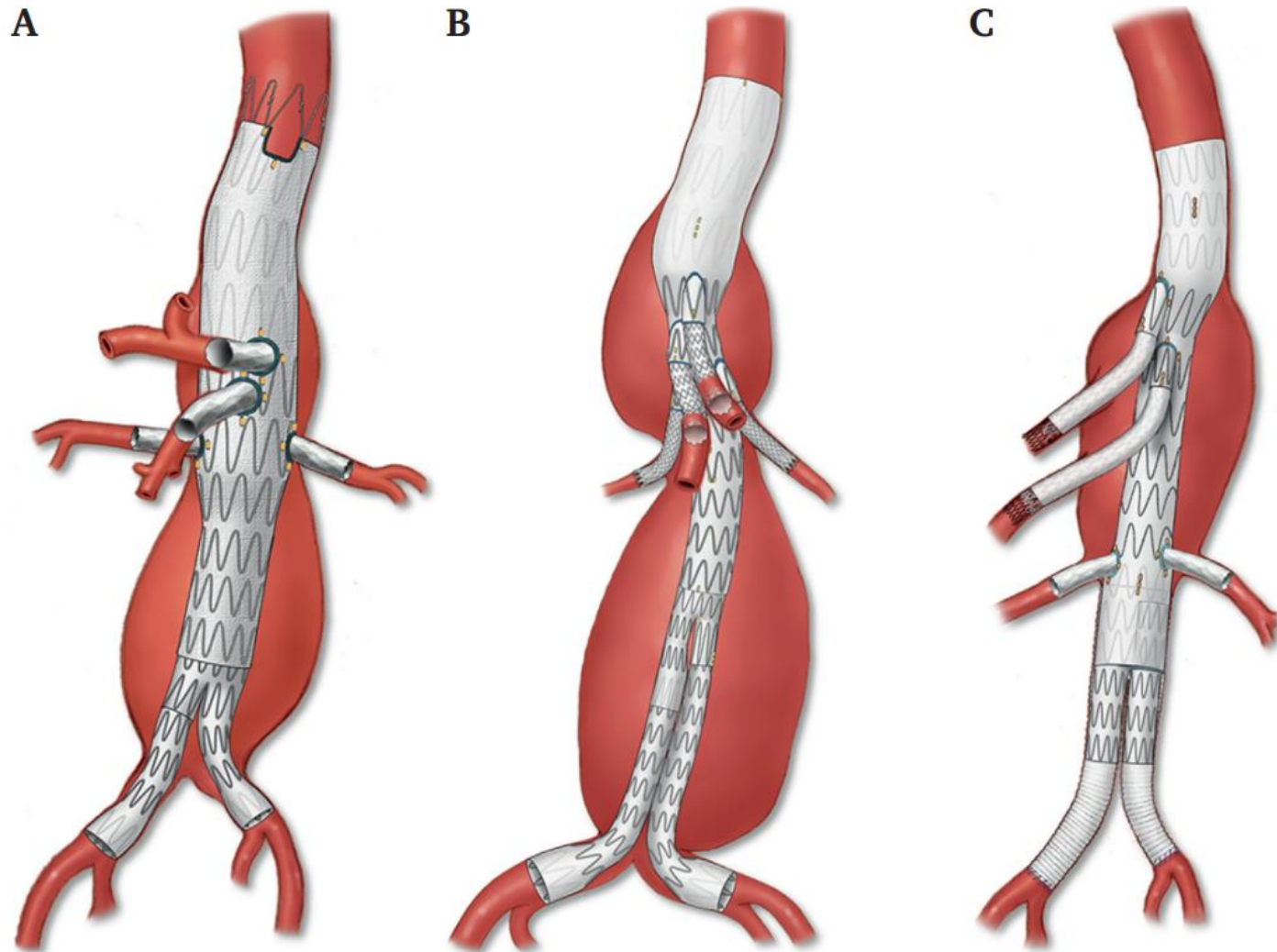


Figure 9. (A) Fenestrated endovascular aortic repair (fEVAR), (B) branched EVAR (bEVAR), and (C) f/bEVAR configurations. Permission to reproduce granted from Elsevier *J Vasc Surg.*⁹³⁵

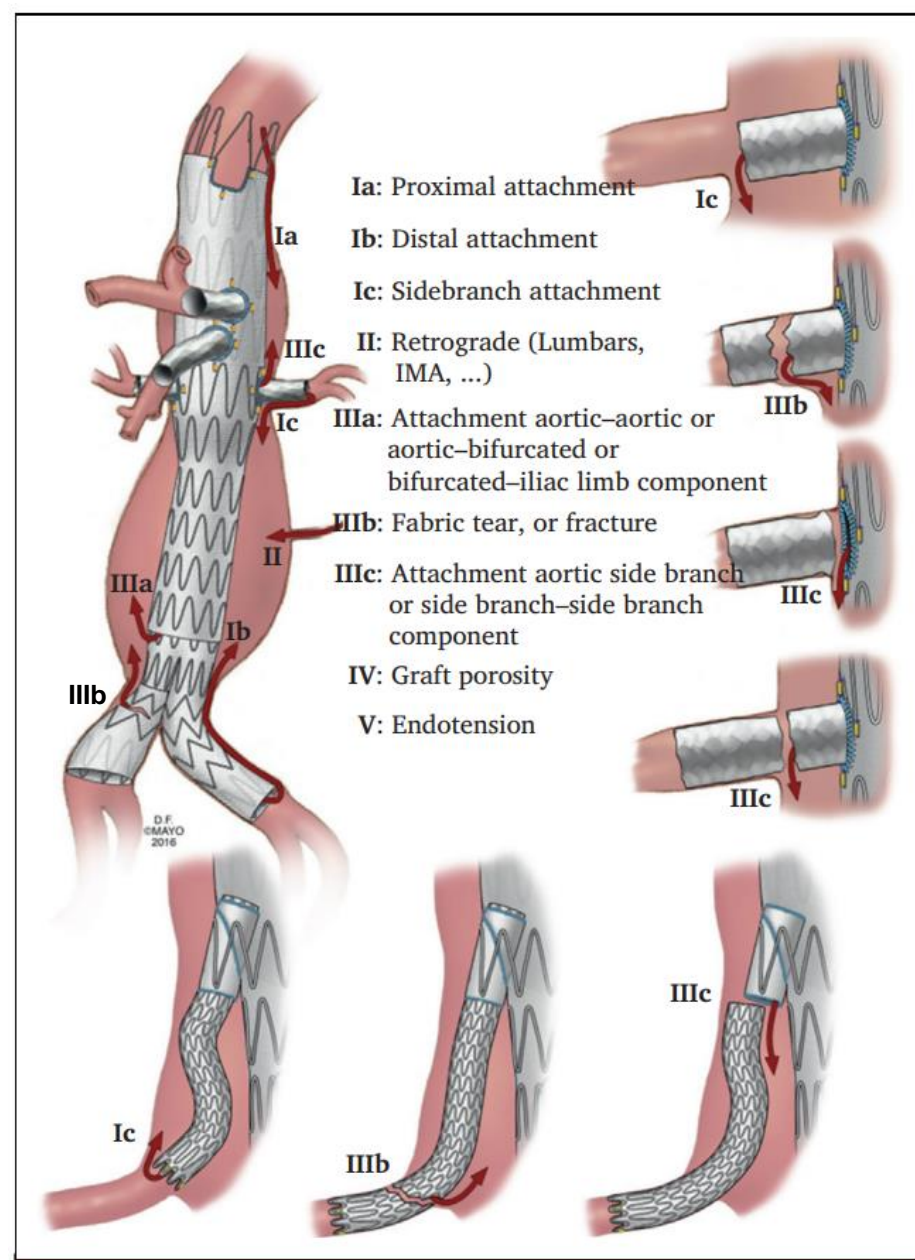
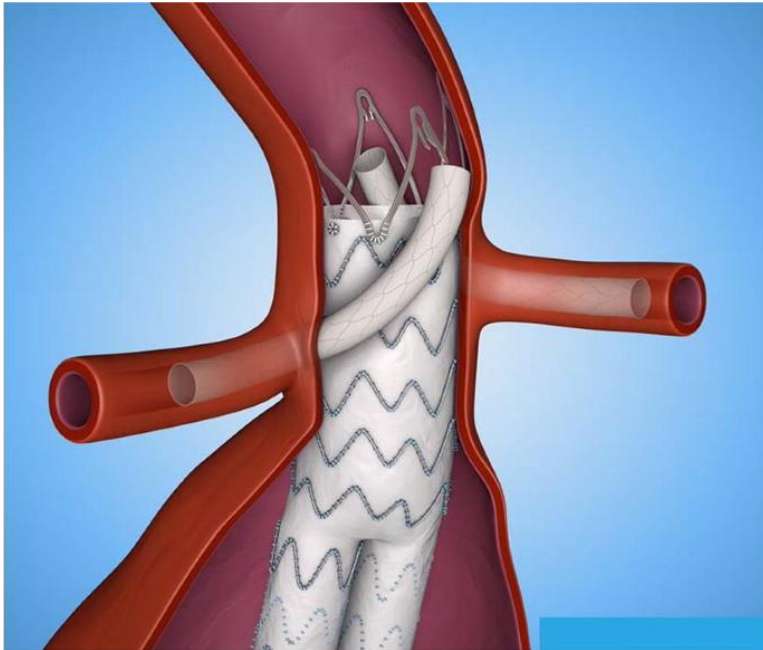


Figure 10. Endoleaks associated with failed bridging stents in the target vessels of fenestrated and branched endovascular aortic repair. IMA = inferior mesenteric artery. Permission to reproduce granted from Elsevier *J Vasc Surg.*⁹³⁵

Nach CHEVAR (chimney-EVAR): «Gutters»



bEVAR: Bessere Abdichtung :

(Typ 1A EL 3,7 %, vs 7,6 % nach CHEVAR)



Recommendation 122

Changed

Endovascular repair for a complex abdominal aortic aneurysm using parallel graft techniques should only be considered as an option in the emergency setting, or as a bailout, and ideally be restricted to ≤ 2 chimneys.

Class	Level	References	ToE
Ila	C	Donas <i>et al.</i> (2015), ⁹⁹² Taneva <i>et al.</i> (2021), ⁹⁹³ Scali <i>et al.</i> (2018) ⁹⁹⁶	

ESVS 2024 guideline

Langzeitkomplikationen nach EVAR

Complications	Definition	Estimated frequency during 5 year follow up
Type I endoleak (high-flow)	Peri-graft flow occurring from attachment sites	5%
A	proximal end of stent graft	
B	distal end of stent graft	
C	iliac occluder	
Type II endoleak (generally low-flow)	Perigraft flow occurring from collateral branches to the aneurysm; inferior mesenteric artery (IIA) and lumbar arteries (IIB) Categorised as early or late/delayed (before or after 12 months) and as transient or persistent (resolved or not resolved ≤ 6 months)	20–40%, 10% persistent at 2 years
Type III endoleak (high-flow)	Peri-graft flow occurring from stent graft defect or junction sites	1–3%
A	leak from junctions or modular disconnection	
B	fabric holes	
Type IV endoleak	Peri-graft flow occurring from stent graft fabric porosity <30 days after placement	1%
Endotension	AAA sac enlargement without visualised endoleak	<1%
Migration	Movement of the stent graft in relation to proximal or distal landing zone	1%
Limb kinking and occlusion	Graft thrombosis or stenosis	4–8%
Infection	Stent graft infection	0.5–1%
Rupture	Aortic rupture	1–5%

Recommendation 107			Changed
Secondary intervention for a Type 2 endoleak after endovascular abdominal aortic aneurysm repair should only be considered in the presence of significant aneurysm sac growth (≥ 10 mm compared with baseline or with the smallest diameter during follow up using the same imaging modality and measurement method), primarily by endovascular means, provided alternative causes including Type 1 or 3 endoleaks have been excluded.			
Class	Level	References	ToE
Ia	C	Sidloff <i>et al.</i> (2013), ⁷¹⁹ Madigan <i>et al.</i> (2019), ⁸⁴⁴ Wu <i>et al.</i> (2021), ⁸⁴⁵ Mulay <i>et al.</i> (2021), ⁸⁴⁶ Ultee <i>et al.</i> (2018), ⁸⁴⁷ Dijkstra <i>et al.</i> (2020), ⁸⁴⁹ Mansukhani <i>et al.</i> (2023) ⁸⁵⁹	

