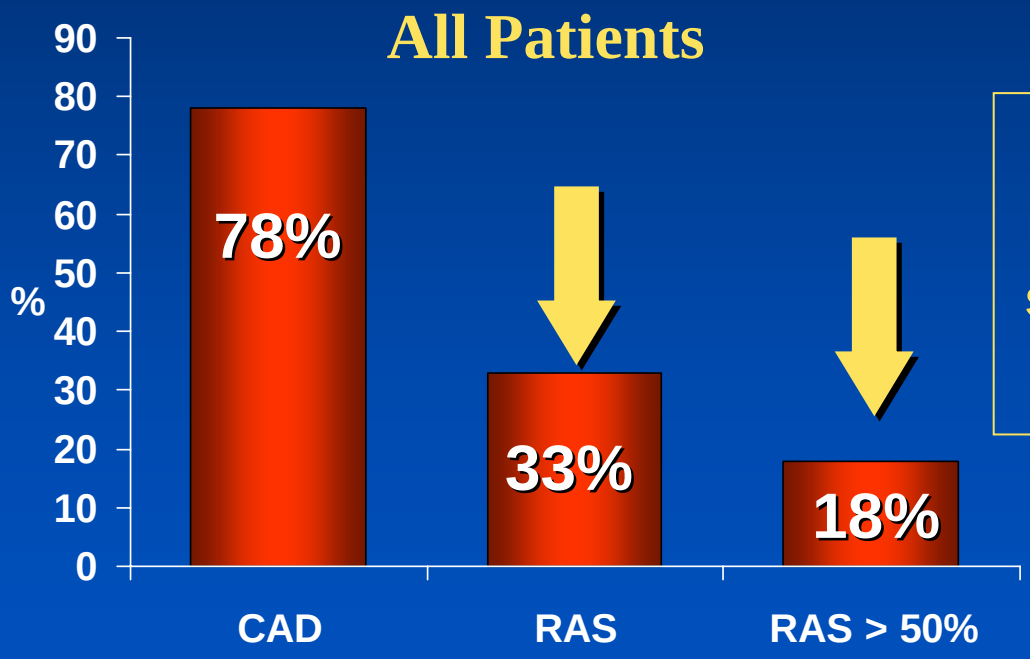
Intervention for Renal Artery Stenosis

Renal Artery Stenosis

	Incidence
General population	0.1%
Hypertensive population	4.0%
HTN & suspected CAD	10 - 20%
Malignant HTN	20 - 30%
Malignant HTN & renal insufficiency	30 - 40%
HTN and PAD	44%

Incidence of Unsuspected RAS

196 consecutive patients referred for coronary angiography for suspected CAD underwent (drive-by) renal angiography.

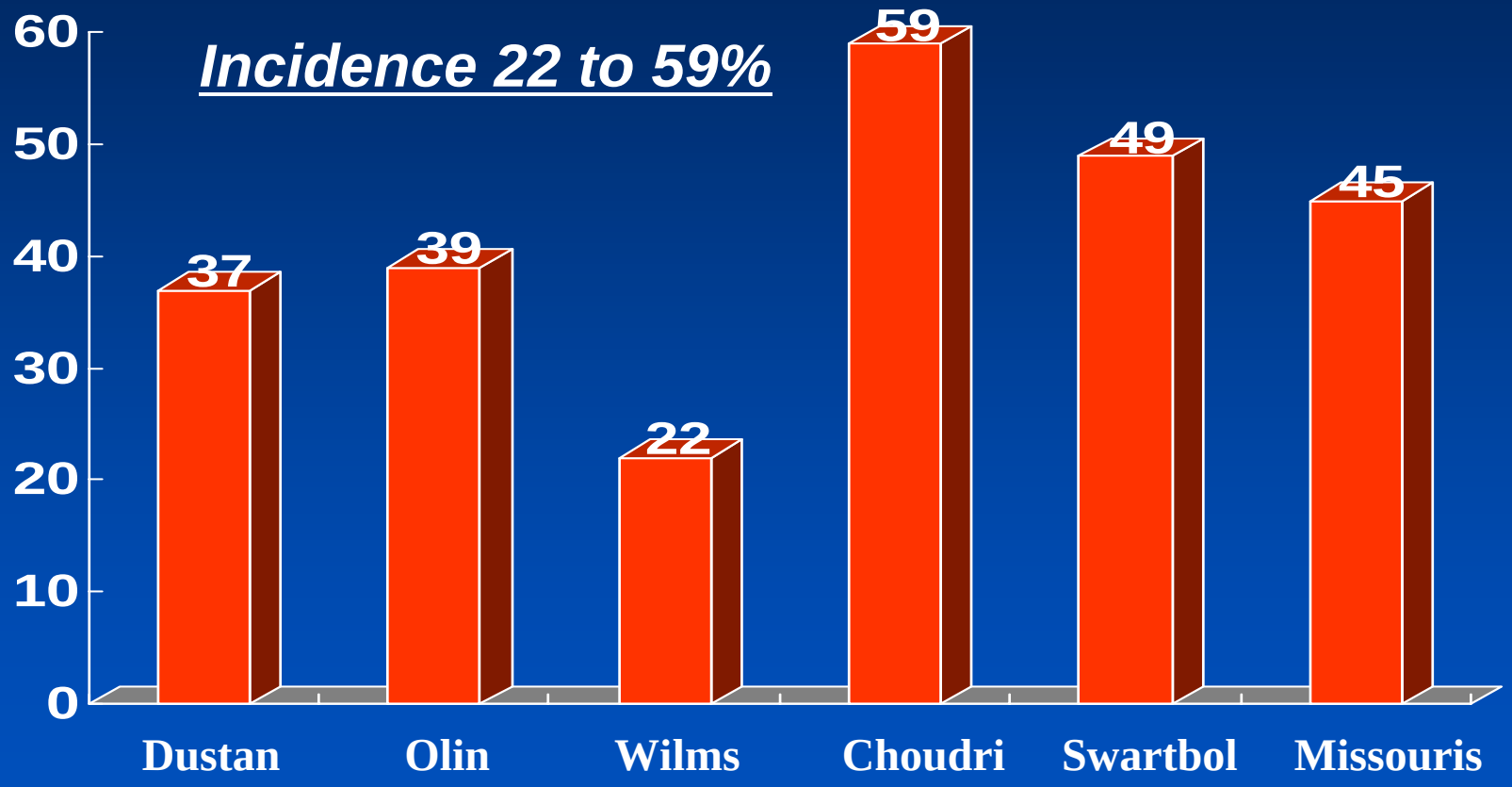


22% (1 in 5) of the patients with CAD had significant (> 50%) renal artery stenosis.

