Nierenarterienstenose

Daniel Staub

Angiologie

Universitätsspital Basel

daniel.staub@usb.ch

Clinical Case

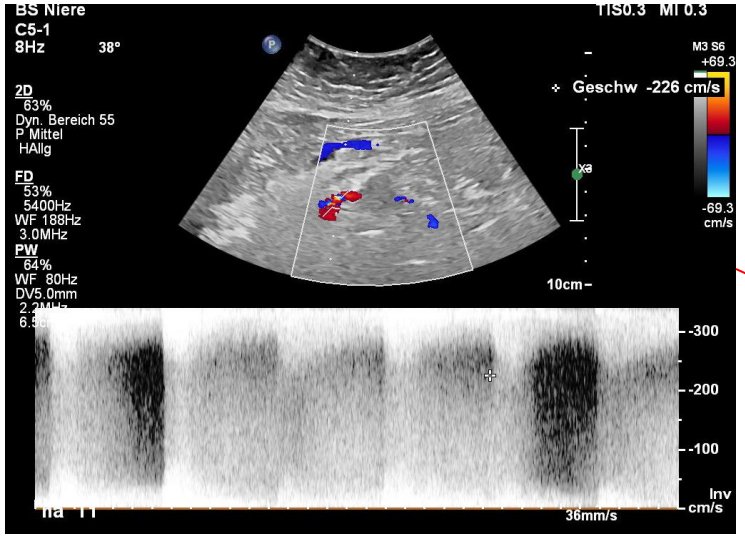
History:

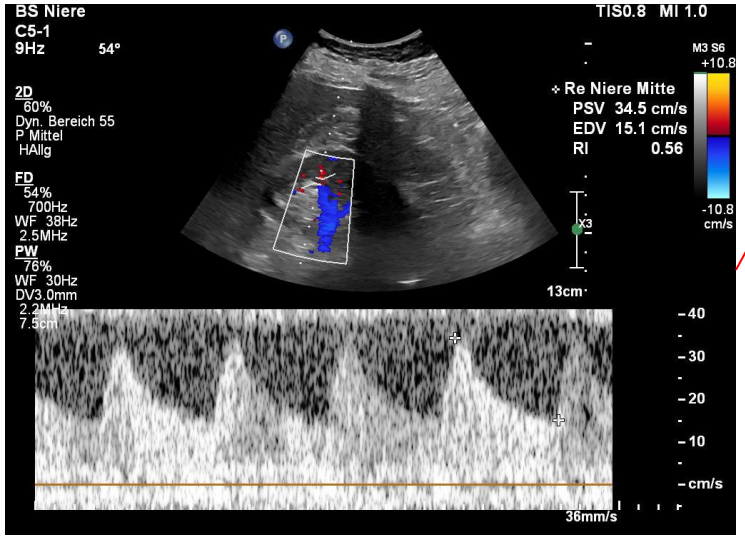
- 46-year old female patient with accelerated, resistant hypertension (Nebivolol, Irbesartan, Aldactone)
- Recurrent episode of acute renal insufficiency (on diuretics) and acute episode of heart failure (flash pulmonary oedema)
- obesity (BMI 37 kg/m^2), Nicotine (10PY)

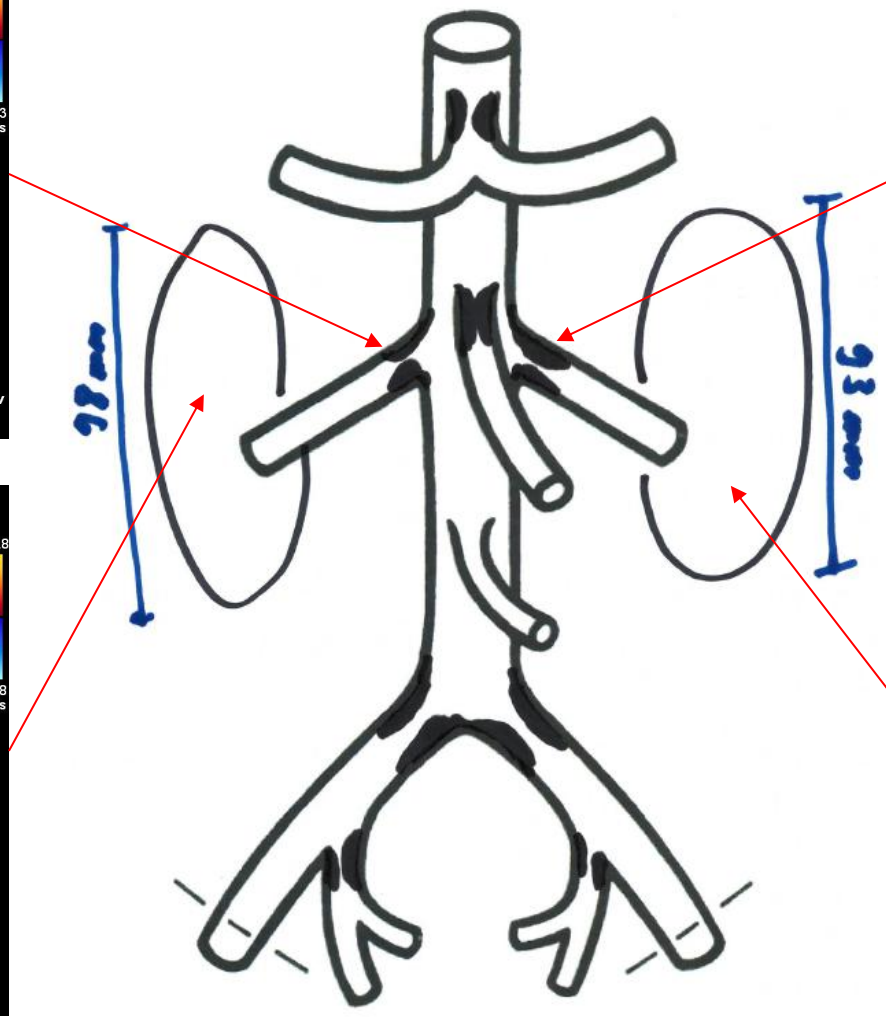
PA:

