Dénervation rénale dans l'HTA

Le concept

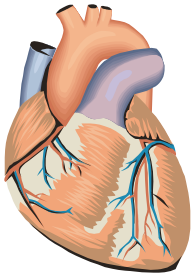
Augmentation de l'activité Nerveuse Sympathique Rénale lors de l'HTA

Vasoconstriction
Athérosclérose

Résistance à l'insuline

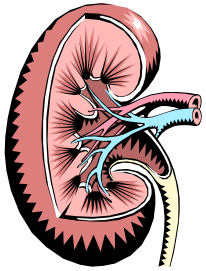
Troubles du sommeil

Nerfs Afférents Rénaux



Hypertrophie
Arythmie
Consommation d'oxygène

Nerfs Efférents Rénaux



↑ Libération Rénine → activation RAAS
↑ Rétention Sodium
↓ Flux sanguin rénal

Grassi G. Assessment of sympathetic cardiovascular drive in human hypertension: achievements and perspectives. Hypertension 2009; 54:690–697.

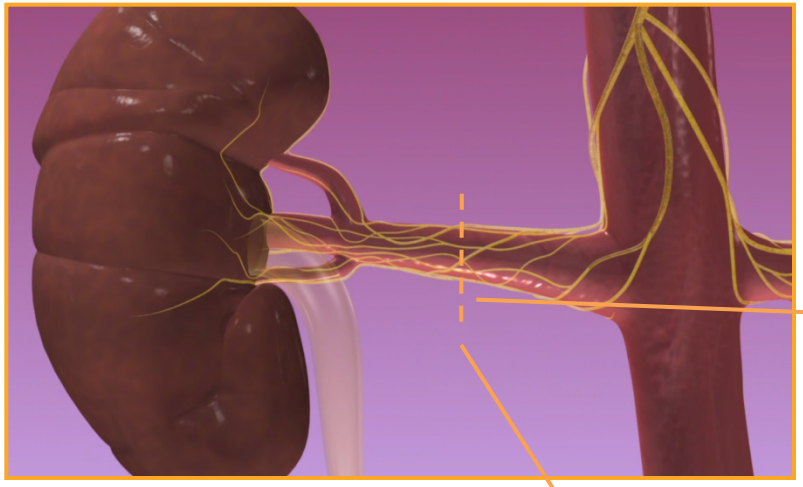
La “Dénervation” chirurgicale des années 50

Smith RH, Thompson JE: Splanchnicectomy for essential hypertension: Results in 1266 cases

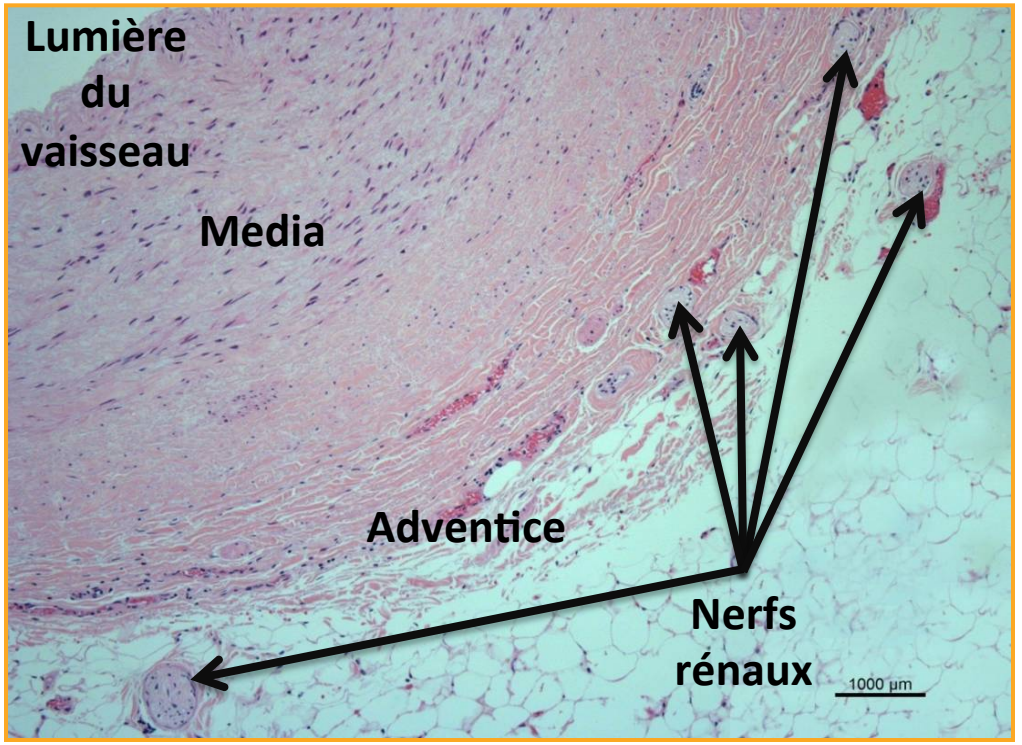
JAMA 152:1501-1504. 1953

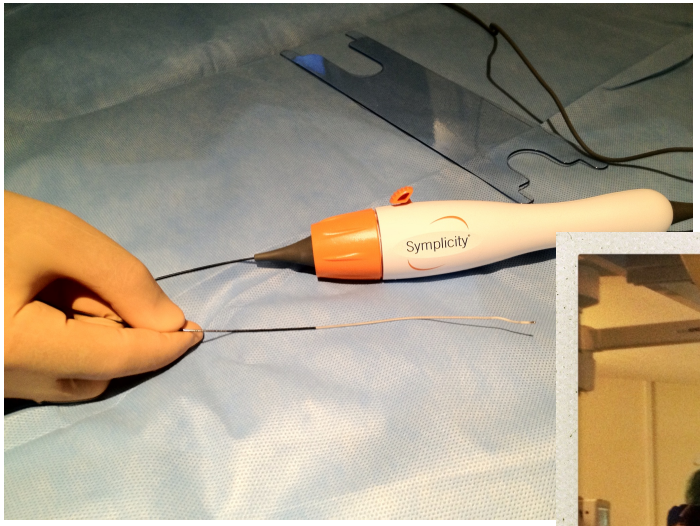
La Technique endovasculaire

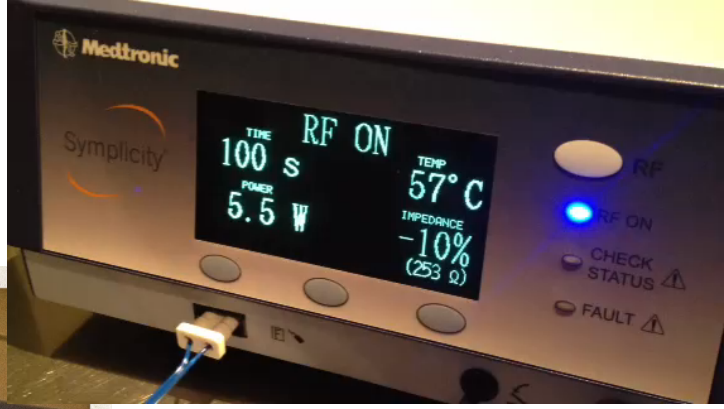
Anatomie Nerveuse Rénale



- Les nerfs naissent de D10-L2
- Les nerfs se ramifient autour de l'artère et se situent principalement dans l'adventice




Symplicity


Medtronic
Symplicity
TIME
100 s
RF ON
TEMP
57° C
POWER
5.5 W
IMPEDANCE
-10%
(253 Ω)
RF
RF ON
CHECK STATUS
FAULT


Dräger
Julian

Le passage à l'Homme

HTN-1

Une cohorte de patients / Etude de faisabilité

Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study

Etude pilote de faisabilité : Symplicity 1

Henry Krum, Markus Schlaich, Rob Whitbourn, Paul A Sobotka, Jerzy Sadowski, Krzysztof Bartus, Boguslaw Kapelak, Anthony Walton, Horst Sievert, Suku Thambar, William T Abraham, Murray Esler

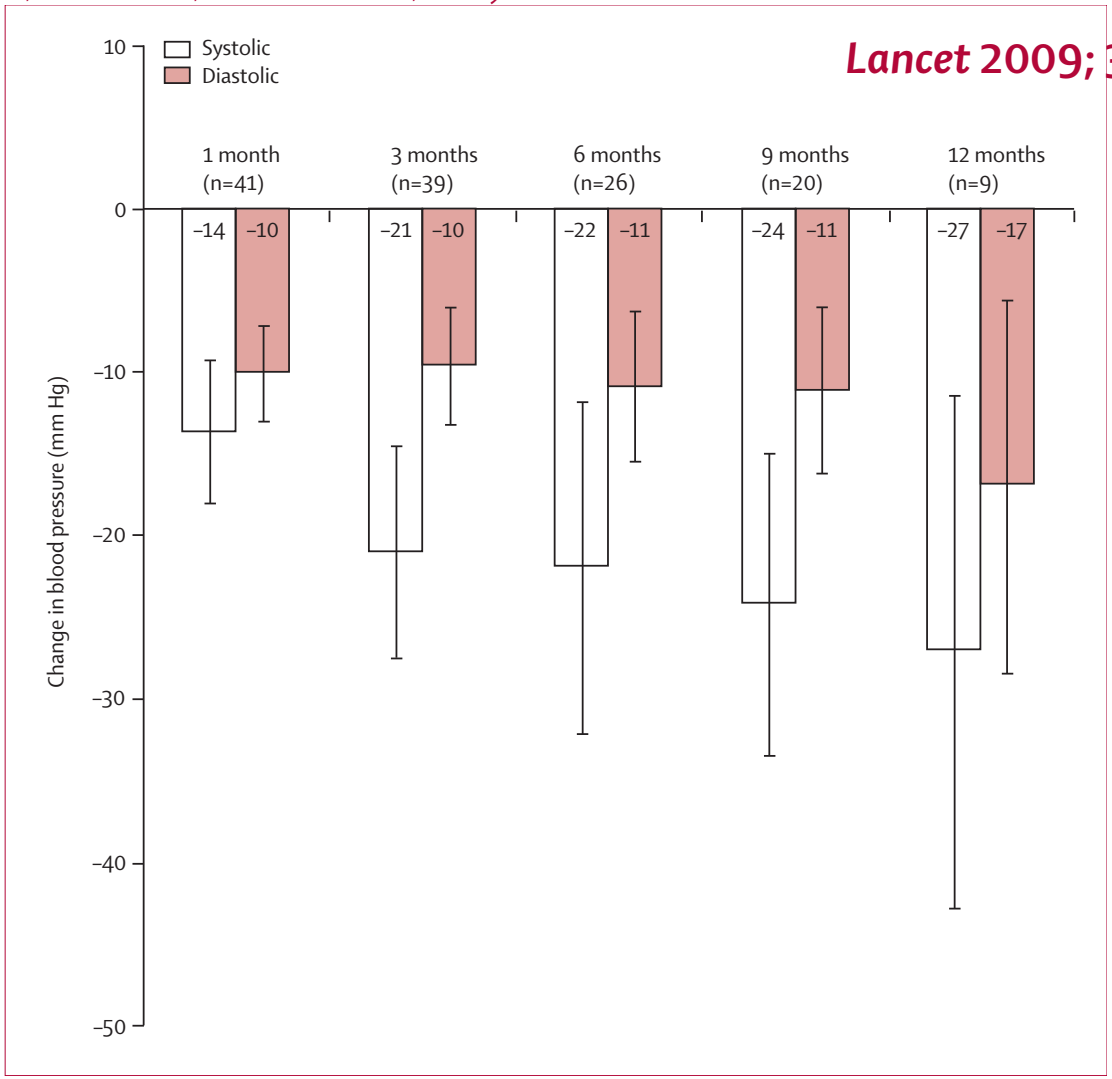
Lancet **2009; 373: 1275–81**

Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study

Etude pilote de faisabilité : Symplicity 1

Henry Krum, Markus Schlaich, Rob Whitbourn, Paul A Sobotka, Jerzy Sadowski, Krzysztof Bartus, Boguslaw Kapelak, Anthony Walton, Horst Sievert, Suku Thambar, William T Abraham, Murray Esler

***Lancet* 2009; 373: 1275–81**



Un effet anti hypertenseur fugace ?