Jean WJ, et al: Cathet Cardiovasc Diagn 1994;32:8-10.

Atherosclerotic Renal Artery Stenosis

Incidence of RAS in Patients with Peripheral Vascular Disease



Scoble JE. In Renal Vascular Disease 1996:143-9

The Consequences: Renovascular Hypertension

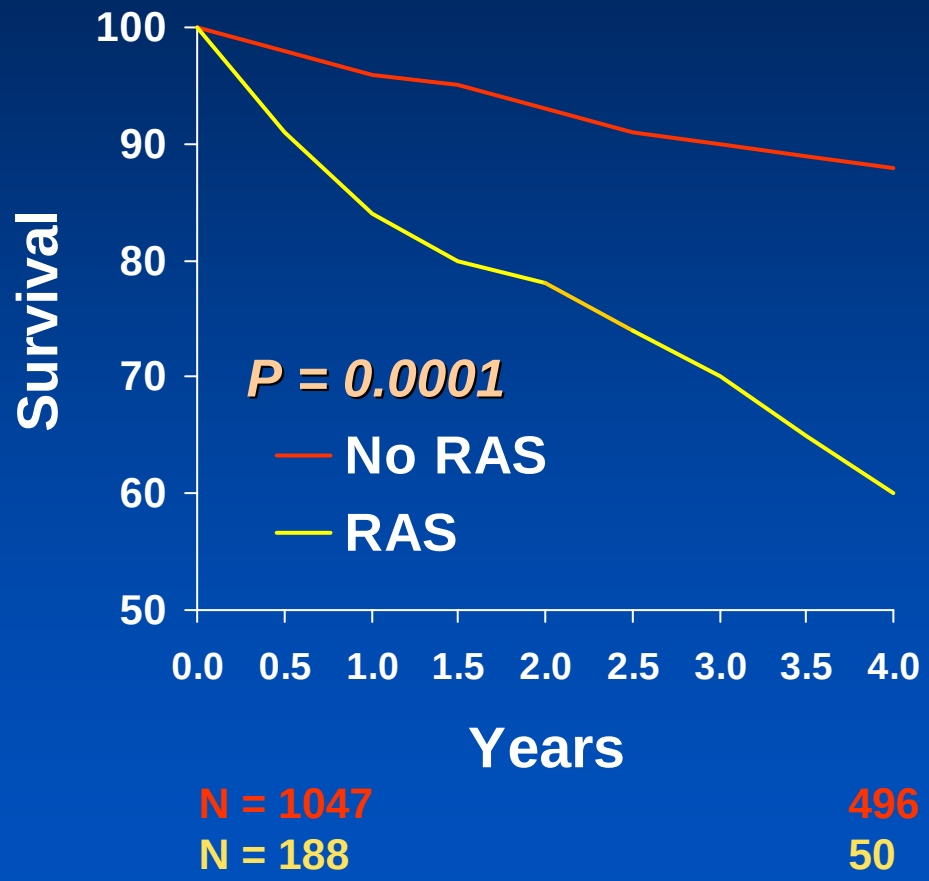
- Cardiovascular
- Renal

Cardiovascular Consequences

- LVH
- Unstable angina
- Pulmonary congestion
- Myocardial infarction
- Aortic dissection
- Stroke

4-Year Mortality

Mulivariate Analysis



Variable	Risk Ratio	P value
RAS	**2.9 (1.7 - 7.0)**	**0.0001**
LVEF	1.7 (1.2 - 2.2)	0.0002
CRI	1.3 (1.1 - 1.5)	0.02
CHF	2.4 (1.3 - 4.1)	0.0021

Conlon PJ, et al: J Am Soc Nephrol 1998;9:252-56.

Natural History of RAS

- Trend in untreated or medically treated renal artery stenoses for progression of stenosis (to occlusion) and loss of renal function.

Natural History of Renal Artery Stenosis

Review of 5 angiographic trials.

Reference	F/U, Months	Patients	Progression, N (%)	Total Occlusion
Wollenweber, 1968	12-88	30	21 (70)	NA
Meaney, 1968	6-120	39	14 (36)	3 (8)
Dean, 1981	6-102	35	10 (29)	4 (11)
Schreiber, 1984	12-60+	85	37 (44)	14 (16)
Tollefson, 1991	15-180	48	34 (71)	7 (15)
TOTAL		237	116 (49)	28 (14)