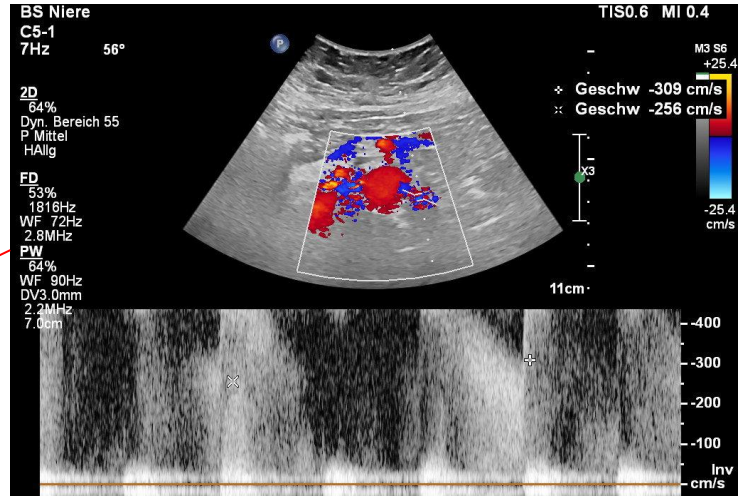
- Obstructive sleep apnea (CPAP not tolerated)

