Sténose artérielle rénale: prise en charge actuelle

Prise en charge diagnostique et thérapeutique

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DPC HTA

19/06/2026

Sténose artérielle rénale athéroscléreuse (SARA)

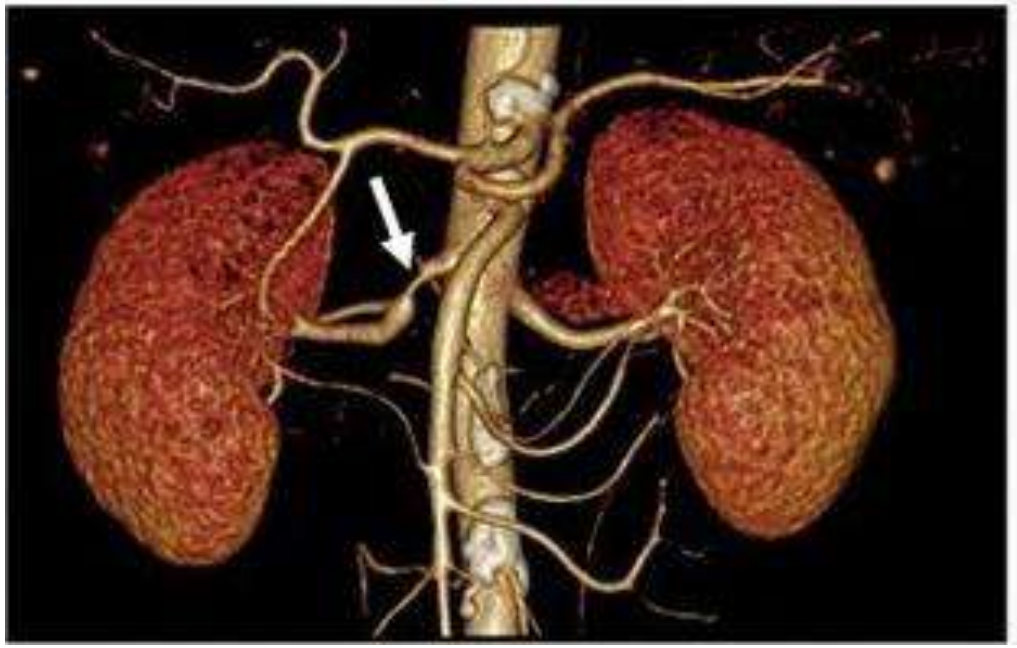
- 90 % des cas de sténose de l'artère rénale chez les patients âgés

Plan

- Définition
- Physiopathologie
- Prévalence
- Pronostic
- PEC diagnostique
- PEC thérapeutique

Définition

- La SARA est un rétrécissement hémodynamiquement significatif du calibre d’une ou des deux artères rénales, dû à des plaques d'athérome
  - Localisation: l’**ostium** ou le segment proximal de l'artère rénale
  - Quel seuil ?
  - Définition ESH : sténose > 60%
  - Sténose > 70%
  - 50-70% si sévérité hémodynamique



Sarafadis et al., **Atherosclerotic renovascular disease: a clinical practice document by the European Renal Best Practice (ERBP) board of ERA and the Working Group Hypertension and the Kidney of the ESH, NDT 2023**

Physiopathologie: 1934

STUDIES ON EXPERIMENTAL HYPERTENSION

I. The Production of Persistent Elevation of Systolic Blood Pressure by Means of Renal Ischemia*†

By HARRY GOLDBLATT, M.D., JAMES LYNCH, M.D., RAMON F. HANZAL, Ph.D., and WARD W. SUMMERVILLE, M.D.

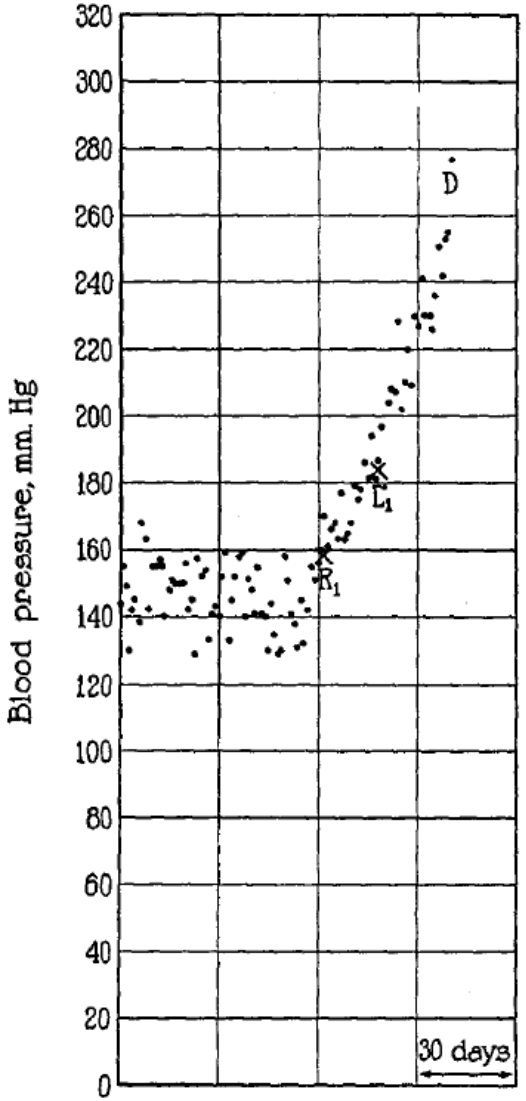
(From the Institute of Pathology, Western Reserve University, Cleveland)

Plates 23 and 24

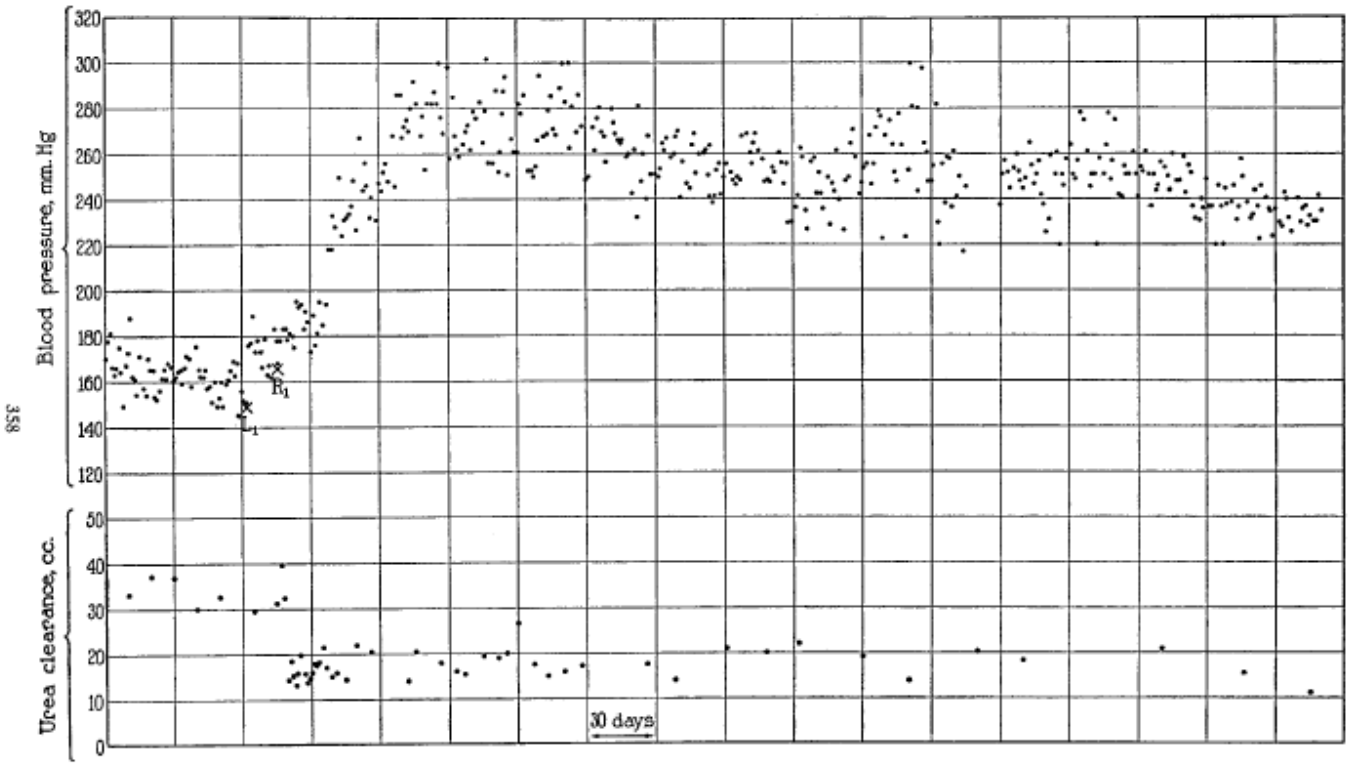
(Received for publication, December 1, 1933)

Goldblatt H, et al. Studies on experimental hypertension. The production of persistent elevation of systolic blood pressure by means of renal ischemia. J Exp Med 1934
Goldblatt H. Renovascular hypertension due to renal ischemia. Circulation 1965

1934



TEXT-FIG. 5. Dog 2-5. Initial weight 12.6 kilos. Final weight 11.2 kilos. R_1, almost complete constriction of main right renal artery; L_1, almost complete constriction of main left renal artery; D, died in uremia.



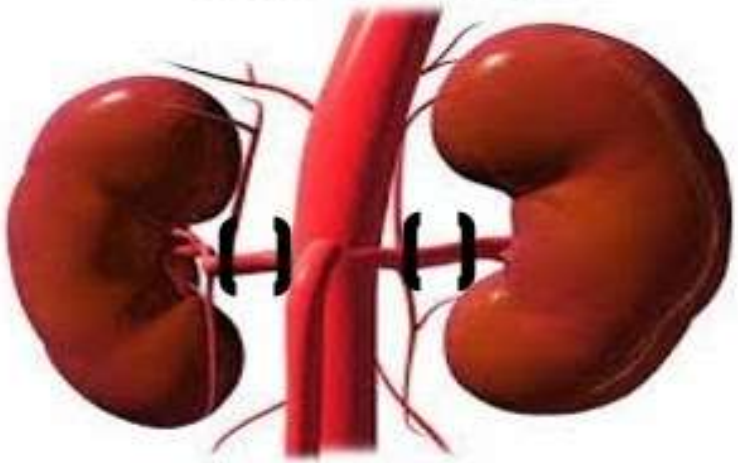
TEXT-FIG. 7. Dog 3-8. Initial weight 11.2 kilos. Final weight 7.6 kilos. L_1, severe constriction of left main renal artery; R_1, severe constriction of right main renal artery. The animal is still alive.

Goldblatt H, et al. Studies on experimental hypertension. The production of persistent elevation of systolic blood pressure by means of renal ischemia. J Exp Med 1934

Goldblatt H. Renovascular hypertension due to renal ischemia. Circulation 1965

Modèles expérimentaux d'HTA rénovasculaire
Ischémie Complète : 2K2C ou 1K1C

SAR Bilatérale



2K2C

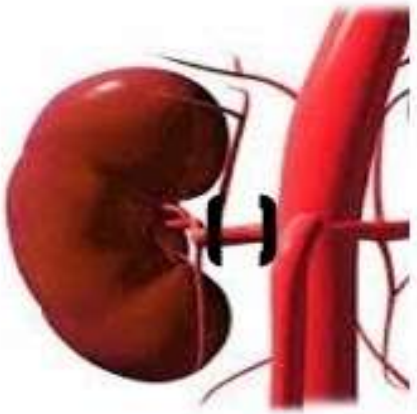
Ischémie Rénale

↑ Rénine

↑ Angiotensine 2

↑ RVS

SAR sur rein unique



1K1C

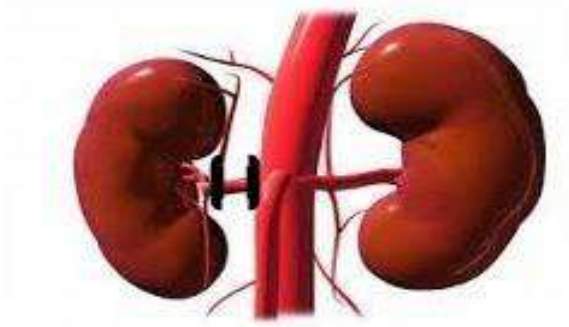
Hyperaldostéronisme Secondaire

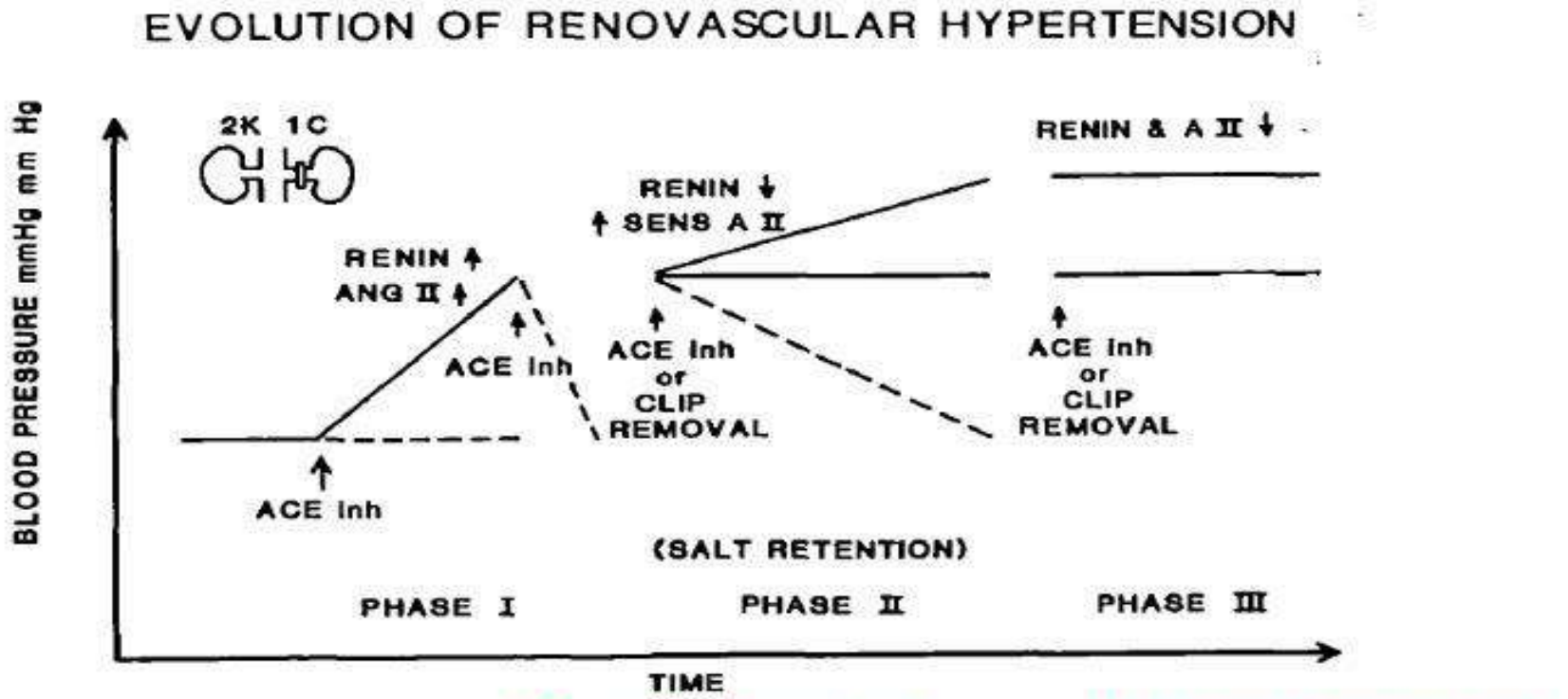
Rétention Hydro-sodée

HTA réactionnelle

Goldblatt H, et al. Studies on experimental hypertension. The production of persistent elevation of systolic blood pressure by means of renal ischemia. J Exp Med 1934
Goldblatt H. Renovascular hypertension due to renal ischemia. Circulation 1965