Percutaneous renal denervation in patients with treatment-resistant hypertension: final 3-year report of the Symplicity HTN-1 study

Suivi à 3 ans de: Symplicity 1

Henry Krum, Markus P Schlaich, Paul A Sobotka, Michael Böhm, Felix Mahfoud, Krishna Rocha-Singh, Richard Katholi, Murray D Esler

Lancet 2014; 383: 622–29

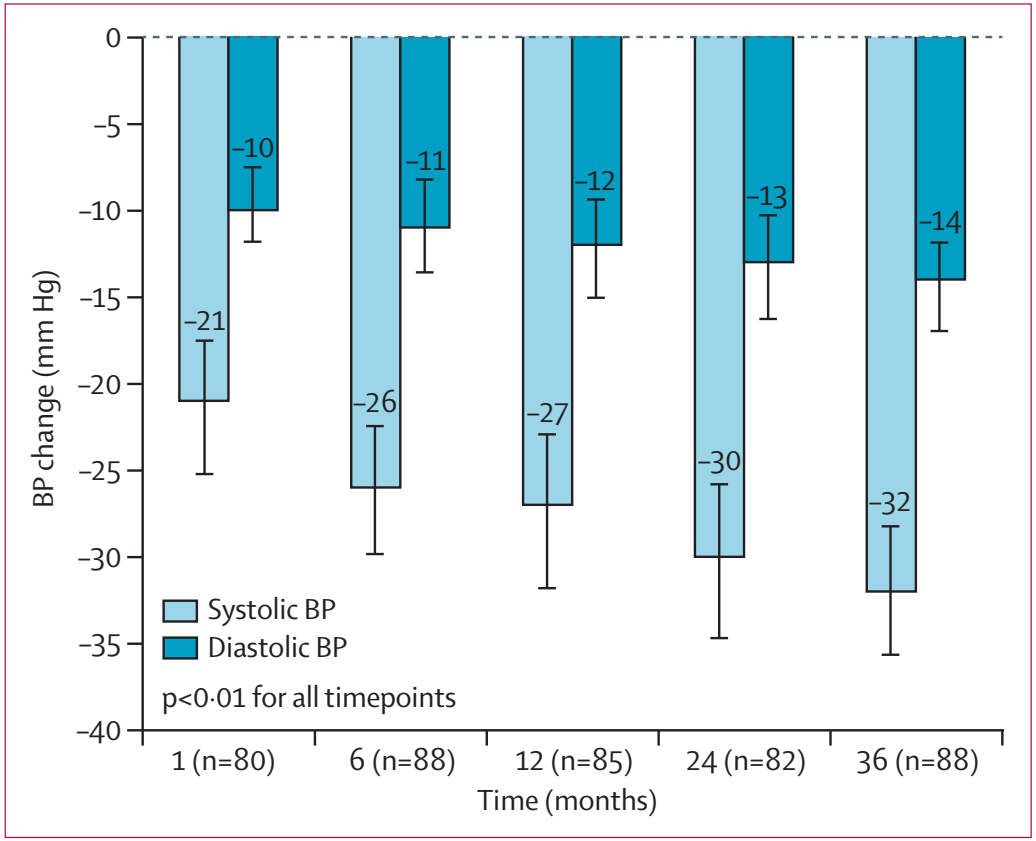


***Figure 2*: Change from baseline in office blood pressure in patients who completed 36 months of follow-up**

HTN-2

Vs groupe contrôle

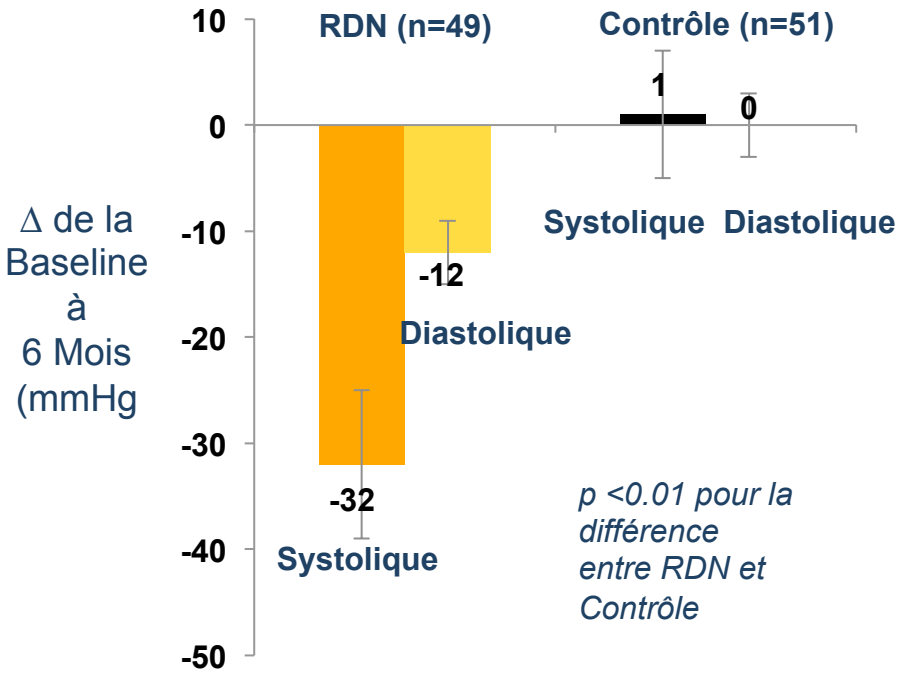
THE LANCET

Renal sympathetic denervation in patients with treatment-resistant hypertension (The Symplicity HTN-2 Trial): a randomised controlled trial

Symplicity HTN-2 Investigators*

Lancet. 2010;376:1903-1909.

Critère primaire (6 mois post-Randomisation)



Symplicity HTN-2: La Dénervation Rénale Supérieure au Traitement Médicamenteux seul, Réductions Maintenues à 18 mois

- **Marquage CE** adopté en Europe

- **Recommandations de l'ESC** :

  "……Catheter based renal denervation could be considered a therapeutic option in patients with drug-resistant hypertension"

En 2013

- **10 000 procédures** de dénervation rénale faites à travers le monde.
- **Medtronic** (Minneapolis, Minesota) achète pour **> 800 Millions de Dollars** la compagnie Ardian (Mountain View California) qui avait crée le concept
- **St Jude** était en train de lancer une étude sur 5000 patients

Meta-analyse 2013

- 294 publications sur la dénervation rénale
- Pratiquement toutes avec des résultats positifs
- Enthousiasme grandissant
  - Indications à élargir aux
    - HTA modérées ?
    - Patients non compliants ?
    - Pays sous developpés ?

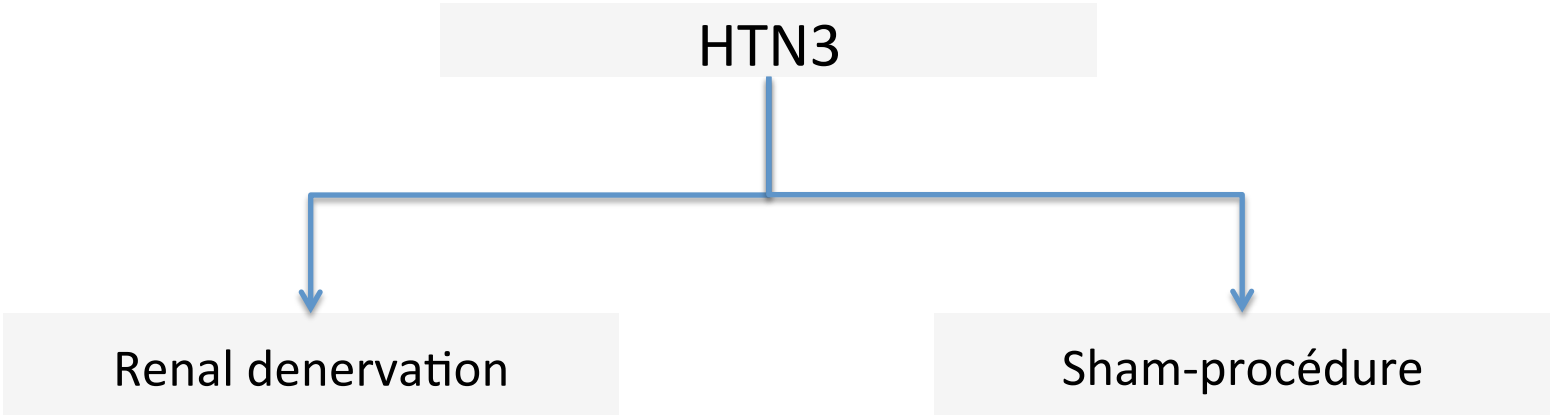
HTN-3

Vs procédure “fictive”

ORIGINAL ARTICLE

A Controlled Trial of Renal Denervation for Resistant Hypertension

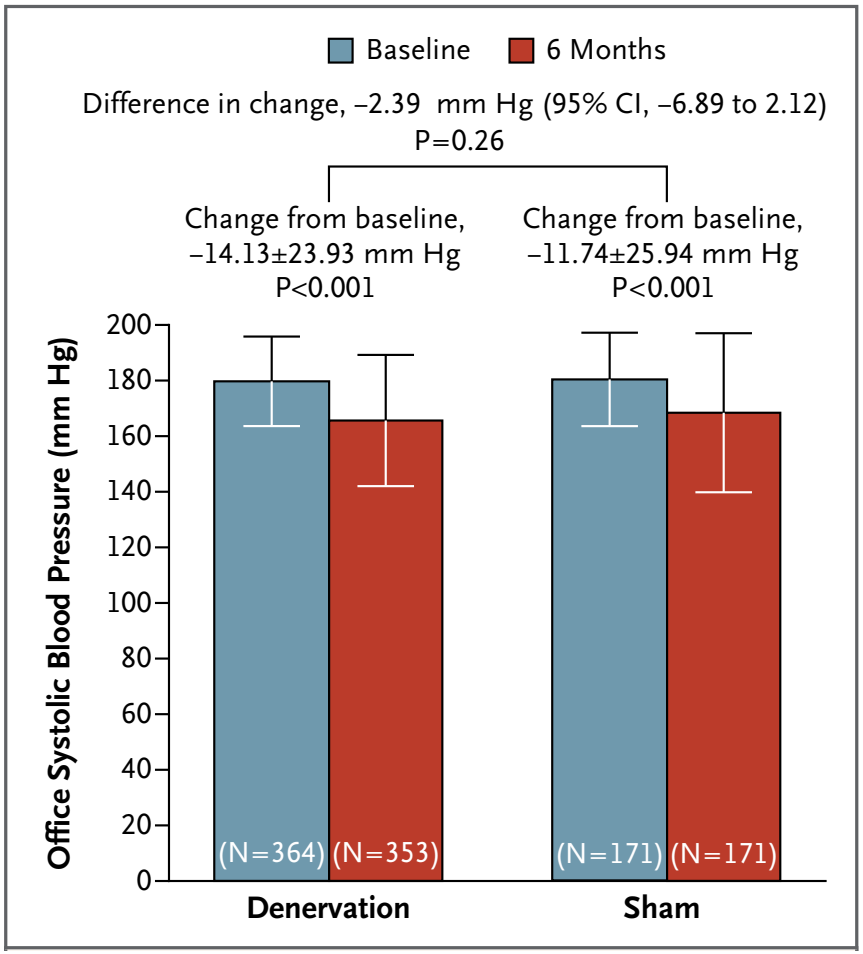
Deepak L. Bhatt, M.D., M.P.H., David E. Kandzari, M.D., William W. O'Neill, M.D., Ralph D'Agostino, Ph.D., John M. Flack, M.D., M.P.H., Barry T. Katzen, M.D., Martin B. Leon, M.D., Minglei Liu, Ph.D., Laura Mauri, M.D., Manuela Negoita, M.D., Sidney A. Cohen, M.D., Ph.D., Suzanne Oparil, M.D., Krishna Rocha-Singh, M.D., Raymond R. Townsend, M.D., and George L. Bakris, M.D., for the SYMPLICITY HTN-3 Investigators*



Etudes dans des centres US

Randomisation 2 pour 1

Résultat critère primaire HTN3.



L’étude HTN3 voue t’elle aux gémonies la Dénervation rénale dans l’HTA ?

Subgroup	Denervation	Sham	Between-Group Difference in Change in Office Systolic Blood Pressure (95% CI)	P Value	P Value for Interaction
	no. of patients		*mm Hg*		
All patients	353	171	−2.39 (−6.89 to 2.12)	0.26	
Diabetes mellitus					0.82
Yes	169	68	−4.53 (−11.51 to 2.46)	0.20	
No	181	101	−3.46 (−9.55 to 2.62)	0.26	
Sex					0.37
Male	208	108	−2.30 (−7.63 to 3.03)	0.40	
Female	142	61	−6.64 (−14.94 to 1.65)	0.12	
Black race					0.09
Yes	85	49	2.25 (−7.27 to 11.78)	0.64	
No	264	120	−6.63 (−11.81 to −1.44)	0.01	
Body-mass index					0.77
<30	91	42	−2.77 (−11.47 to 5.93)	0.53	
≥30	259	126	−4.36 (−9.76 to 1.03)	0.11	
Receiving aldosterone antagonist at baseline					0.36
Yes	76	47	−8.05 (−17.63 to 1.52)	0.10	
No	274	122	−3.24 (−8.42 to 1.93)	0.22	
Estimated GFR					0.31
<60 ml/min/1.73 m^2	68	38	0.54 (−8.29 to 9.37)	0.90	
≥60 ml/min/1.73 m^2	282	131	−5.22 (−10.51 to 0.06)	0.05	
Age					0.27
<65 yr	246	128	−5.73 (−11.06 to −0.40)	0.04	
≥65 yr	104	41	0.09 (−8.80 to 8.99)	0.99	
Any medication change					0.68
Yes	132	70	−5.41 (−13.49 to 2.67)	0.19	
No	218	99	−3.44 (−8.83 to 1.96)	0.21	

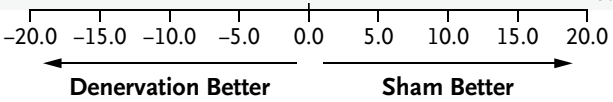


Figure 3. Selected Subgroup Analyses.