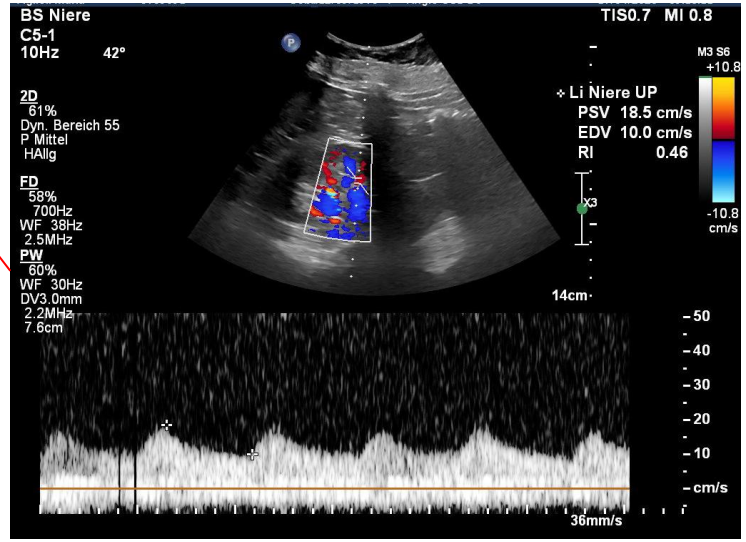
Clinical Case - Diagnostic



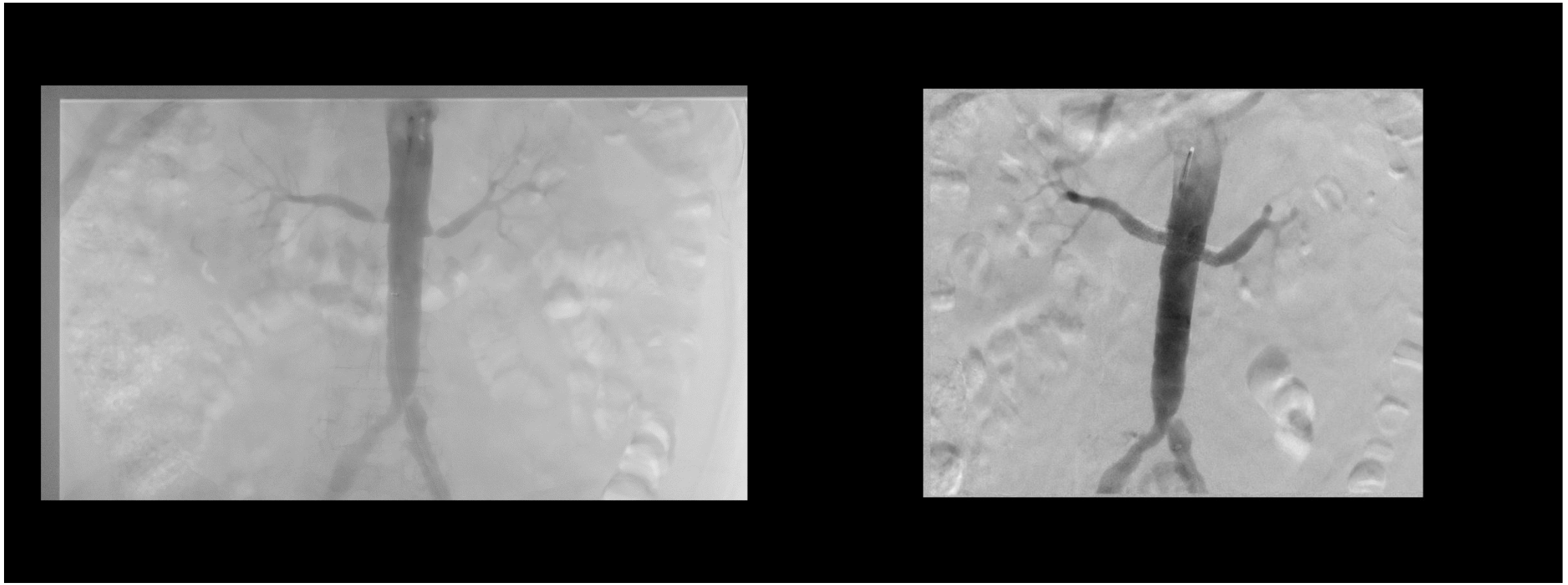








Clinical Case - Therapy

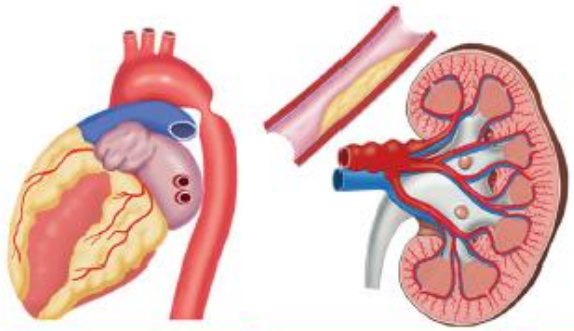


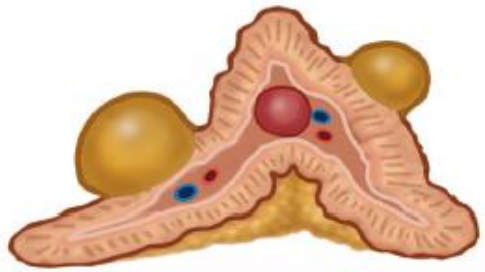
Etiology of renovascular hypertension

Disease	Prevalence
Atherosclerotic renal vascular disease	**85-90%**
Renal fibromuscular dysplasia (FMD)	**5-10%**
(Dynamic) renal artery stenosis or renal artery occlusion: • Aortic dissection with renal artery involvement • Traumatic or spontaneous acute renal artery dissection • Renal artery thrombosis or embolism	< 1-2%
Large vessel vasculitis • Takayasu arteritis, Giant cell arteritis	< 1-2%
Other form of vasculitis: • Behçet disease • Polyarteritis nodosa • Kawasaki syndrome	rare
Systemic arterial mediolysis	rare
Pediatric syndromes: • Neurofibromatosis type 1 (Von Recklinghausen disease) • Williams-Beuren syndrome • Allagile syndrome	rare
Post renal denervation iatrogenic stenotic disease	rare

Tendera M et al. *Eur Heart J* 2011 Persu A et al. *Hypertension* 2021

Pathophysiology of renal artery stenosis





	Coartation of Aorta	Renovascular Hypertension	Primary Aldosteronism	Pheochromocytoma /Paraganglioma	Cushing Syndrome
	• Vasculopathy • Sympathetic activity	• Angiotensin II • Aldosterone • Sodium/volume retention	• Aldosterone • Sodium retention	• Catecholamines	• Cortisol
LVH	↑↑	↑ARAS ↔FMD	↑↑	↑	↑
Diastolic Function	↓	↑ARAS ↔FMD	↓↓	↔	↓
Systolic Function	↓(advanced)	-	↓↓ strain	↓↓ strain	↓
In CMR	LVH, aortic dilatation	-	LVH, fibrosis, edema	fibrosis, edema	↔ fibrosis
Cardiac Events	CAD, HF	ARAS: CAD, AHF FMD: SCAD	CAD, HF, AF	TTS, hypertrophic/dilated cardiomyopathy, arrhythmias, ACS, AHF	CAD