Recommendation 108			New
Patients with persistent aneurysm growth after endovascular attempt(s) to treat Type 2 endoleaks should be considered for elective open conversion with or without graft preservation.			
Class	Level	References	ToE
Ia	C	Dias <i>et al.</i> (2018), ⁸⁰³ Goudekettig <i>et al.</i> (2019), ⁸¹⁹ Madigan <i>et al.</i> (2019), ⁸⁴⁴ Wu <i>et al.</i> (2021), ⁸⁴⁵ Ultee <i>et al.</i> (2018) ⁸⁴⁷	

nach FEVAR (Endoleak)

20 % der EL 2 sind 1/3

Druck

weils Intervention notwendig

Wahl < 1 %)

in sich spontan

(29 % AAA progression), in 11% später neu auftretend

Aneurysmawachstum

1 Jahr nach EVAR (11%), häufig assoziiert mit

erendem oder verzögertem Endoleak zeigen ein

innerhalb 2 Jahren Re-Intervention)

inm wird häufig als Schwelle zur Intervention verwendet

Wanhainen A *et al.* *Eur J Vasc Endovasc Surg* 2024
Picel AC, Kansal N. *AJR* 2014;203:W358

Verlauf nach EVAR (Dysfunktion des Stents)

Stent-Migration

- 5-10mm gilt als signifikante Migration
- Kann zu Endoleak, Stentverschluss, Ruptur führen

Limb Kinking oder Thrombose

- Kinking kann zur Migration, Thrombose und Endoleak führen

Recommendation 89				New
Patients treated by endovascular abdominal aortic aneurysm repair who present with symptomatic, evolving, or haemodynamically significant thrombus formation inside the stent graft may be considered for individualised intervention or escalation of antithrombotic therapy.				
Class	Level	References	ToE	
I b	C	Perini <i>et al.</i> (2018), ⁷³² Russell <i>et al.</i> (2022) ⁷³³		

Recommendation 88				New
For patients treated by endovascular abdominal aortic aneurysm repair who present with asymptomatic non-obstructive mural thrombus formation limited to the main body of stent graft, intervention or escalation of antithrombotic therapy is not indicated.				
Class	Level	References	ToE	
III	C	Perini <i>et al.</i> (2018), ⁷³² Bianchini <i>et al.</i> (2020) ⁷³⁴		

Infektionen & andere vaskuläre Komplikationen

Selten, aber gefürchtet und komplex zu behandeln

Perianastomotische Aneurysmen: Infektion ausschliessen !

Recommendation 101			New
For patients with para-anastomotic aneurysm formation after previous abdominal aortic aneurysm repair, infection as the underlying cause should be considered.			
Class	Level	References	
Ia	C	Consensus	

Männer: Sexuelle Dysfunktion

Recommendation 100			New
For patients treated for abdominal aortic aneurysm who are distressed by post-operative new onset sexual dysfunction, referral to specialised teams should be considered.			
Class	Level	References	ToE
Ia	C	Regnier <i>et al.</i> (2018) ⁷⁷⁹	

Verlauf nach EVAR

AAA-Ruptur

- Verzögerte AAA-Ruptur nach EVAR ist selten (0.5% /Jahr)
- Aneurysmawachstum wichtigster Prädiktor (Wachstum in 21% der Fälle über 5 Jahre)
- Aber auch ohne Wachstum bei plötzlicher Druckerhöhung im Aneurysmasack durch Typ I oder Typ III Endoleak

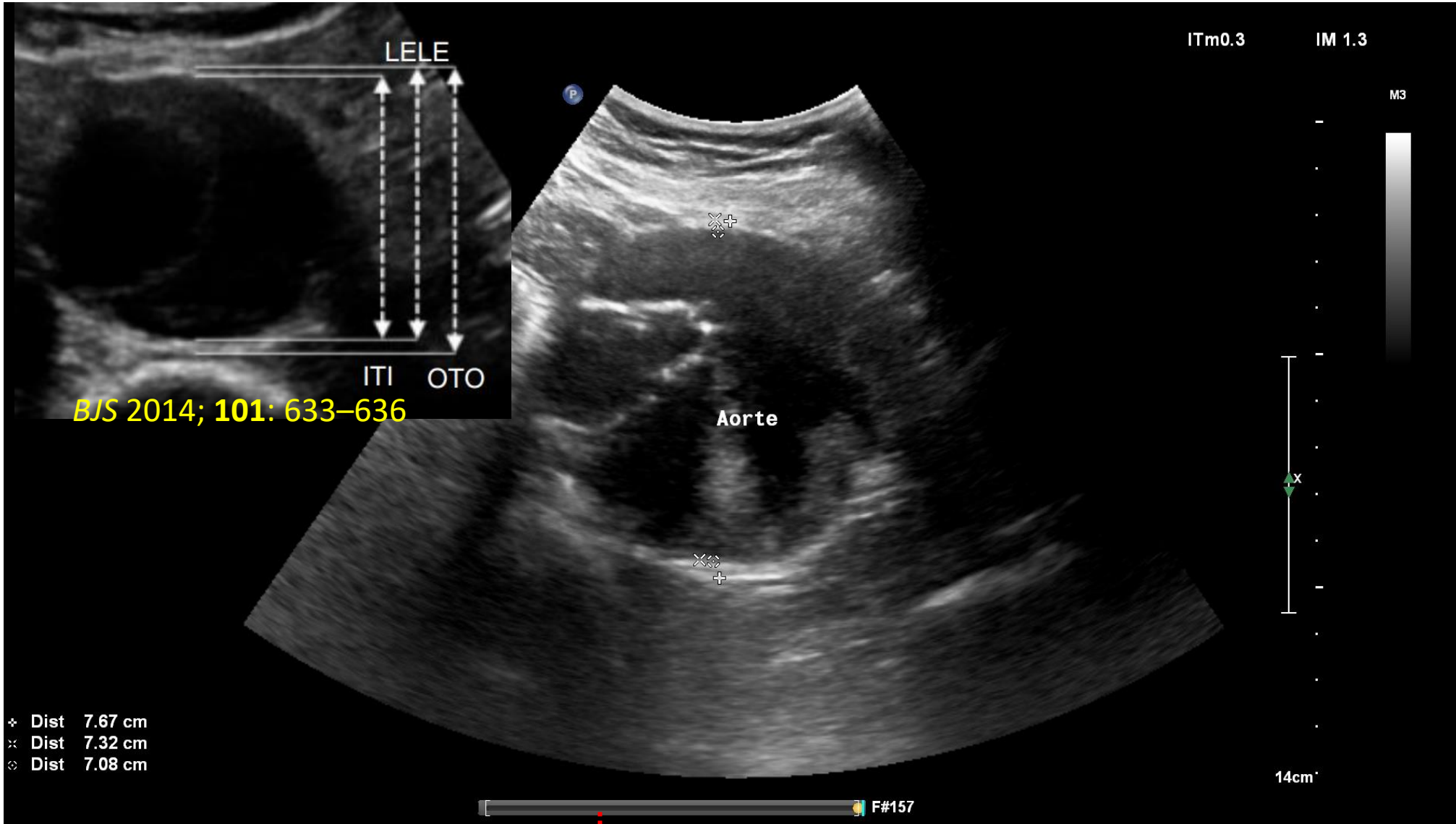


Regelmässige und langfristige bildgebende Verlaufskontrolle nötig

Optionen der Bildgebung für Verlaufskontrollen nach Aorteneingriffen

	Imaging modality						
	AXR	DUS	CE-DUS	CT	CTA	MRA	PET-CT
Detection of possible EVAR complication							
Aneurysm sac enlargement	No	Yes	Yes	Yes	Yes	Yes	Yes
Endoleak	No	Yes	Yes	No	Yes	Yes	No
Sealing zone and component overlap	Yes	Limited	Limited	Yes	Yes	No	Yes
Migration	Yes	Limited	Limited	Yes	Yes	No	Yes
Limb kinking or occlusion	No	Yes	Yes	Kinking	Yes	Yes	Kinking
Stentgraft infection	No	Limited	Limited	Limited	Yes	Yes	Yes
Risks	Ionizing radiation	None known	None known	Ionizing radiation	Ionizing radiation. Contrast nephropathy.	Risk for nephrogenic systemic fibrosis if eGFR<30	Ionizing radiation
Technical aspects	Reproducibility difficult due to changes in patient position	Operator and patient dependent	As DUS	None	Timing of contrast administration important	Unsuitable for ferromagnetic stents & pacemaker bearers. Artefacts.	Non-specific markers for inflammation/ cell proliferation, risk of false positive findings.
Suitable as sole modality for EVAR follow-up	No – combined with DUS/ CE- DUS	No – combined with CT or AXR ± CE-DUS	No – combined with CT or AXR	No – combined with DUS/ CE- DUS	Yes	No – as complement to CT/AXR + DUS/CE-DUS	No - only in case of suspected infection