Ann Intern Med 1993;118:712-9

Progression

24,312
Diagnostic caths

↓ Suspected abdominal aorta or renal disease

14,152
Abdominal aortogram

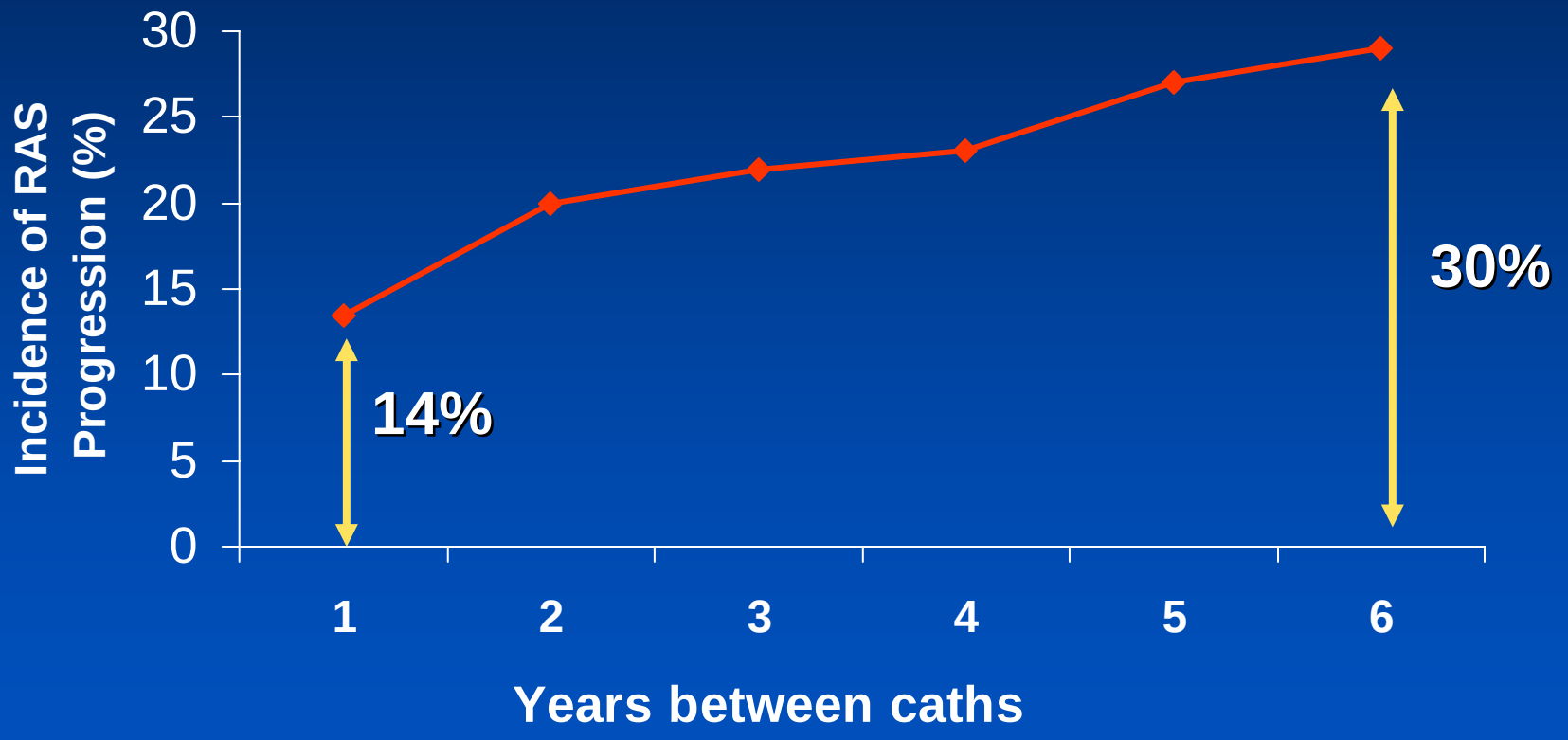
↓ > 6 months between two angiograms

1,189
F/U Aortogram

Crowley JJ, et al: Am Heart J 1998;136:913-8.

Progression

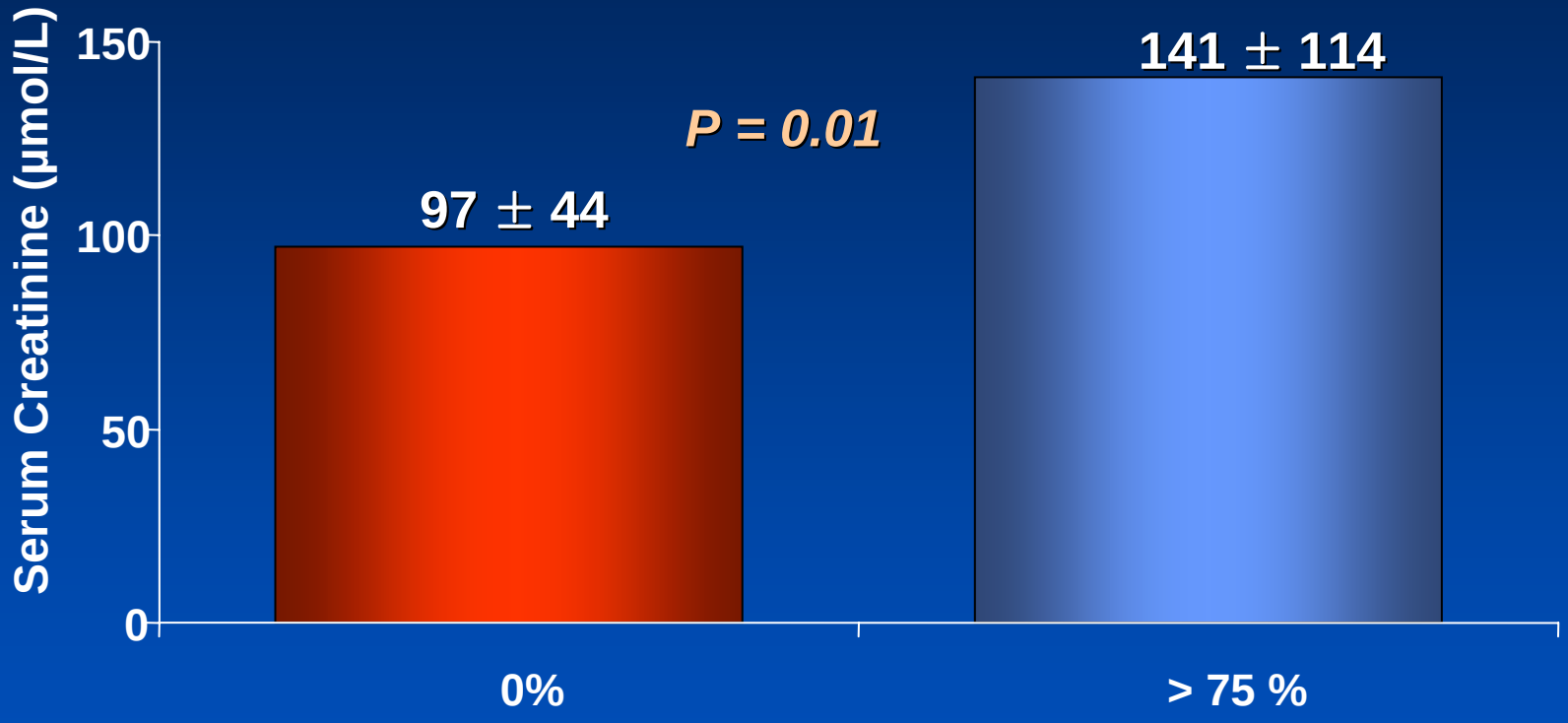
RAS progression according to time between studies (N = 1189)



Crowley JJ, et al: Am Heart J 1998;136:913-8.

Loss Of Renal Function

Disease progression is associated with a decline in renal function.



Patients with normal renal arteries at baseline.

Crowley JJ, et al: Am Heart J 1998;136:913-8.

Renal Artery Stenosis

Diagnosis

Diagnostic Tests

- IVP
- Renal vein renins
- Radionuclide renography
- Renal artery duplex imaging
- Magnetic resonance angiography
- Spiral computed tomography
- Angiography

Drive-By Angiography

- Renal angiography during cardiac or peripheral angiography in patients at increased risk for having asymptomatic renal artery stenosis:
  - Atherosclerosis
  - Hypertension

Routine Screening Angiography
The Facts

- Incidence of RAS is high in this population.
- Progression (silent) with loss of renal mass.
- Risk of screening angiography is minimal.
- RAS independently impacts prognosis.
- Angiography is the “gold standard” for diagnosis.