Modèles expérimentaux d'HTA rénovasculaire
Ischémie Partielle : 2K1C





HTA rénine dépendante

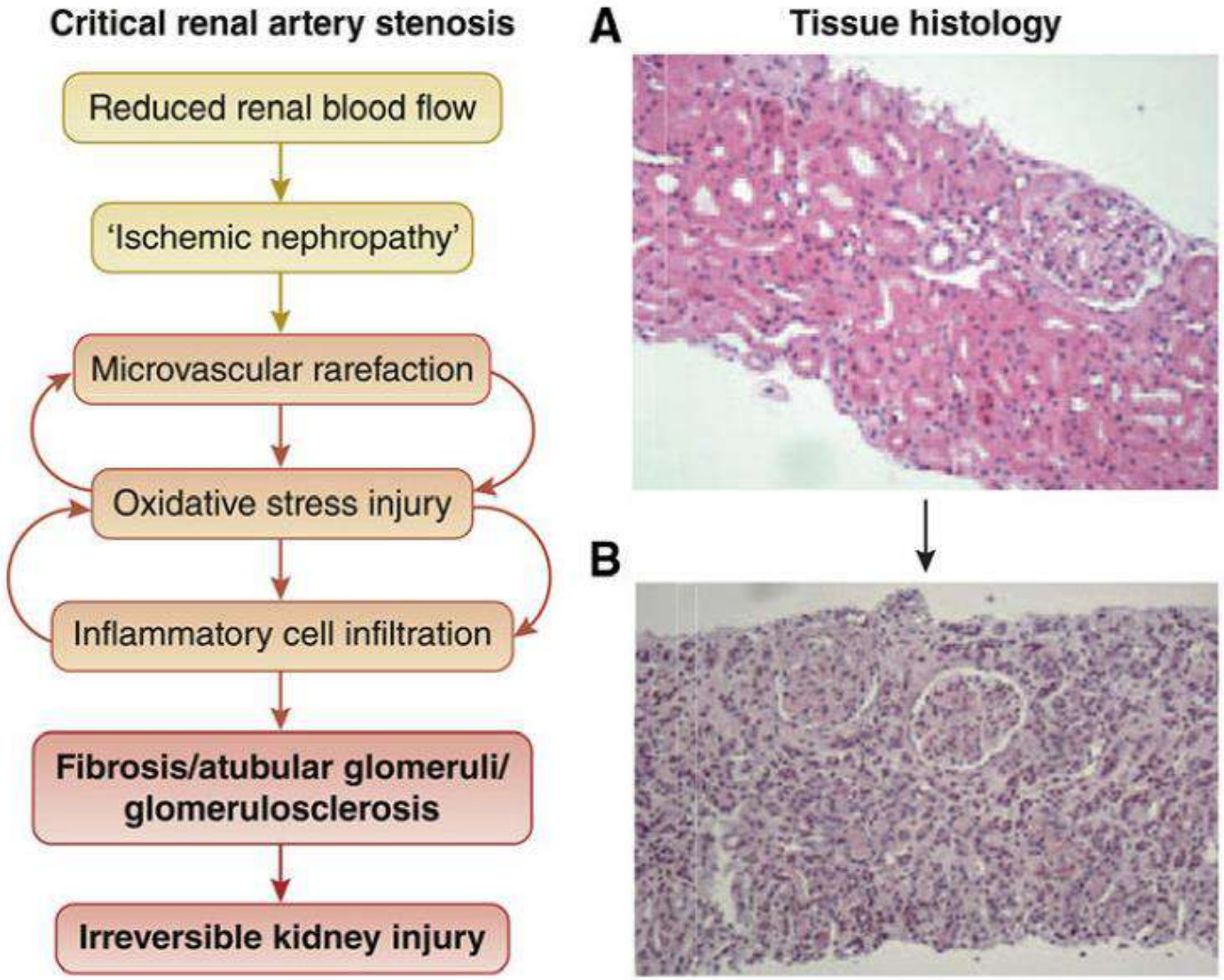
HTA volo-dépendante
Hyperaldo 2R
Augmentation RVS

Lésions irréversibles
Ischémie homolatérale
NAS controlatérale

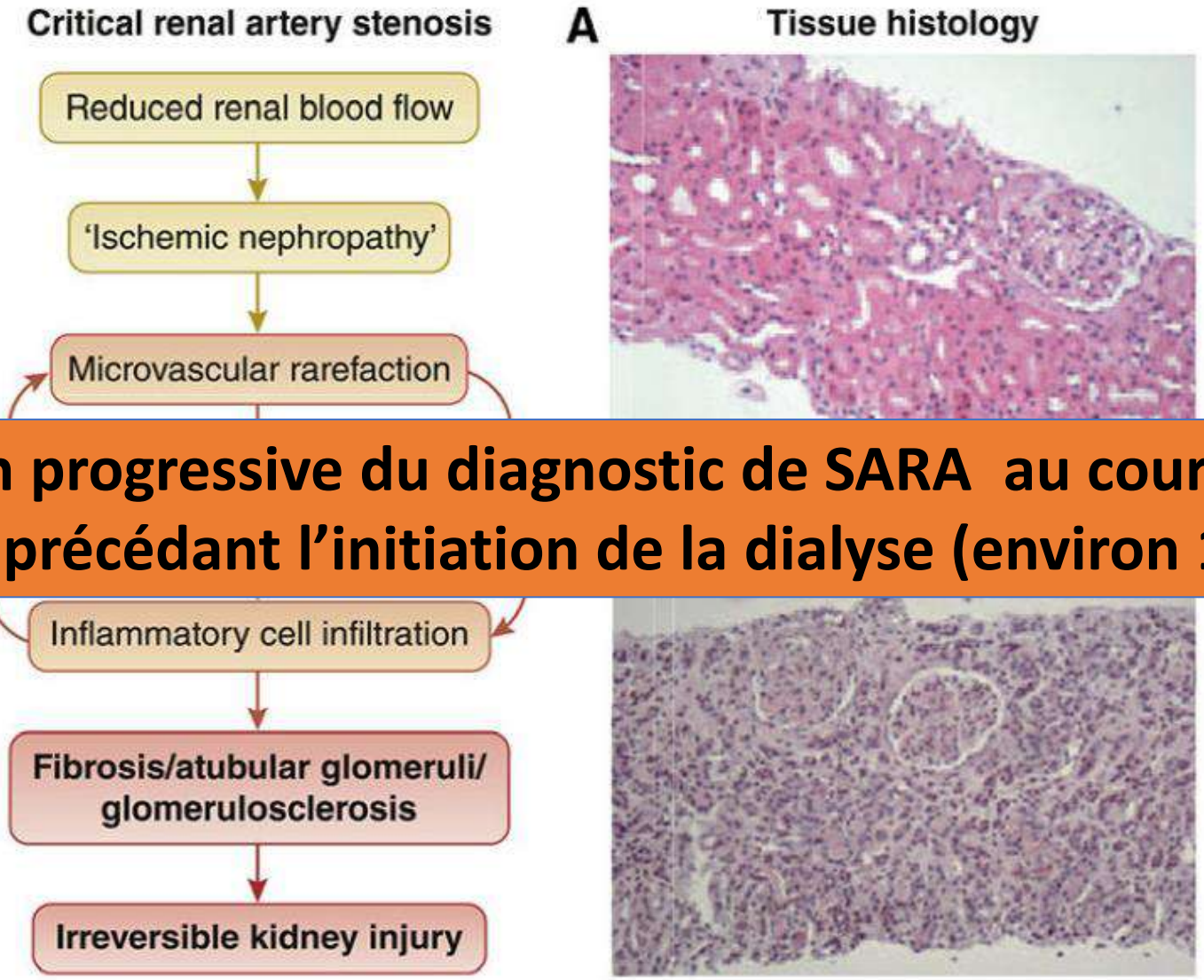
Robertson et al., *Journal of Hypertension*, 1986

Martinez-Maldonado et al., Pathophysiology of Renovascular Hypertension, Hypertension 1991

Au-delà de la Sténose : Dommages Parenchymateux. x



Au-delà de la Sténose : Dommages Parenchymateux. x



augmentation progressive du diagnostic de SARA au cours des deux années précédant l'initiation de la dialyse (environ 10%)

Guo H *et al.* Atherosclerotic renovascular disease in older US patients starting dialysis, 1996 to 2001. *Circulation* 2007

Prévalence des SARA par population

40 études, 15 879 patients

Sujets >65 ans

Suspicion de SARA

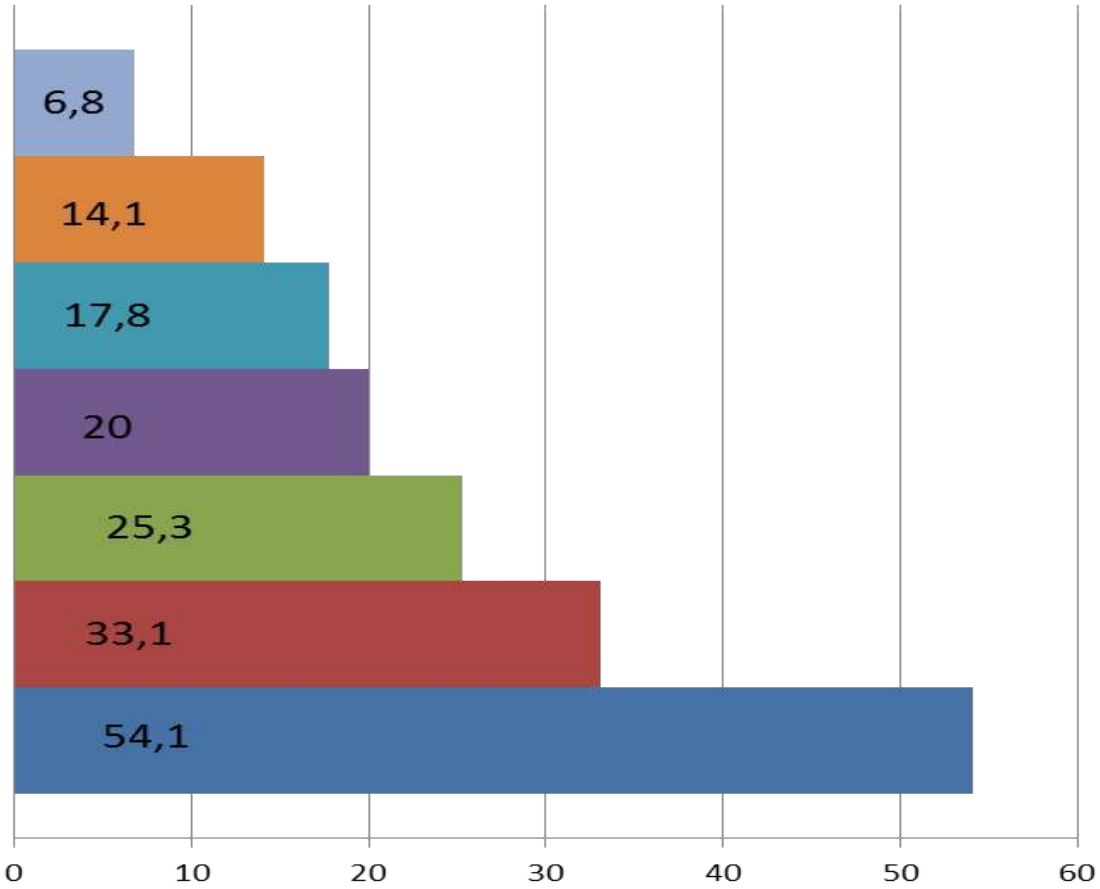
Maladie coronaire

Hypertendus diabétiques

Artérite des MI

Anévrisme de l'aorte abdominale

Insuffisance cardiaque



Sarafadis et al., **Atherosclerotic renovascular disease: a clinical practice document by the European Renal Best Practice (ERBP) board of ERA and the Working Group Hypertension and the Kidney of the ESH, NDT 2023**

Prévalence des SARA: prisme de l'HTA

HTA modérée <1%

HTA sévère / brutal / résistante 14-24%

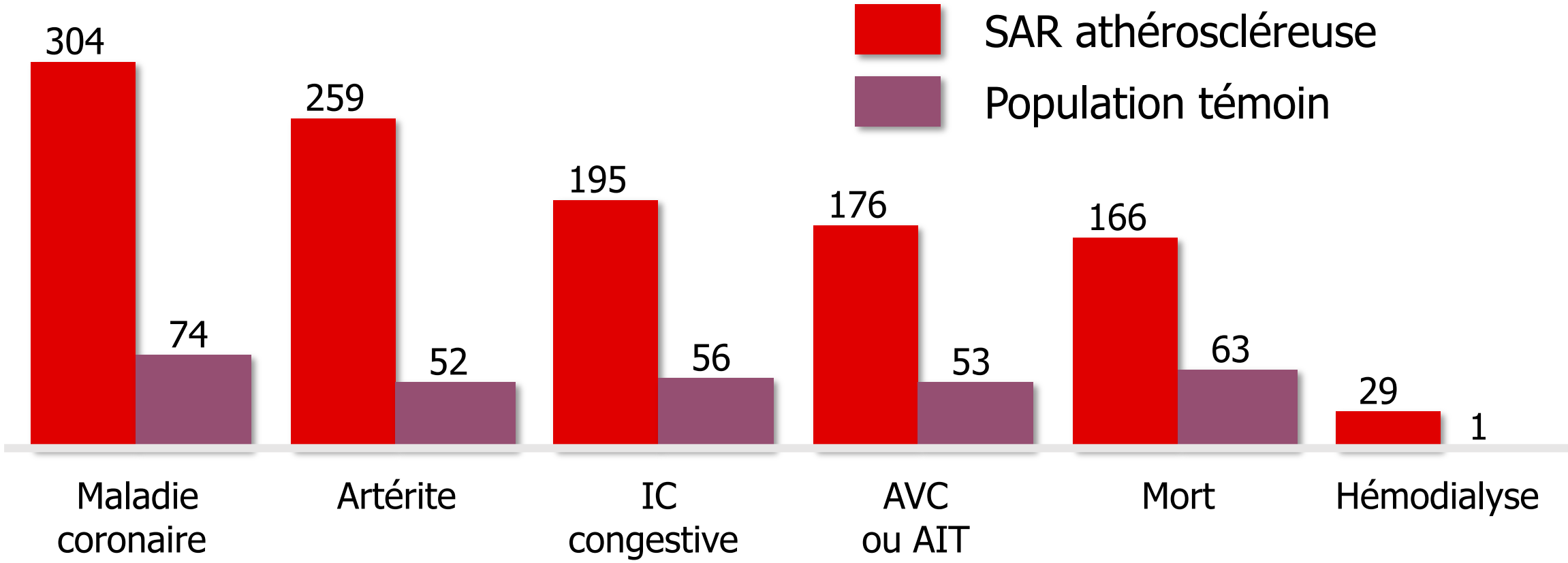
Sarafadis et al., **Atherosclerotic renovascular disease: a clinical practice document by the European Renal Best Practice (ERBP) board of ERA and the Working Group Hypertension and the Kidney of the ESH, NDT 2023**

Pronostic

- La progression de la maladie est fréquente.
- Dans un délai de 5 ans:
  - Aggravation de la sténose : ~50 % des patients
  - Progression vers l’occlusion : 8–16 %
  - Passage d’une atteinte unilatérale à bilatérale : 17 %
- FdR Identiques à l'athérosclérose systémique :
  - âge avancé,
  - tabagisme,
  - diabète,
  - hypertension
  - dyslipidémie

Pronostic: une SARA ne se réduit pas à une maladie rénale

Incidence des événements CV ou rénaux pour 1000 années-patient



5875 patients ≥67 ans ayant une SARA

Kalra PA et al, Kidney Int 2005

PEC diagnostique: Qui dépister ?