Verlaufskontrolle: 3 Methoden Aneurysmadurchmesser a-p



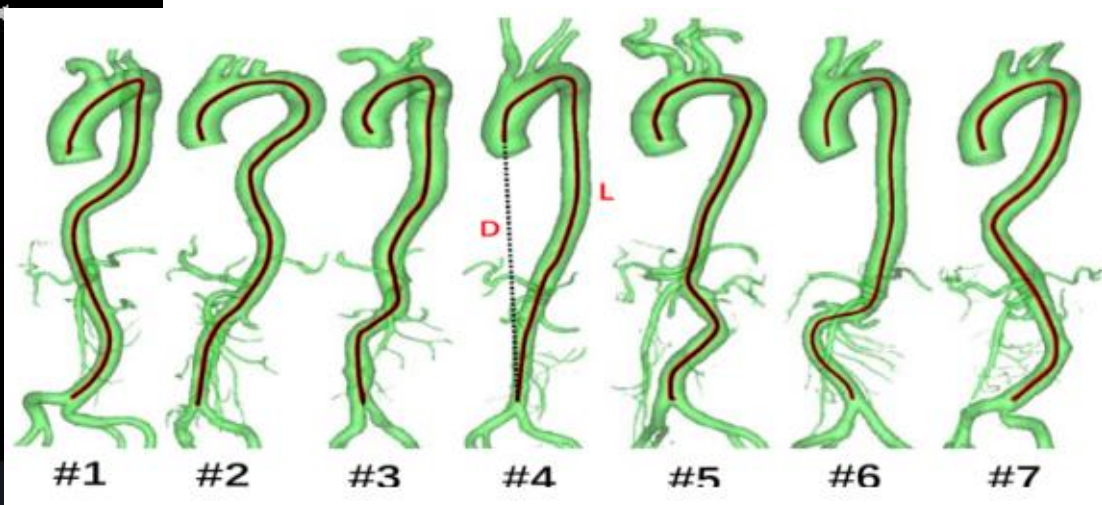
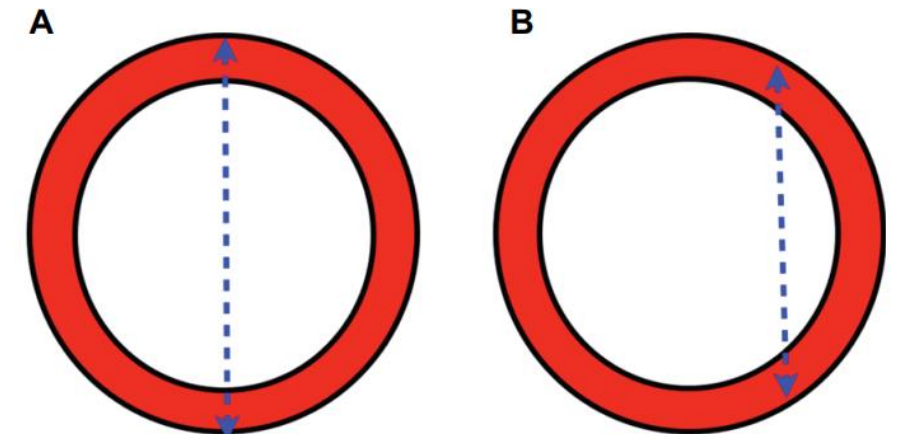
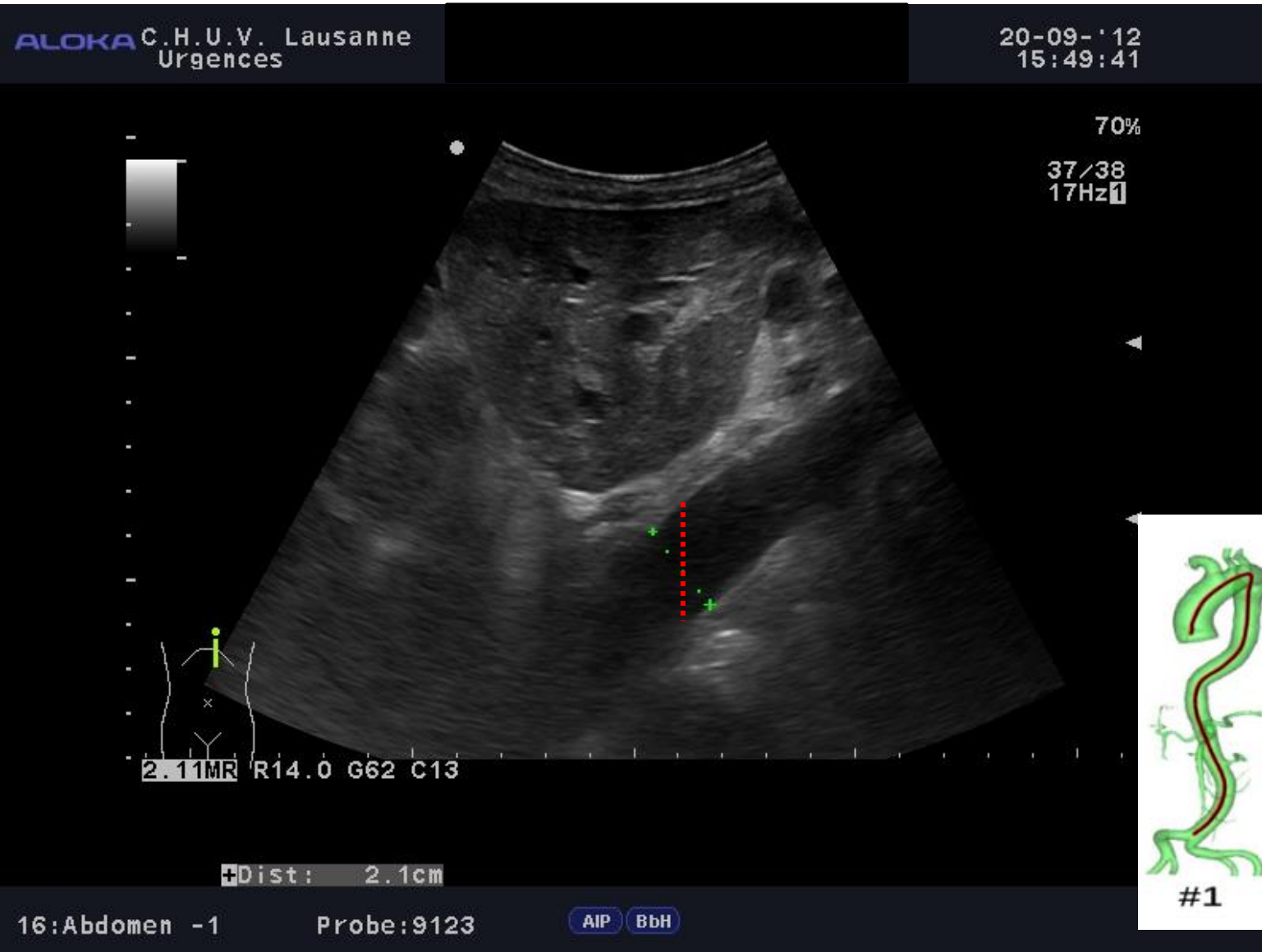
3 Methoden:

ITI = inner-to-inner

LELE = Leading
edge Methode

OTO = outer-to-
outer

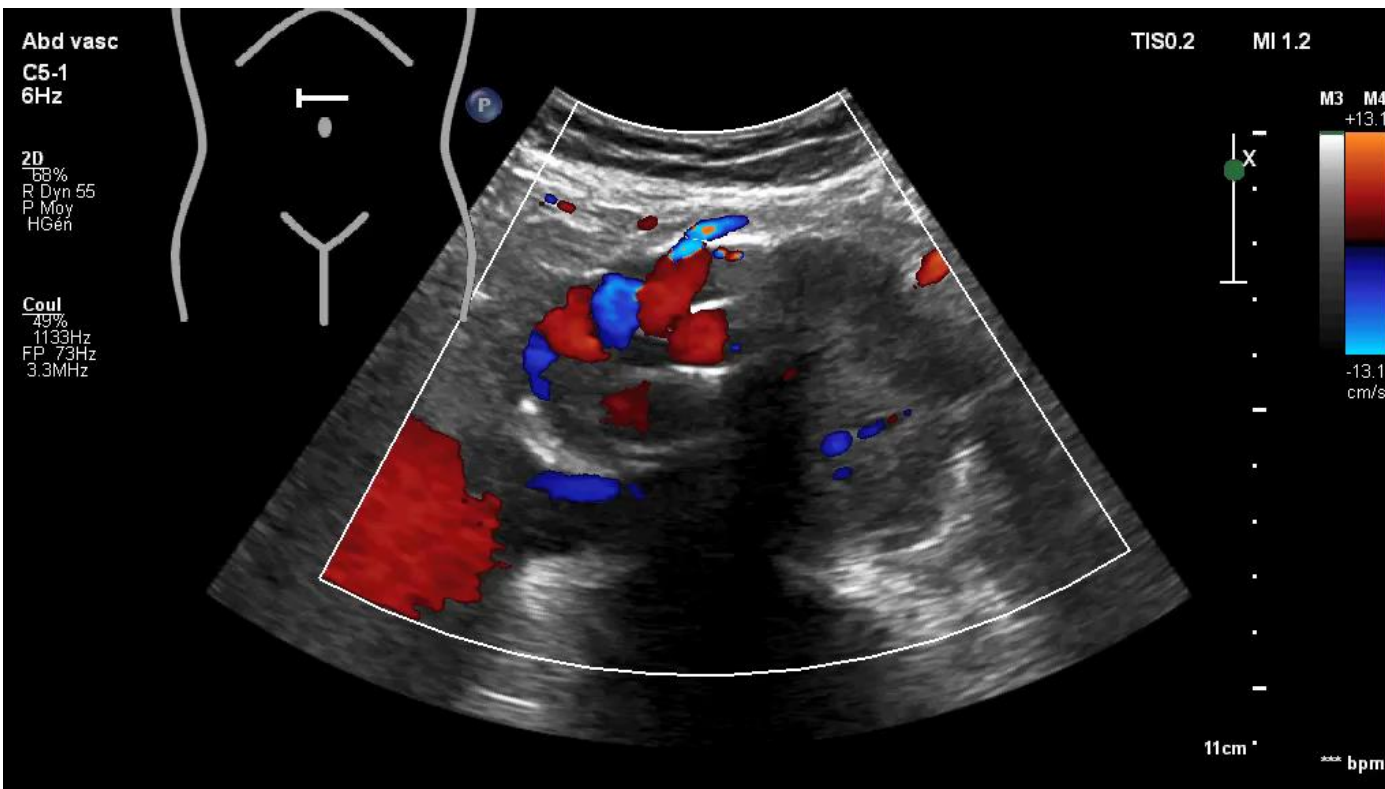
Messung Aorta und Iliakalarterien



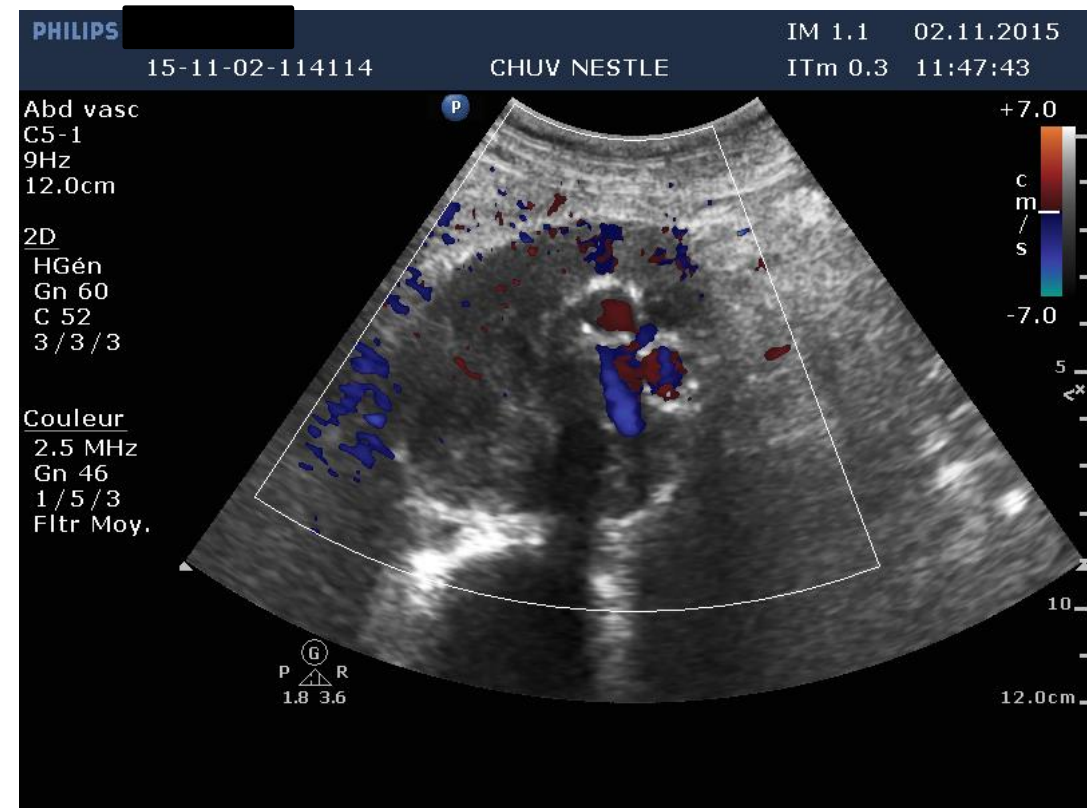
Verlaufskontrolle nach EVAR mit Duplex nativ

Farbkodierte Dopplersonographie als Alternative zur CTA

- Aneurysma-Durchmesser, Endoleak, Offenheit des Stents/Stenosen
- Sensitivität von 77% und Spezifität von 97% im Vergleich zu CTA für Detektion von Endoleaks