Low Risk Information

- Neglible risks of abdominal Aortography
  - Little if any extra contrast.
  - Minimal x-ray.
  - Pigtail catheter is atraumatic and will be advanced to the heart anyway.

Renal Artery Stenting

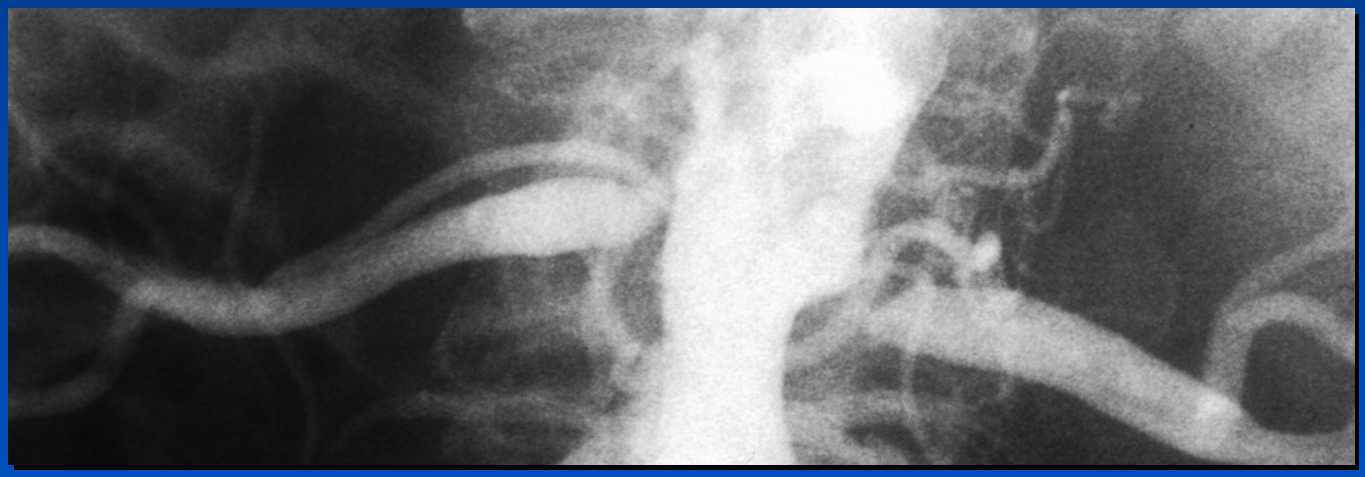
Effect and Indication

Goal of Renal Stenting

- Clinical goals
  - Improves control of HTN
  - Preserves renal function
  - Controls of cardiac syndromes (CHF/Angina)

Criteria For Renal Stenting

- Which lesions, if any, should be treated ?
  - Solitary ≥ 70% stenosis.
  - Bilateral ≥ 70% stenoses.
  - Unilateral ≥ 70% stenosis.



RA Stenting - Technical Success

Study Series	Year of Publication	Study Period	# of Arteries	Stent Type	Ostial Lesion	Success Definition	Technical Success (%)
Rodriquez-Lopez	1999	93-96	125	Palmaz	66	No RS/dissection	98
van de Ven	1999	93-97	52	Palmaz	100	RS*<50%	90
Henry	1999	NA	104	AVE	77	RS <20%	99
Rocha-Singh	1999	93-95	180	Palmaz	43	#PG<5mmHg	98
Tuttle	1998	91-96	148	Palmaz	100	RS<30%	98
Dorros	1998	90-95	202	Palmaz	NA	RS<50%	99
Rundback	1998	NA	54	Palmaz	NA	RS<30%	94
White	1997	92-94	133	Palmaz	81	RS<30%	99
Harden	1997	92-95	32	Palmaz	75	RS<10%	100
Blum	1997	89-96	74	Palmaz	100	RS<50%	100
Henry	1996	90-94	64	Palmaz	53	RS<20%	100
Iannone	1996	92-93	83	Palmaz	78	RS<30%	99
Hennequin	1994	87-91	21	Wallstent	33	NA	100
Rees	1994	88-92	296	Palmaz	100	RS<30%	98