Shown are between-group differences in the change in office systolic blood pressure from baseline to 6 months in selected subgroups. The body-mass index is the weight in kilograms divided by the square of the height in meters. GFR denotes glomerular filtration rate.

European Heart Journal (2015) **36**, 219–227
doi:10.1093/eurheartj/ehu441

Predictors of blood pressure response in the SYMPLICITY HTN-3 trial

David E. Kandzari[1]*, Deepak L. Bhatt[2], Sandeep Brar[3], Chandan M. Devireddy[4], Murray Esler[5], Martin Fahy[3], John M. Flack[6], Barry T. Katzen[7], Janice Lea[4], David P. Lee[8], Martin B. Leon[9], Adrian Ma[8], Joseph Massaro[10], Laura Mauri[2,10], Suzanne Oparil[11], William W. O'Neill[12], Manesh R. Patel[13], Krishna Rocha-Singh[14], Paul A. Sobotka[15], Laura Svetkey[13], Raymond R. Townsend[16], and George L. Bakris[17]

European Heart Journal (2015) **36**, 219–227

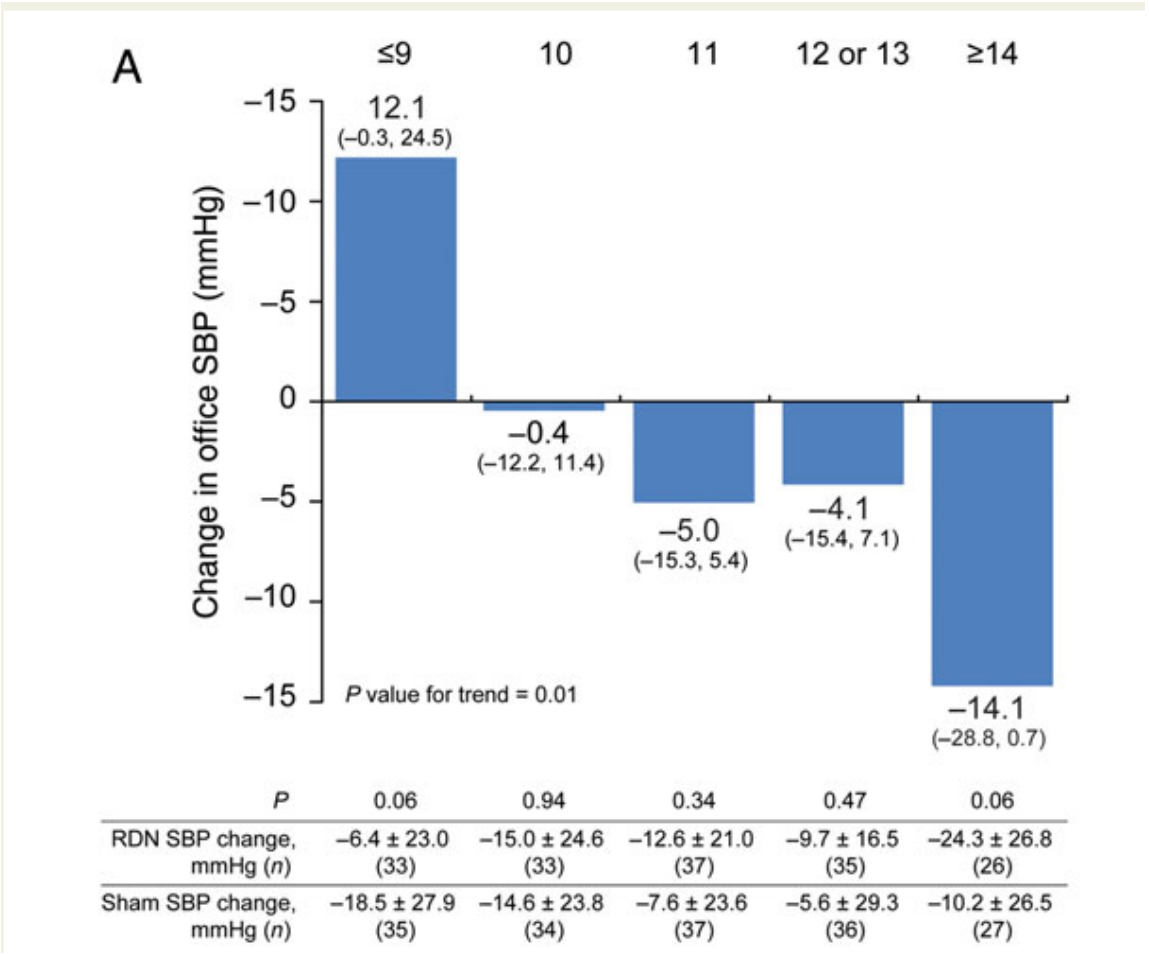
Prédicteurs d'une réponse à la Dénervation

- TAS > 180 mm Hg
- Utilisation d'anti-aldostérone
- Nombre d'ablations
- Ablations dans tous les quadrants
- Américains Non africains

Prédicteurs d'une réponse à la Dénervation

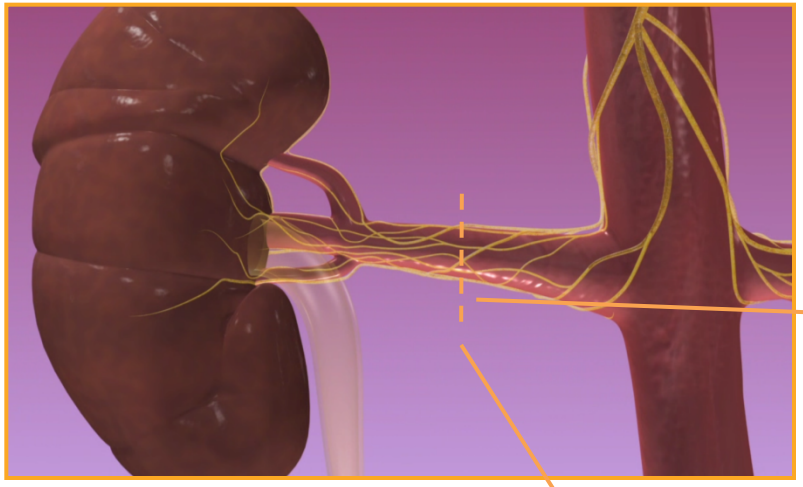
- TAS > 180 mm Hg
- Utilisation d'anti-aldostérone
- Nombre d'ablations
- Ablations dans tous les quadrants
- Américains Non africains

Réponse sur la TAS en fonction du nombre d'ablations

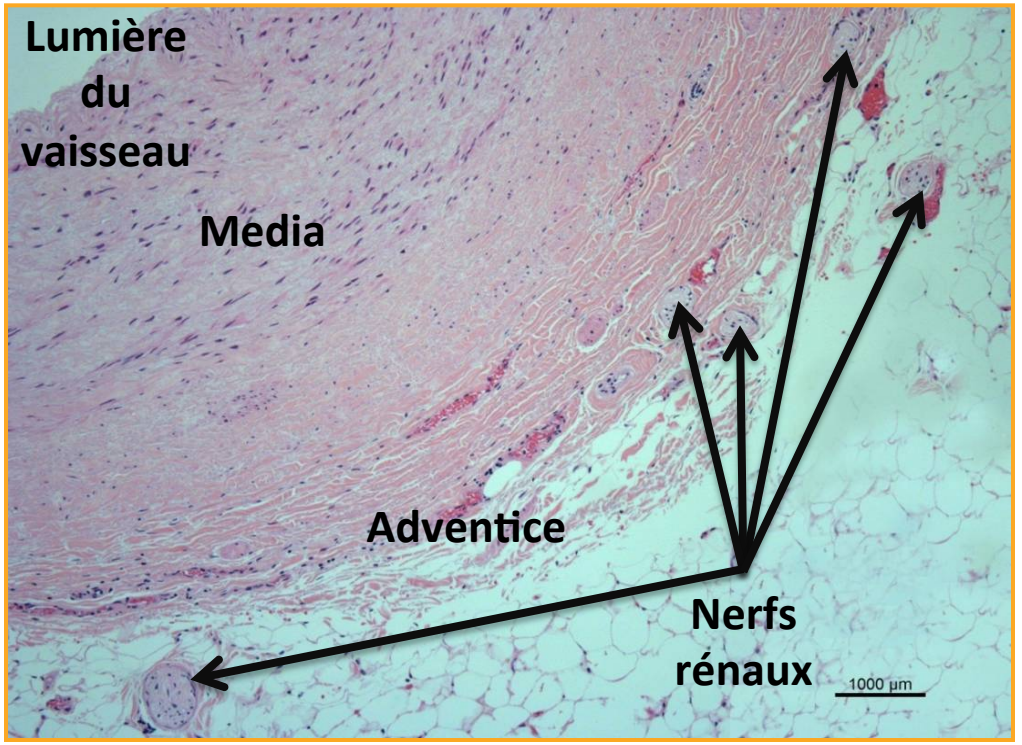


P	0.06	0.94	0.34	0.47	0.06
RDN SBP change, mmHg (*n*)	−6.4 ± 23.0 (33)	−15.0 ± 24.6 (33)	−12.6 ± 21.0 (37)	−9.7 ± 16.5 (35)	−24.3 ± 26.8 (26)
Sham SBP change, mmHg (*n*)	−18.5 ± 27.9 (35)	−14.6 ± 23.8 (34)	−7.6 ± 23.6 (37)	−5.6 ± 29.3 (36)	−10.2 ± 26.5 (27)

Anatomie Nerveuse Rénale



- Les nerfs naissent de D10-L2
- Les nerfs se ramifient autour de l'artère et se situent principalement dans l'adventice



Renal denervation: symply trapped by complexity?

Felix Mahfoud[1]* and Thomas Felix Lüscher[2]

European Heart Journal (2015) **36**, 199–202
doi:10.1093/eurheartj/ehu450

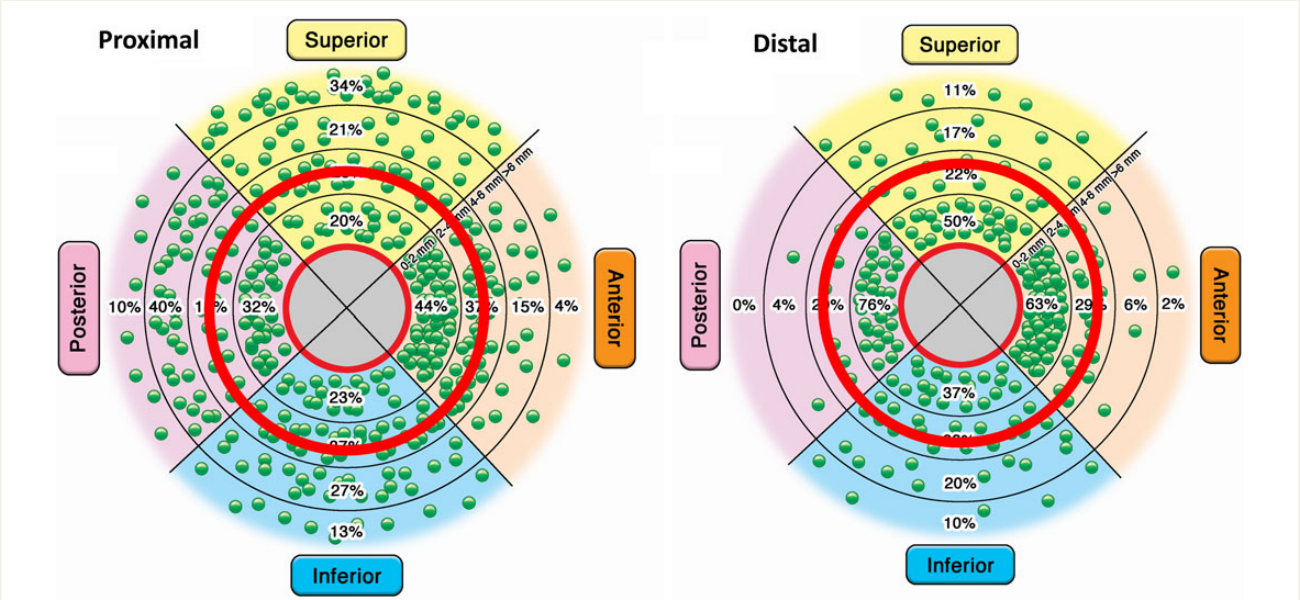
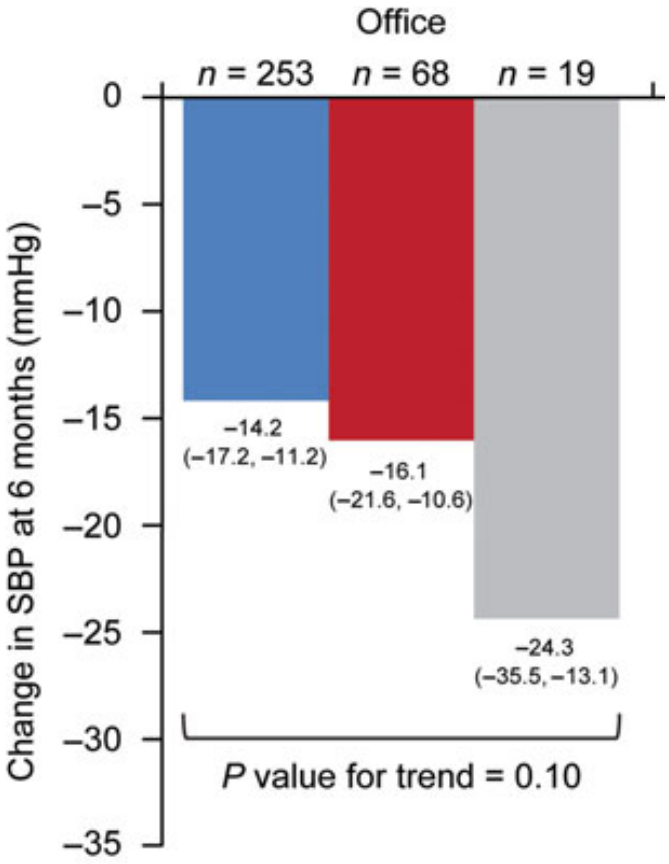