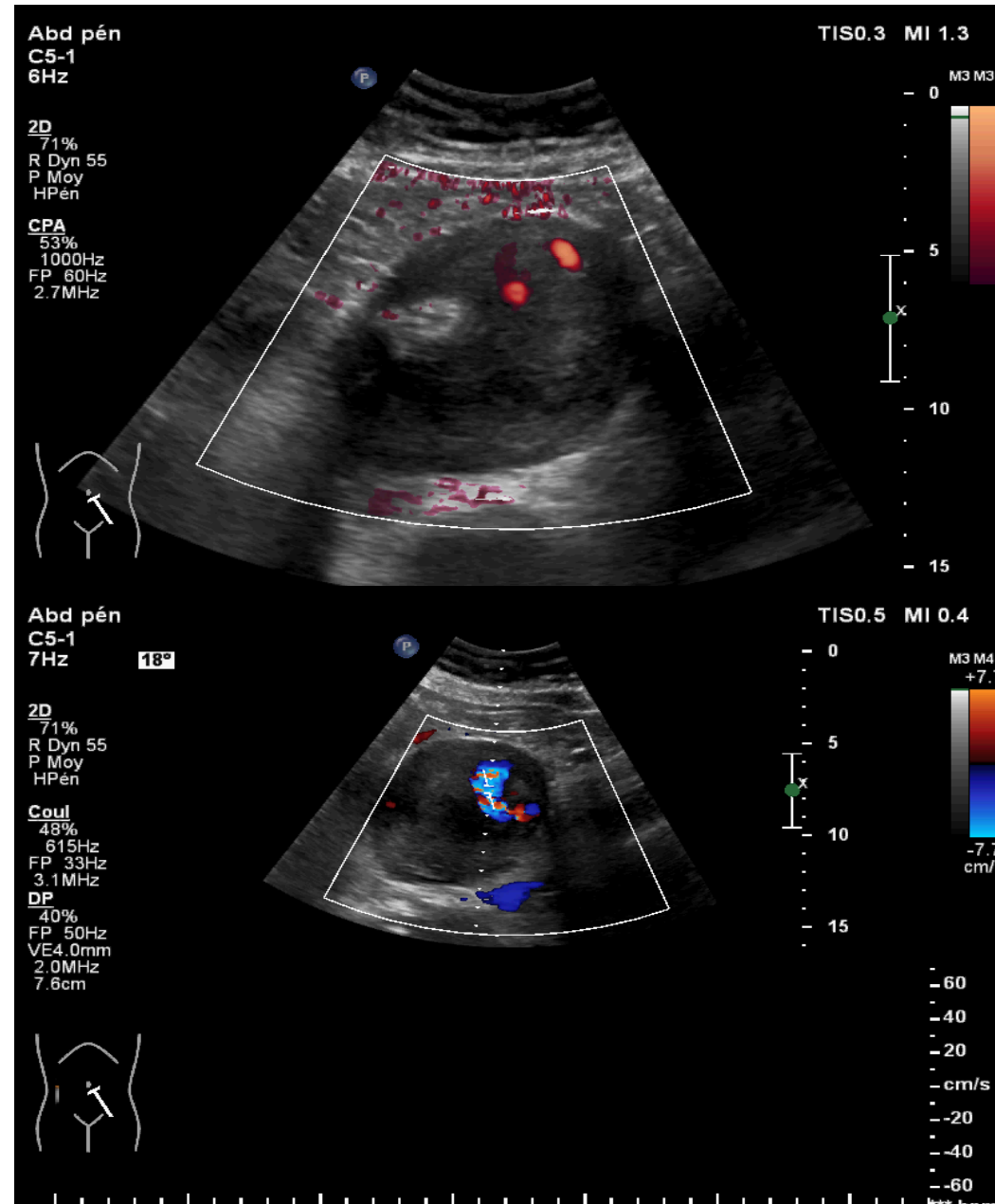
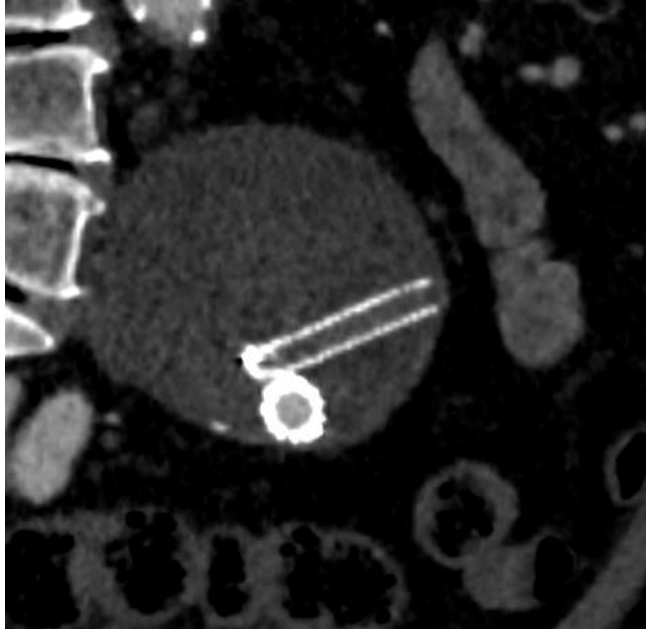
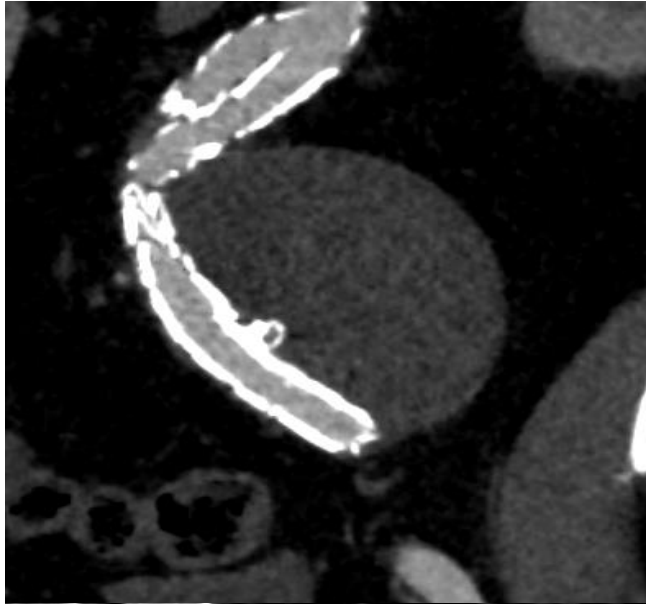


Endoleak Typ II



Endoleak Typ III

Iliaca communis-Aneurysma links



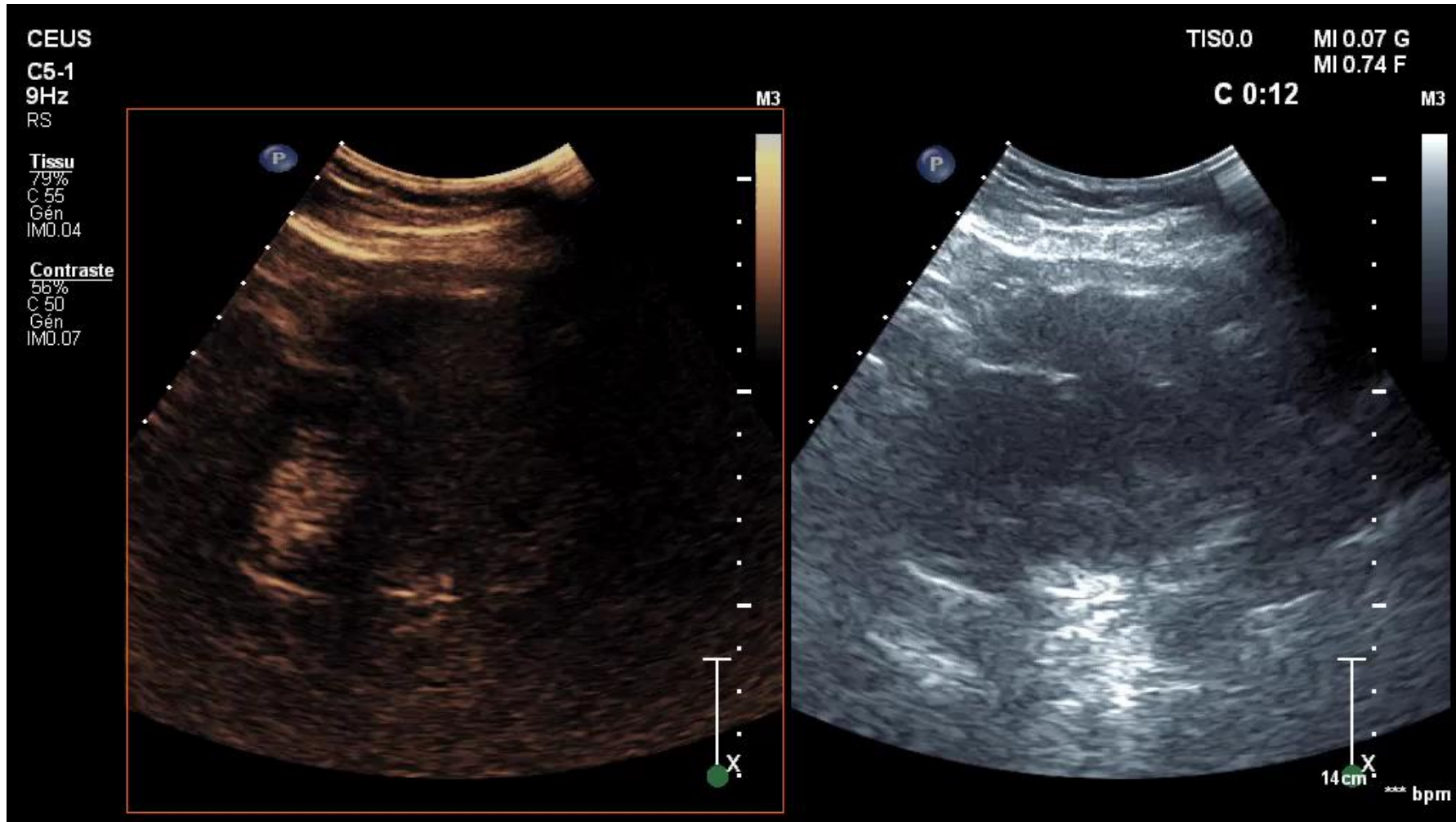
Powerdoppler

Farbdoppler:

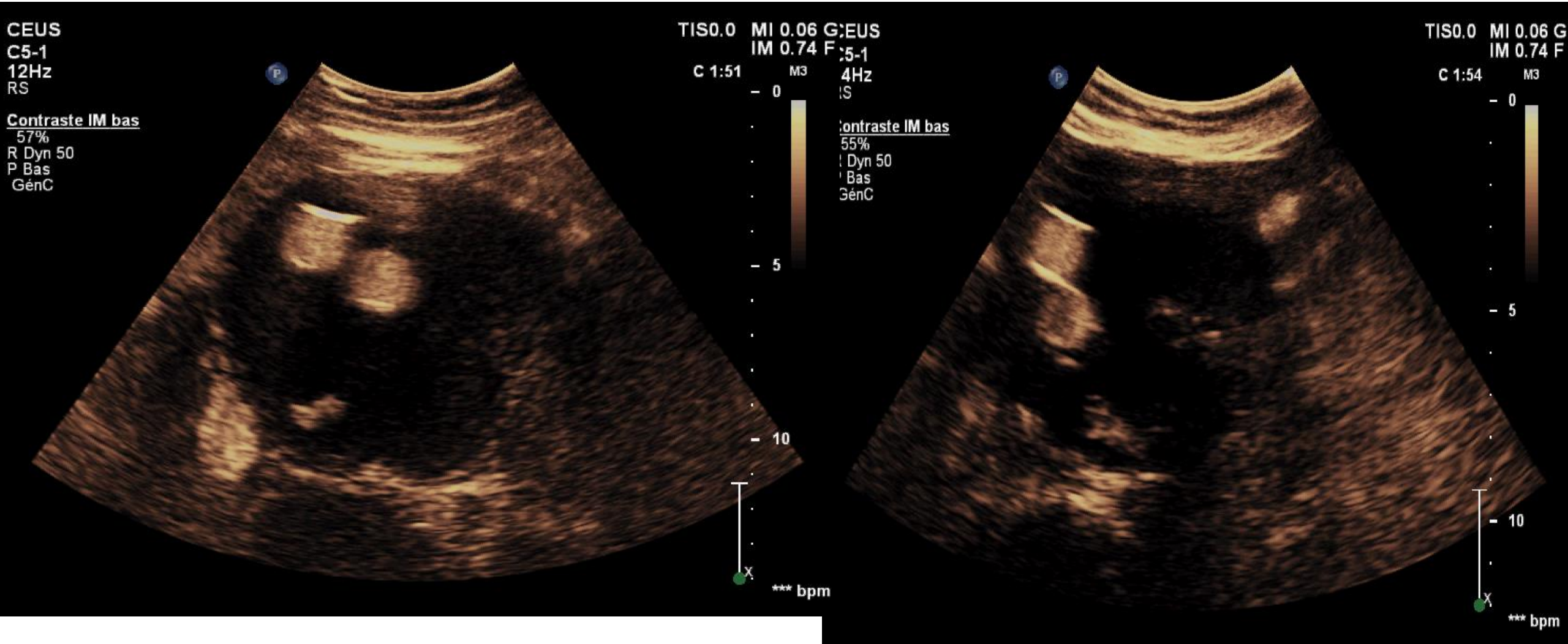
«To-and fro-Signal»
(= Pendelfluss)