- **Pas de dépistage systématique recommandé**
- **Indications du dépistage de SARA:**

.

Table 1: Clinical phenotypes of ARVD that should prompt investigations for this entity.

Hypertension	Sudden onset or worsening of existing hypertension
	Grade III hypertension (especially in the presence of other cardiovascular risk factors or atherosclerotic disease in other circulatory beds)
	Resistant hypertension
Kidney disease	Atrophic kidney or size difference >1.5 cm between kidneys
	Rapid, unexplained kidney function decline
	Decline in kidney function (eGFR) >30% after starting treatment with ACEIs/ARBs
	Increased albuminuria/proteinuria due to hypertensive damage in the non-stenotic kidney in unilateral RAS
Heart failure	Repeated hospital admissions for decompensated heart failure with preserved left ventricular function on echocardiography
	Sudden unexplained ('flash') pulmonary oedema

Sarafadis et al., **Atherosclerotic renovascular disease: a clinical practice document by the European Renal Best Practice (ERBP) board of ERA and the Working Group Hypertension and the Kidney of the ESH, NDT 2023**

PEC diagnostique: stratégie diagnostique

- Stratégie : **imagerie non invasive → angiographie invasive sélective**.

Summary of Imaging Modalities Used to Diagnose Atherosclerotic Renovascular Disease

Imaging Modality	Sensitivity	Specificity	Strengths	Limitations
Duplex ultrasound	91%-100%	82%-91%	Inexpensive, noninvasive, provides waveform and velocity data, provides data about kidney viability (resistive index)	Operator-dependent, limited by high BMI, limited availability in some countries
Multidetector CTA	64%-96%	90%-92%	Rapid multiplanar acquisition, allows detection of accessory renal arteries	Low/moderate levels of radiation, requires iodinated contrast
MRA	94%-97%	85%-93%	No radiation or iodinated contrast required	Long acquisition times (~1 h), may overestimate degree of stenosis
Catheter angiography	100%	100%	Gold standard of renal artery evaluation, enables measurement of pre- and postintervention gradients, can evaluate and treat in same setting	Invasive procedure, only 2D planar images acquired, ideally requires iodinated contrast (CO_2 can be substituted with lesser resolution)

Abbreviations: BMI, body mass index; CTA, computed tomographic angiography; MRA, magnetic resonance angiography; 2D, 2-dimensional.

PEC diagnostique: Echographie-doppler

Diagnostic SARA

PSV >200 Cm/s -> sténose 50%

Renal:aorta PSV RATIO > 3,5 -> sténose 60%

Viabilité rénale

Table 4: Evaluation of the possible viability of the kidney with ARVD following revascularization.

Variable	Likely to benefit	Unlikely to benefit
RAS degree	>70%	<50%
Kidney length (cm)	>8 cm[a]	<7 cm
Renal resistive index	<0.8	>0.8

Mais opérateur dépendant, obésité, gazs intestinaux

PEC diagnostique

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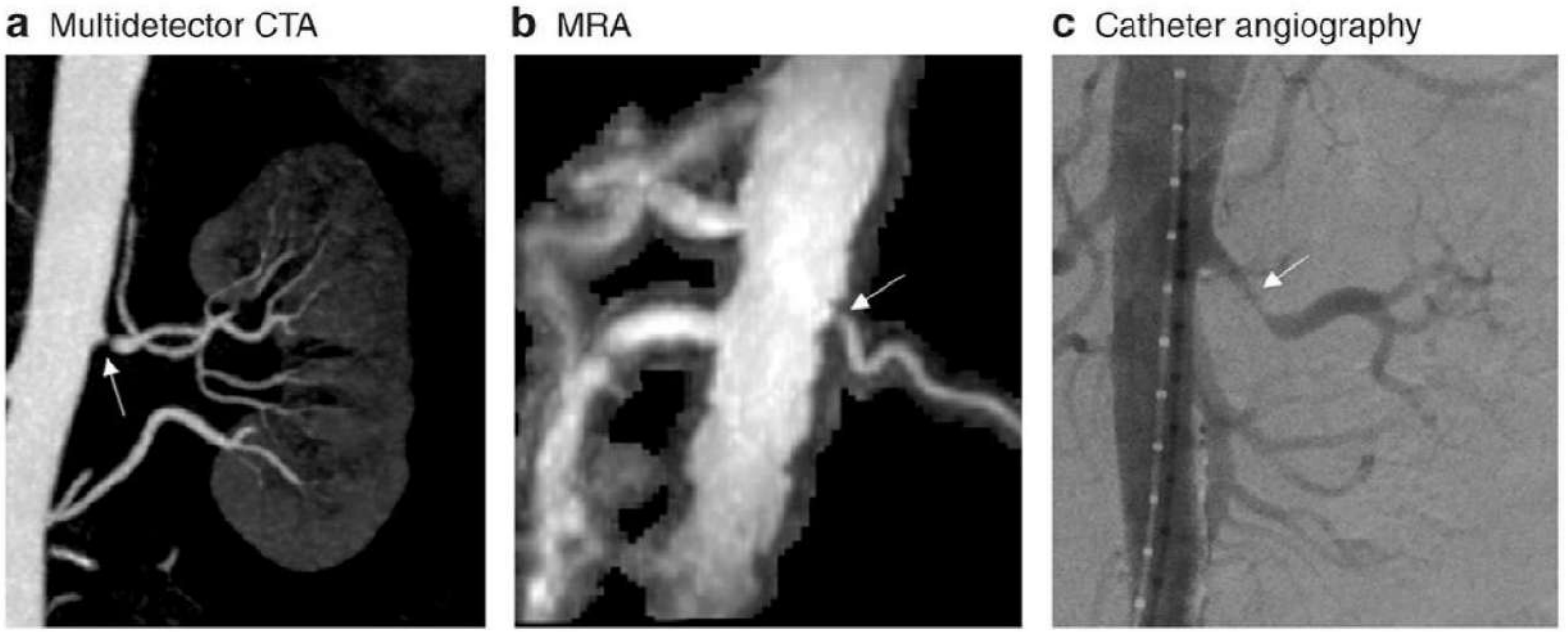
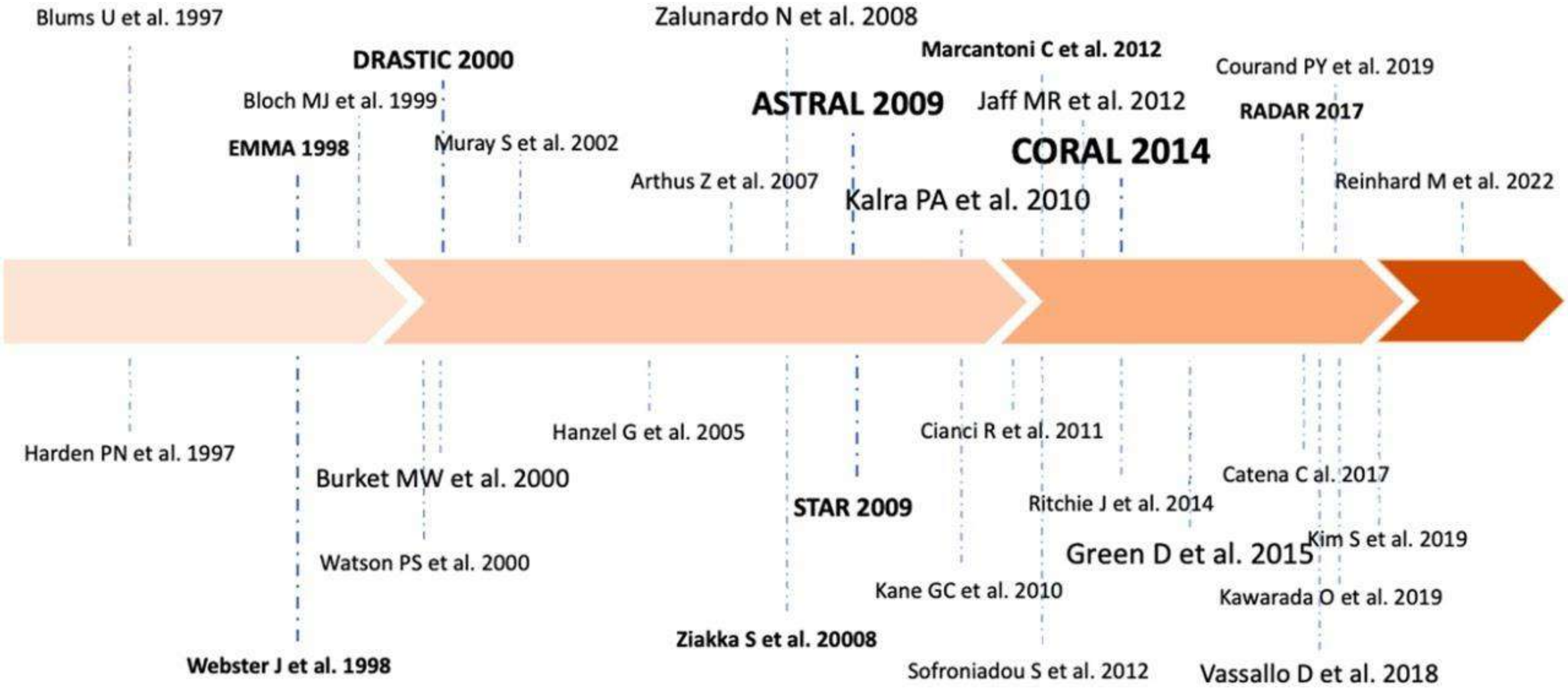


PEC thérapeutique

Fig. 1. Timeline of published papers on renal artery stenosis (RAS) from 1945 to today. Data from PubMed ® (U.S. Department of Health and Human Services, www.ncbi.nlm.nih.gov). The terms entered in the query box are renal artery stenosis. Since 1934, when Goldblatt described the relationship between RAS and renovascular hypertension, over 16,600 articles on RAS have been published.

SARA: Grand essais



Avant CORAL

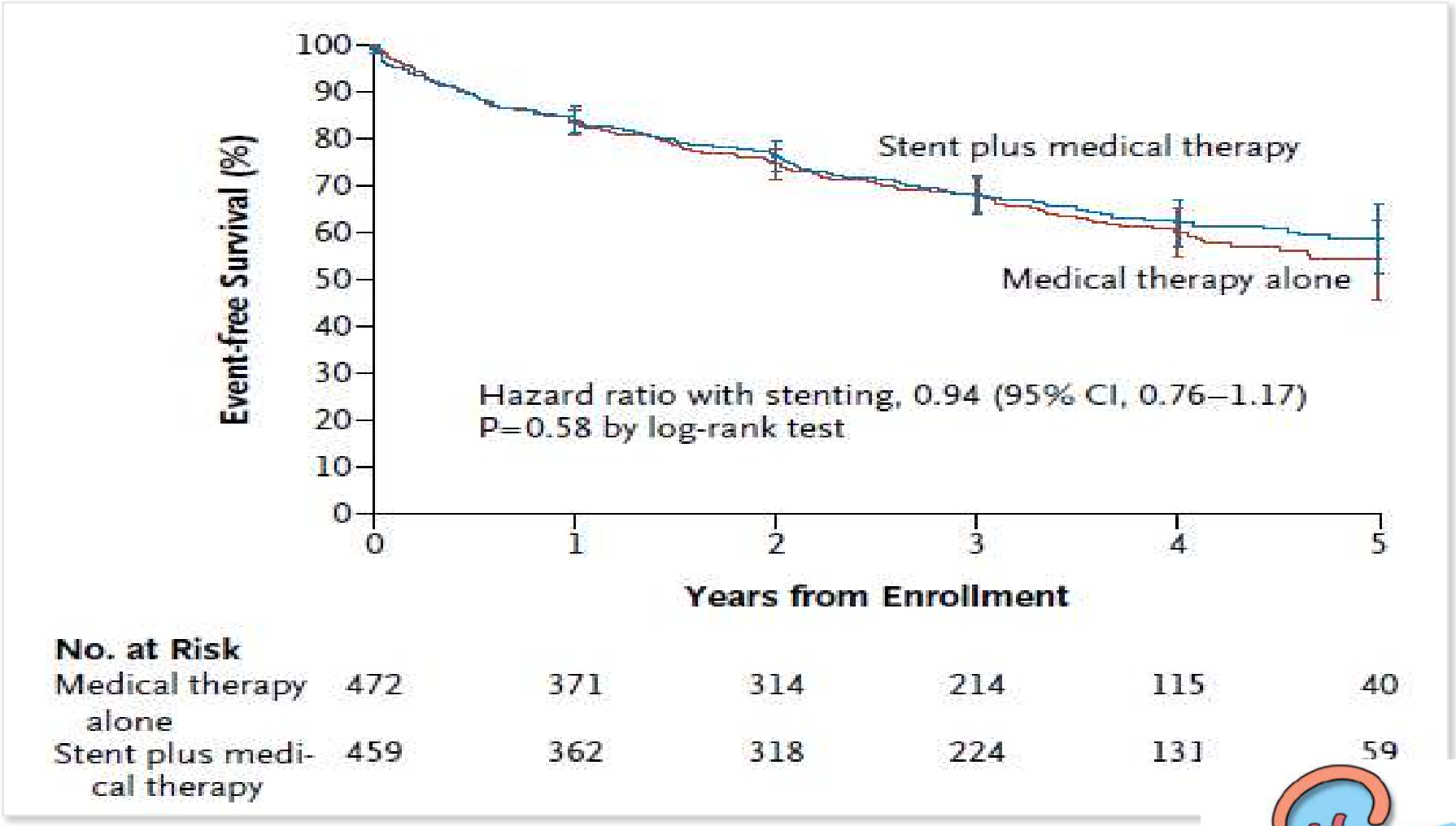
Table 1
Key randomized controlled trials (RCT) in atherosclerotic renal artery stenosis (ARAS).

Trial (Year)	N (patients)	Population	Intervention	Comparator	Primary outcome	Main findings
DRASTIC (1998)	106	HTN, ≥50 % RAS	PTA (angioplasty)	Medical therapy	BP control	No significant benefit of PTA over medical therapy; high crossover (~44 %).
STAR (2004)	140	CKD + RAS (>50 %)	Stent + OMT	OMT	Change in renal function (eGFR)	No benefit of stenting; underpowered, many with moderate stenosis.
ASTRAL (2009)	806	Suspected RAS	Stent + OMT	OMT	Renal function (slope of GFR decline)	No significant benefit of stenting; criticized for inclusion of non-hemodynamically significant stenoses.
CORAL (2014)	947	HTN and/or CKD + ARAS (>60 %)	Stent + OMT	OMT	Composite CV/renal endpoint (death, MI, stroke, dialysis, doubling of creatinine)	No significant benefit of stenting; modest BP reduction (~2 mmHg); periprocedural risk present.