Figure 1 Distribution of nerves stratified according to the total number (each green dot represents 10 nerves), relative number as a percentage per segment, and distance from the lumen in the relative (left) proximal and (right) distal location. The red ring represents the average ablation depth (approximately 3 mm) of the currently available radiofrequency renal denervation systems. Modified from Sakakura *et al.*[19] and Mahfoud *et al.*[18]

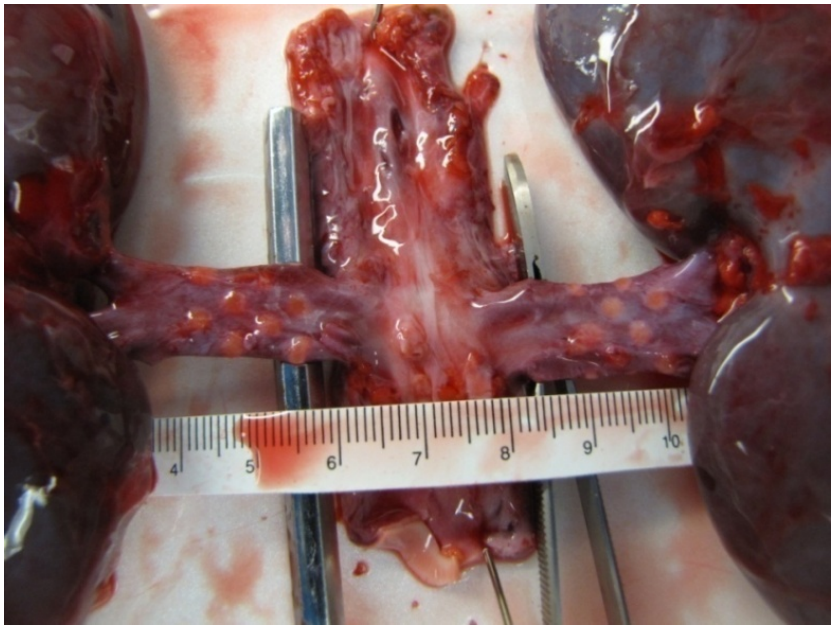
Variation de la TAS à 6 mois en fc des localisations des sites d'ablation

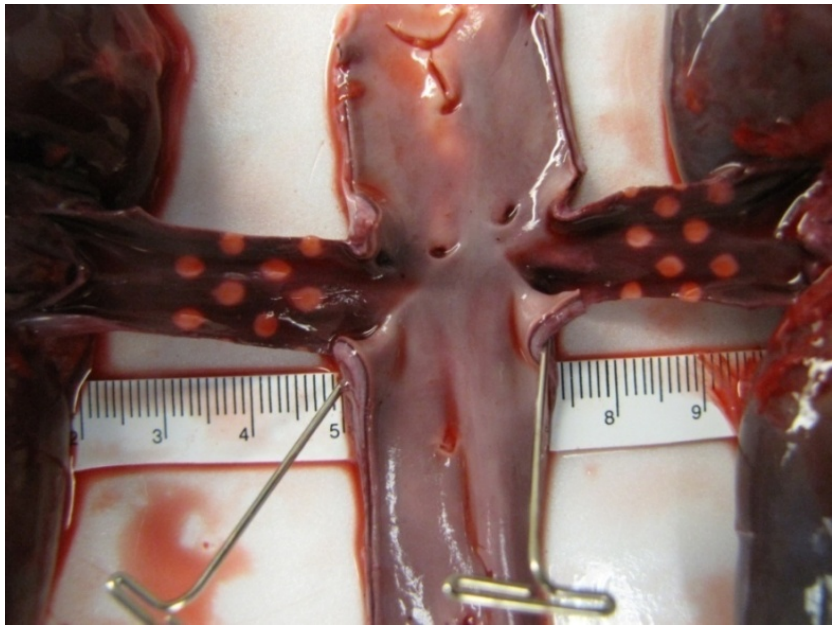


Pas d'ablation dans les 4 quadrants

Ablation dans les 4 quadrants sur 1 Rein

Ablation dans les 4 quadrants sur 2 Reins





Vue externe de l'artère

Vue interne de l'artère

Prédicteurs d'une réponse à la Dénervation

- TAS > 180 mm Hg
- Utilisation d'anti-aldostérone
- Nombre d'ablations
- Ablations dans tous les quadrants
- Américains Non africains

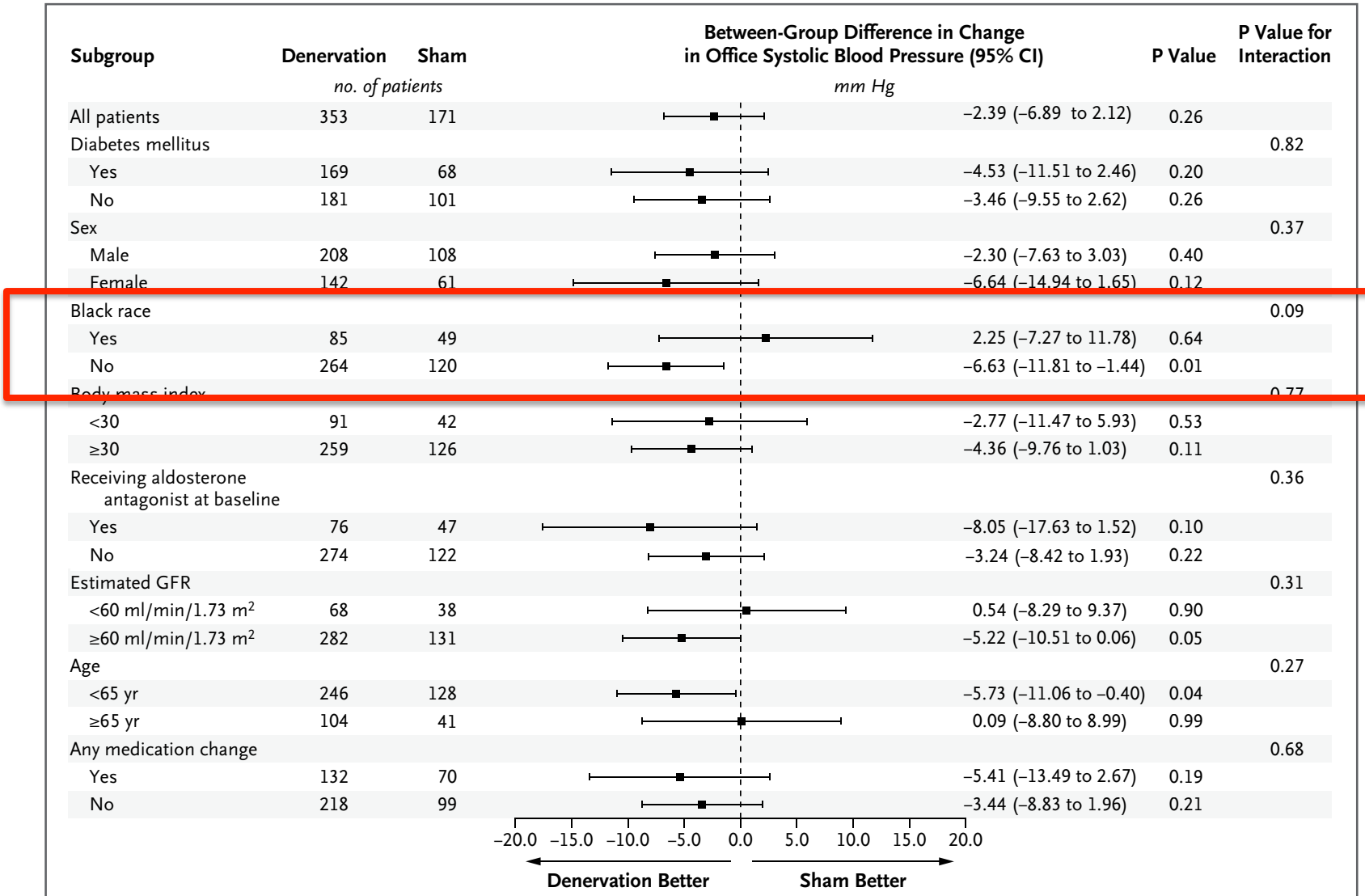


Figure 3. Selected Subgroup Analyses.

Shown are between-group differences in the change in office systolic blood pressure from baseline to 6 months in selected subgroups. The body-mass index is the weight in kilograms divided by the square of the height in meters. GFR denotes glomerular filtration rate.

Variation de la TAS en fonction de l'ethnie

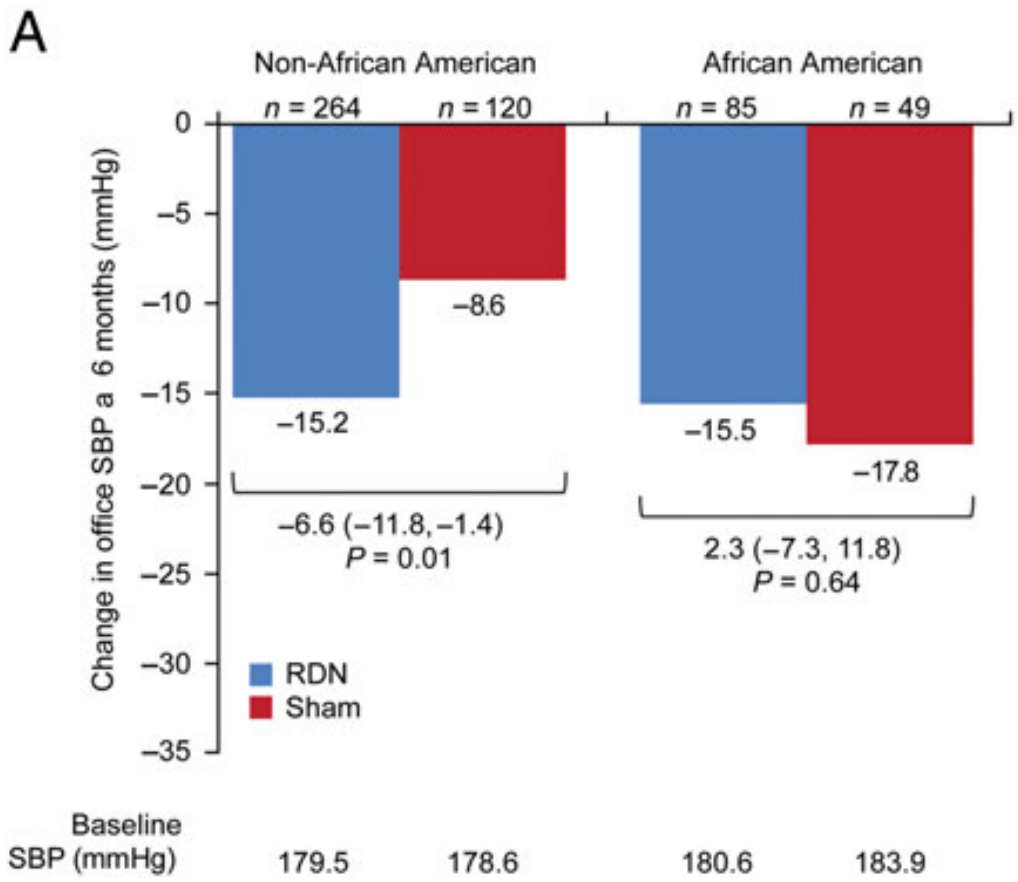


Figure 1 Change in office systolic blood pressure at 6 months for non-African-American and African-American subgroups (*A*) and for non-African-American and African-American subgroups according to baseline vasodilator use (*B*). *P*-values shown are for the difference between the 6-month change from baseline for the RDN group and the sham group. All 6-month change from baseline values are significant ($P < 0.001$).