Verlaufskontrolle nach EVAR mit CEUS

Querschnitt, kraniokaudaler Sweep



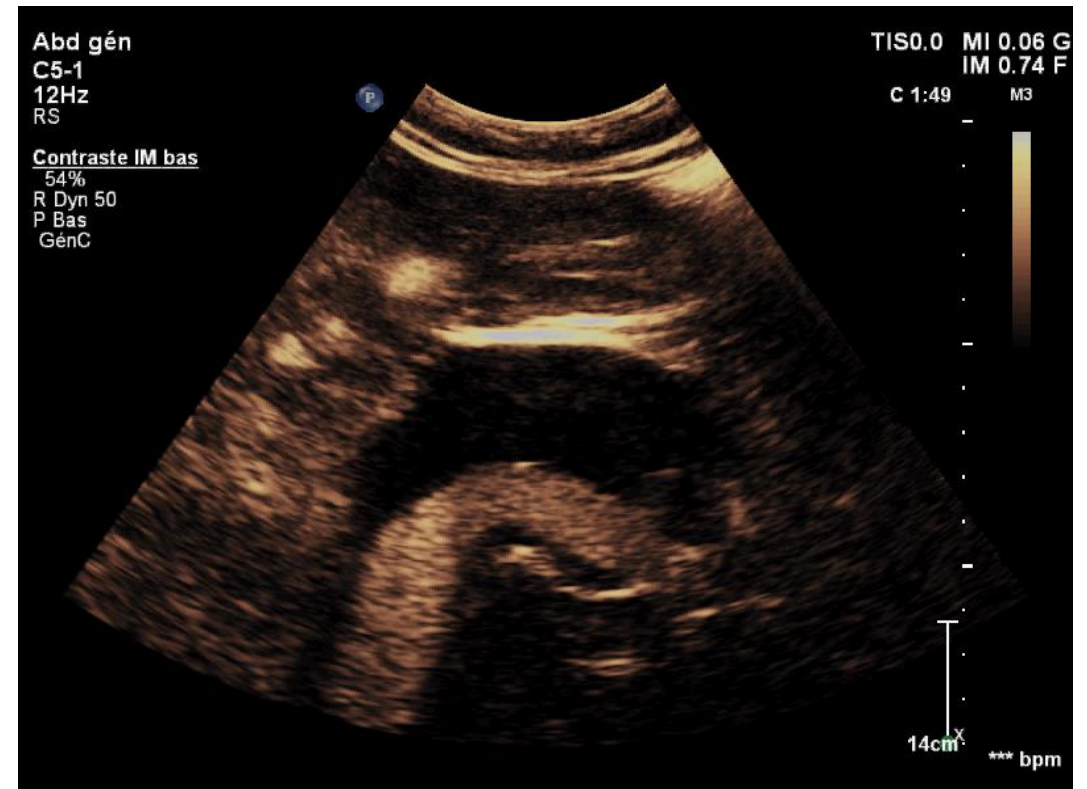
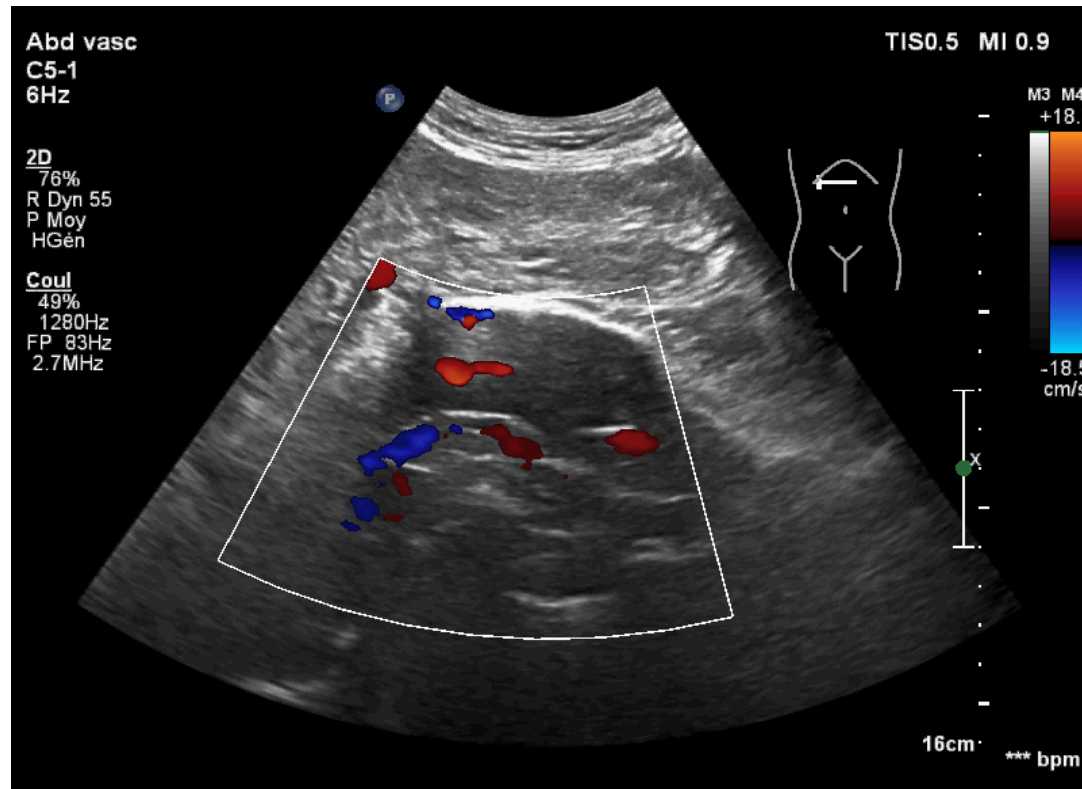
Verlaufskontrolle nach EVAR mit CEUS



Typ II Endoleak aus Lumbalarterie

Flash-Mode: zerstört kurz die Mikrobläschen

♂ 74 J., 2.5 J nach EVAR Aneurysmadurchmesser gleichbleibend

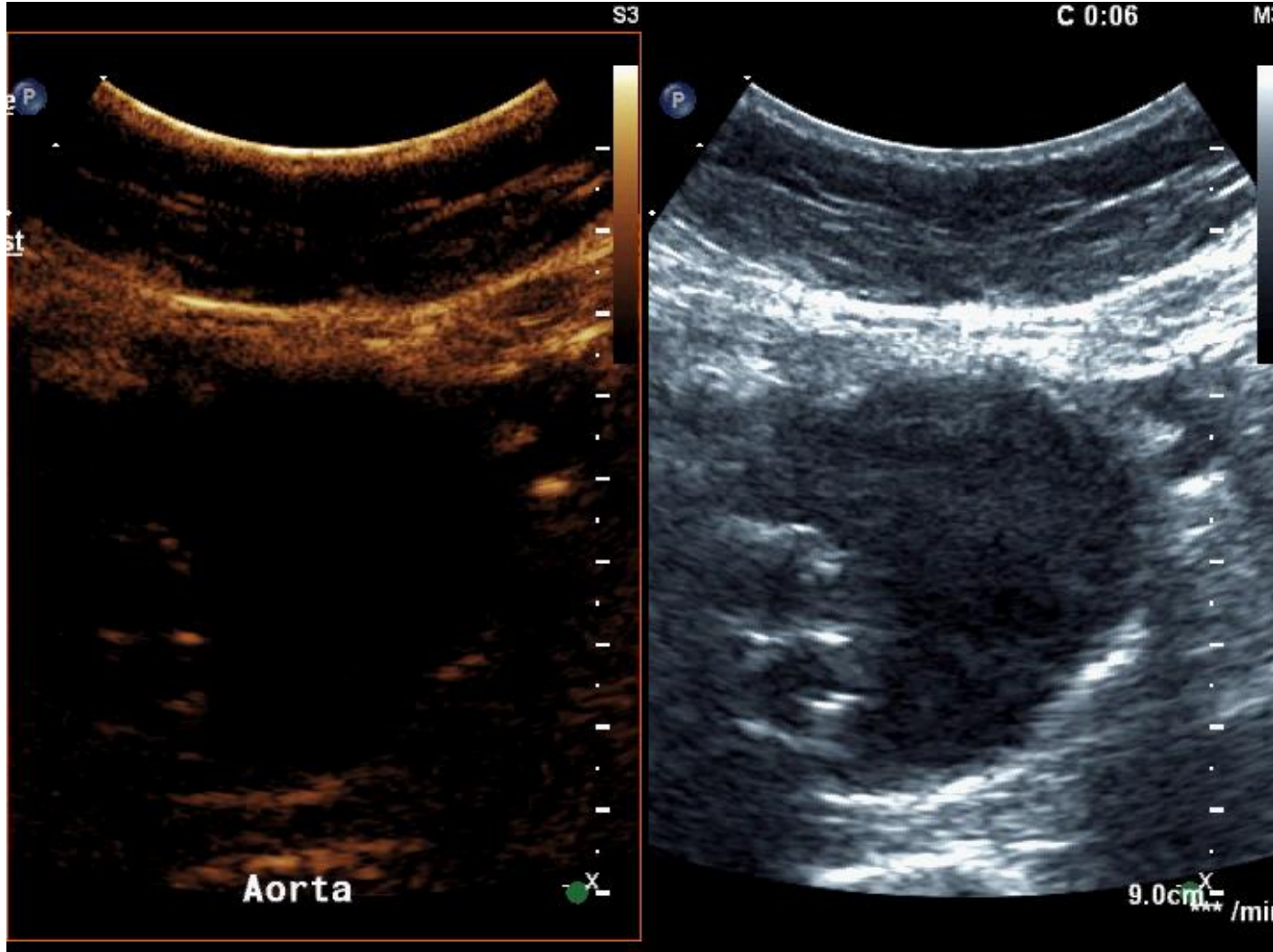


Endoleaktherapie

- Embolisation eines Typ II Endoleak mit Onyx und Histoacryl einer Lumbalarterie



Intra-interventionelle Kontrolle nach Endoleaktherapie mit CEUS



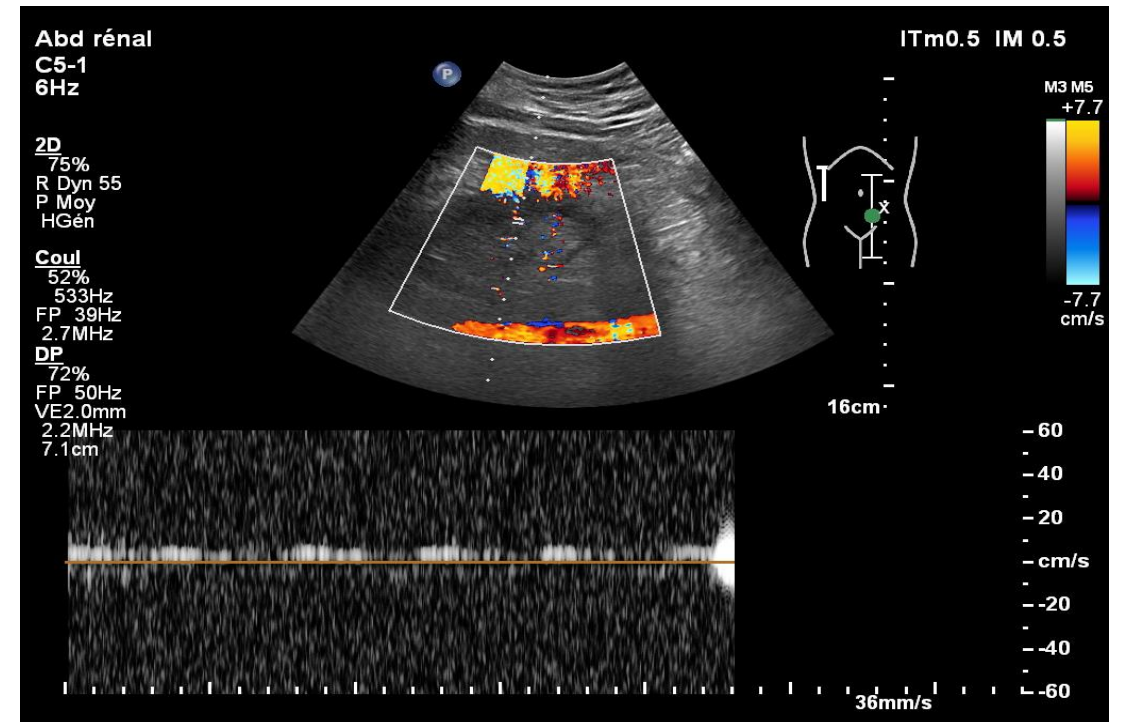
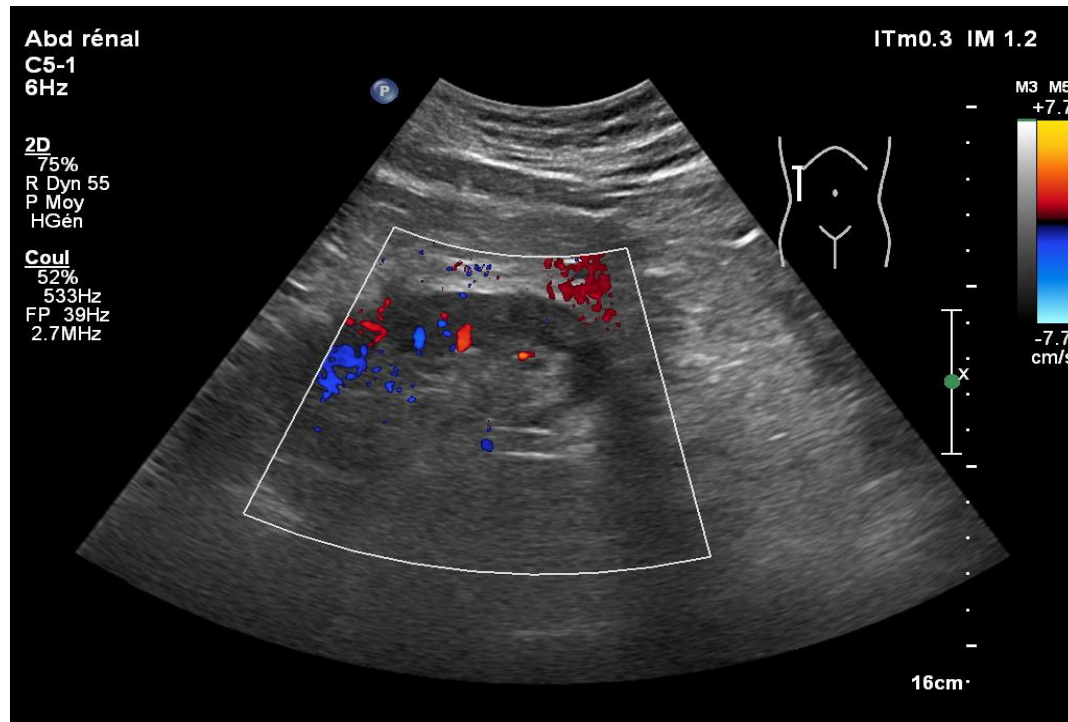
z.B. Bei Patienten mit
Niereninsuffizienz