CORAL (Cardiovascular Outcomes in RA Lesions)

Indication	PAS ≥155 mmHg, ≥2 antiHT, RAS ≥80% (lecture centralisée) ou ≥60% + gradient ≥20 mmHg à l'angiographie, créatinine <354 µM, rein >7 cm
Tt médical	candesartan, atorvastatin, ± amlodipine et HCTZ
Stent	Palmaz Genesis
Critère primaire	Mort CV, AVC, infarctus, hémodialyse, ↓ DFG ≥ 30%, hospitalisation pour insuffisance cardiaque
Population	947 inclusions dont 20% d'ischémie globale, 6,1% perdus de vue, 0,7% de cross-over

CORAL: Résultat primaire

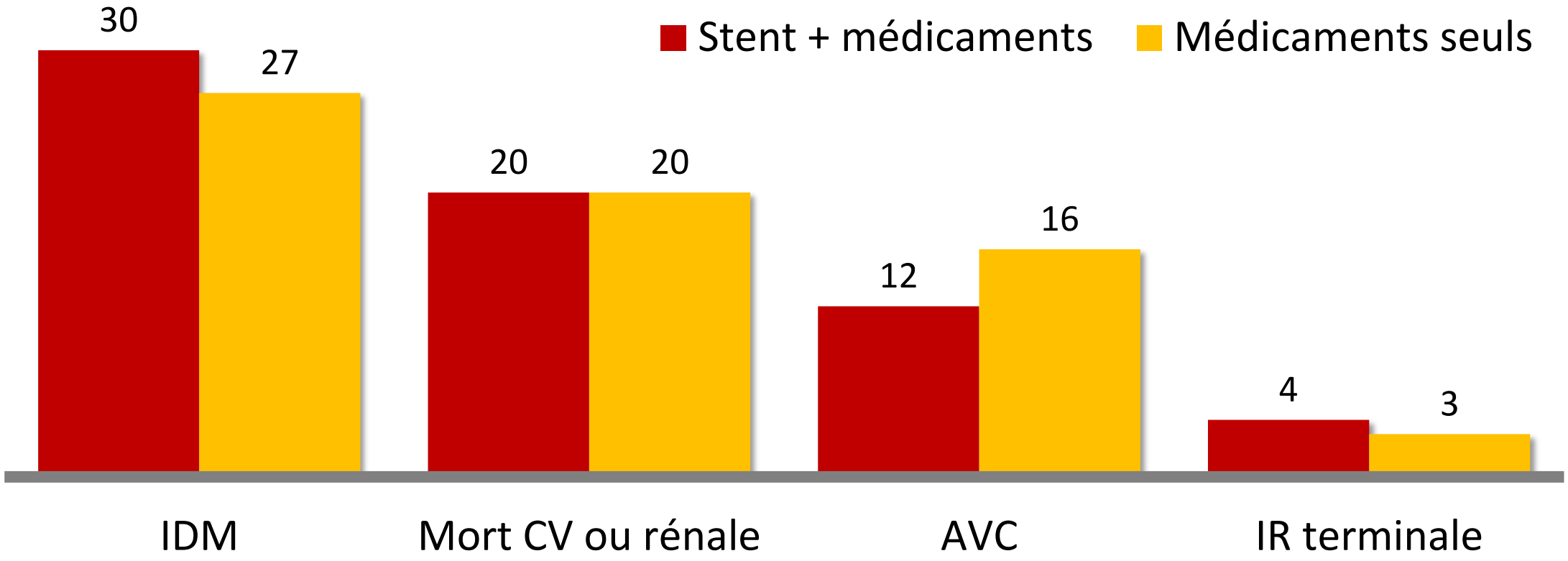


No. at Risk

Medical therapy alone	472	371	314	214	115	40
Stent plus medical therapy	459	362	318	224	131	59

Cardiovascular Outcomes In Renal Atherosclerotic Lesions

CORAL: résultats secondaires



Cardiovascular Outcomes In Renal Atherosclerotic Lesions

PEC thérapeutique

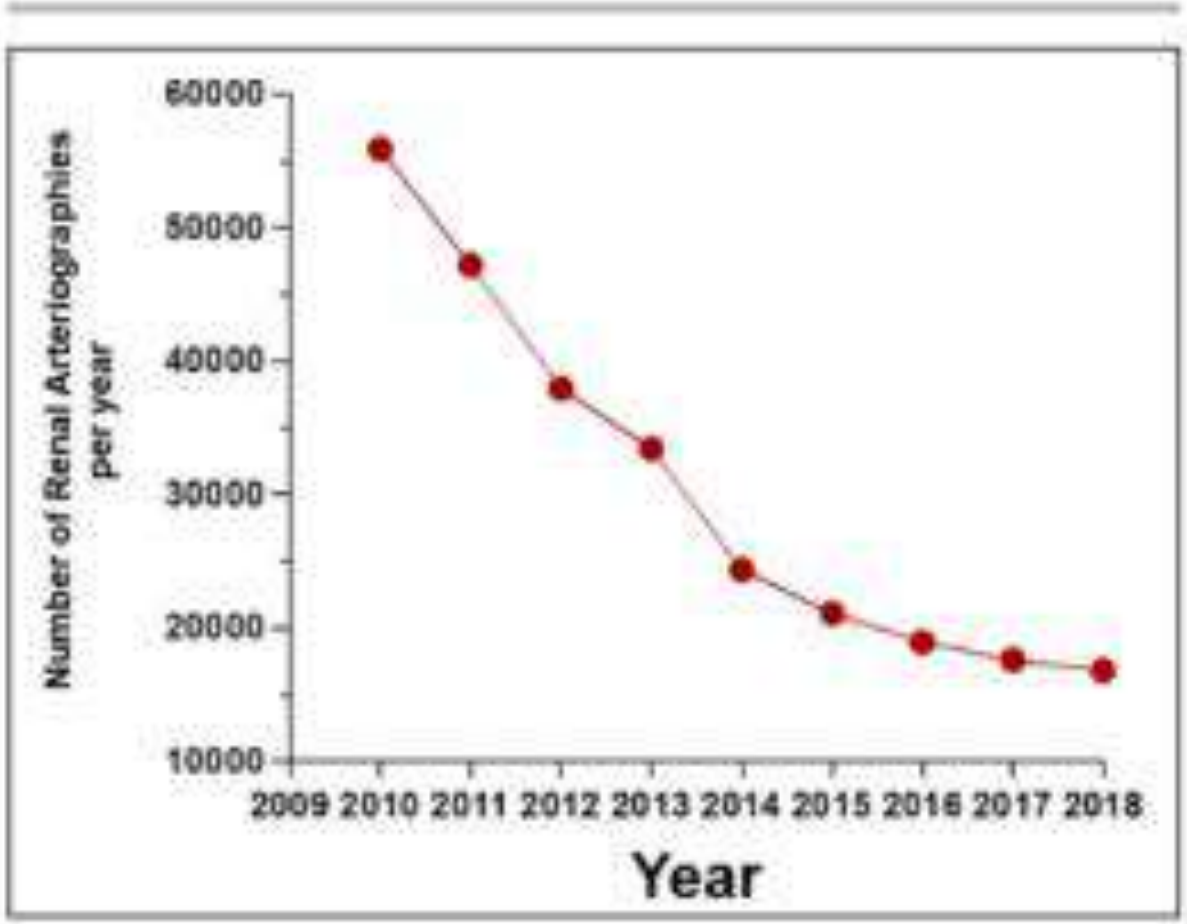


Figure 2. Decline in the number of submitted services per year for percutaneous renal artery arteriography.
The number of submitted services per year for percutaneous renal artery arteriography decreased by 70% from 2010 to 2018 in a survey of the nationwide Medicare Part B databases (drawn from the study by Lee et al[19]).

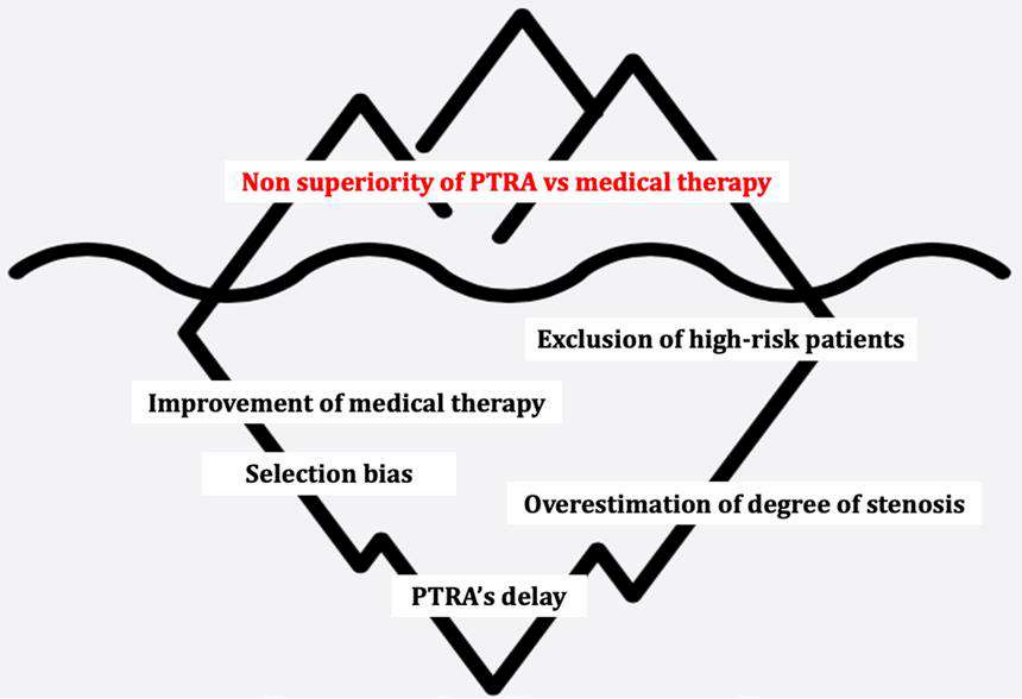
PEC thérapeutique à l’ère post-CORAL

- Le Traitement Médical Optimal : La Pierre Angulaire
  - **Inhibiteurs du SRAA :** IEC ou ARA II
  - **Statines**
  - **inhibiteurs du SGLT2**
  - **Kardegic ?**

Limites des essais

Table 3: Major limitations of RCTs in the field of ARVD.

- Non-standardized inclusion criteria
- Inclusion of patients with mild/asymptomatic RAS, mild hypertension or advanced CKD
- Exclusion of patients with clinical presentation suggestive of critical RAS (recurrent flash pulmonary oedema, resistant hypertension, progressive renal function decline)
- Great variability between and within study protocols in imaging techniques of RAS diagnosis and evaluation, often resulting in overestimation of the degree of stenosis
- Enrolment delays
- Protocol revisions during the trial
- High crossover rates between treatment arms
- Low event rates of major outcomes



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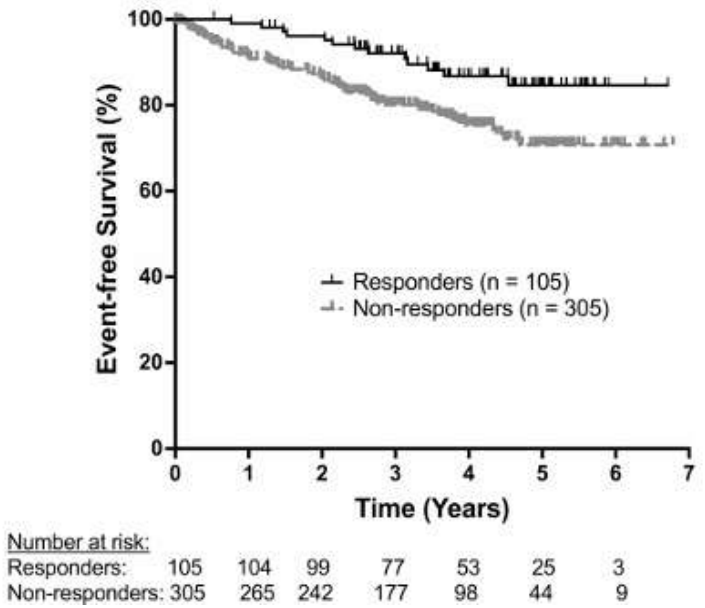
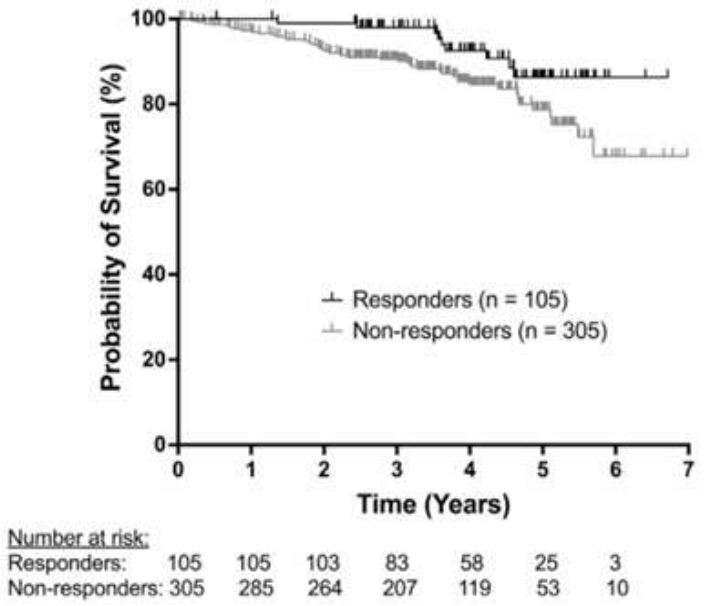
Analyse post-HOC CORAL

Table II. Outcomes for stented and medical therapy subgroups

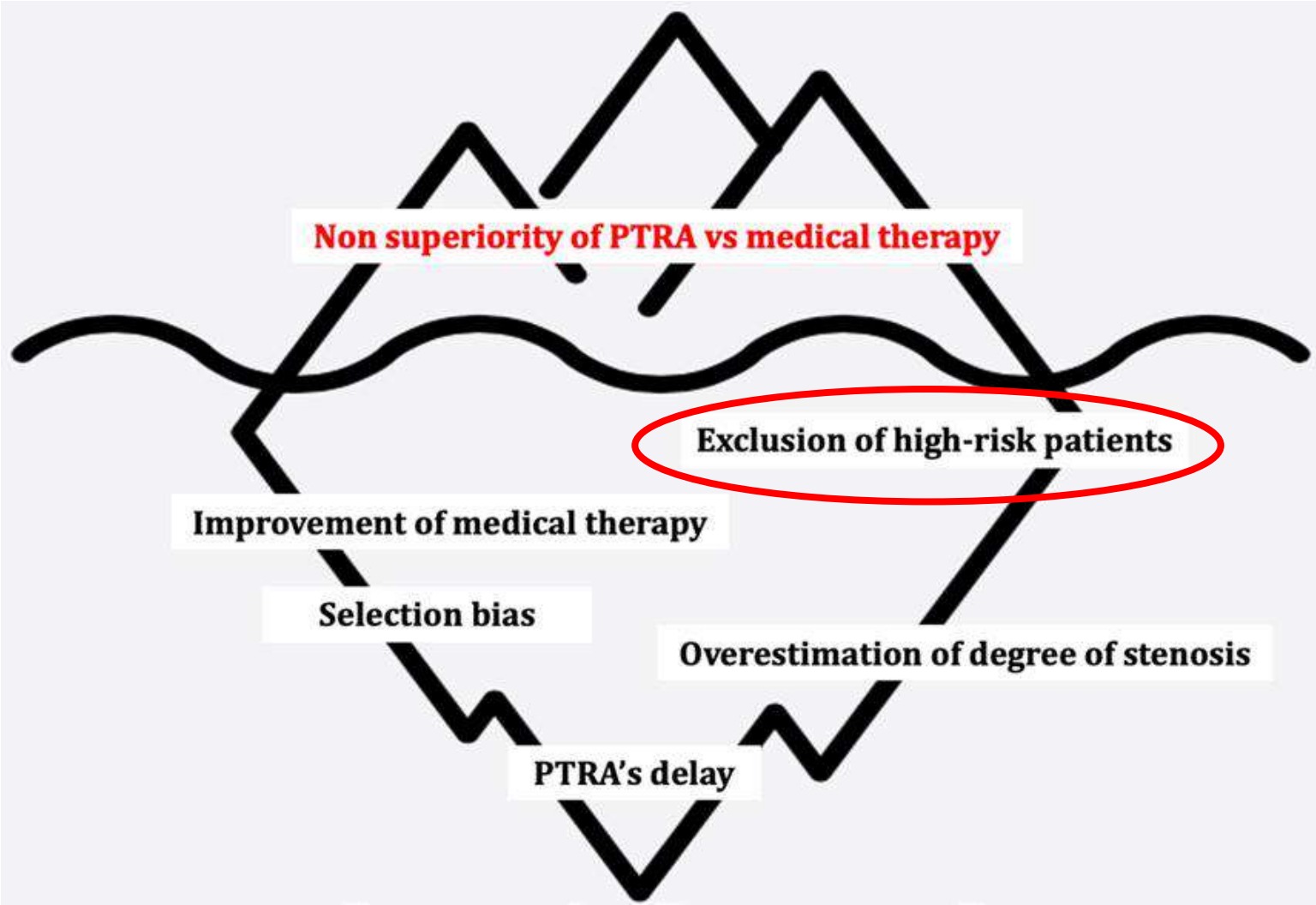
Preoperative parameter	Stented (n = 410)	Medical therapy (n = 432)	*P* value
Change in systolic BP, mm Hg	−14.0 (−35.6 to 4.6)	−15.3 (−33.0 to 2.0)	.95
Change in diastolic BP, mm Hg	−7.5 (−17.0 to 2.0)	−6.3 (−17.0 to 4.0)	.35
Change in serum creatinine, mg/dL	0 (−0.19 to 0.22)	0.04 (−0.13 to 0.29)	.02
Percent change in eGFR from baseline	0 (−18.9 to 20.4)	−4.6 (−19.8 to 13.6)	.03
Improved vs stable vs worsened eGFR			
Improved eGFR (≥20% increase)	105 (25.6)	74 (17.1)	.003
Stable eGFR (<20% change)	209 (51.0)	253 (58.6)	.03
Worsened eGFR (≥20% decrease)	96 (23.4)	105 (24.3)	.81