HTN3
Les possibles raisons de l’échec

Renal denervation: symply trapped by complexity?

Felix Mahfoud[1]* and Thomas Felix Lüscher[2]

European Heart Journal (2015) **36**, 199–202
doi:10.1093/eurheartj/ehu450

(i) Although stable antihypertensive medication was required, 22% of all patients had medication changes 2–6 weeks prior to screening. Between baseline and 6-month endpoint assessment, medication changes were documented in another 39%.

Table 1. Selected Findings of the SYMPLICITY HTN-2 and HTN-3 Studies.

Variable	SYMPLICITY HTN-2		SYMPLICITY HTN-3	
	Renal Denervation	No Renal Denervation	Renal Denervation	Sham Procedure
No. of patients	52	54	364	171
No. of antihypertensive medications at baseline	5.2±1.5	5.3±1.8	5.1±1.4	5.2±1.4
Aldosterone antagonist at baseline (% of patients)	17	17	22.5	28.7
Office systolic blood pressure at baseline (mm Hg)	178±18	178±16	179.7±16.1	180.2±16.8
Heart rate at baseline (beats/min)	75±15	71±15	NR	NR
Change in office systolic blood pressure at 6 mo (mm Hg)				
Absolute change	−32±23	1±21	−14.1±23.9	−11.7±25.9
Change relative to control group	−33		−2.4	
Change in home systolic blood pressure at 6 mo (mm Hg)				
Absolute change†	−20±17	2±21	−7.4	−6.0
Change relative to control group	−22		−1.3	
Change in 24-hr ambulatory systolic blood pressure at 6 mo (mm Hg)				
Absolute change‡	−11±15	−3±19	−6.8±15.1	−4.8±17.2
Change relative to control group	−8		−1.96	
Change in antihypertensive medication (% of patients)				
Decrease in dose or no. of medications	20	6	NR	NR
Increase in dose or no. of medications	8	12	NR	NR

Messerli FH. Renal denervation for resistant hypertension ? Editorial NEJM

Table 1. Selected Findings of the SYMPLICITY HTN-2 and HTN-3 Studies.

Variable	SYMPLICITY HTN-2		SYMPLICITY HTN-3	
	Renal Denervation	No Renal Denervation	Renal Denervation	Sham Procedure
No. of patients	52	54	364	171
No. of antihypertensive medications at baseline	HTN-2		HTN-3	
Aldosterone antagonist at baseline (% of patients)	17	17	22.5	28.7
Baisse TAS groupes "denervation"	-32 mm Hg	vs	-14 mm Hg	
Heart rate at baseline (beats/min)	75±15	71±15	NR	NR
Change in office systolic blood pressure at 6 mo (mm Hg)				
Baisse TAS groupes "contrôle"	1 mm Hg	vs	-11 mm Hg	
Change relative to control group				
Change in home systolic blood pressure at 6 mo (mm Hg)				
Absolute change†	−20±17	2±21	−7.4	−6.0
Change relative to control group	−22		−1.3	
Change in 24-hr ambulatory systolic blood pressure at 6 mo (mm Hg)				
Absolute change‡	−11±15	−3±19	−6.8±15.1	−4.8±17.2
Change relative to control group	−8		−1.96	
Change in antihypertensive medication (% of patients)				
Decrease in dose or no. of medications	20	6	NR	NR
Increase in dose or no. of medications	8	12	NR	NR

Messerli FH. Renal denervation for resistant hypertension ? Editorial NEJM

Pourquoi faut-il encore y croire ?

Symplicity-Flex trial (TCT 2014)

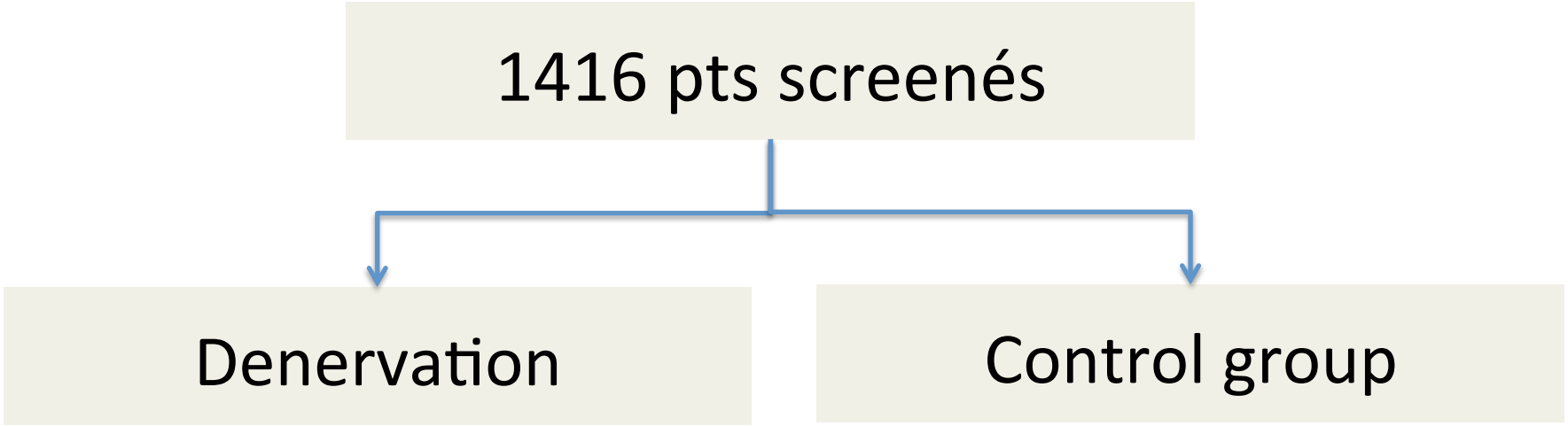
- HTA modérée
  - PAS 135-149 mm Hg
  - PAD 90-94 mm Hg
  - Trt optimal
- Sham procédure
- MAPA sur 24h.
- En per protocole:
  - **Réduction de 7 mm vs 3.5 mm p=0.04**

DENERV HTN

Optimum and stepped care standardised antihypertensive treatment with or without renal denervation for resistant hypertension (DENERHTN): a multicentre, open-label, randomised controlled trial

*Michel Azizi, Marc Sapoval, Philippe Gosse, Matthieu Monge, Guillaume Bobrie, Pascal Delsart, Marco Midulla, Claire Mounier-Véhier, Pierre-Yves Courand, Pierre Lantelme, Thierry Denolle, Caroline Dourmap-Collas, Hervé Trillaud, Helena Pereira, Pierre-François Plouin, Gilles Chatellier, and the Renal Denervation for Hypertension (DENERHTN) investigators**

www.thelancet.com **Published online January 26, 2015**



Standardised antihypertensive treatment		
Indapamide 1·5 mg†	53 (100·0)	53 (100·0)
Ramipril 10 mg†	46 (86·8)	43 (81·1)
Irbesartan 300 mg†	7 (13·2)	10 (18·9)
Amlodipine 10 mg†	51 (96·2)	49 (92·5)
Amlodipine 5 mg†	2 (3·8)	4 (7·5)

Denerv HTN

	Renal Denervation	**Control group**	difference	p
TAS	-15,8 mm Hg	-9,9 mm Hg	-5,9	0.03
TAD	-9.9 mm Hg	-6.8 mm Hg	-3.1	0.09
TAS 24H	-15.4 mm Hg	-9,5 mm Hg	-5,9	0.023

www.thelancet.com **Published online January 26, 2015**

Denerv HTN

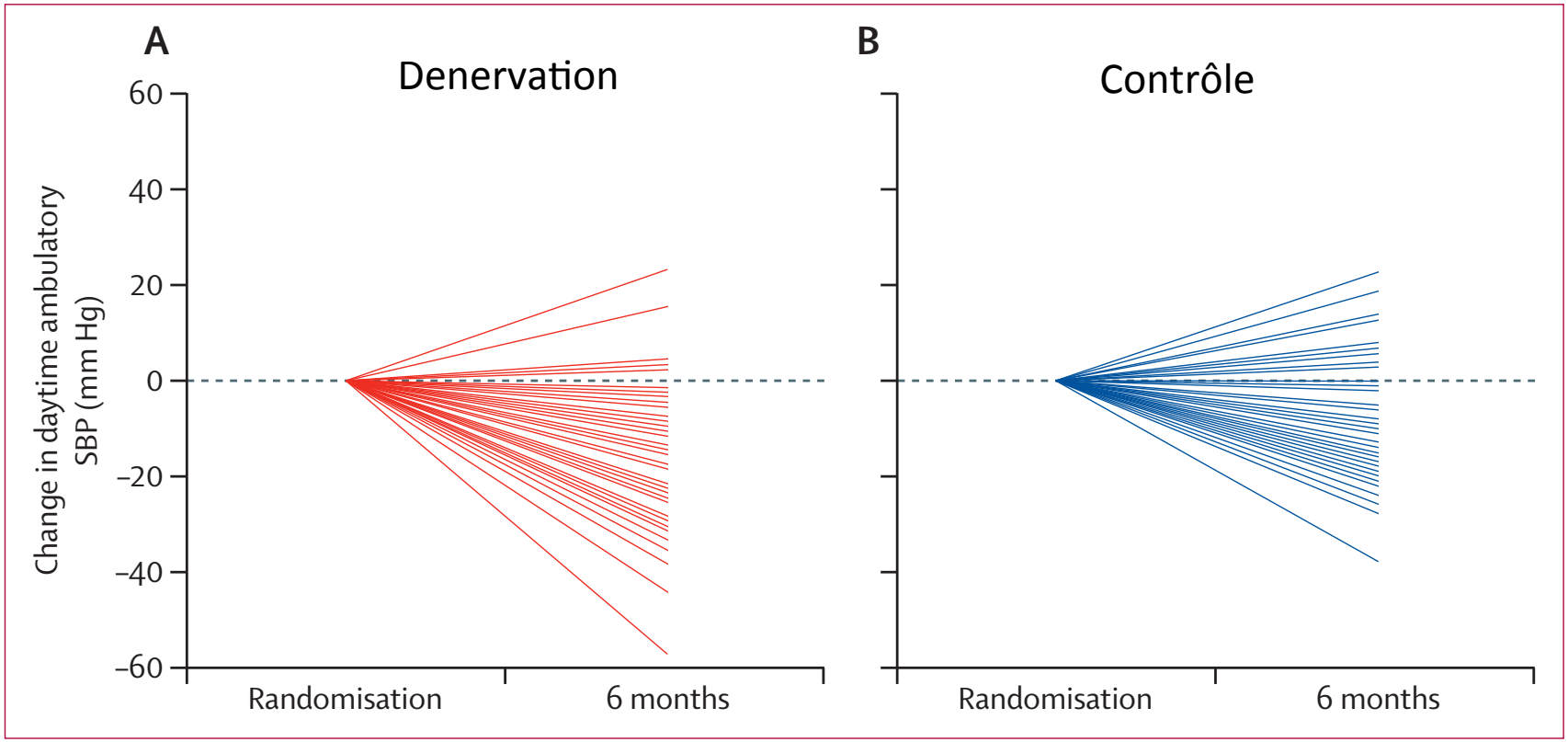


Figure 2: **Between-Patient variability**

Conclusions

- Il faut continuer à **EVALUER** la technique de Denervation Rénale.
- Le **choix** des patients est important
- La **technique** est importante
- Un **Marqueur** qui puisse reflèter une denervation réussie sera utile.
- ..Thrombolyse dans l'Infarctus du myocarde

Un marqueur d’efficacité de la denervation ?