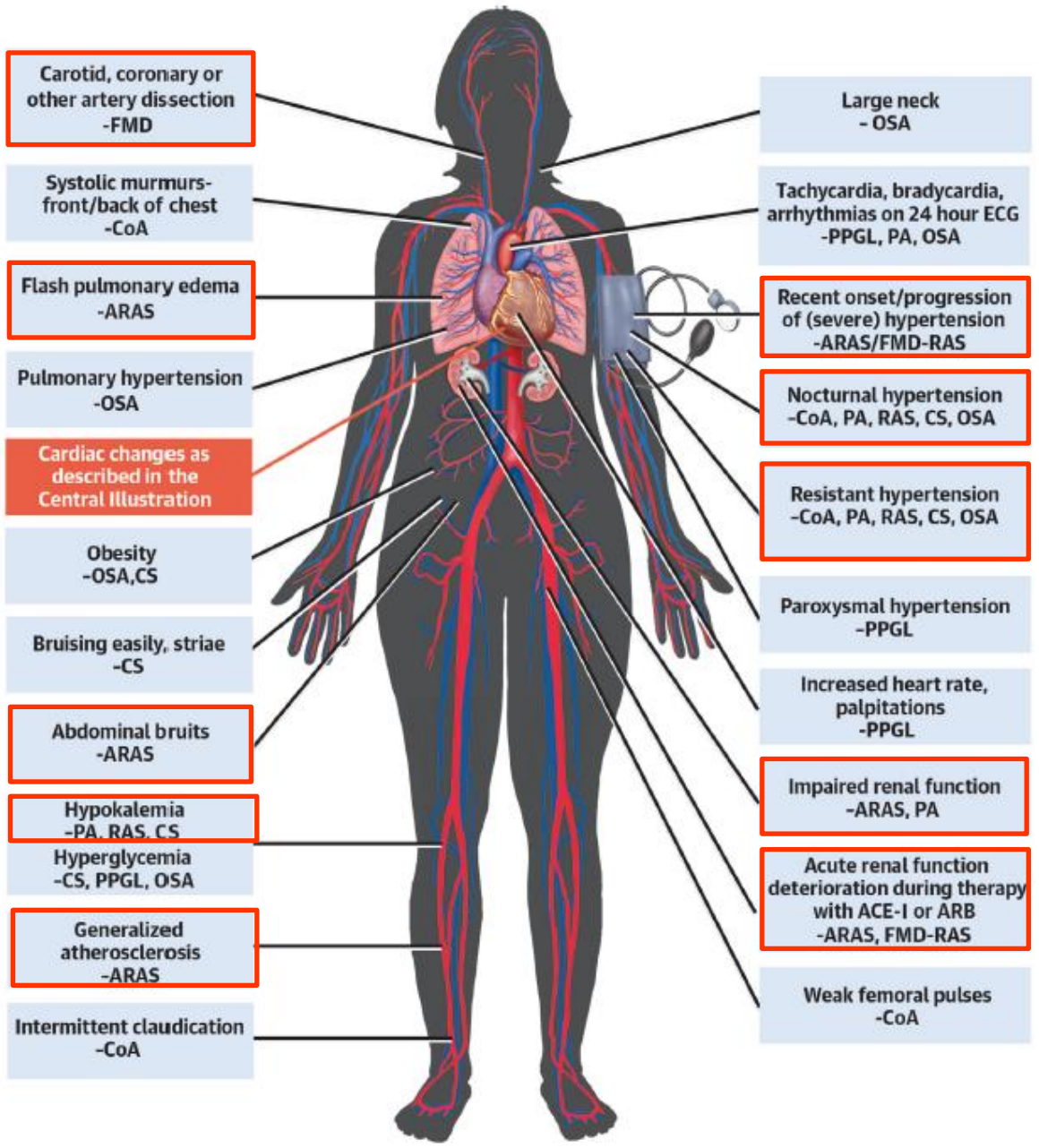
Januszewicz A et al. *JACC* 2022

Signs, Symptoms, and Screening of Secondary Hypertension

Onset of hypertension before the age of **30 years**

Hypertensive crisis (i.e. acute renal failure, acute heart failure, hypertensive encephalopathy, or grade 3-4 retinopathy)

Unexplained atrophic kidney (7- 8 cm) or **discrepancy in kidney size** (>1.2-1.5 cm)



Onset of severe hypertension after the age of **55 years**

Resistant hypertension: (i.e. other secondary form unlikely and target not achieved despite 4 drug classes including a diuretic and a mineralocorticoid-receptor antagonist in appropriate doses)

2024 ESC Guidelines. *Eur Heart J* 2024

Januszewicz A et al. *JACC* 2022

Diagnostic methods

Recommendations	Class[a]	Level[b]
DUS is recommended as the first-line imaging modality in patients with suspicion of RAS.[787,789–791]	I	B
In cases of DUS-based suspicion of RAS or inconclusive DUS, MRA, or CTA are recommended.[789,791]	I	B
In patients with atherosclerotic RAS, it is recommended to assess clinical high-risk features and kidney viability when evaluating renal artery revascularization.[809,810]	I	B

Clinical high-risk features
- Rapidly progressive, treatment-resistant arterial hypertension
- Rapidly declining renal function
- Flash pulmonary oedema
- Solitary kidney

Kidney viability
- Renal size >8cm
- Renal cortex >0.5cm
- Alb-Crea ratio <20mmg/mmol
- Renal resistive index <0.8

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Duplexsonographie

Tab. 2 Stenosegraduierung der viszeralen Arterien und Nierenarterie (AbuRhama AF J Vasc Surg 2012; 55:428, Staub D Ultraschall Med 2007; 28:45)

Stenosegrad %	0 (Normal)	≥ 50	≥ 70	Verschluss
Nierenarterien				
Durchmesser [mm]	5			
Spektralmuster	monophasisch	monophasisch	monophasisch	postocclusiver oder fehlender intrarenaler Fluss
PSV [cm/s]	60–160	> 200	> 300	kein Fluss
EDV [sm/s]	20–100	20–100	> 100	kein Fluss
RAR	1,1	> 2,5	> 3,5	
RI intrarenal	0,5–0,6 (<60 Jahre) 0,6–0,7 (>60 Jahre)	↓ oder ↑ bei Nephrosklerose	↓↓ oder ↑ bei Nephrosklerose	↓↓↓ oder fehlender Fluss intrarenal
Δ RI intranal	0	> 0,01	> 0,05	
AT [ms] intrarenal	< 70	> 70	> 70	
AI [m/s^2] intrarenal	> 3,0–3,8	< 3,0	< 3,0	
«Early systolic peak» intrarenal	vorhanden	fehlt	fehlt	

PSV: maximale systolische Geschwindigkeit, EDV: enddiastolische Geschwindigkeit, RAR: reno-aortaler Quotient (PSV Nierenarterie/PSV juxtarenale Aorta), RI: Widerstands-Index (Resistive Index), AT: Akzelerations-Zeit, AI: Akzelerations-Index

Staub D, Aschwanden M. Vaskulärer Ultraschall: arterielles System. In: *Klinische Angiologie* 2022

Recommendations for treatment strategies for renal artery disease – Medical Therapy

Recommendations	Class[a]	Level[b]
Medical therapy		
In patients with atherosclerotic RAS the use of low-dose aspirin may be considered.[811]	IIb	C

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Recommendations	Class[a]	Level[b]
Medical therapy		
ACEIs/ARBs are recommended for treatment of hypertension associated with unilateral RAS.[219–222,240]	I	B
Calcium channel blockers, beta-blockers and diuretics are recommended for treatment of hypertension associated with renal artery disease.	I	C
ACEIs/ARBs may be considered in bilateral severe RAS and in the case of stenosis in a single functioning kidney, if well-tolerated and under close monitoring.[219,221]	IIb	B

2017 ESC Guidelines. *Eur Heart J* 2018

Recommendations for treatment strategies for renal artery disease - Revascularization