Modrall et al., Retrieval of renal function after renal artery stenting improves event-free survival in a subgroup analysis of the Cardiovascular Outcomes in Renal Atherosclerotic Lesions trial, J Vasc surgery 2023

Limites des essais



Domaines peu explorés

L’OAP flash

L’insuffisance rénale (IR) progressive

L’IR induite par les IEC/ARA2

L’HTA résistante

Ritchie J et al, Am J Kidney Dis 2014

Dans l'OAP flash et l'IR progressive

263 patients avec SAAR ≥70%

(1986 à 2014)

Haut risque : OAP flash ± HTA sévère ± baisse rapide DFG

Bas risque (contrôles) (n=136)	ATL ± stent	n=40
	Ttt med	n=96
Haut risque (n=127)	ATL ± stent	n=55
	Ttt med	n=72

	Bas risque		Haut risque	
	HR	p	HR	p
Mort	0,84	0,5	0,69	0,1
IRT	0,86	0,5	0,59	**0,02**
Evt CV	0,96	0,9	0,65	**0,05**
Tout	1,00	0,9	0,67	**0,06**

Multivarié, revasc versus non revasc

La revascularisation serait utile uniquement dans les présentations cliniques à haut risque ?

Vassallo et al. Nephrol Dial Transplant 2018;33:497

HTA résistante

Renal Artery Stenosis

Resistant Hypertension and Atherosclerotic Renal Artery Stenosis

Effects of Angioplasty on Ambulatory Blood Pressure. A Retrospective Uncontrolled Single-Center Study

Pierre-Yves Courand,* Miriana Dinic,* Aurélien Lorthioir, Guillaume Bobrie, Christine Grataloup, Nicolas Denarié, Gilles Soulat, Elie Mousseaux, Marc Sapoval, Michel Azizi, Laurence Amar

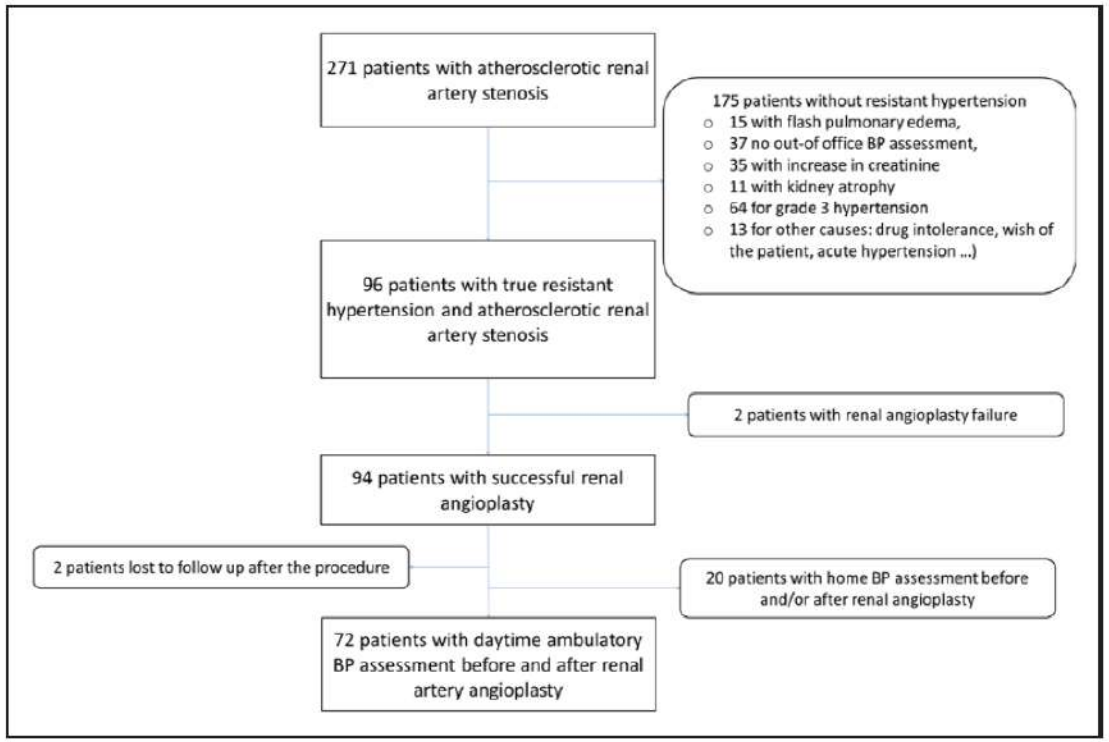


Figure 1. Flowchart for the generation of this cohort. BP indicates blood pressure.

HTAR

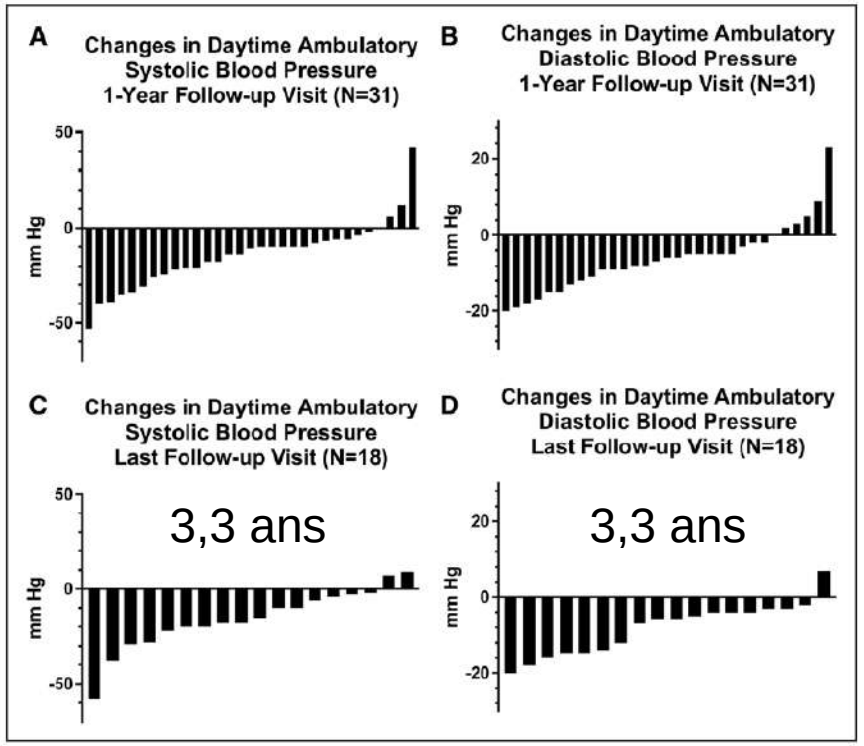
Table 1. Baseline Characteristics of Patients

Characteristics	Patients	Data Available, n
Mean age, y	67.8±11.2	72
Women/men (%)	36.1/63.9	72
BMI, kg/m²	26.3 [24.4–29.3]	72
Systolic uOBP, mm Hg	162±25	72
Diastolic uOBP, mm Hg	80±14	72
Systolic dABP, mm Hg	157±16	72
Diastolic dABP, mm Hg	82±10	72
Smoking (current/past/never), n (%)	17 (23.6)/24 (33.3)/31 (43.1)	72
Dyslipidemia, n (%)	54 (750)	72
Diabetes mellitus, n (%)	14 (19.4)	72
Heart failure, n (%)	7 (9.7)	72
Coronary artery disease, n (%)	15 (20.8)	72
Acute myocardial infarction, n (%)	7 (9.7)	72
Stroke, n (%)	12 (16.7)	72
Peripheral artery disease, n (%)	27 (37.5)	72
eGFR (mL/min)	52 [41–63]	72
eGFR ≥90 mL/min, n (%)	5 (6.9)	
eGFR 60–89 mL/min, n (%)	20 (27.8)	
eGFR 45–59 mL/min, n (%)	26 (36.1)	
eGFR 30–44 mL/min, n (%)	15 (20.8)	
eGFR 15–29 mL/min, n (%)	6 (8.4)	

Table 2. Comparison Between Baseline Characteristics and at the First Follow-Up Visit After Renal Angioplasty

Characteristics	Baseline (N=72)	First Visit (N=72)	*P* Value
Systolic uOBP, mm Hg	162±25	147±22	<0.001
Diastolic uOBP, mm Hg	80±14	72±14	<0.001
Systolic dABP, mm Hg	157±16	143±17	<0.001
Diastolic dABP, mm Hg	82±10	75±10	<0.001
Controlled hypertension (%)	0	34.7	<0.001
eGFR, mL/min	52 [41–63]	53 [42–67]	0.630
Antihypertensive treatment, n	4.0±1.0	3.6±1.4	0.002
DDD antihypertensive treatment, n	5.2±1.9	4.6±2.0	0.002
Antiplatelet therapy (%)	54.8	100	<0.001
Statins (%)	71.2	93.1	0.001
Other lipids lowering drugs (%)	12.3	9.7	0.596

57j (34-132)



HTAR

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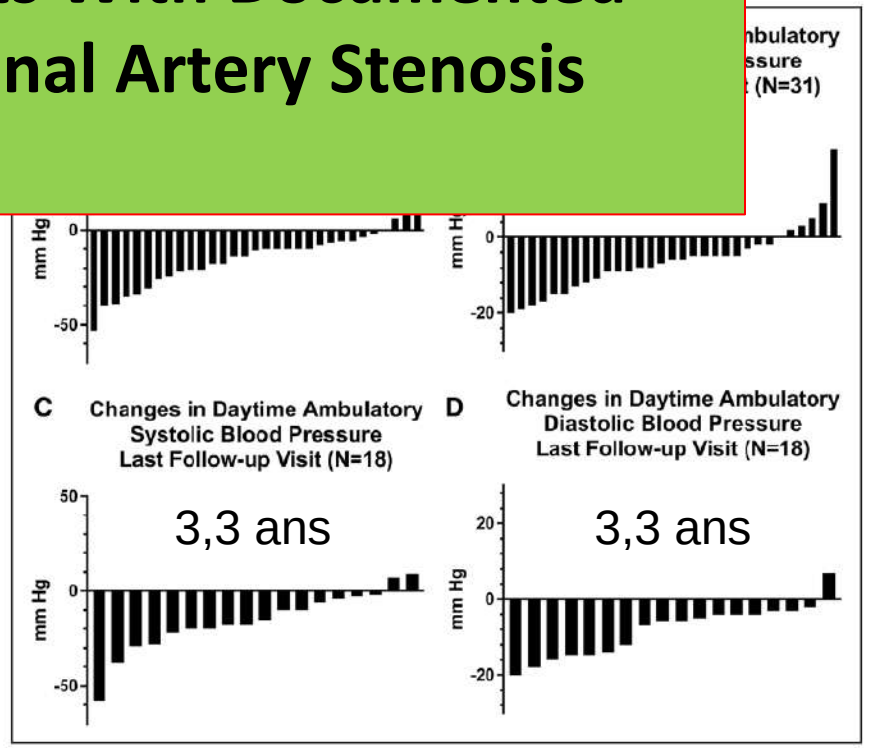
BMI, kg/m²	26.3 [24.4–29.3]	72
Systolic uOBP, mm Hg	162±25	72
Coronary artery disease, n (%)	15 (20.8)	72
Acute myocardial infarction, n (%)	7 (9.7)	72
Stroke, n (%)	12 (16.7)	72
Peripheral artery disease, n (%)	27 (37.5)	72
eGFR (mL/min)	52 [41–63]	72
eGFR ≥90 mL/min, n (%)	5 (6.9)	
eGFR 60–89 mL/min, n (%)	20 (27.8)	
eGFR 45–59 mL/min, n (%)	26 (36.1)	
eGFR 30–44 mL/min, n (%)	15 (20.8)	
eGFR 15–29 mL/min, n (%)	6 (8.4)	

Table 2. Comparison Between Baseline Characteristics and at the First Follow-Up Visit After Renal Angioplasty

Characteristics	Baseline (N=72)	First Visit (N=72)	*P* Value
Systolic uOBP, mm Hg	162±25	147±22	<0.001
Diastolic uOBP, mm Hg	80±14	72±14	<0.001
Systolic dABP, mm Hg	157±16	143±17	<0.001
Diastolic dABP, mm Hg	82±10	75±10	<0.001
Controlled hypertension (%)	0	34.7	<0.001
eGFR, mL/min	52 [41–63]	53 [42–67]	0.630
Antihypertensive treatment, n	4.0±1.0	3.6±1.4	0.002

Intérêt d'un essai contrôlé pour tester l'effet de la revascularisation sur la PA dans l'HTAR: Renal Artery Stenting in Patients With Documented Resistant Hypertension and Atherosclerotic Renal Artery Stenosis (ANDORRA) (NCT02539810)



Journal of the American Heart Association

ORIGINAL RESEARCH

Renal Artery Stenting in Consecutive High-Risk Patients With Atherosclerotic Renovascular Disease: A Prospective 2-Center Cohort Study

Mark Reinhard, MD, PhD; Karoline Schousboe, MD, PhD; Ulrik B. Andersen, MD; Niels Henrik Buus, MD, PhD, DMSc; Jesper Moesgaard Rantanen, MD, PhD; Jesper Nørgaard Bech, MD, PhD; Hossein Mohit Mafi, MD; Sten Langfeldt, MD; Arindam Bharadwaz, MD, EBIR; Arne Hørlyck, MD; Mogens Kærsgaard Jensen, MD; Jørgen Jeppesen, MD, DMSc; Michael Hecht Olsen, MD, PhD, DMSc; Ib Abildgaard Jacobsen, MD, DMSc; Bo Martin Bibby, MSc, PhD; Kent Lodberg Christensen, MD, DMSc

ETUDE DAN-PTRA: cohorte danoise prospective

- **Objectif**

L'objectif était d'évaluer prospectivement les effets du stenting rénal spécifiquement chez des patients présentant des **critères cliniques de gravité**, souvent exclus des grands essais randomisés précédents.

- **Population**

L'étude a porté sur 102 patients consécutifs répondant à au moins un des critères de haut risque suivants

Hypertension résistante vraie (PA systolique ambulatoire moyenne ≥ 130 mmHg sous ≥ 3 médicaments à doses optimales).