Nach Ch-EVAR/b-EVAR: Permeabilität Nieren-/viszerale Arterien

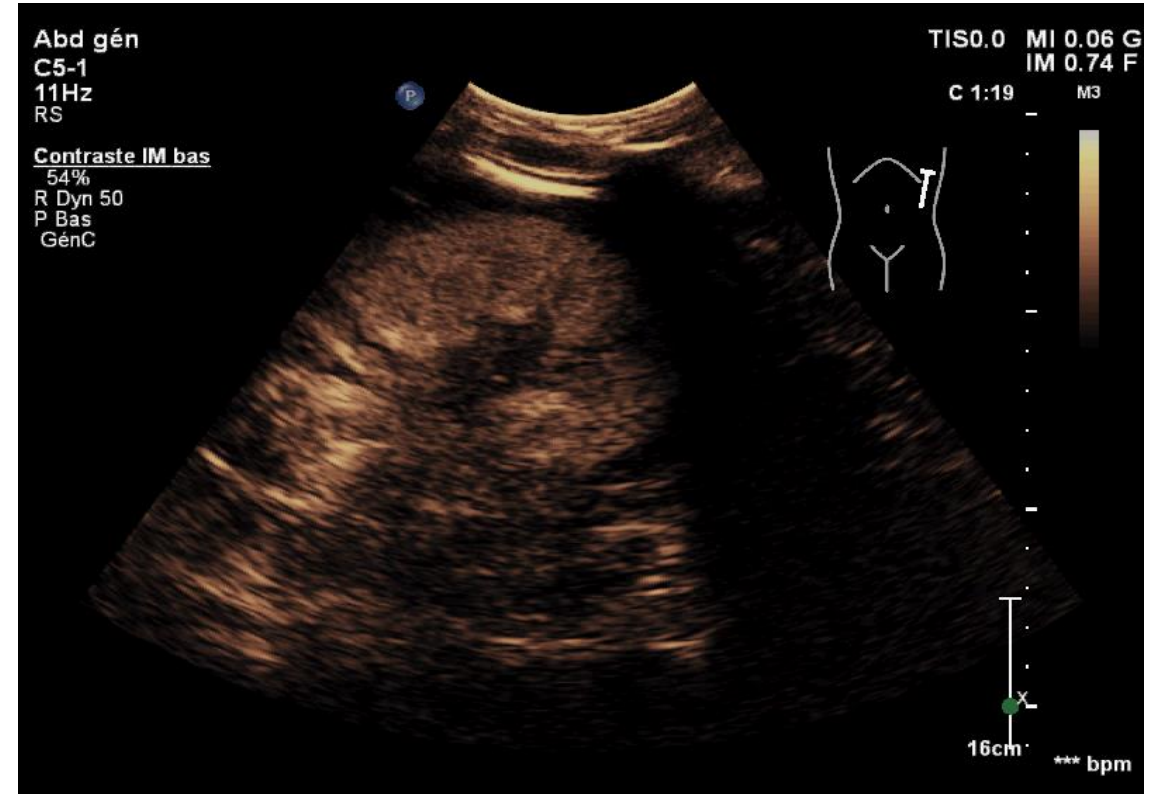
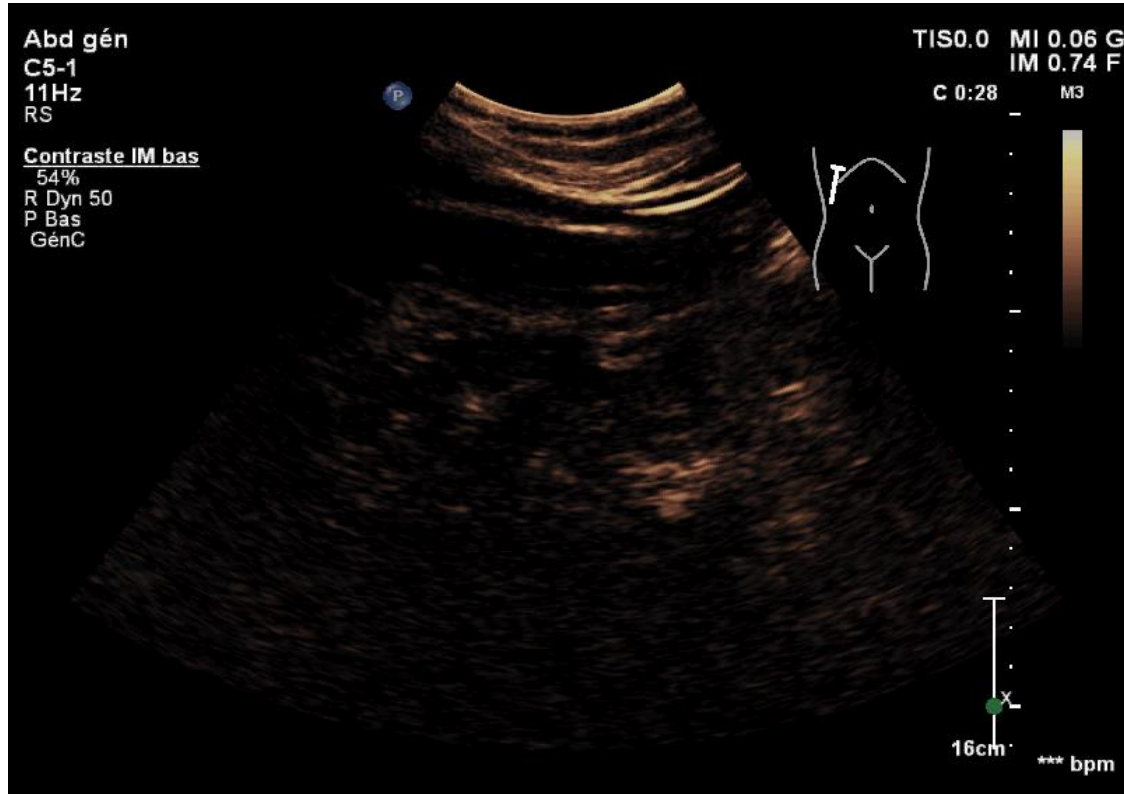
(OP's 2002, 2007, 2010, 05/16 wegen AAA/TAA)

06/16 CHEVAR (NELLIX) AMS, TC und beider Nierenarterien

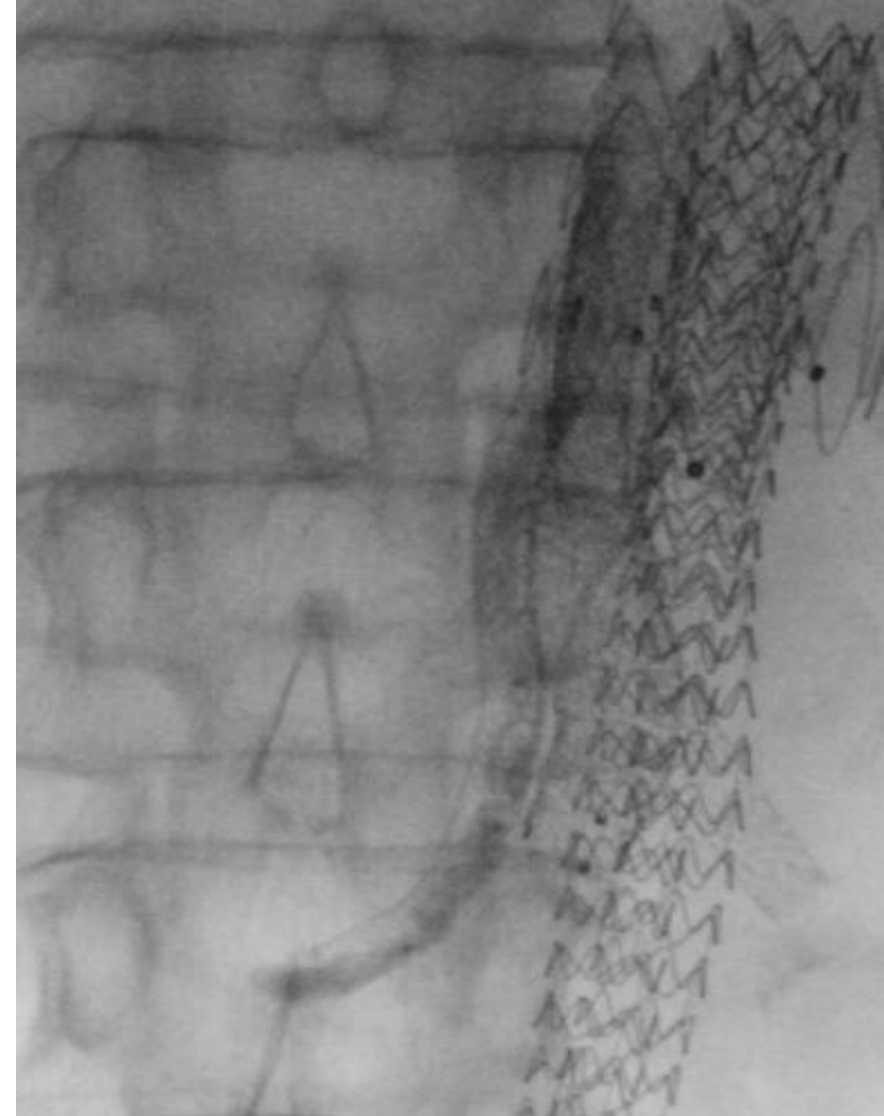
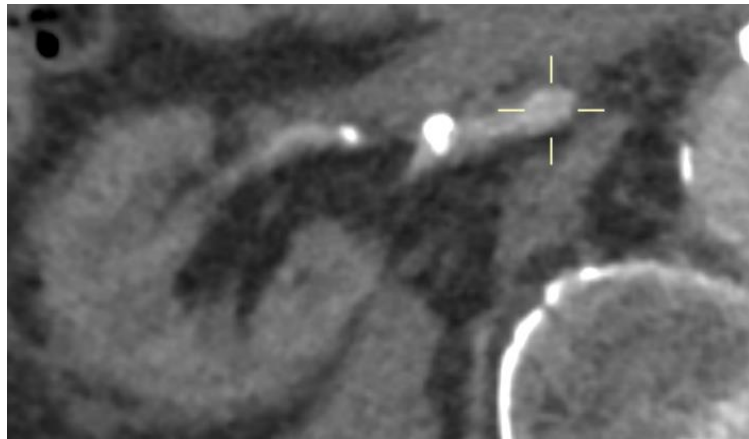
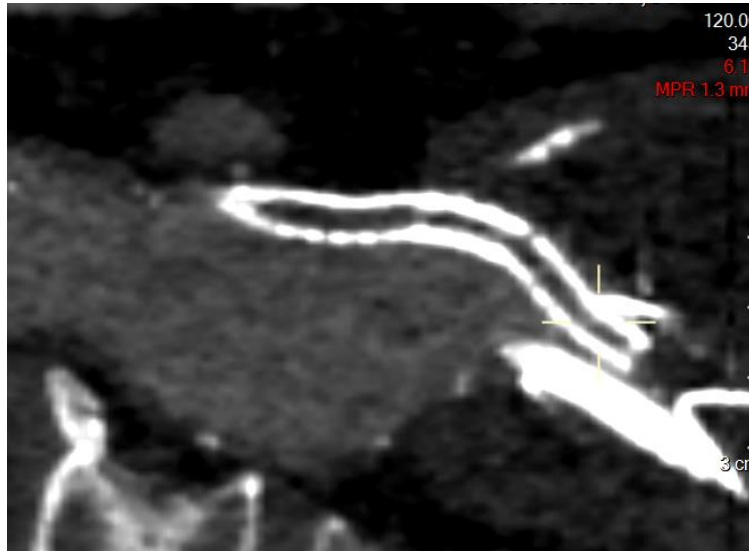
Nach Re-Intervention wegen Endoleak III (AMS): Kreatininanstieg + Hypertonie