Revascularization		
In patients with atherosclerotic unilateral >70% RAS, concomitant high-risk features, and signs of kidney viability, renal artery revascularization should be considered after OMT has been established.[798,809,810]	IIa	B
In patients with atherosclerotic bilateral (>70%) RAS or RAS in a solitary kidney, concomitant high risk features, and signs of kidney viability, renal artery revascularization should be considered.[800–802]	IIa	B
In patients with hypertension and/or signs of renal dysfunction due to RAS caused by fibromuscular dysplasia, concomitant high-risk features, and signs of kidney viability, revascularization with primary balloon angioplasty and bailout stenting should be considered.[812,813]	IIa	B
In patients with atherosclerotic unilateral RAS, routine revascularization is not recommended.[324,800–804,814]	III	A

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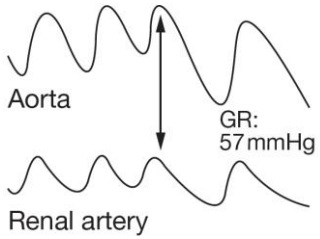
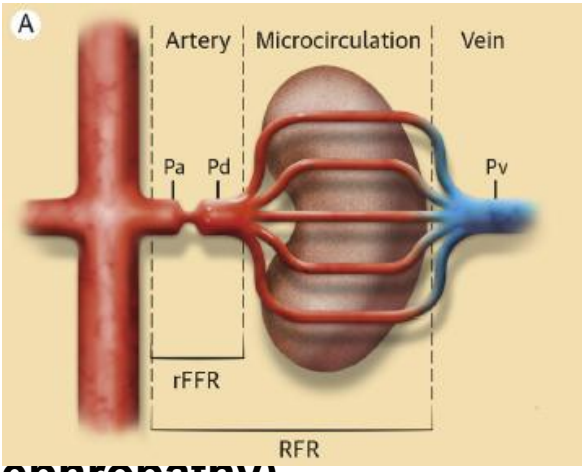
Indication for PTRA in renal artery stenosis



- PTRA/Stenting of **hemodynamic relevant >50-70% RAS** only in selected cases:
  - trans-stenotic systolic pressure gradient > 20mmHg
  - Pd / Pa mean pressure distal to stenosis / mean aortic pressure <0.9
  - renal fractional flow reserve (rFFR) = Pd / Pa with max. vasodilation