Déclin rapide de la fonction rénale (**baisse du DFG > 5 mL/min/1,73m² par an**).

Insuffisance cardiaque décompensée récurrente ou **OAP "flash"**.

Table 1. Baseline Characteristics of the Study Participants (N=102)

Characteristics	
Age, y	69.2 (62.5–76.3)
Female sex	52 (51.0)
Body mass index, kg/m^2	26.2 (22.8–30.1)
Ambulatory blood pressure readings, mm Hg	
24-h systolic ABPM	166.2±21.6
24-h diastolic ABPM	82.3±12.3
Daytime systolic ABPM	168.0±21.3
Daytime diastolic ABPM	84.6±12.8
Nighttime systolic ABPM	161.9±25.0
Nighttime diastolic ABPM	77.6±12.7
Duration of antihypertensive treatment, y	10 (2–20)
Number of antihypertensives	4.0±1.3
Defined daily dose of antihypertensives	6.3 (4.3–9.0)
Estimated GFR,* mL/min per 1.73 m^2	39.7 (23.5–54.0)
Estimated GFR* <60 mL/min per 1.73 m^2	82 (80.4)
Urine albumin-creatinine ratio, mg/g	61 (17–396)
Single kidney function	
Anatomical single kidney	6 (5.9)
Functional single kidney	17 (16.7)
Missing data	10 (9.8)
Medical history and risk factors	
Diabetes (all type 2)	20 (19.6)
History of ischemic heart disease	27 (26.5)
History of cerebrovascular disease	17 (16.7)
History of heart failure	17 (16.7)
History of malignancy	11 (10.8)
Current or former smoker	84 (82.4)
Lipid-lowering drug use	87 (85.3)

Data are mean±SD or median (interquartile ranges) for continuous variables and number (%) for categorical variables. ABPM indicates ambulatory blood pressure monitoring; and GFR, glomerular filtration rate.

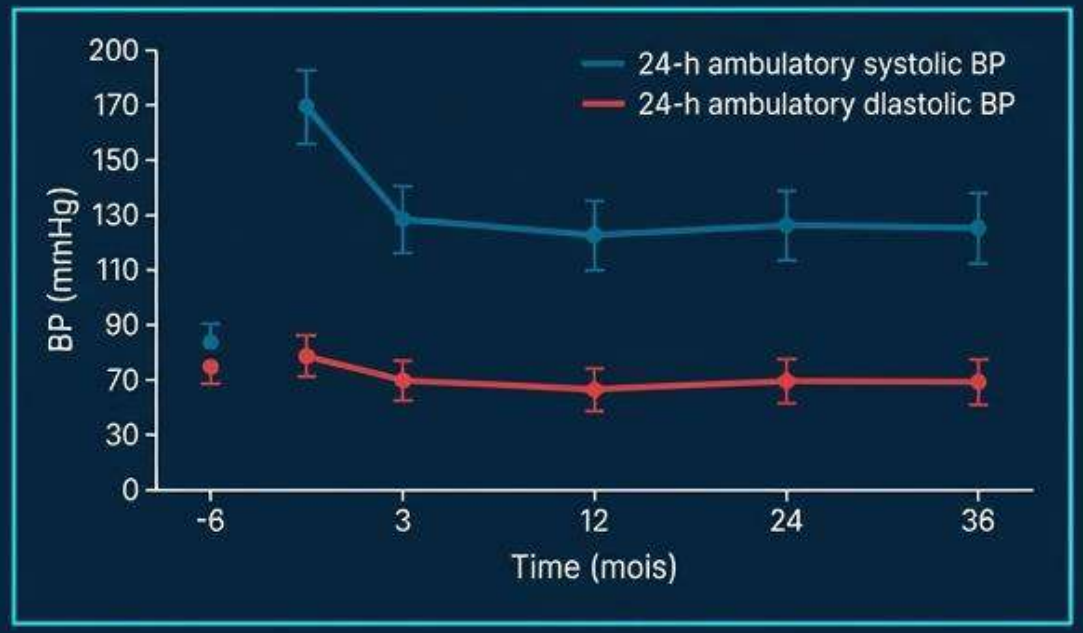
*The estimated GFR was calculated with the use of the Chronic Kidney Disease Epidemiology Collaboration formula.

Table 2. Indications for Angioplasty and Results of Baseline Investigations (N=102)

Indications for angioplasty	
Resistant hypertension	95 (93.1)
Decline in estimated GFR of ≥5 mL/min per 1.73 m^2 per year*	63 (61.8)
Recurrent heart failure/sudden pulmonary edema	20 (19.6)
Subacute angioplasty† performed in	14 (13.7)
Doppler ultrasound	
Performed in	82 (80.4)
Size of right kidney, cm	10.1±1.7
Size of left kidney, cm	9.9±1.9
No signs of stenosis	12 (11.8)
Signs of unilateral stenosis	56 (54.9)
Signs of bilateral stenosis	14 (13.7)
Missing	20 (19.6)
Resistance index ≥0.8 in successfully treated kidneys (n=112)‡	13 (11.6)
Resistance index <0.8 in successfully treated kidneys (n=112)‡	67 (59.8)
Resistance index missing in successfully treated kidneys (n=112)‡	32 (28.6)
Renography	
Low probability of renal artery stenosis	12 (11.8)
Intermediate/high probability of renal artery stenosis	75 (73.5)
Missing	15 (14.7)
Imaging before angioplasty	
Computed tomographic angiography	93 (91.2)
Magnetic resonance angiography	5 (4.9)
No imaging before angioplasty	4 (3.9)
Identified renal arteries	204
Bilateral disease§	53 (52.0)
Angiographic findings	
Bilateral disease§	55 (53.9)
Bilateral renal artery stenting	15 (14.7)
Number of renal artery stentings‖	113
Renal artery stenosis <70%¶	3 (2.7)
Renal artery stenosis 70%–79%	22 (19.5)
Renal artery stenosis 80%–89%	32 (28.3)
Renal artery stenosis ≥90%	46 (39.8)
Nonassessable	10 (8.8)

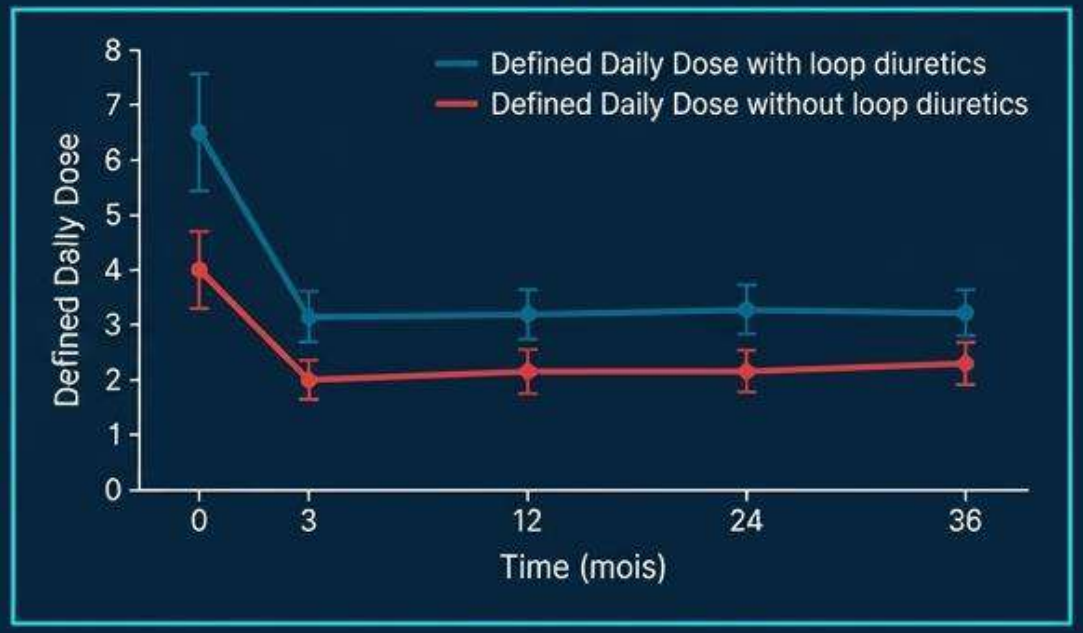
Impact Hémodynamique : Chute Spectaculaire de la Pression et du Fardeau Médicamenteux

Pression Artérielle Systolique (Ambulatoire 24h)



- Baisse moyenne globale : -19.6 mmHg (à 3 mois, maintenue à 24 mois).
- Baisse dans la cohorte la plus sévère (PA >150 base) : -32.2 mmHg.

Fardeau Médicamenteux (Doses Quotidiennes)



- Réduction de 52 % de la Dose Quotidienne Définie (DDD).
- Le nombre moyen de médicaments est passé de 4.0 à 3.0, avec une meilleure tolérance aux bloqueurs du SRAA (ACEi/ARB).

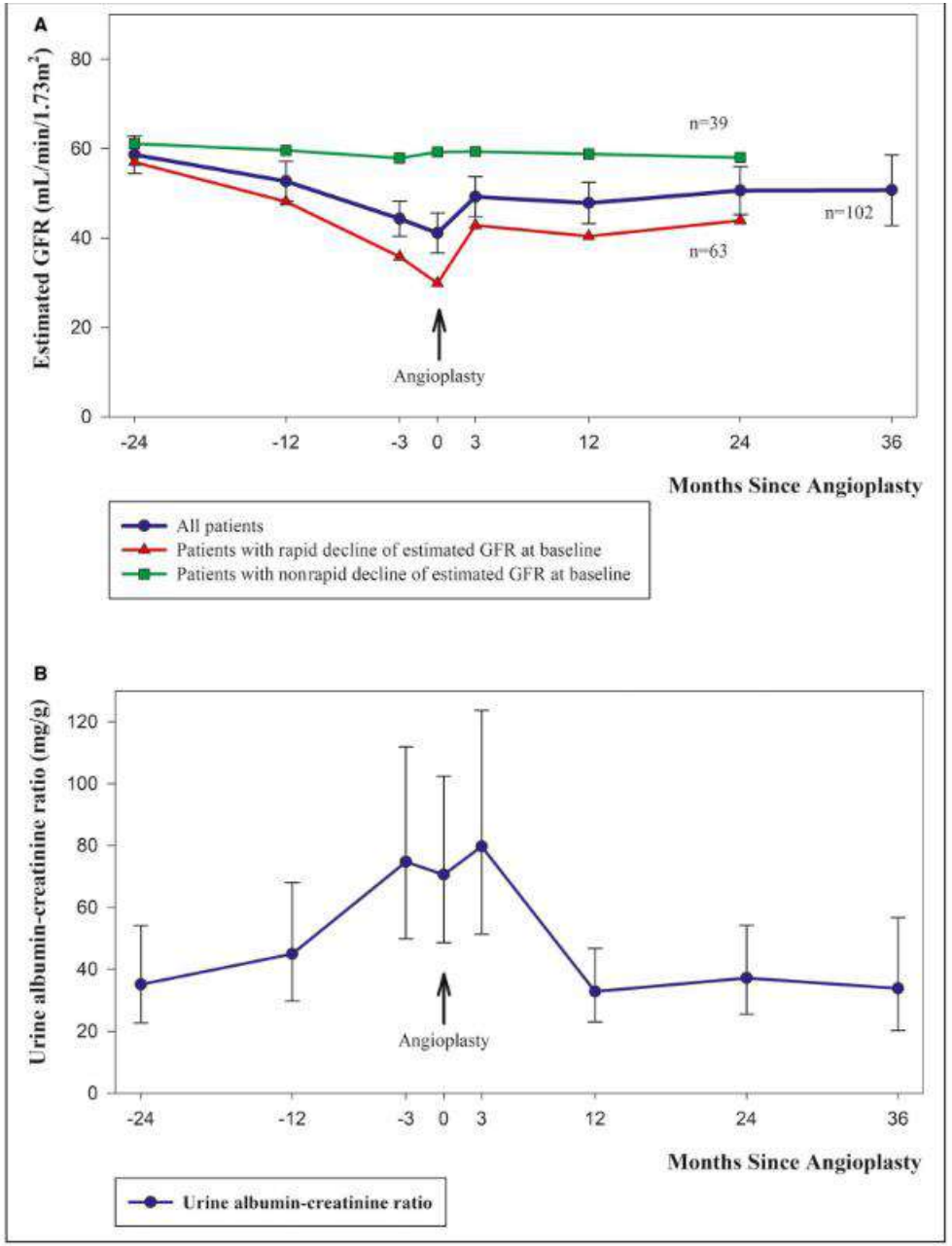


Figure 3. **Estimated glomerular filtration rate (GFR) and urine albumin-creatinine ratio.**

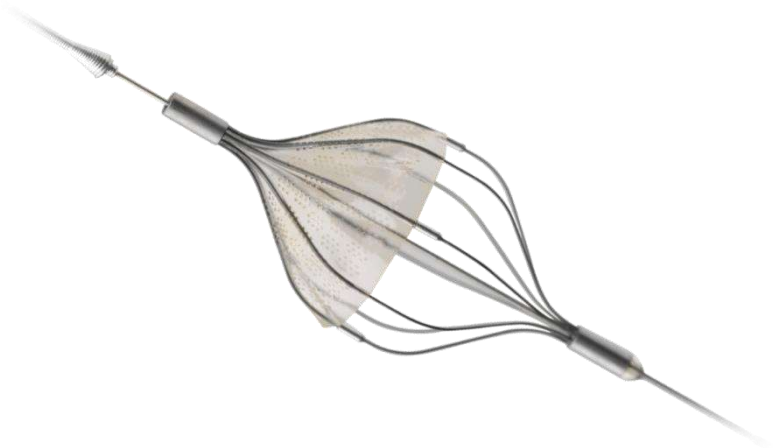
Résultats principaux (suivi à 3 et 24 mois)
Fonction rénale : Une augmentation significative du DFG moyen de **7,8 mL/min/1,73m²**.

Évènements cardiaques : Sur 17 patients ayant des antécédents d'hospitalisation pour insuffisance cardiaque, 14 (82 %) n'ont eu **aucun nouvel épisode** après la revascularisation.

DAN-PTRA study

Table S1. Comparison of angiographic complications between the present study (DAN-PTRA) and the Cardiovascular Outcomes in Renal Atherosclerotic Lesions (CORAL) trial.