*RS=Residual Stenosis #PG=Pressure Gradient

~98%

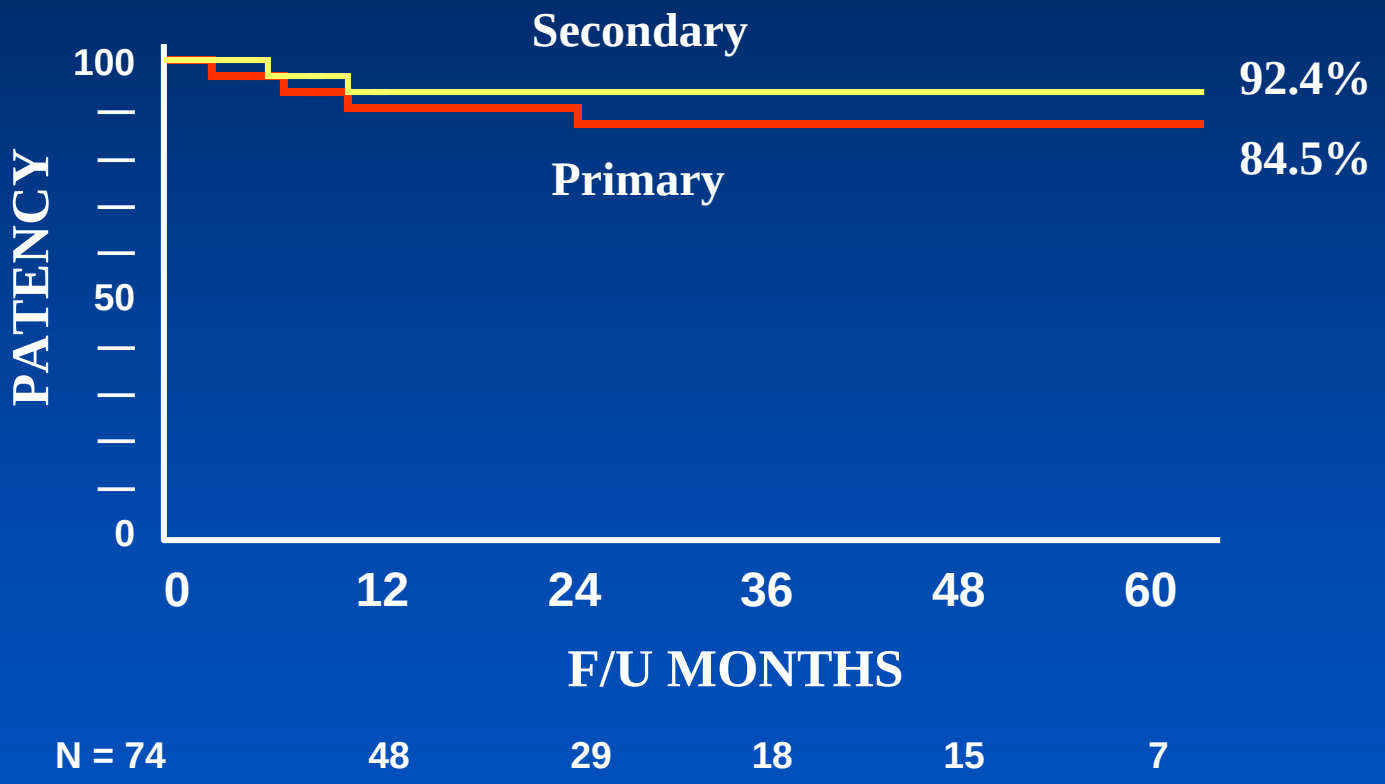
RA Stenting - Restenosis

Study Series	# of Arteries	Arteries Evaluated (% original total arteries)	Ostial Lesion	Stent Type	Method of Evaluation	Average time to evaluation (months)	Restenosis (% of arteries evaluated)
van de Ven, 1999	52	50 (95%)	100	Palmaz	angio*	6	21%
Rocha-Singh, 1999	180	158 (88%)	43	Palmaz	duplex+angio	13	12%
Tuttle, 1998	148	49 (33%)	100	Palmaz	angio	8	14%
Rundback, 1998	54	28 (52%)	NA	Palmaz	angio+spiral CT	12	26%
White, 1997	133	80 (60%)	81	Palmaz	angio*	9	19%
Harden, 1997	32	24 (75%)	75	Palmaz	angio*	6	12%
Blum, 1997	74	74 (100%)	100	Palmaz	angio*	24	11%
Henry, 1996	64	54 (84%)	53	Palmaz	angio*	14	9%
Iannone, 1996	83	69 (85%)	78	Palmaz	duplex	11	14%
Dorros, 1995 [30]	92	56 (61%)	100	Palmaz	angio*	7	25%
Hennequin, 1994	21	20 (95%)	33	Wallstent	angio*	29	20%
Rees, 1994	296	150 (51%)	100	Palmaz	angio*	7	33%
					Weighted Average	10	~20%

Renal Stent Patency

6-year follow-up

n = 74

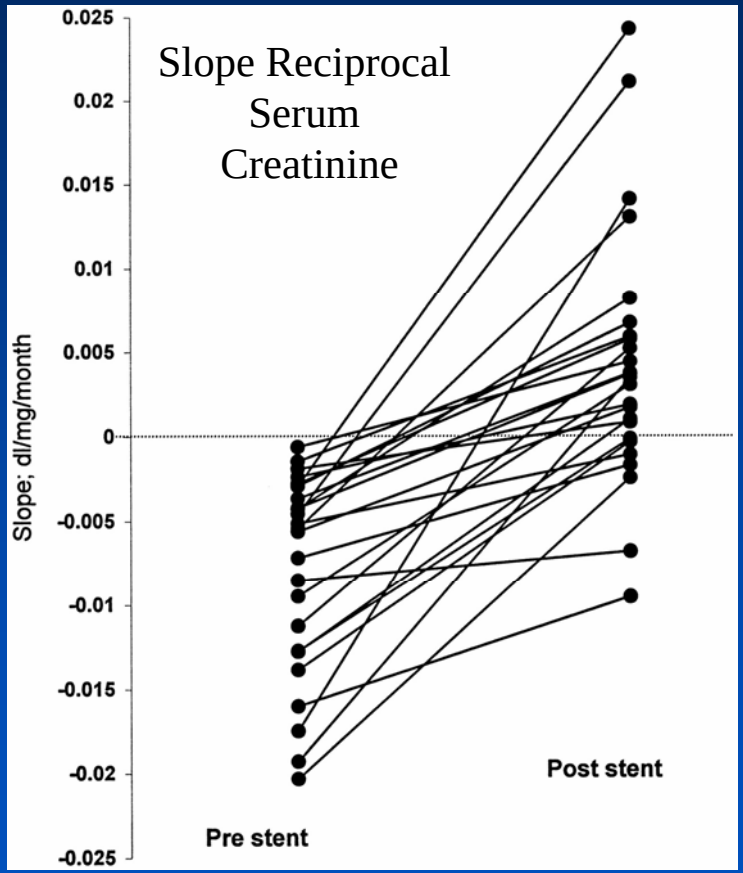


Blum, et al. *N Engl J Med.* 1997;336:459-465.

Renal Artery Stenting & Renal Dysfunction

Effect of Renal Artery Stenting on Renal Function and Size

- 25 patients (mean 20±11 m)
- Renal stenting:
  - CRI (Cr ≥ 1.5 mg/dL)
  - Global renal ischemia (≥ 70% stenosis)
  - Bilateral RAS
  - Unilateral RAS with solitary kidney
- Before intervention all negative slope
- After intervention, slopes were positive in 18 and less negative in 7 patients



Circulation 2000;102:1671-7

Kidney Size Following Renal Stenting

Kidney size did not change

- Pre-intervention and serial follow-up sonograms obtained
- Baseline renal length 10.4±1.4 cm
- Follow-up renal length 10.4 ±1.1 cm (mean follow-up 19 ±10 months