Efficacité de la denervation mesurée par la secrétion de Norépinephrine

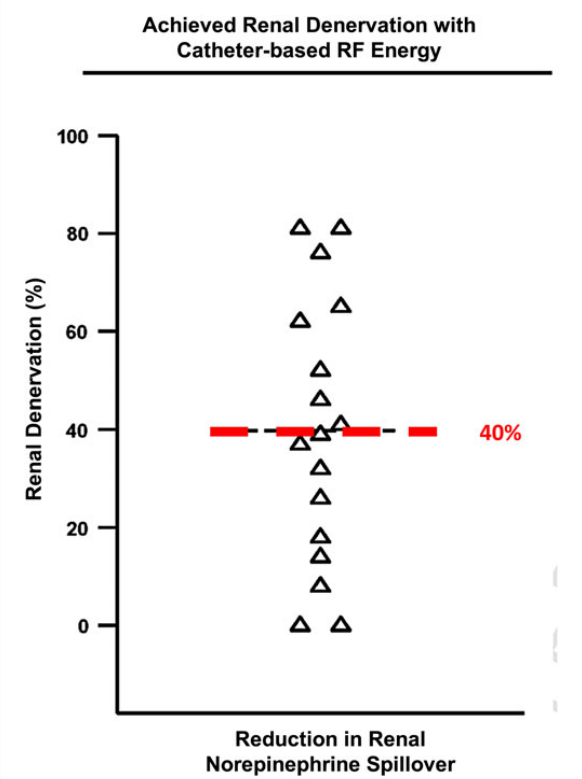


Figure 2 Effectiveness and variability of catheter-based renal denervation 30 days after the procedure measured by renal norepinephrine (NE) spillover ($n = 17$). Modified from Esler.[21]

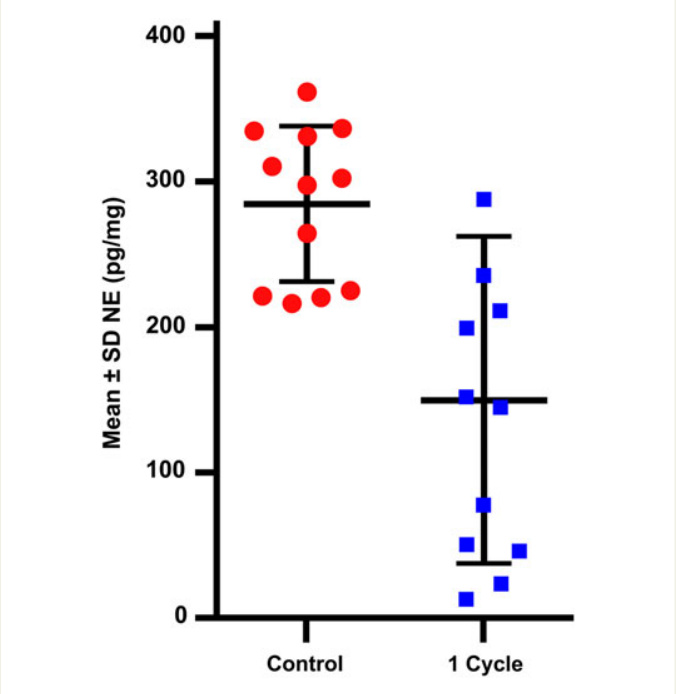


Figure 3 Effectiveness and variability of catheter-based renal denervation measured by tissue norepinephrine tissue content in pigs ($n = 12$), with application of four radiofrequency (RF) ablations in the main renal artery. Modified from Melder R.J., oral presentation TCT 2014.

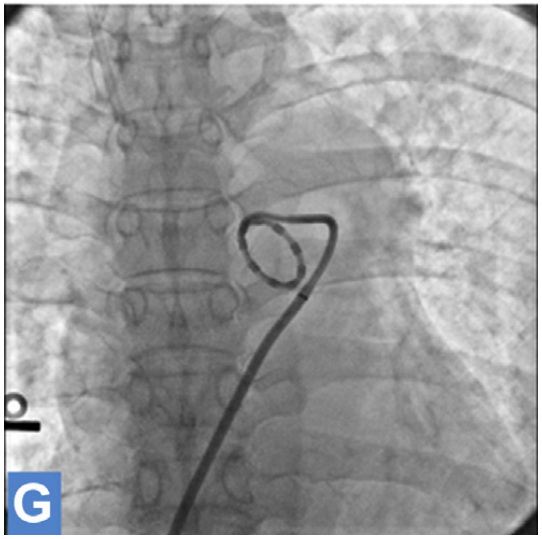
Mahfoud F, Lüsher T. Renal denervation symply trapped by complexity. Eur H J 2015

Pulmonary Artery Denervation to Treat Pulmonary Arterial Hypertension

The Single-Center, Prospective, First-in-Man PADN-1 Study (First-in-Man Pulmonary Artery Denervation for Treatment of Pulmonary Artery Hypertension)

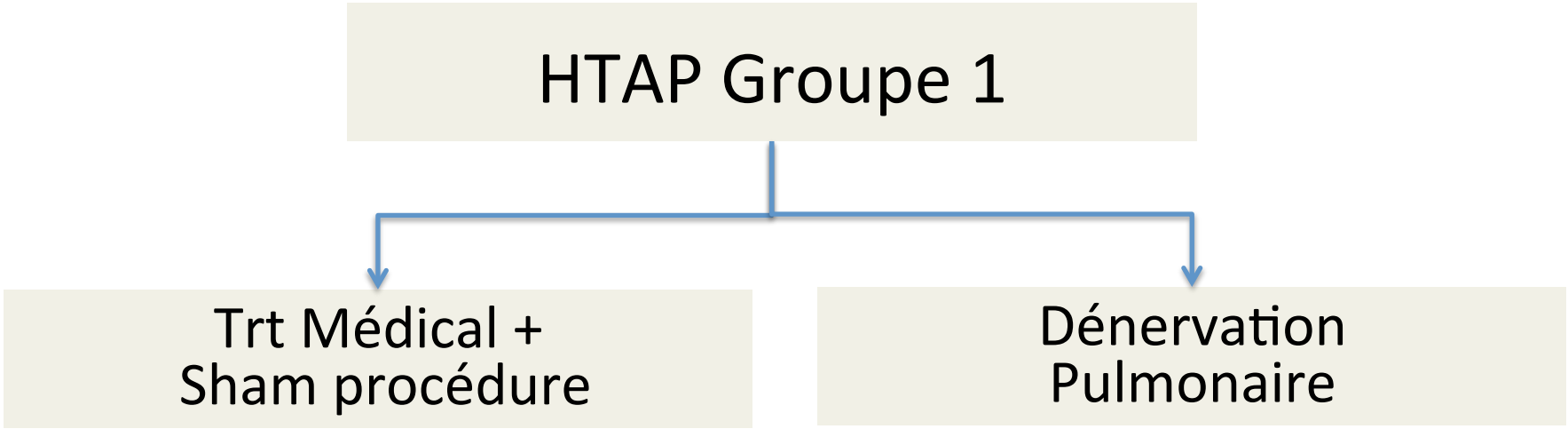
Shao-Liang Chen, MD,*† Feng-Fu Zhang, MD,* Jing Xu, MD,* Du-Jiang Xie, MD,* Ling Zhou, MD,* Thach Nguyen, MD,‡ Gregg W. Stone, MD§

Nanjing, China; Hobart, Indiana; and New York, New York

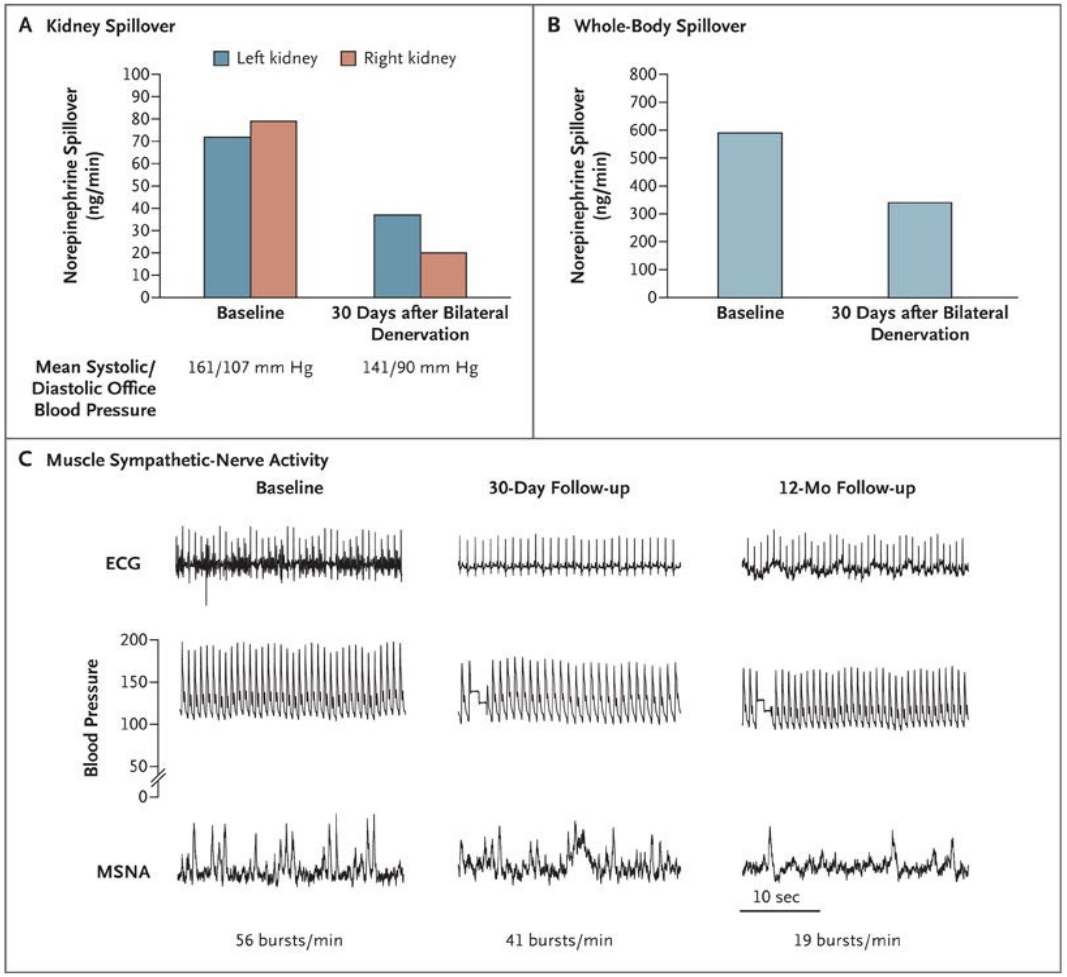


PAP Moy (mm Hg)	55	36
PAP Syst (mm Hg)	86	71
IC (l/mn/m2)	2	2.8

DENERV HTAP


HTAP Groupe 1
Trt Médical +
Sham procédure
Dénervation
Pulmonaire

Norepinephrine Renal and Whole-Body Spillover and Results of Microneurography before and after Renal-Nerve Ablation.



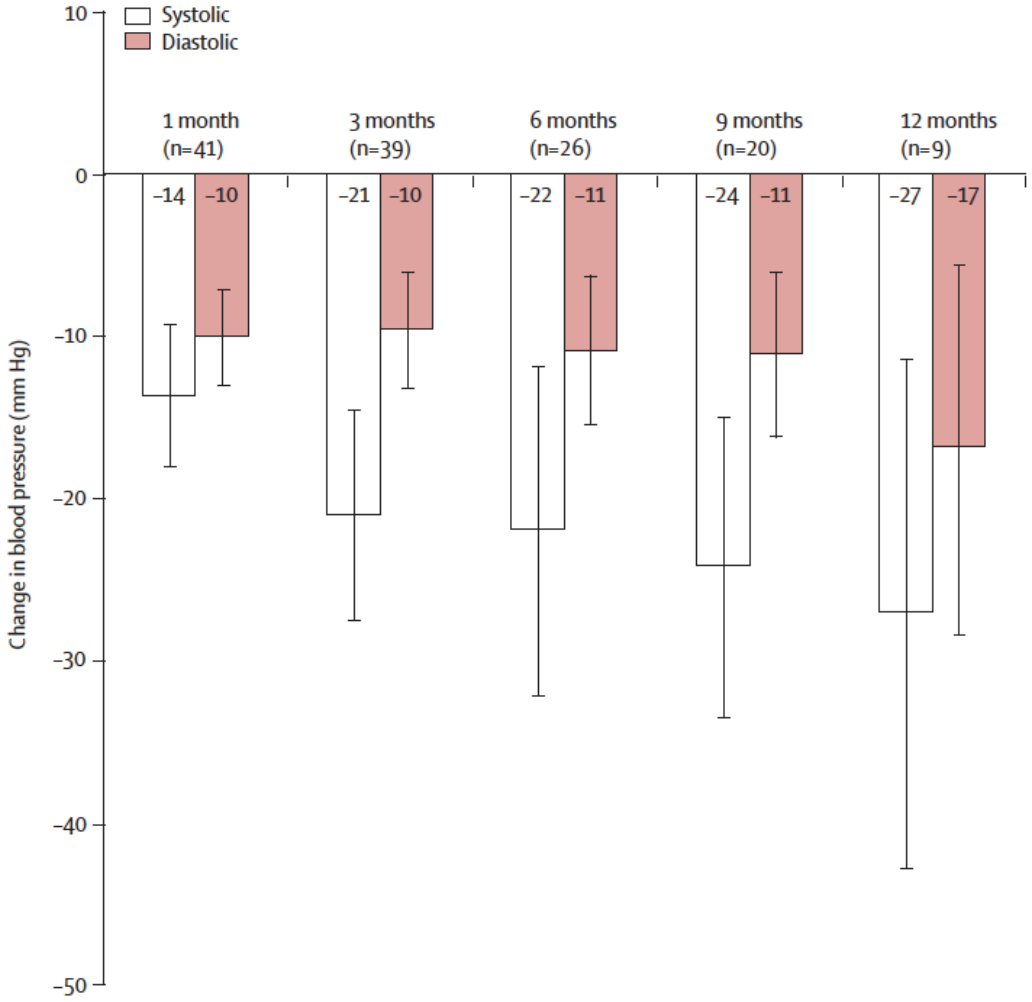
Schlaich MP et al. N Engl J Med 2009;361:932-934.