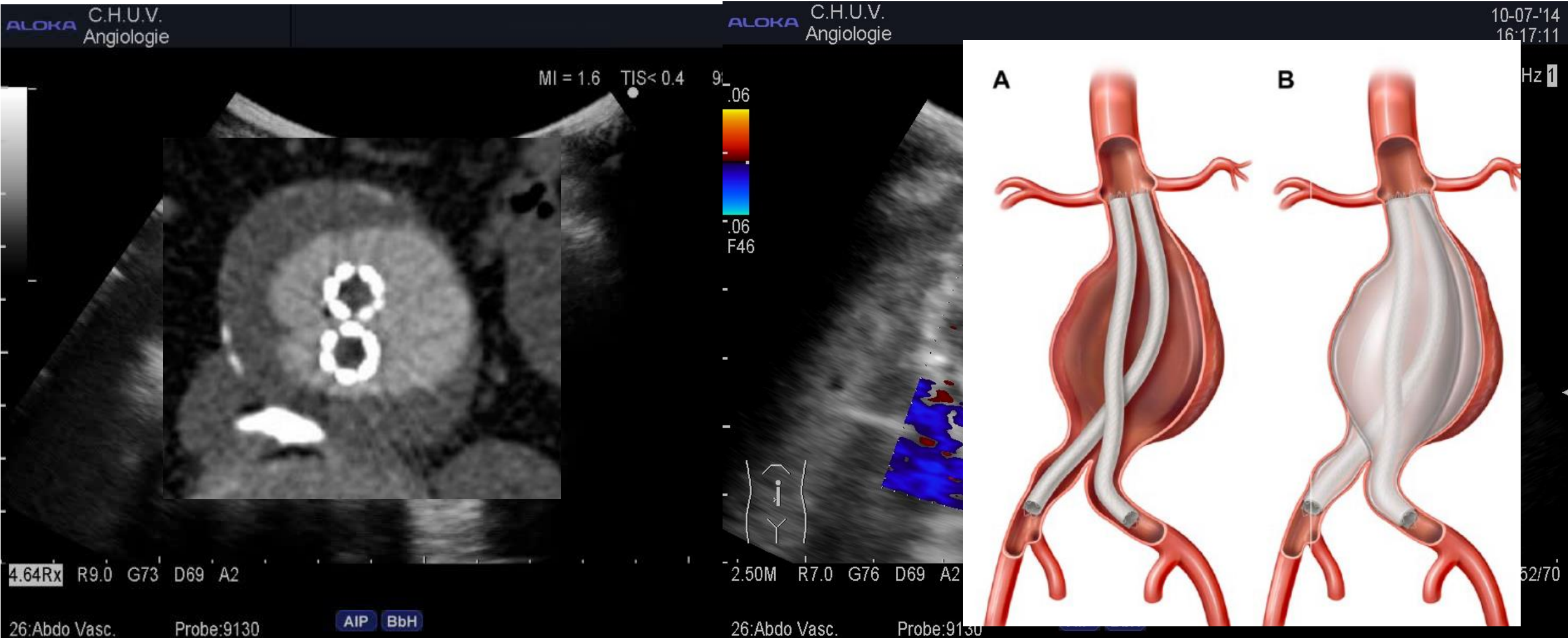
Perfusion CEUS Niere R/L



CTA / Angiographie

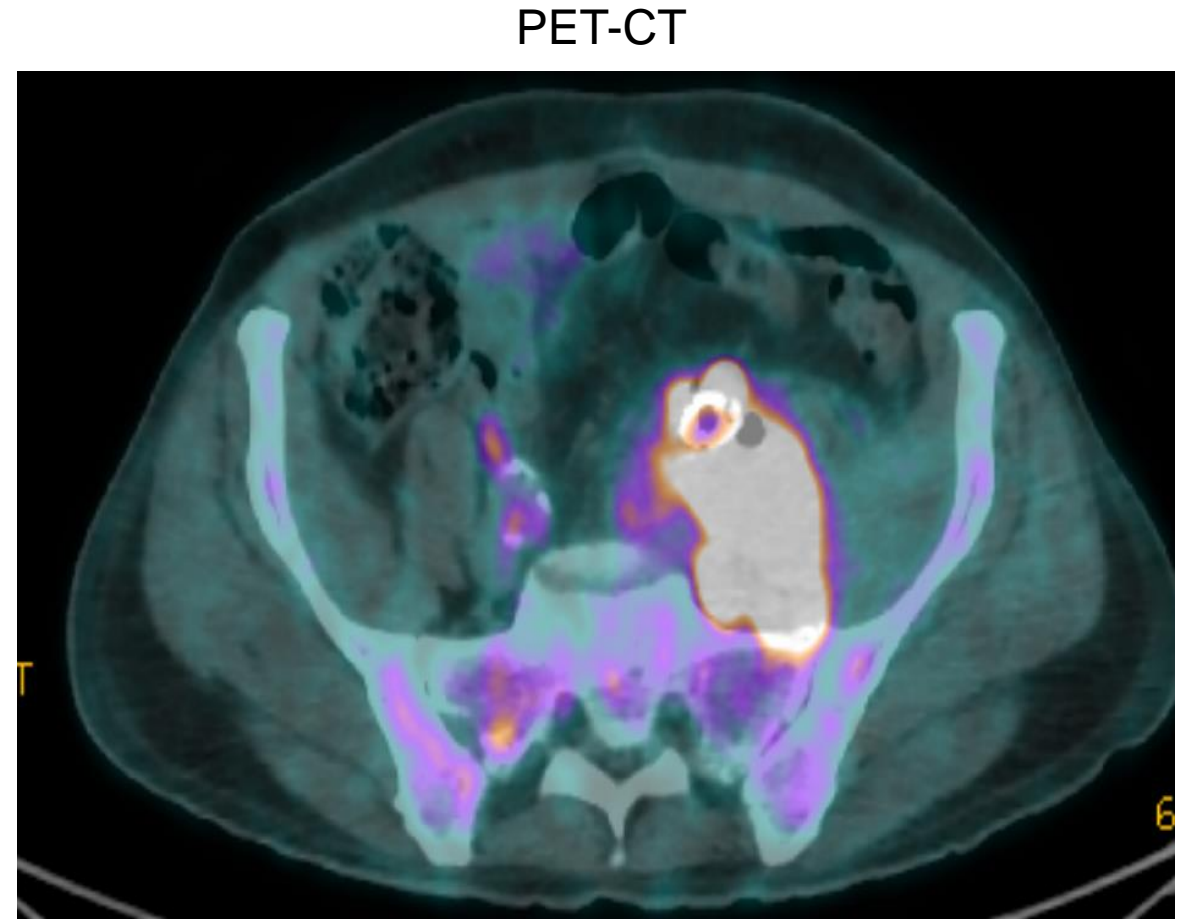
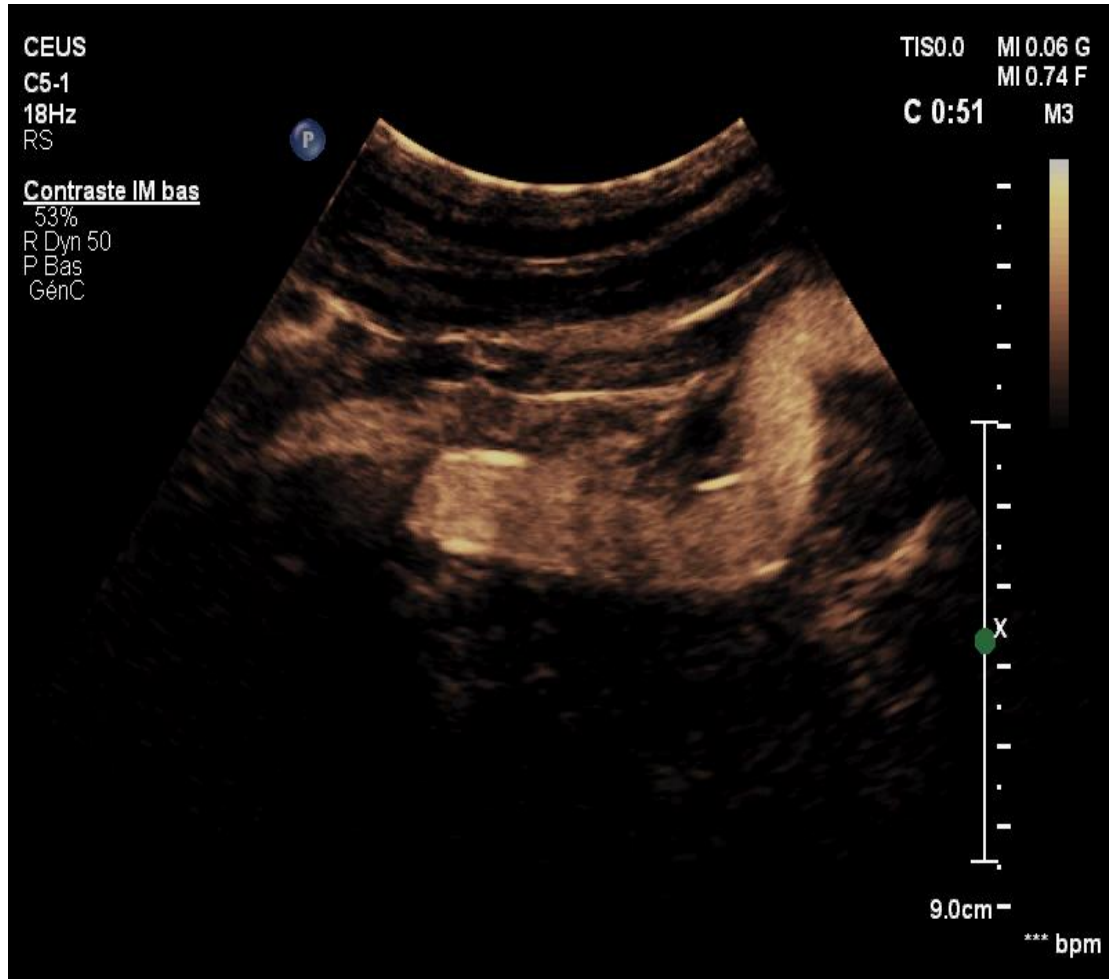


Freitag abend...