Circulation 2000;102:1671-7

Effect on Renal Function

Table 4. Effect of Renal Stenting on Renal Function

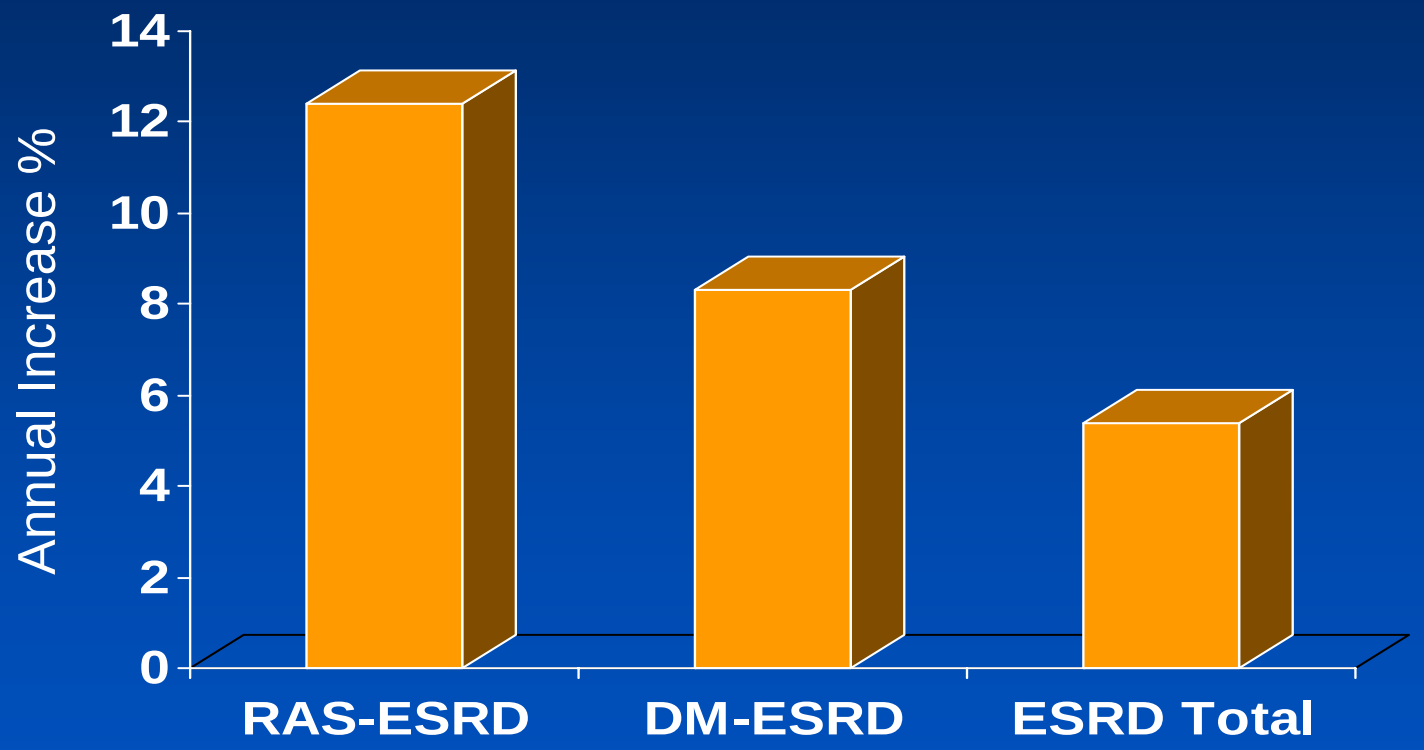
Study series	No. of patients	Renal function		
		Improved (%)	Stable (%)	Deteriorated (%)
van de Ven, 1999	42	12%	62%	26%
Rocha-Singh, 1999	150	22%	70%	8%
Tuttle, 1998	129	15%	81%	4%
Dorros, 1998	163	18%	48%	34%
Rundback, 1998	45	20%	47%	33%
Harden, 1997	32	34%	38%	28%
Weighted Averag		**19%**	**62%**	**19%**

Lim and Rosenfield, Curr Int Cardiol 2000,2:130-139.

Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

- Dialysis-dependent renal failure with > 70% renal artery stenosis to entire functioning renal mass
  - Bilateral RAS
  - RAS to solitary functioning kidney
- Rapid decline in renal function in the 14 weeks prior to starting dialysis is favorable prognostic sign for recovery of renal function (Hansen, 1995)

Mortality in ESRD Attributed to RAS



Am J Kidney Dis 2001;37:1184-90

Renal Artery Stenosis and HTN

Renal Artery Stenting

Effect on Hypertension

Study series	No.	Cure (%)	Improved (%)	Benefits (%)
Tegtmeyer	65	23	71	94
Klinge	134	10	68	78
Martin	94	22	46	68
Lossino	153	12	51	63
Rodriguez-Perez	37	0	81	81
Blum	74	16	62	78
Pooled Result	586	14	63	~ 77%

ASPIRE 2

A Study to evaluate the safety and effectiveness of the **P**almaz balloon expandable stent **I**n the **RE**nal artery after failed angioplasty

- Restenosis rate of 17% after stenting is comparable to restenosis rates in literature
  - Extremely favorable compared to PTRA alone
  - Comparable to surgical revascularization
- Blood Pressure Response showed significant reductions in blood pressure at 9 and 24 months
  - Systolic:
    - 18.1 point improvement at 9 mo. (10.8% decrease)
    - 18.3 point improvement at 24 mo. (10.9% decrease)
  - Diastolic:
    - 4.2 point improvement at 9 mo. (5.1% decrease)
    - 4.7 point improvement at 24 mo. (5.7% decrease)

Rocha-Singh K, J Am Coll Cardiol 2005;46:776-86.

ASPIRE 2

A Study to evaluate the safety and effectiveness of the **P**almaz balloon expandable stent **I**n the **RE**nal artery after failed angioplasty

ASPIRE 2 Trial — Systolic Pressure

Visit	N	Mean±SD	P-Value
Baseline	208	167.6±25.2	
Discharge	202	147.6±22.3	<0.001
1 Month	196	151.5±24.4	<0.001
6 Month	182	149.2±22.9	<0.001
9 Month	178	149.5±23.8	<0.001
24 Month	**158**	**149.3 ± 25.3**	**<0.001**

Rocha-Singh K, J Am Coll Cardiol 2005;46:776-86.