Angiographic complications per vessel treated		
	DAN-PTRA	CORAL
Dissection/rupture/occlusion/wire perforation of renal artery	4/113 (3.5%)	19/495 (3.8%)
Distal embolization	2/113 (1.8%)	6/495 (1.2%)
Pseudoaneurysm formation	4/113 (3.5%)	1/495 (0.2%)



Domaines peu explorés

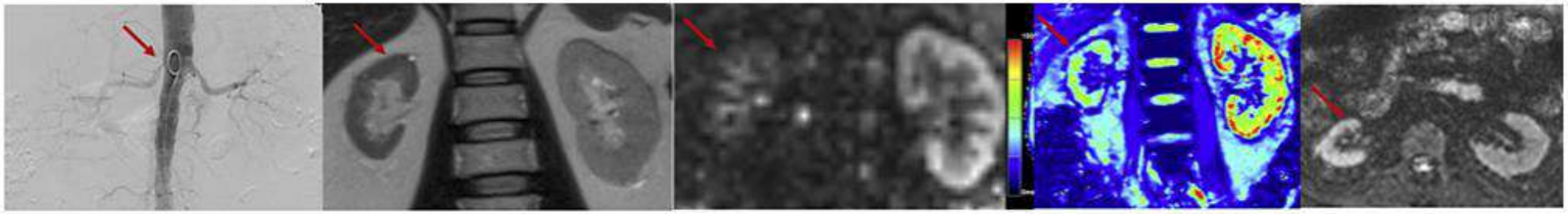
L’OAP flash

L’insuffisance rénale (IR) progressive

L’IR induite par les IEC/ARA2

L’HTA résistante

Perspectives: Le Rôle de l'IRM Fonctionnelle



Modality	Interventional Radiology	Traditional MRI	Functional MRI		
Discerption	Digital subtraction Angiography	T2WI sequence	Arterial Spin Labeling	Blood Oxygenation Level Dependent	Diffusion Weighted Imaging ($b=800mm^2/s$)
Measurement	Assess the degree of stenosis, ranging from no stenosis, mild, moderate, to severe stenosis	Quantify alterations in the dimensions and renal parenchymal signal intensity of the stenotic kidney.	Measures renal blood flow (RBF) without the need for exogenous contrast agents.	Measure T2* to reflect the difference between oxygenated hemoglobin and deoxygenated hemoglobin.	Under the mono-exponential model, the measured value is the Apparent Diffusion Coefficient (ADC).
Significance	Gold standard	Morphological information	Perfusion	Blood oxygenation level	Motion of water molecules
Information	Right renal artery stenosis (arrow)	Small size, low signal, unclear corticomedullary boundary in right renal	Hypo-intensity and lower RBF value in right renal	Hypo-intensity and a lower T2* value	Higher signal in DWI and lower ADC value in right renal

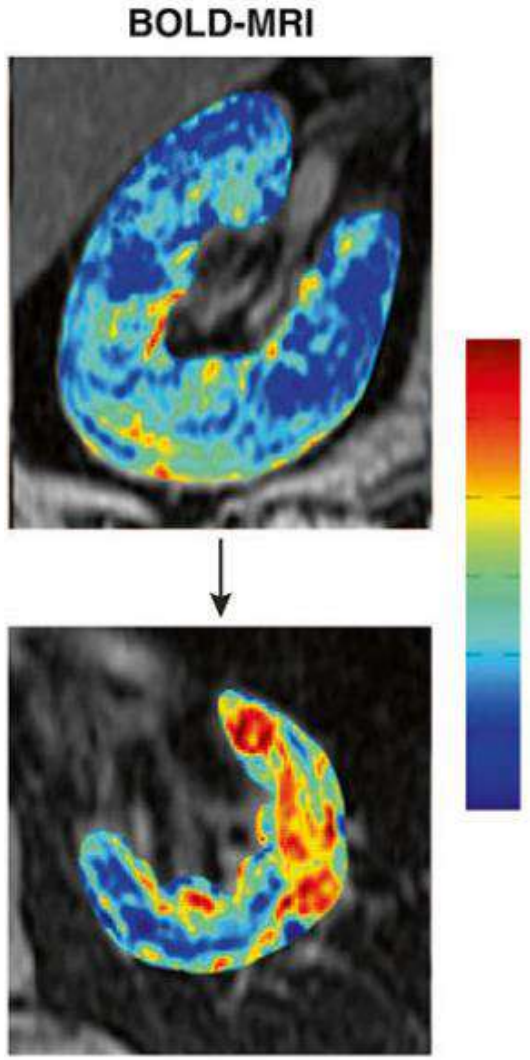
IRM BOLD

1. **Marqueur de l ’hypoxie tissulaire**

- L'IRM BOLD utilise la désoxyhémoglobine comme agent de contraste endogène
- Une forte concentration de désoxyhémoglobine indique une **hypoxie tissulaire**
- permet de visualiser des zones d'hypoxie corticale et médullaire critique.

2. **Marqueur de viabilité rénale**

- Le succès du stenting dépend de la capacité du rein à récupérer après le rétablissement du flux sanguin.
- Si l'oxygénation est encore présente ou répond à des tests dynamiques (comme l'injection de furosémide), le succès fonctionnel du stenting est plus probable.
- Si l'IRM montre une atrophie complète ou une absence totale de réponse oxygénée, la revascularisation sera vraisemblablement **futile**, car les dommages structurels (glomérulosclérose, fibrose) sont trop avancés.



Perpectives: Fractional flow reserve

ESC European Society of Cardiology

European Heart Journal (2026) **47**, 761–769
https://doi.org/10.1093/eurheartj/ehaf746

CLINICAL RESEARCH
Clinical trials

Fractional flow reserve-guided renal artery stenting in atherosclerotic renovascular hypertension: the FAIR randomized trial

Yuxi Li [1,2,3,4,†], Jingang Zheng[5,†], Chengzhi Lu[6,†], Fangfang Fan[1,2,3], Zhihao Liu[1,2,3], Shengcong Liu[1,2,3], Tieci Yi[1,2,3], Long Zhang[1,2,3], Haoyu Weng[1,2,3], Beining Wang[1,2,3], Xu Liu[1,2,3], Hui Zhou[7], Dengfeng Ma[8], Zhi Jia[9], Li Xiang[10], Renqiang Yang[11], Dongmei Shi[12], Hui Chen[13], Li Xu[14], Cun Liu[15], Kazuomi Kario[16], Yan Zhang [1,2,3,17,*], and Jianping Li [1,2,3,17,*]; on behalf of the FAIR Investigators

FRACTIONNAL FLOW RESERVE

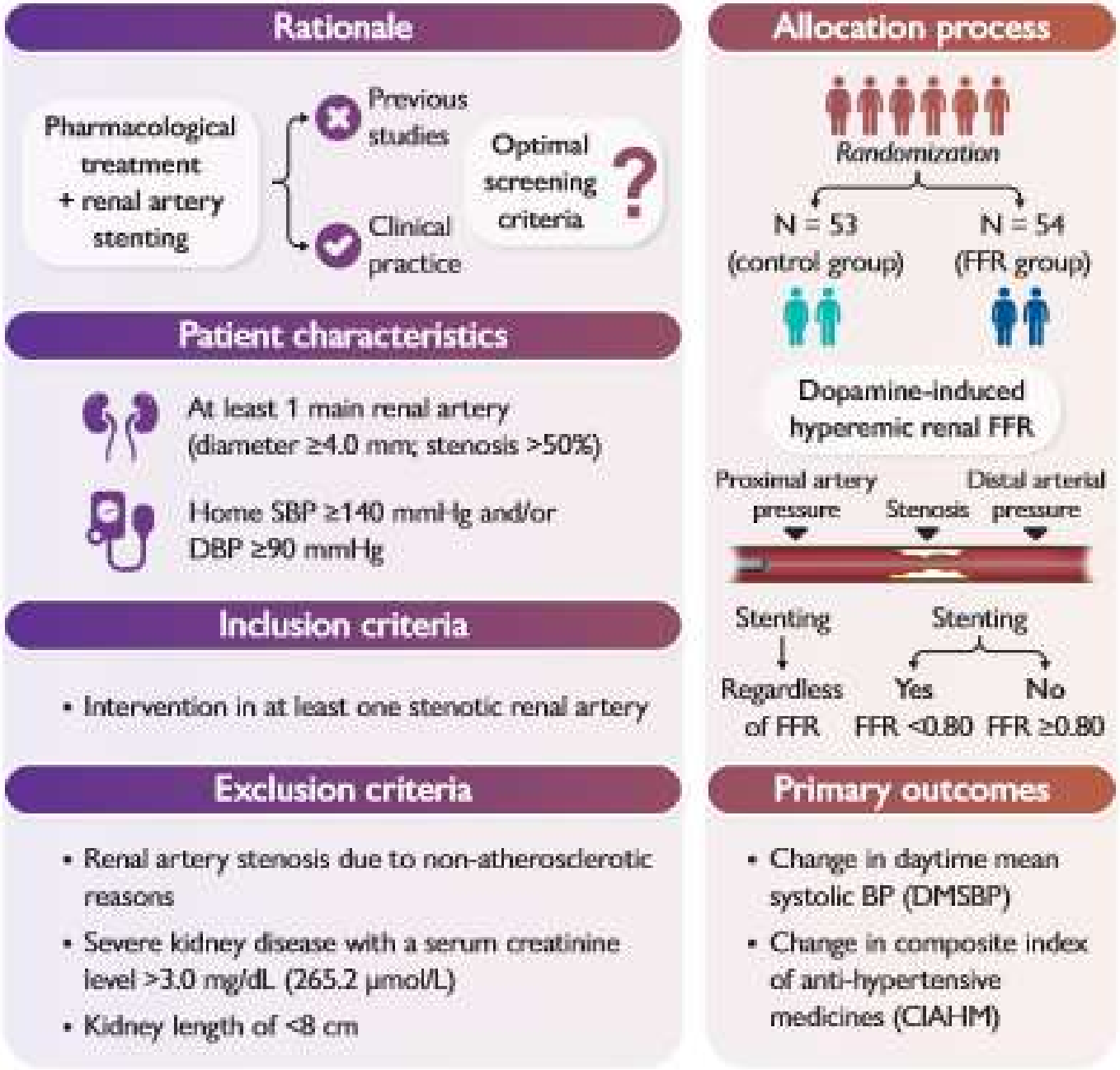
Mesure de la FFR Rénale (au cours artériographie)

- Utilisation d'un **guide de pression** (0,014 pouce) introduit dans l'artère rénale
- Injection intra-rénale de **dopamine** (50 µg/kg) pour induire une hyperémie maximale (environ 10min)
  - **Objectif de l'hyperémie :** Pour évaluer si une sténose est réellement significative sur le plan fonctionnel, il est nécessaire de mesurer le flux sanguin lorsqu'il est à son maximum (état d'hyperémie).

- Le calcul de la FFR est le rapport entre la pression distale (après la sténose) et la pression aortique

FAIR trial

"If the investigators determined that intervention was needed in at least one stenotic renal artery, then the patient was randomized. "



Patient flow diagram

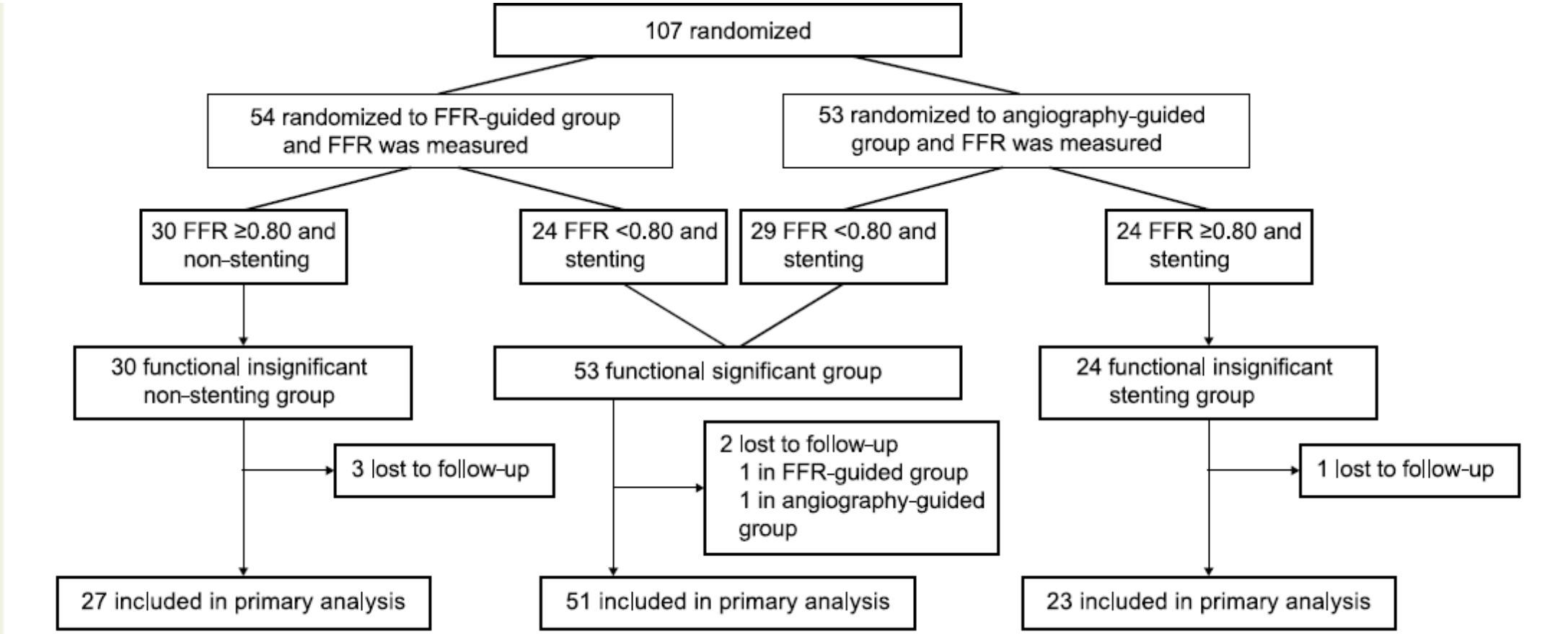


Figure 1 Patient flow diagram. FFR, fractional flow reserve

RESULTATS

Table 3 **Primary outcomes in the different treatment groups**

Characteristic	FFR < 0.80	FFR ≥ 0.80		P
	Functional significant stenting group N = 51	Functional insignificant non-stenting group N = 27	Functional insignificant stenting group N = 23	
Twenty-four–hour ABPM-measured DMSBP, median [IQR], mmHg				
Baseline	140 [128, 154]	139 [129, 145]	132 [123, 139]	.28
Three months of follow-up	126 [122, 135]	136 [127, 143]	133 [126, 146]	.07
Percentage DMSBP reduction, median [IQR], %	9 [3, 14]	3 [−5, 10]	0 [−4, 4]	<.01
Absolute DMSBP reduction, median [IQR], mmHg	13 [4, 21][a]	4 [−8, 13][b]	0 [−6, 5][c]	<.01
CIAHM, median [IQR]				
Baseline	6 [3, 9]	4 [4, 11]	4 [3, 7]	.21
Three months of follow-up	2 [1, 5]	4 [4, 12]	4 [1, 6]	<.01
CIAHM reduction, median [IQR]	2 [0, 5][d]	0 [0, 2][e]	0 [0, 1][f]	<.01
Renal artery stenting, *n* (%)	51 (100.0)	0 (0.0)	23 (100.0)	<.01