RESULTATS H

Catheter-based renal sympathetic denervation for resistant hypertension: a multicentre safety and proof-of-principle cohort study

Henry Krum, Markus Schlaich, Rob Whitbourn, Paul A Sobotka, Jerzy Sadowski, Krzysztof Bartus, Bogusław Kapelak, Anthony Walton, Horst Sievert, Suku Thambar, William T Abraham, Murray Esler

Etude pilote de faisabilité : Symplicity 1

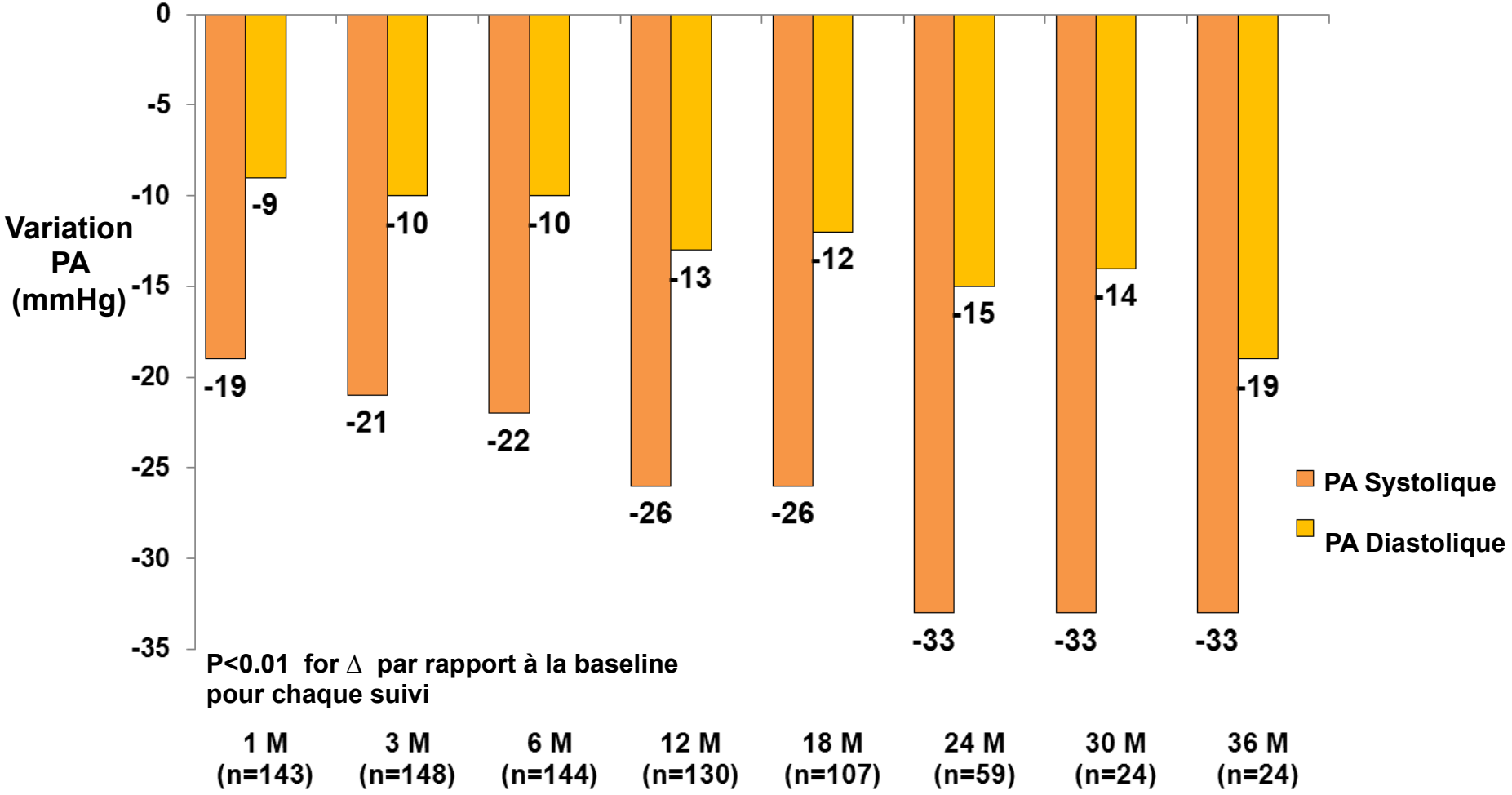


COMPLICATIONS :

- Douleurs per procédure +++
- 1 dissection de l'artère rénale
- 1 faux anévrisme au point de ponction

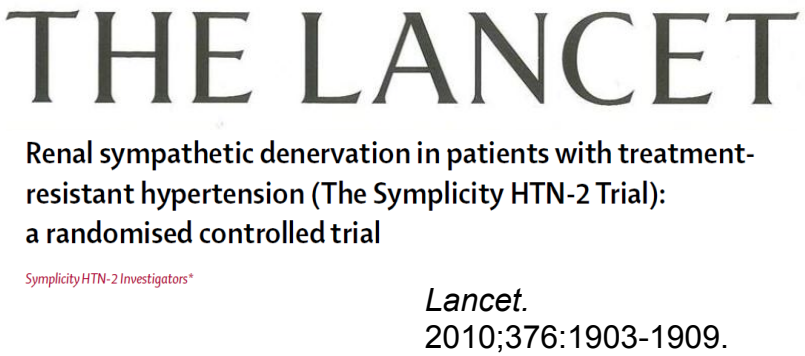
Lancet 2009; 373: 1275–81

Symplicity HTN-1: Réductions de la Pression Artérielle pendant 3 ans



*Expanded results presented at the *American College of Cardiology Annual Meeting 2012* (Krum, H.)

Etude Symplicity HTN-2


THE LANCET

Renal sympathetic denervation in patients with treatment-resistant hypertension (The Symplicity HTN-2 Trial): a randomised controlled trial

Symplicity HTN-2 Investigators*

Lancet. 2010;376:1903-1909.

- **Objectif:** démontrer l'efficacité de la dénervation rénale par cathéter pour réduire la pression artérielle des patients avec une hypertension non contrôlée dans une étude clinique contrôlée prospective randomisée
- **Patients:** 106 patients randomisés 1:1 traitement par dénervation rénale vs. contrôle
- **Centres:** 24 centres en Europe, Australie, & Nouvelle Zélande (67% de centre d'excellence de l'hypertension)

Symplicity HTN-2 Investigators. Lancet. 2010;376:1903-1909.

Cost-Effectiveness of Hypertension Therapy According to 2014 Guidelines

Andrew E. Moran, M.D., M.P.H., Michelle C. Odden, Ph.D., Anusorn Thanataveerat, M.P.H., Keane Y. Tzong, M.P.H., Petra W. Rasmussen, M.P.H., David Guzman, M.S.P.H., Lawrence Williams, M.S., Kirsten Bibbins-Domingo, Ph.D., M.D., Pamela G. Coxson, Ph.D., and Lee Goldman, M.D., M.P.H.

N Engl J Med 2015; 372:447-455January 29, 2015DOI: 10.1056/NEJMsa1406751

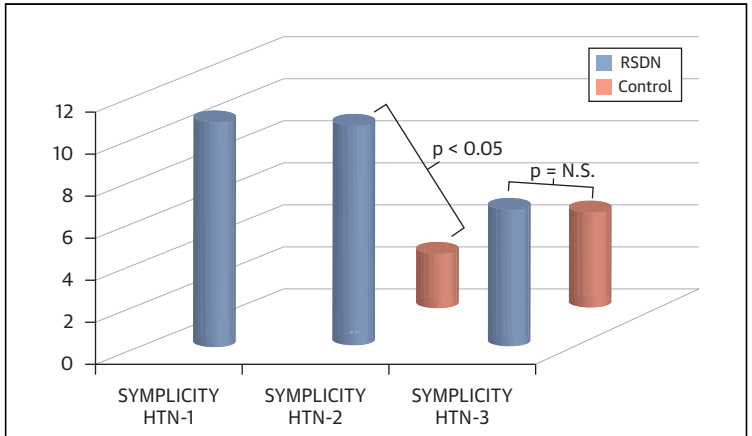


FIGURE 1 24-h Ambulatory Systolic Blood Pressure Changes in the SYMPLICITY Trials

Table 1 **Multivariable predictors of systolic blood pressure change at 6 months**

Covariate	Estimate	95% Confidence interval	*P*-value
Pooled patients			
Office SBP change ($n = 518$)			
Randomized to RDN	−3.64	−7.96, 0.69	0.100
Baseline office SBP ≥180 mmHg	−14.94	−19.06, −10.82	<0.0001
Aldosterone antagonist	−6.39	−11.24, −1.54	0.010
Vasodilator	5.49	1.26, 9.72	0.011
Ambulatory SBP change ($n = 483$)			
Randomized to RDN	−2.11	−5.10, 0.88	0.167
Baseline eGFR ≥60 mL/min/1.73 m^2	−3.91	−7.39, −0.44	0.028
Aldosterone antagonist	−3.98	−7.24, −0.72	0.017
RDN group			
Office SBP change ($n = 318$)			
Baseline office SBP ≥180 mmHg	−14.31	−19.23, −9.39	<0.0001
Total number of ablation attempts	−0.94	−1.82, −0.05	0.040
Aldosterone antagonist	−9.77	−15.83, −3.72	0.002
Vasodilator	7.55	2.38, 12.72	0.005
Ambulatory SBP change ($n = 293$)			
Baseline eGFR ≥60 mL/min/1.73 m^2	−4.56	−8.99, −0.13	0.044
Aldosterone antagonist	−5.19	−9.33, −1.06	0.014
Sham group[a]			
Office SBP change ($n = 169$)			
Baseline office SBP ≥180 mmHg	−8.00	−16.42, 0.41	0.064
African-American race	−11.97	−19.81, −4.14	0.003
Alpha-1 blocker use	−12.00	−23.60, −0.40	0.044

P value needs to be <0.2 to enter the model, and needs to be <0.1 to stay.

[a]There were no multivariable predictors of ambulatory SBP change in the sham group.