Von Brussel PM et al. *JACC Cardiovasc Int* 2017

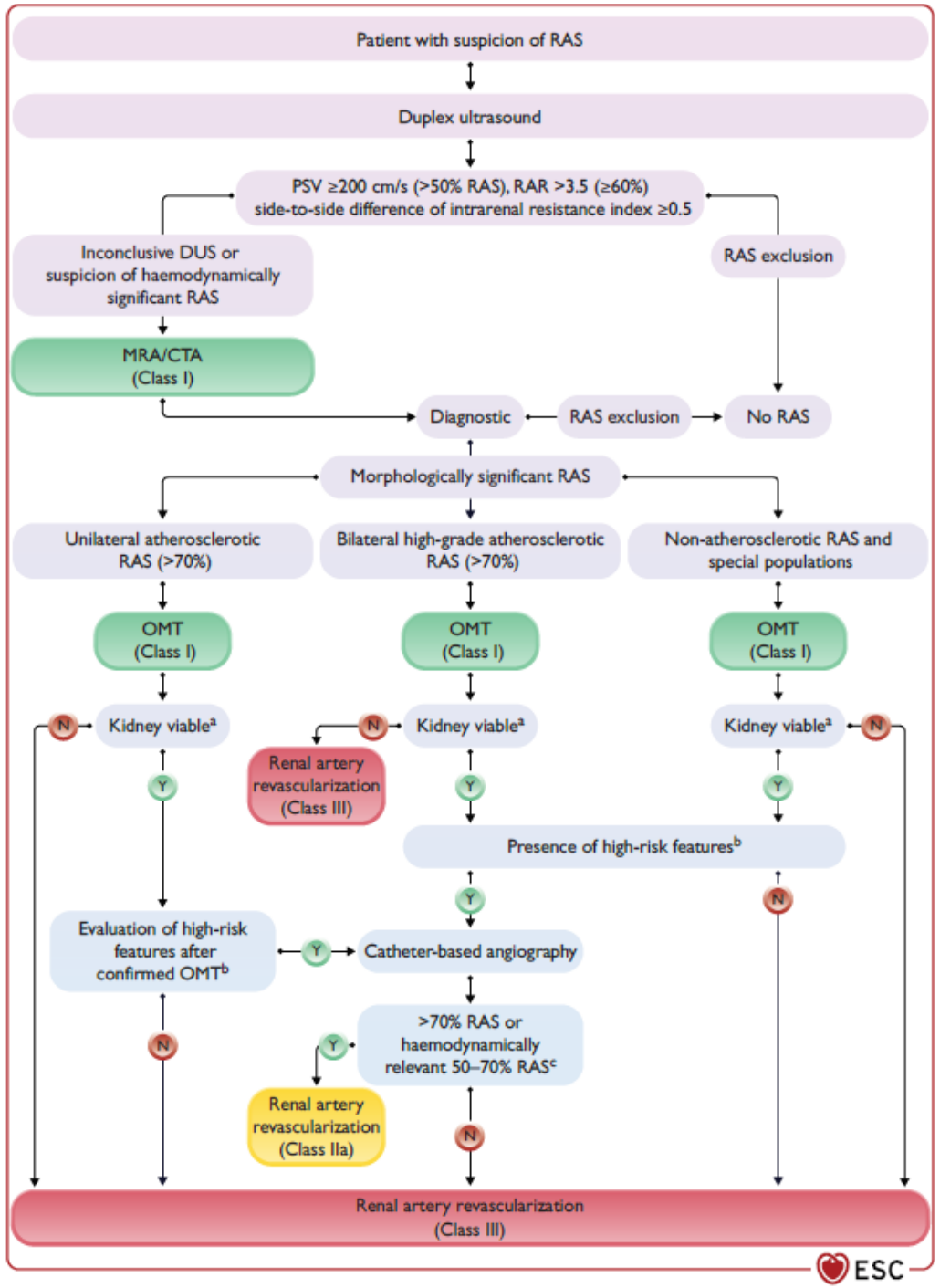


- **Treatment of renovascular hypertension and/or renal insufficiency (ischemic nephropathy)**
  - Fibromuscular dysplasia: Slovut DP, Olin JW *NEJM* 2004
    - Cure rate 37% (fell with increased age), improved hypertension 80% Tian Y et al. *Ann Vasc Surg* 2022
    - Measurement of trans-stenotic pressure gradient, post-stenotic systolic pressure gradient <10mmHg or reduction by at least 80% Cadour F et al. *J Vasc Surg* 2022
  - ARAS (rapidly progressive, treatment-resistant hypertension)
  - Kidney viability: Intrarenal resistive index (RI) < 0.8, renal size >8cm Radermacher J *NEJM* 2001
  - Bilateral RAS, RAS of solitary kidney without renal atrophy

- **Recurrent, unexplained heart failure, flash pulmonary edema**
- **(Pickering Syndrom)**

Kane GC et al. *Nephrol Dial Transplant* 2010
Sanga V et al. *J Am Heart Assoc* 2023

Diagnostic and treatment algorithm for renal artery stenosis



[a]Kidney viability

- Renal size >8cm
- Renal cortex >0.5cm
- Alb-Crea ratio <20mmg/mmol
- Renal resistive index <0.8

[b]Clinical high-risk features

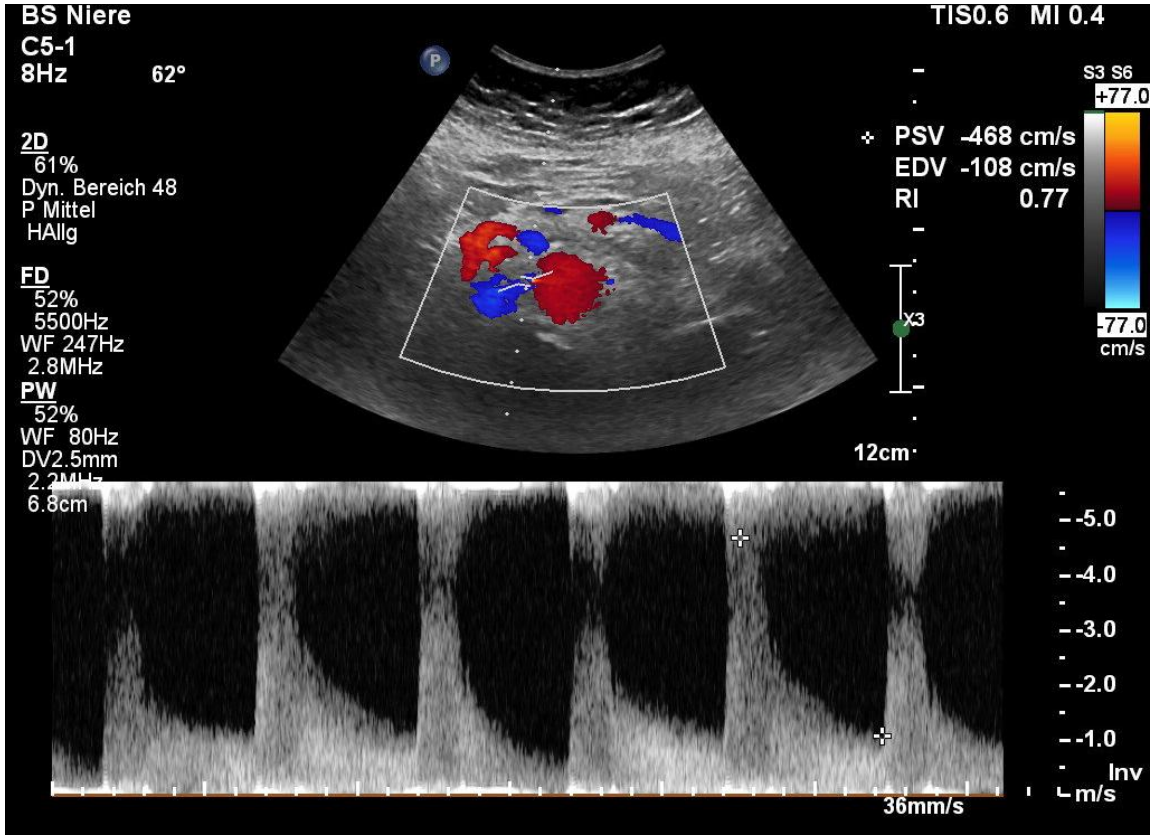
- Rapidly progressive, treatment-resistant arterial hypertension
- Rapidly declining renal function
- Flash pulmonary oedema
- Solitary kidney