RESULTATS

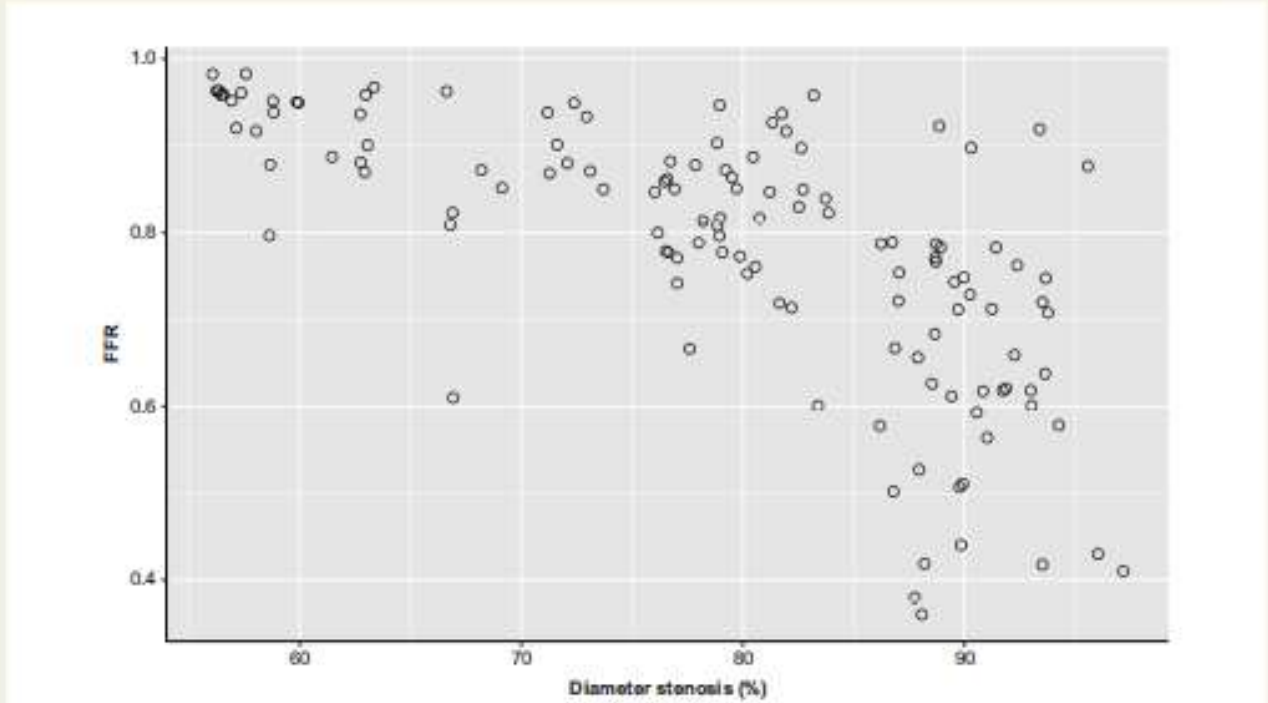


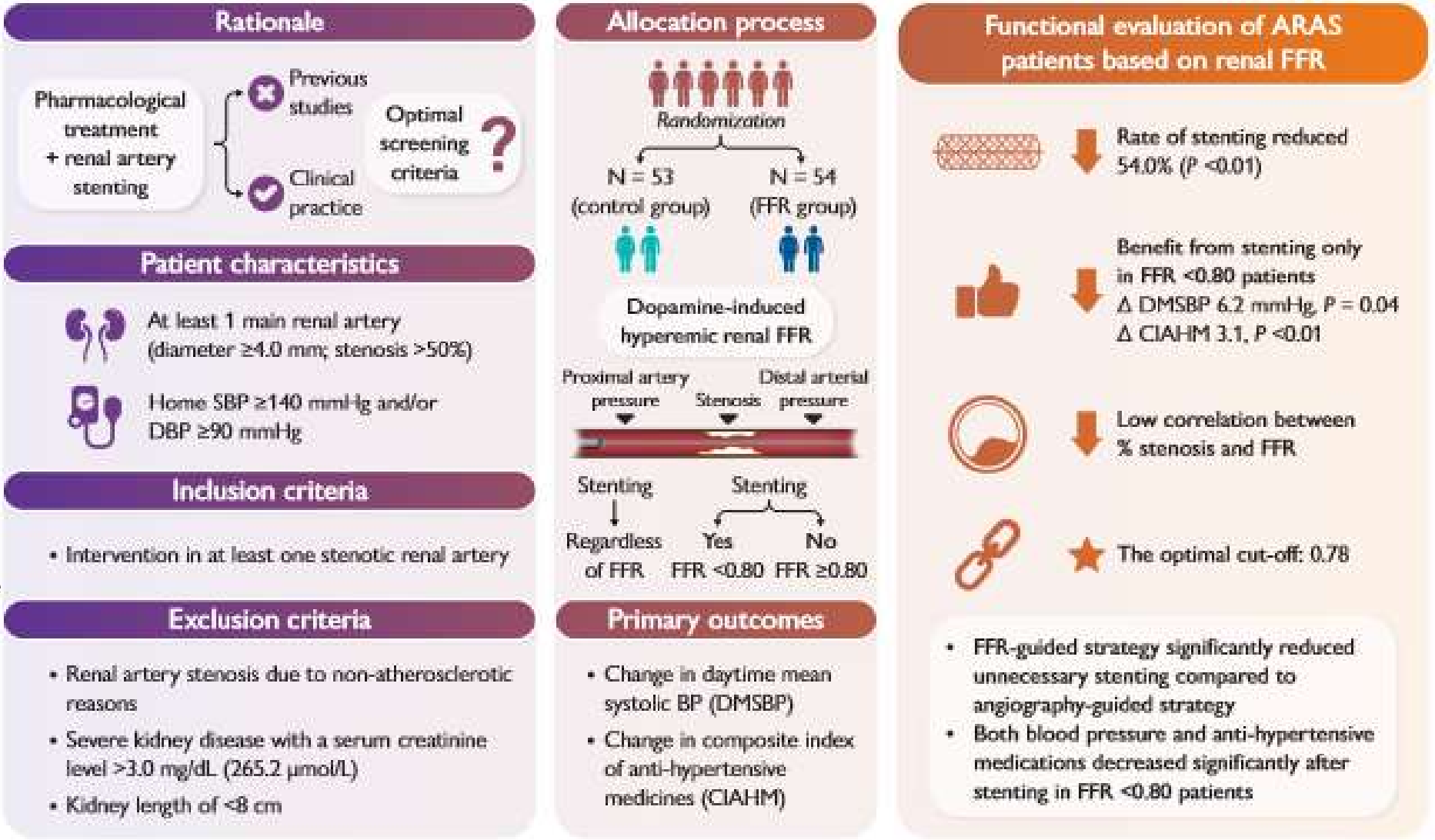
Figure 2 Correlation between renal artery stenosis and renal fractional flow reserve (FFR)

Table 1 Baseline characteristics of the study population

Characteristic	Overall N = 101	FFR-guided group N = 50	Angiography-guided group N = 51
Age, median [IQR], years	63 [57, 69]	64 [59, 72]	62 [57, 68]
Male sex, *n* (%)	62 (61.4)	28 (56.0)	34 (66.7)
Baseline 24 h ABPM, median [IQR], mmHg			
Daytime SBP	138 [125, 146]	140 [126, 146]	137 [125, 145]
Daytime DBP	80 [74, 89]	81 [75, 90]	80 [73, 88]
Baseline CIAHM, median [IQR]	4 [3, 9]	4 [4, 10]	6 [3, 9]
Baseline number of medicines, *n* (%)			
2	57 (56.4)	30 (60.0)	27 (52.9)
3	32 (31.7)	12 (24.0)	20 (39.2)
4	9 (8.9)	6 (12.0)	3 (5.9)
≥5	3 (3.0)	2 (4.0)	1 (2.0)
Baseline antihypertensive medication, *n* (%)			
ACEIs/ARBs	62 (61.4)	32 (64.0)	30 (58.8)
Diuretics	21 (20.8)	13 (26.0)	8 (15.7)
CCBs	89 (88.1)	44 (88.0)	45 (88.2)
Beta-blockers	62 (61.4)	30 (60.0)	32 (62.7)
Alpha-blockers	9 (8.9)	5 (10.0)	4 (7.8)
Others	15 (14.9)	8 (16.0)	7 (13.7)
Baseline eGFR, median [IQR], mL/min/1.73 m^2	55.8 [39.2, 72.0]	52.0 [33.2, 70.2]	56.0 [42.2, 73.0]
Stage ≥ 3 chronic kidney disease, *n* (%)	63 (62.4)	34 (68.0)	29 (56.9)
Medical history and risk factors, *n* (%)			
Hypertension	95 (94.1)	47 (94.0)	48 (94.1)
Diabetes	49 (48.5)	24 (48.0)	25 (49.0)
Hyperlipidaemia	80 (79.2)	40 (80.0)	40 (78.4)
Prior coronary artery disease	27 (26.7)	13 (26.0)	14 (27.5)
Prior cerebral disease	18 (17.8)	7 (14.0)	11 (21.6)
Peripheral artery disease	13 (12.9)	4 (8.0)	9 (17.6)
Chronic kidney disease	53 (52.5)	28 (56.0)	25 (49.0)
Prior smoking	53 (52.5)	27 (54.0)	26 (51.0)
Prior drinking	22 (21.8)	9 (18.0)	13 (25.5)
Body mass index, median [IQR], kg/m^2	25.7 [23.2, 26.6]	25.6 [22.7, 26.6]	26.0 [23.4, 26.6]
Procedural characteristics			
Renal FFR, mean (SD)	0.76 (0.17)	0.78 (0.19)	0.75 (0.14)
FFR measurement success, *n* (%)	101 (100)	50 (100)	51 (100)
Percent stenosis, mean (SD)	75.7 (14.3)	74.4 (15.1)	76.9 (13.4)
Stenting, *n* (%)	74 (73.3)	23 (46.0)	51 (100.0)
No. of stenotic renal arteries, *n* (%)			
1	68 (67.3)	36 (72.0)	32 (62.7)
2	30 (29.7)	11 (22.0)	19 (37.3)

Continued

Fractional flow reserve-guided renal artery stenting in atherosclerotic renovascular hypertension: the FAIR randomized trial



ARAS, atherosclerotic renal artery stenosis; BP, blood pressure; CIAHM, composite index of anti-hypertensive medicines; DMSBP, daytime mean systolic blood pressure; DBP, diastolic blood pressure; FFR, fractional flow reserve; SBP, systolic blood pressure

Li Y, et al. *European Heart Journal*.

"If the investigators determined that intervention was needed in at least one stenotic renal artery, then the patient was randomized. "

Finalement: comment mieux caractériser les patients à revasculariser?

ESH 2023

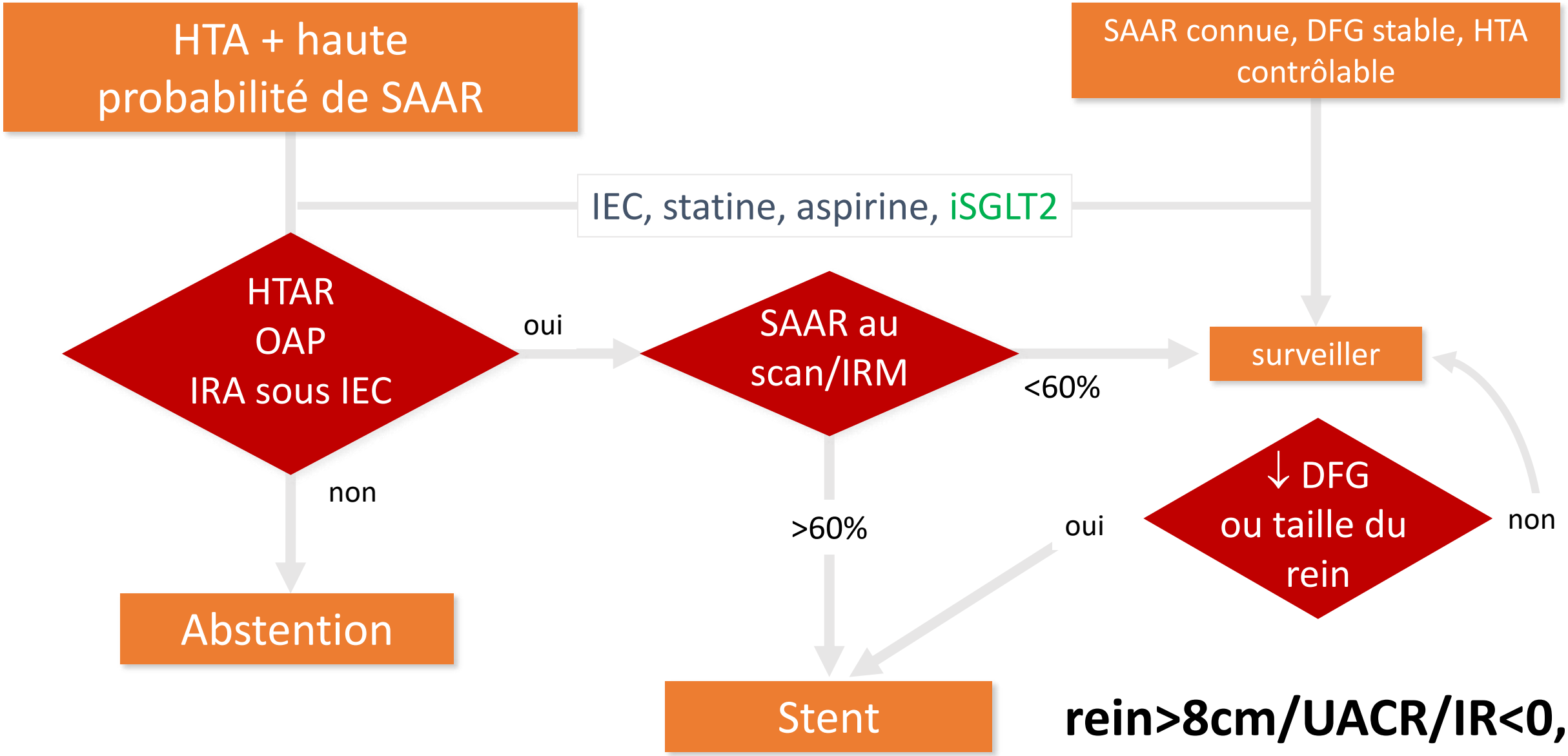
Table 5: Indications of PTRA in patients with ARVD.

Strong indications

- High-grade (>70%) RAS in association with one of the following criteria:
  - Resistant hypertension
  - New-onset or recently uncontrolled hypertension
  - Acute pulmonary oedema or acute decompensated HF
  - Rapid decline of eGFR (bilateral stenosis or solitary kidney)
  - ACEI or ARB intolerance (≥30% eGFR reduction)
  - Renal replacement treatment (with possibly viable renal parenchyma) if
    stenosis detected <3 months after renal replacement treatment or if uncontrolled hypertension with multiple (five or more) antihypertensive agents
- AKI due to acute renal artery occlusion or high-grade stenosis
- Kidney transplant with RAS

Moderately strong indications

- High-grade (>70%) RAS in association with one of the following criteria:
  - Chronic HF
  - Asymptomatic but either bilateral or supplying a solitary kidney with viable renal parenchyma (non-atrophic kidney, distinct renal cortex)



60% (définition ESH)

Unité d'HTA, HEGP, 2019

HTA + haute probabilité de SAAR

IEC, statine, aspirine, iSGLT2

HTAR
OAP
IRA sous IEC

IRC évolutive/IC

oui

non

SAAR au scan/IRM

>70%

50-70%

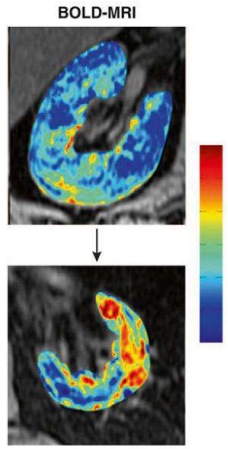
pas encore disponible en routine

IRM fonctionnelle

oui

non

Surveiller Progression !



Abstention

Stent (FFR ?)

Table 4: Evaluation of the possible viability of the kidney with ARVD following revascularization.

Variable	Likely to benefit	Unlikely to benefit
RAS degree	>70%	<50%
Kidney length (cm)	>8 cm³	<7 cm
Renal resistive index	<0.8	>0.8
Cortical thickness	Cortex distinct, e.g. >0.5 cm	Loss of corticomedullary differentiation, no cortex

Modifié par PG DELIEGE

PEC thérapeutique: Sans oublier le suivi

- **Suivi Post-Revascularisation**

- Évaluation clinique de la PA et de la fonction rénale dans la première semaine.
- Écho-doppler à 1 mois, puis annuellement pour dépister une resténose intra-stent.(**20 % à 1 an** et **32 % à 5 ans**)
- Poursuite rigoureuse du SOC

Sarafadis et al., **Atherosclerotic renovascular disease: a clinical practice document by the European Renal Best Practice (ERBP) board of ERA and the Working Group Hypertension and the Kidney of the ESH, NDT 2023**

Conclusion

- Fréquent
- Grave
  - Pronostic rénal +++
  - Mortalité cardiovasculaire
- Pathologie complexe
  - Définition: pas seulement anatomique, aspect fonctionnel +++ (Limites du doppler..)
  - Évolutive: timing d'intervention +++
- Perspectives
  - BOLD IRM +++
  - FFR

Merci