Pourquoi HTN-3 n'est peut être pas la fin de l'histoire

- Parceque la denervation il faut VRAIEMENT la faire

Nb d'ablations	Baisse de la PAS
>16 / pt	21.1 mm Hg
9 / pt	6 mm Hg

Is the Failure of Symplicity HTN-3 trial to meet its efficacy endpoint the "end of the road" for Renal Denervation. Epstein M et all JASH in press

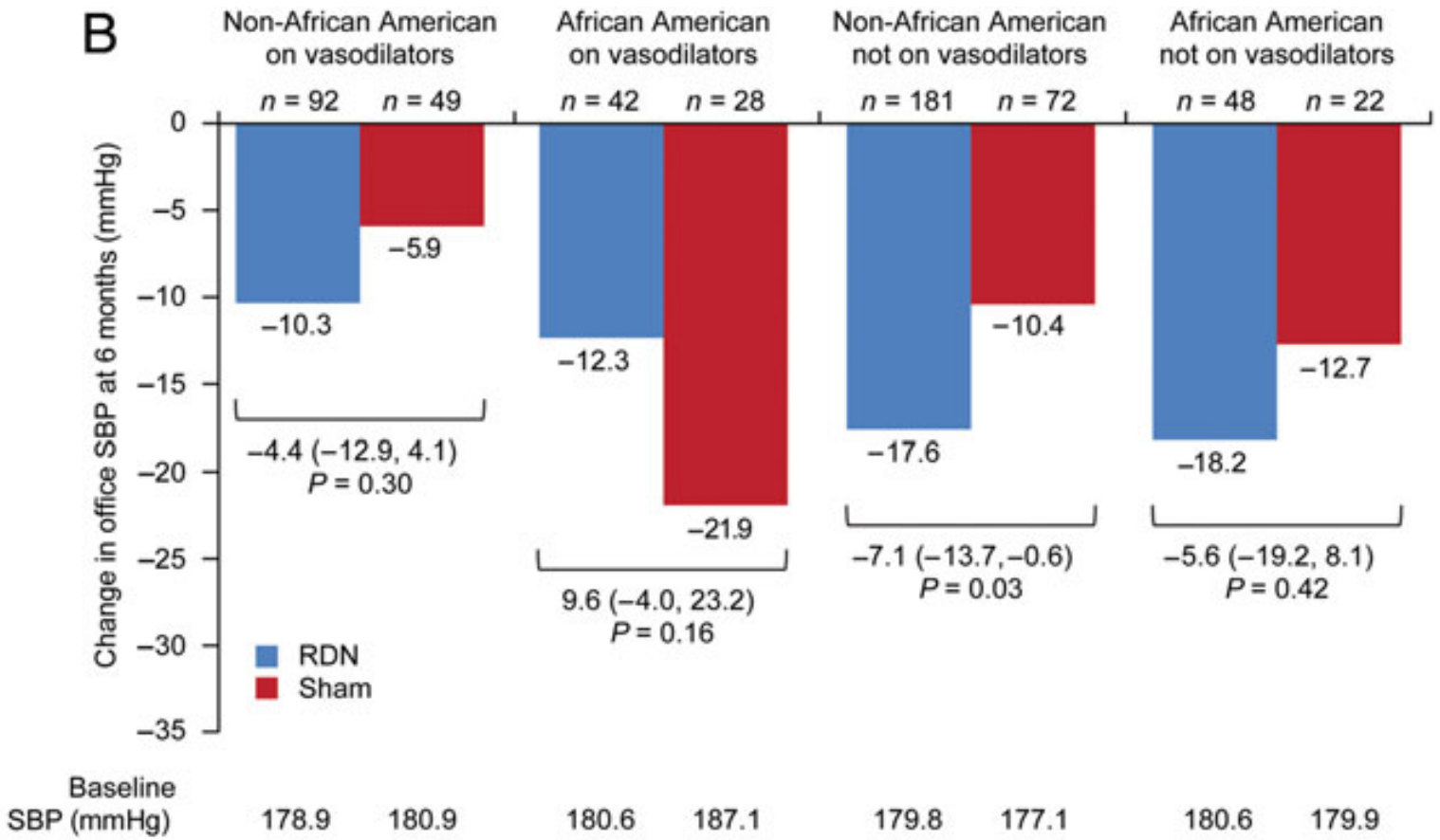
(i) Although stable antihypertensive medication was required, 22% of all patients had medication changes 2–6 weeks prior to screening. Between baseline and 6-month endpoint assessment, medication changes were documented in another 39%.

(ii) Baseline office systolic blood pressure $\geq$ 180 mmHg, aldosterone antagonist use, and non-use of vasodilators were predictors of office systolic blood pressure change at 6-month follow-up in patients undergoing renal denervation.

(iii) The number of ablation attempts and energy delivery in all four quadrants (anterior, inferior, posterior, and anterior) were associated with greater reductions in office and ambulatory blood pressure change.

(iv) Non-African Americans receiving renal denervation had a significantly greater change in office blood pressure compared with those receiving sham treatment.

Variation de la TAS sous vasodilatateurs en fonction de l'ethnie



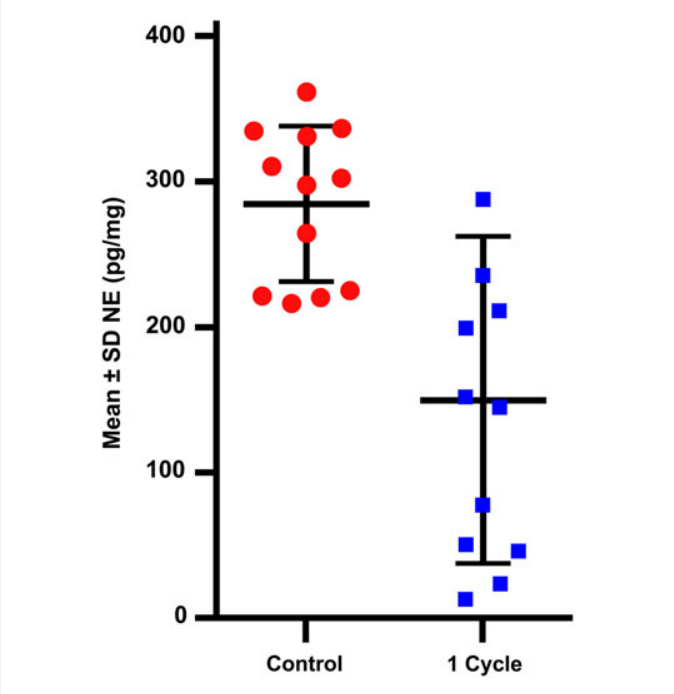
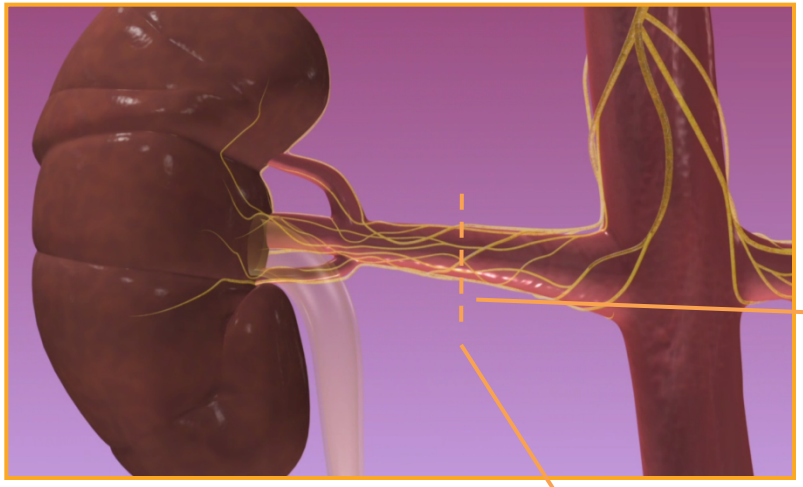


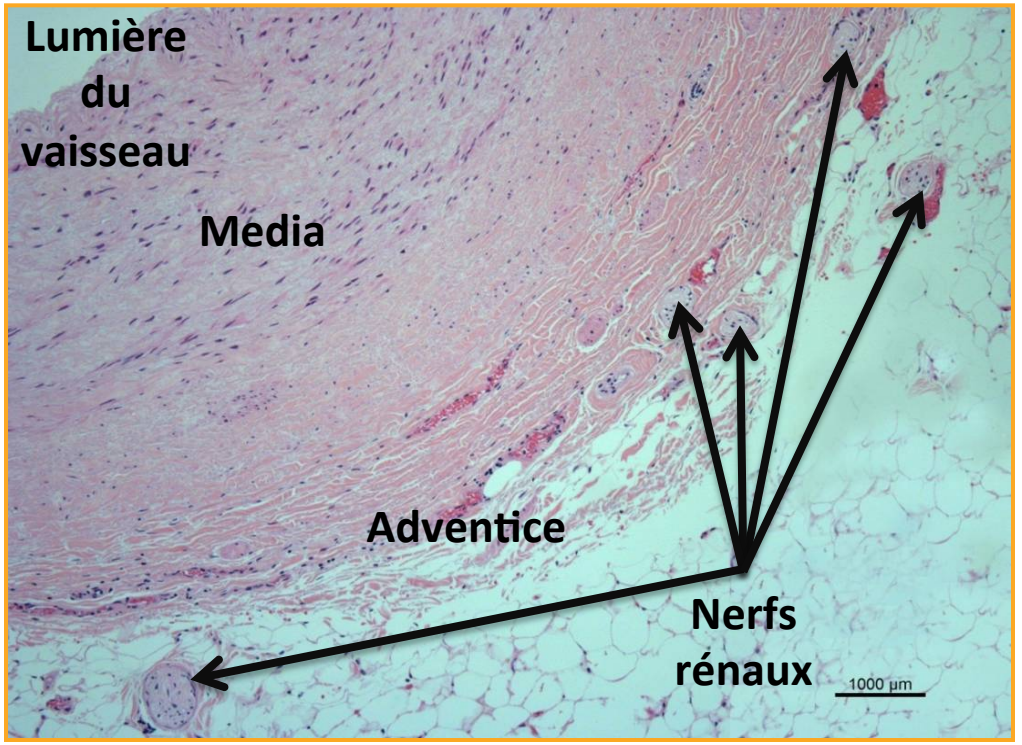
Figure 3 Effectiveness and variability of catheter-based renal denervation measured by tissue norepinephrine tissue content in pigs ($n = 12$), with application of four radiofrequency (RF) ablations in the main renal artery. Modified from Melder R.J., oral presentation TCT 2014.

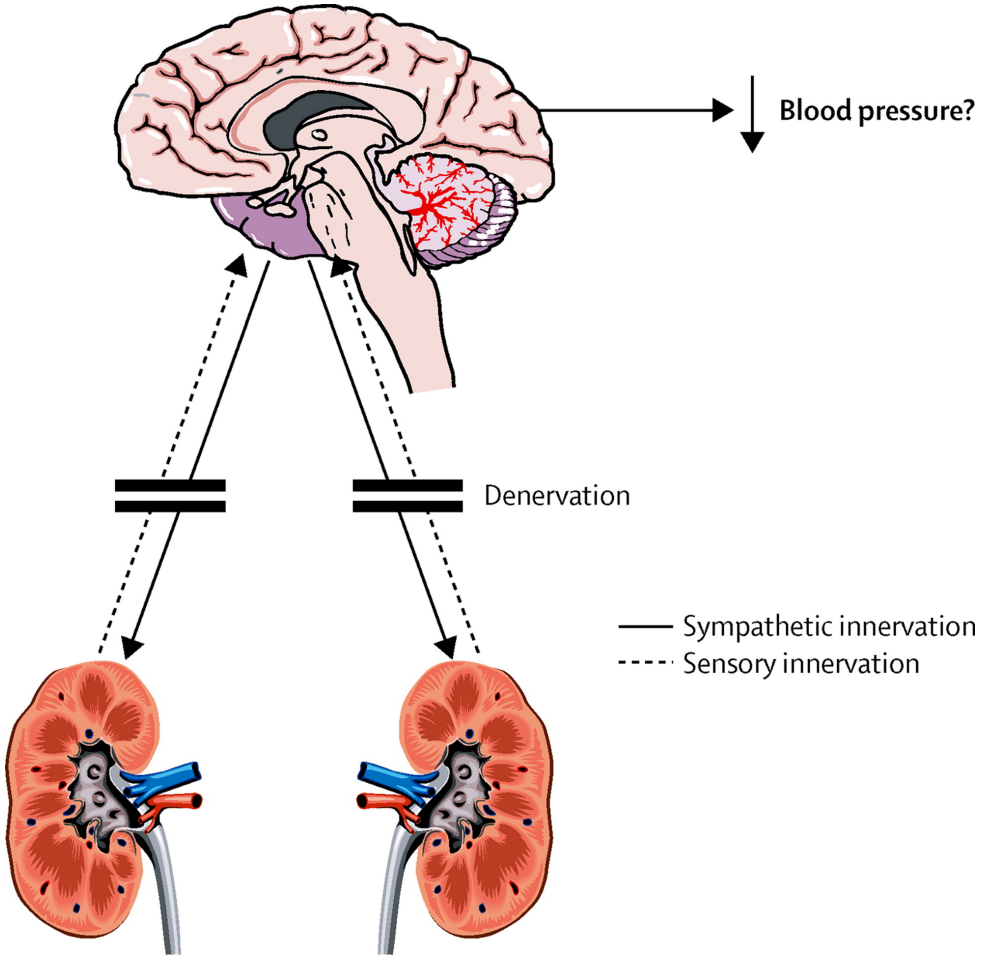
was adequate. Recently, Murray Esler published the effectiveness of catheter-based renal denervation as assessed by renal norepinephrine spillover before and 30 days after the procedure in a slightly larger population of 17 patients (*Figure 2*).[21] Again, the response to renal denervation was 40% on average, but was highly variable, ranging from 0 to 80%. Such a variability of treatment effects of renal denervation has also been documented in pre-clinical studies in pigs, when four radiofrequency ablations have been applied in the main renal artery (*Figure 3*). These results argue in favour of an incomplete and insufficient ablation of renal sympathetic nerves as a major cause of inadequate blood pressure responses to catheter-based interventions and inevitably lead to some questions. (i) Can catheter design and/or specific treatment strategies help to reduce the variability and increase conformity of the response renal nerve ablation? (ii) Does renal denervation exert a class effect or will different devices with distinct electrode designs and/or energy delivery show similar efficacy and safety?

Anatomie Nerveuse Rénale



- Les nerfs naissent de D10-L2
- Les nerfs se ramifient autour de l'artère et se situe principalement dans l'adventice




Blood pressure?
Denervation
Sympathetic innervation
Sensory innervation