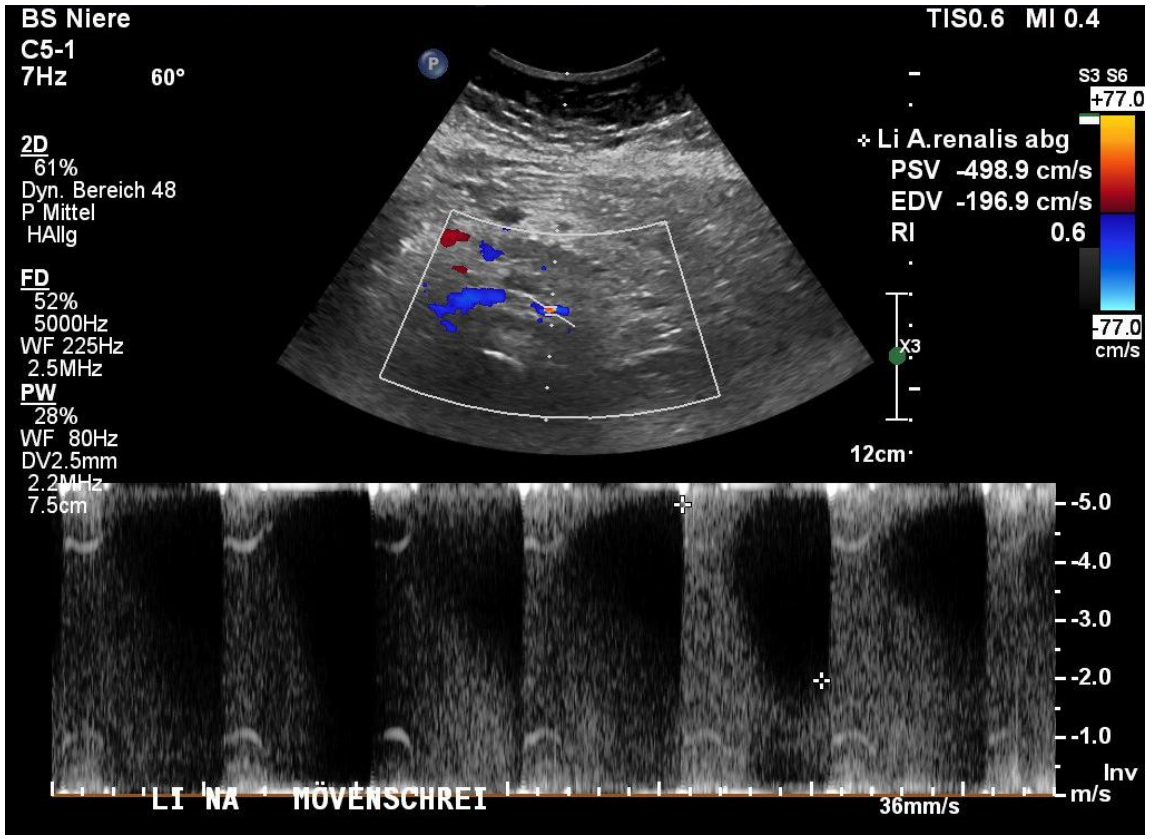
[c]Hemodynamic relevant RAS

- Resting mean pressure gradient > 10mmHg
- Systolic pressure gradient > 20mmHg
- Renal PdPa ≤ 0.9 (or 0.8)

2024 ESC Guidelines. *Eur Heart J* 2024

Clinical Case – follow up 1 year after PTRA





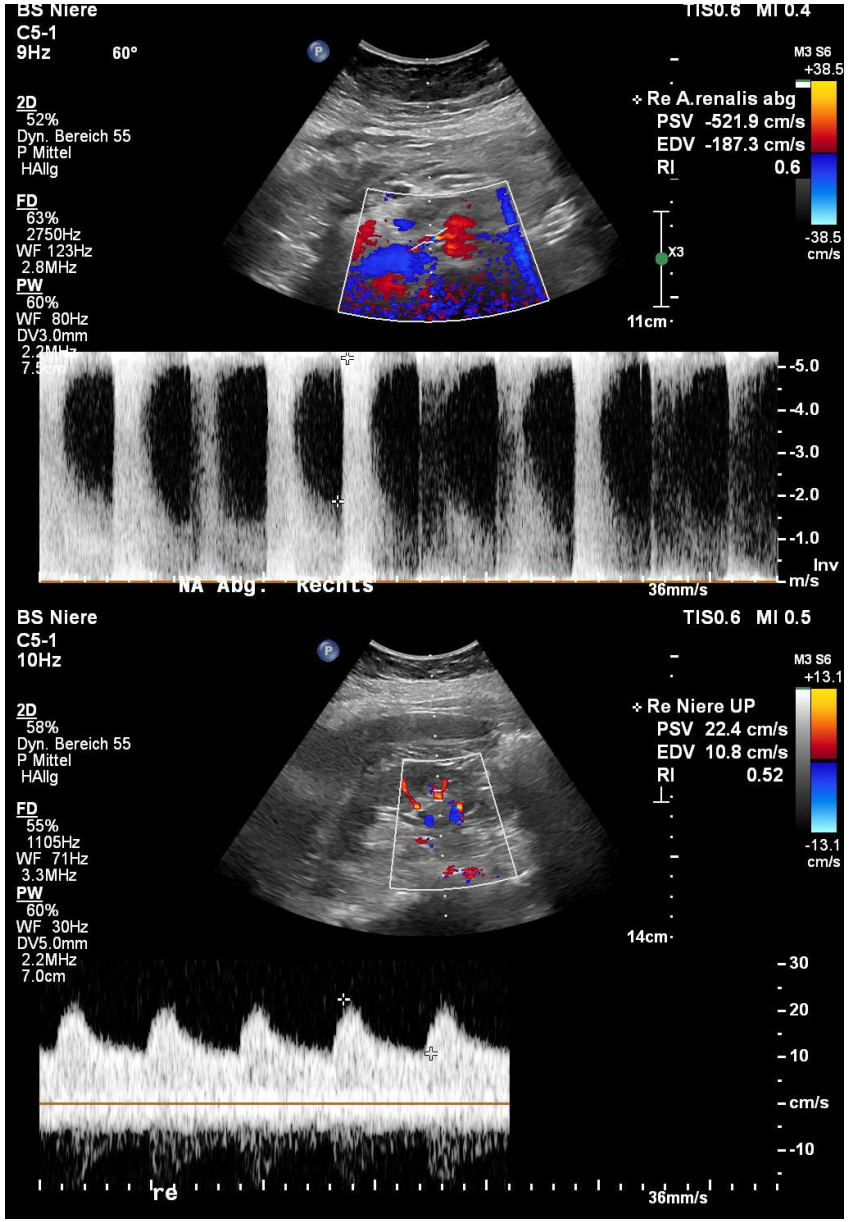
- 47-year old female patient with in-stent-renal artery stenosis at both sides
- Re-PTRA with DEB at both sides