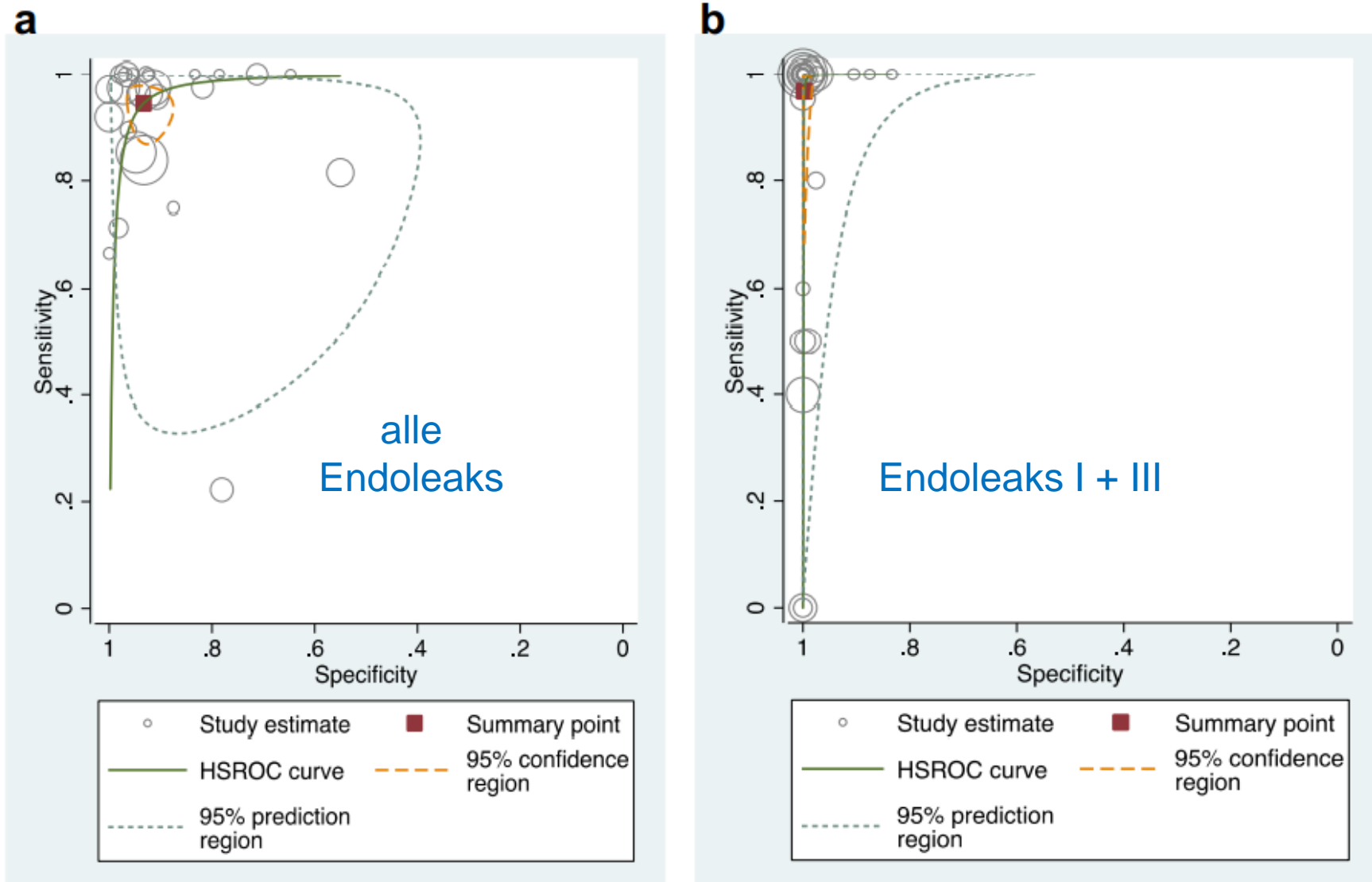
Nellix Endoprothese

67j Patient 4 Wo nach endovaskulärer Therapie eines a. iliaca interna Aneurysmas



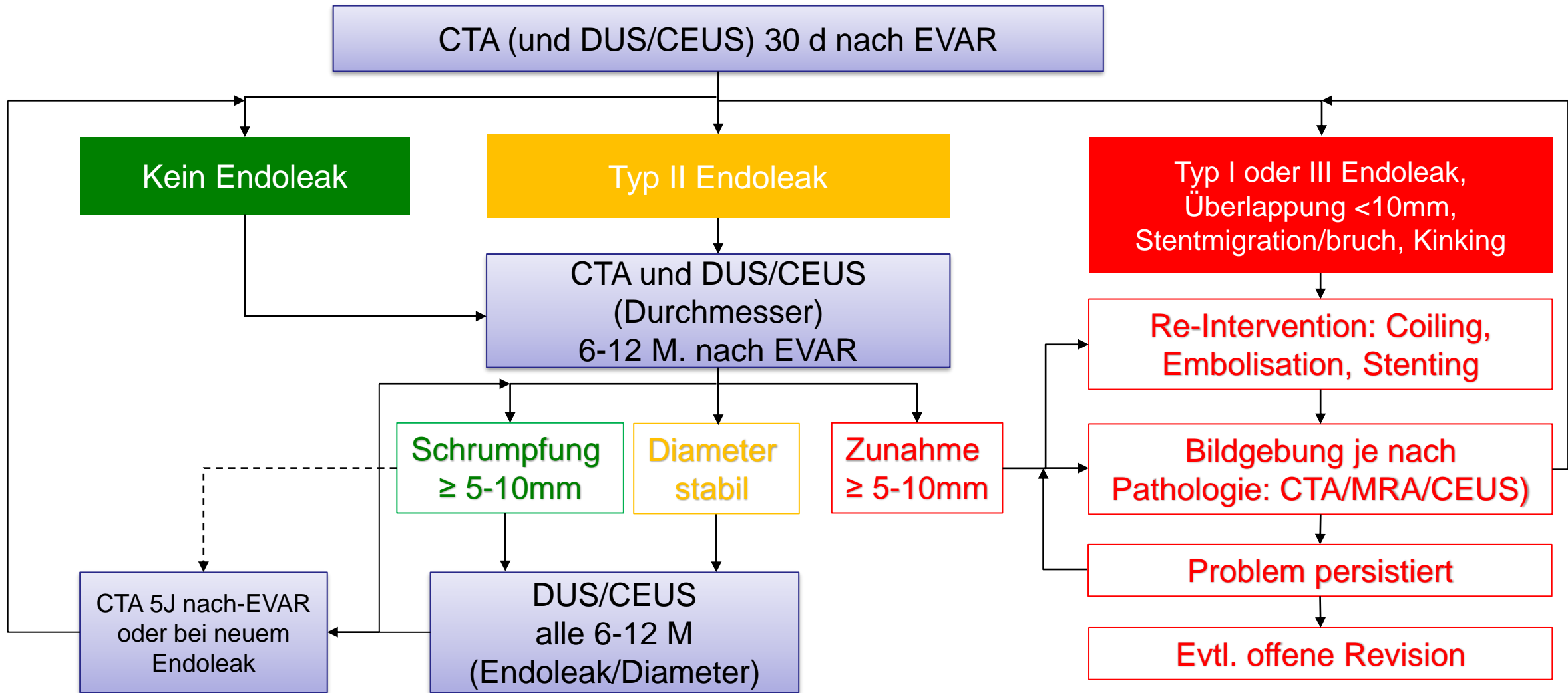
Infekt Endoprothese

Methodenvergleich CTA/ CEUS zur Endoleakdetektion



Kapetanios D. J Vasc Surg. 2019 Jan;69(1):280-294.e6.: (2638 CTA/CEUS paare, 2217 pts.)

Verlaufskontrollen nach EVAR - Zusammenfassung



Verlaufskontrollen nach komplexen b/f/Ch-EVAR - Zusammenfassung

Recommendation 130		Changed
<p>After endovascular treatment for a complex abdominal aortic aneurysm, long term imaging surveillance is recommended; with computed tomography angiography within 30 days and one year and thereafter individualised.</p>		
Class	Level	References
I	C	Consensus

Recommendation 131		New	
<p>After endovascular treatment for a complex abdominal aortic aneurysm, duplex ultrasound surveillance may be considered as an alternative to continued computed tomography angiography surveillance after the first post-operative year in selected patients.</p>			
Class	Level	References	ToE
IIb	C	Gargiulo <i>et al.</i> (2014), ¹⁰⁵⁵ Perini <i>et al.</i> (2012), ¹⁰⁵⁶ Heneghan <i>et al.</i> (2016) ¹⁰⁶⁴	

Evidenz für die Kontrollen ?

Meta-Analyse mit n = 22767: Mortalität, AAA-assoziierte Mortalität, Zweitinterventionsrate unverändert, ob inkompletter oder kompletter follow up (Rupturrate paradoxerweise bei non complianten Patienten niedriger (!?!))

Studie aber zu kritisieren (Heterogene Kontrollschemas, observationelle & retrospektive Studien)

Nach EVAR bei Low risk Patienten evtl. low frequency imaging ?
Während Jahr 1-5 post OP
Aber: Langfristig auch nach 5 Jahren Kontrollen gerechtfertigt

Recommendation 114			Changed
Patients who have undergone endovascular abdominal aortic aneurysm repair and have been stratified as low risk of complications* based on early post-operative computed tomography angiography should be considered for low frequency imaging follow up during the first five years.			
Class	Level	References	ToE
Ia	C	Bastos Gonçalves <i>et al.</i> (2013), ⁸²¹ Bastos Gonçalves <i>et al.</i> (2014), ⁸²² Baderkhan <i>et al.</i> (2018), ⁸²³ Geraedts <i>et al.</i> (2021), ⁸²⁴ Patel <i>et al.</i> (2010), ⁹²⁶ Antoniou <i>et al.</i> (2020) ⁹²⁷	

* No endoleak, anatomy within IFU, adequate overlap and seal of ≥ 10 mm proximal and distal stent graft apposition to arterial wall.

Recommendation 115			New
Patients who have undergone endovascular abdominal aortic aneurysm repair are recommended for long term imaging follow up (regardless of initial risk stratification), to detect late complications and identify late device failure and disease progression.			
Class	Level	References	ToE
I	B	Patel <i>et al.</i> (2016), ⁴⁶⁶ Geraedts <i>et al.</i> (2022), ⁹¹⁷ de Mik <i>et al.</i> (2019), ⁹¹⁹ Grima <i>et al.</i> (2018), ⁹²⁰ Wanken <i>et al.</i> (2020) ⁹²²	

Addendum: Iliakalarterienaneurysmen

Recommendation 135

Changed

Patients with an iliac artery aneurysm (common iliac artery, internal iliac artery, and external iliac artery, or combination thereof) should be considered for elective repair at a diameter of ≥ 40 mm.

Class	Level	References	ToE
Ila	C	Charisis <i>et al.</i> (2021), ⁸²⁶ Laine <i>et al.</i> (2017), ¹⁰⁶⁵ Krupski <i>et al.</i> (1998), ¹⁰⁶⁶ Chaer <i>et al.</i> (2008), ¹⁰⁷² Steenberge <i>et al.</i> (2022), ¹⁰⁷⁷ Huang <i>et al.</i> (2008), ¹⁰⁷⁹ Jalalzadeh <i>et al.</i> (2020), ¹⁰⁸¹ Fossaceca <i>et al.</i> (2015), ¹⁰⁸³ Kasirajan <i>et al.</i> (1998), ¹⁰⁸⁴ Kobe <i>et al.</i> (2018) ¹⁰⁸⁵	

Recommendation 134

New

For patients with an iliac artery aneurysm (common iliac artery, internal iliac artery, and external iliac artery, or combination thereof), imaging surveillance using ultrasound should be considered; every three years for aneurysms 20 – 24 mm in diameter, every two years for aneurysms 25 – 29 mm in diameter, and yearly for aneurysms ≥ 30 mm, taking into account life expectancy, suitability for future repair, concomitant aortic dilatation, and patient preferences.

Class	Level	References	ToE
Ila	C	Steenberge <i>et al.</i> (2022) ¹⁰⁷⁷	

Clearly the lack of robust follow up data for IAAs makes recommendations on follow up difficult. Longer term outcomes particularly for endovascular repair are needed. Until then, follow up should be in accordance with the recommendations for AAA (see Chapter 7).