Follow-up Examination

- Restenosis after PTRA/Stent: 11-14%
  White CJ and Olin JW *Nat Clin Pract Cardiovasc Med* 2009
- Follow-up with duplex ultrasound :
  - Directly after PTRA
  - 6 week, 6 and 12 months after PTRA, afterward according to the ultrasound findings
- Duplex criteria for restenosis equal to criteria for native arteries
  Zeller T *Catheter Cardiovasc Interv* 2008, Fleming SH *J Vasc Surg* 2010
- Maybe higher threshold value after Stenting (changes in compliance, similar to carotis stents)
  Chi YW *J Vasc Surg* 2009
- Duplex criteria for the detection of ≥60% renal artery In-stent Restenosis (n=132)
  - PSV < 241 cm/s (NPV 96%) and RAR <2.6 (NPV 95%)
  - PSV ≥296 cm/s (PPV 94%) and RAR ≥4.4 (PPV 96%)

  Del Conde I et al. *Catheter Cardiovasc Intervention* 2014

Clinical Case – follow up 6 months after Re-PTRA



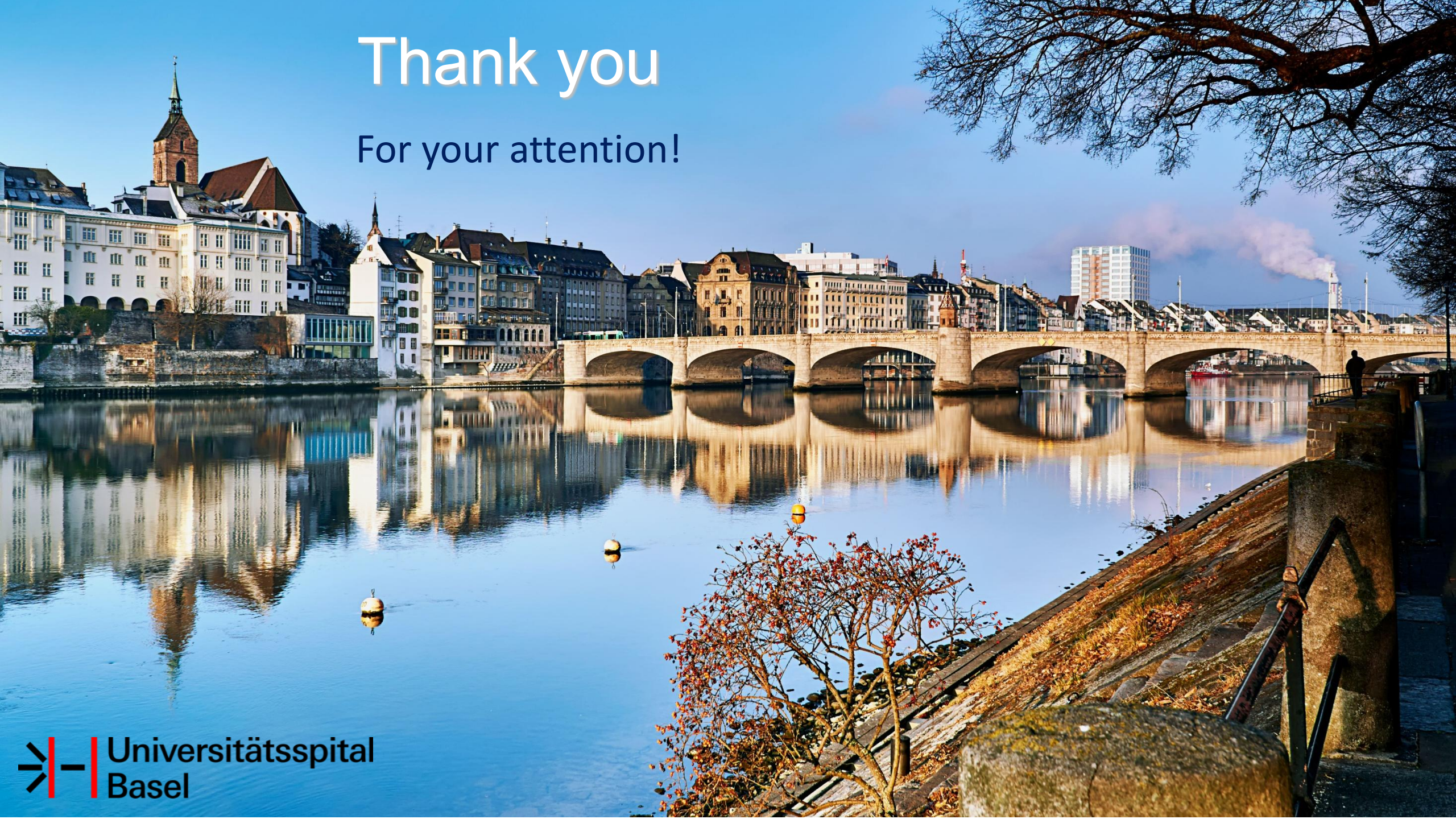
- 48-year old female patient with recurrent in-stent-renal artery stenosis at the right side
- Hepatico-renal Bypass

In patients with an indication for renal artery revascularization and complex anatomy, or after failed endovascular revascularization, open surgical revascularization should be considered.[805,806]	IIa	B

2024 ESC Guidelines. *Eur Heart J* 2024

Thank you

For your attention!



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