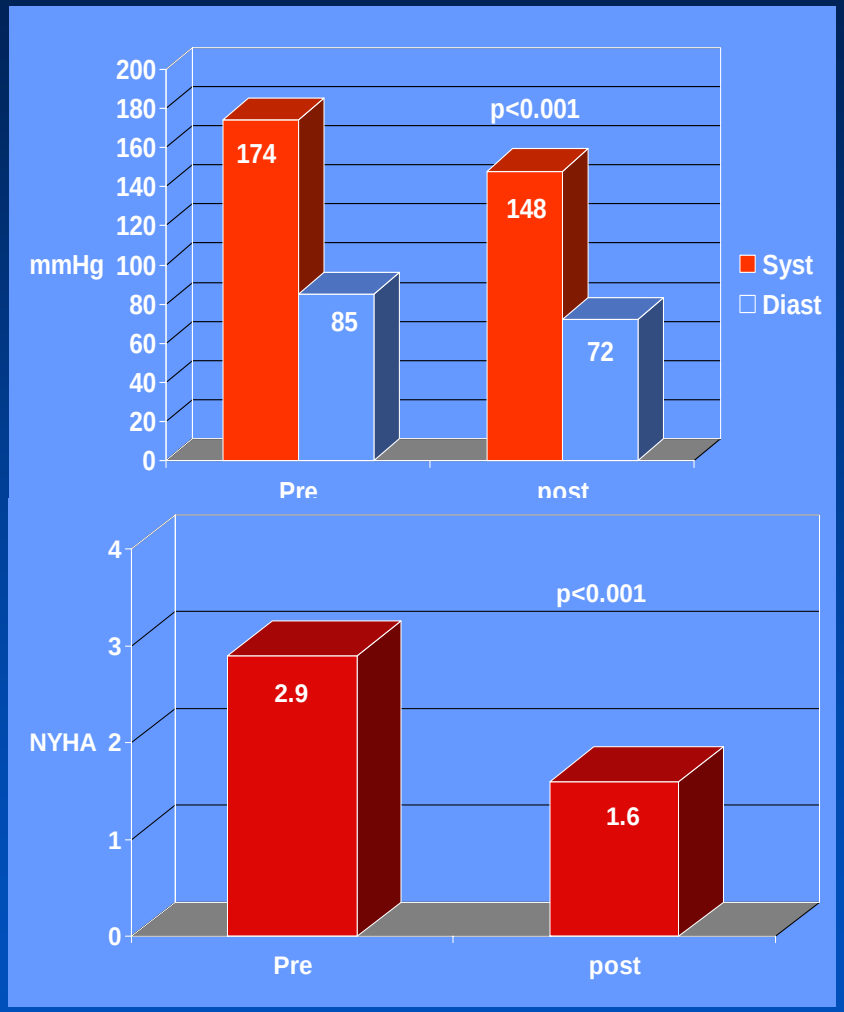
Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

- Refractory/resistant hypertension and unilateral/bilateral > 70% RAS
  - Expect decrease in number of antihypertensive medications required
  - Easier to control blood pressure
  - Unlikely to "cure" hypertension

CHF and Pulmonary Edema

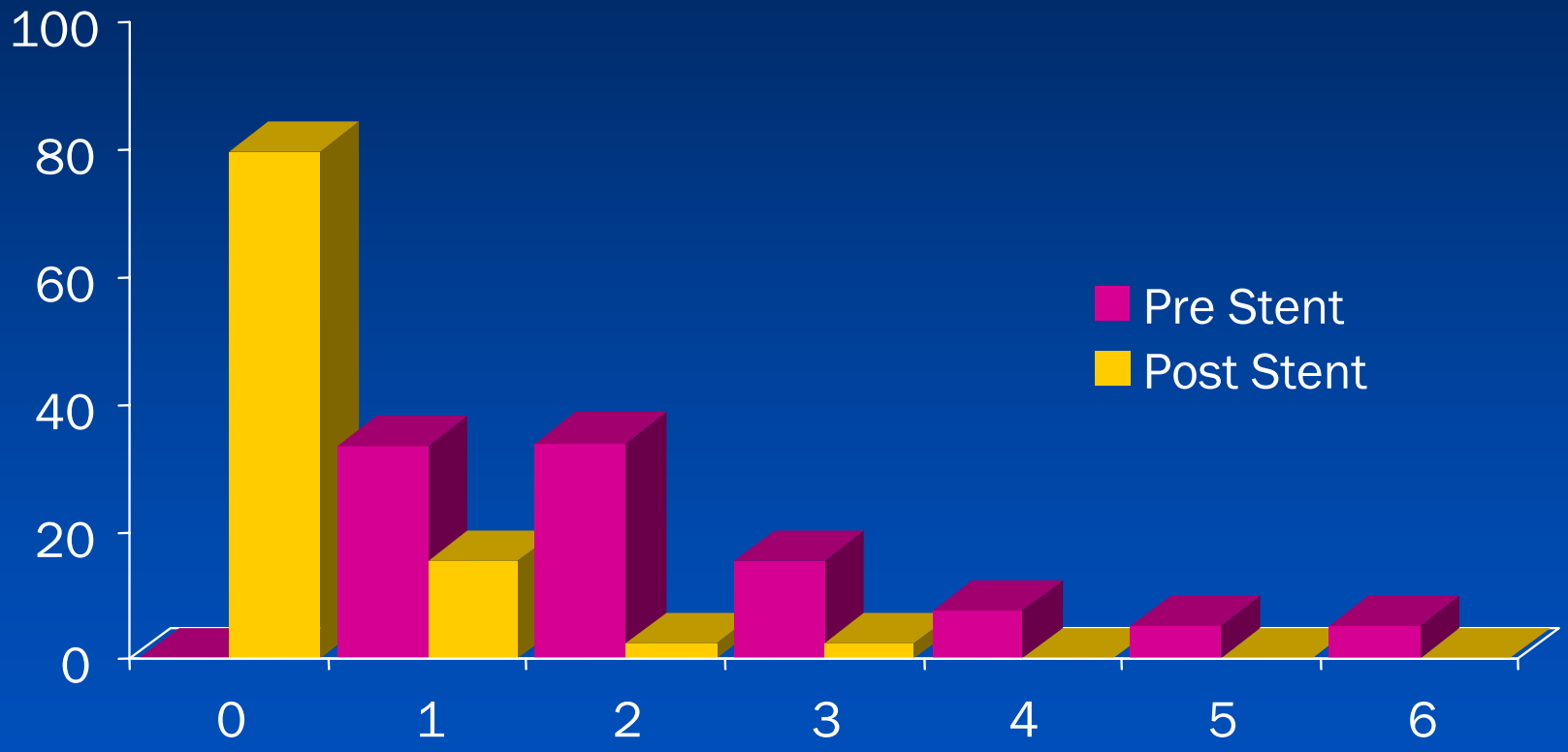
Renal Artery Stenting for Control of Congestive Heart Failure

- 39 RAS for of recurrent CHF and flash pulmonary edema
- All patients had either:
  - Bilateral RAS >70% (n = 18) or >70% RAS to a solitary kidney (n = 21)
  - Of patients with bilateral RAS, 12 (66.6%) underwent bilateral stenting



Gray BH, et al. *Vascular Med.* 2002;7:275-279.

Effects of Renal Artery Stenting on Hospitalizations for CHF



Gray BH, et al. *Vascular Med.* 2002;7:275-279.

Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

- Recurrent "flash" pulmonary edema
  - Solitary functioning kidney
  - Bilateral renal artery stenosis
  - Improvement in symptoms; blood pressure; reduction in hospitalizations for flash pulmonary edema

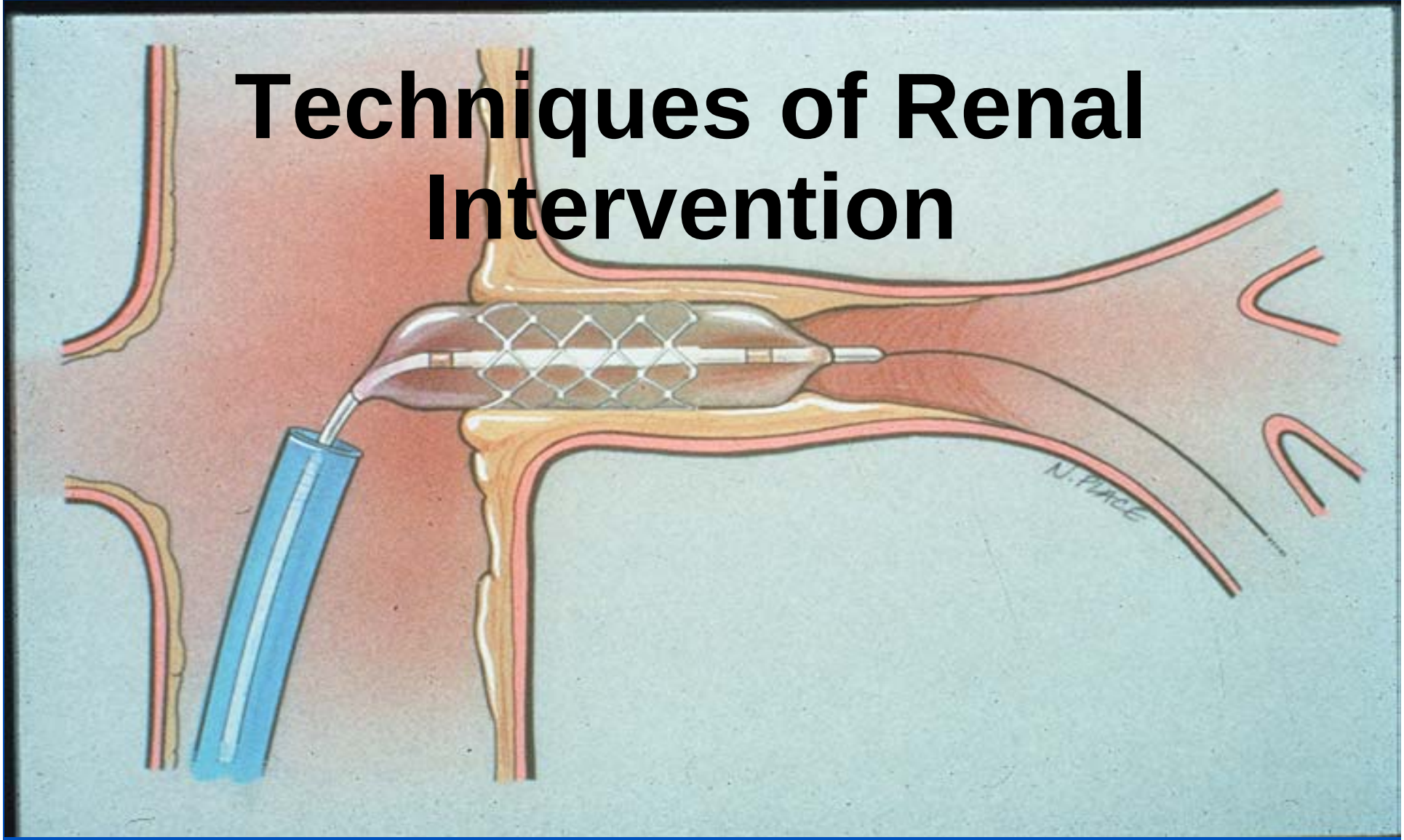
RAS without HTN or RI

Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

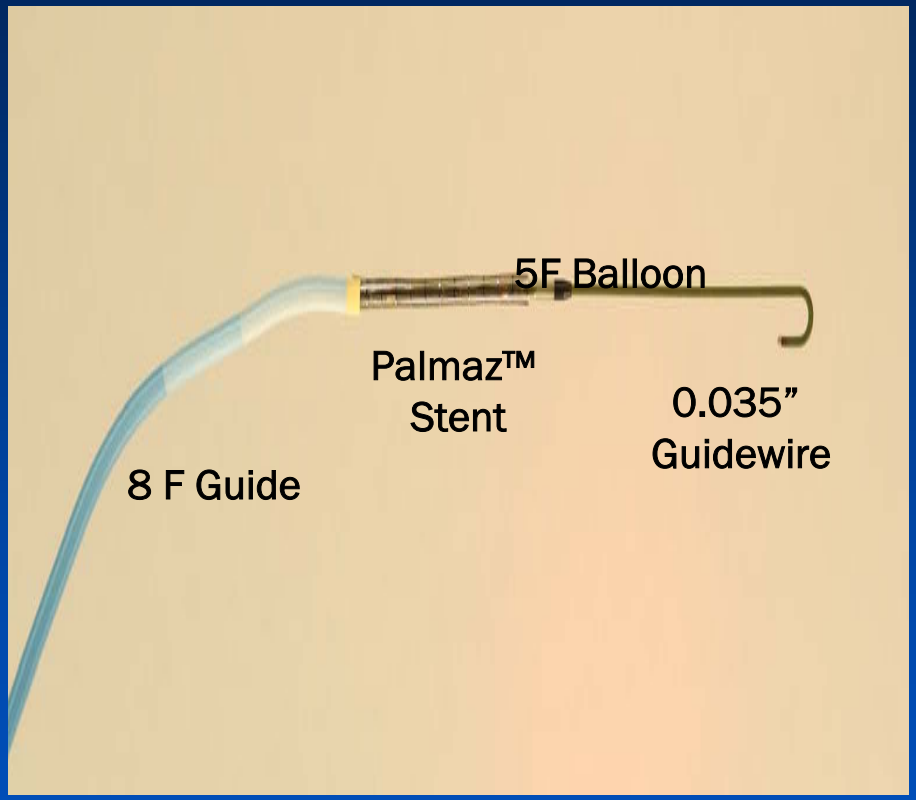
- Unilateral renal artery stenosis with normal/well-controlled hypertension, normal renal function
  - Observe
    - Serial duplex surveillance program
  - (?) Revascularize if lesion is critical

Renal Artery Stenting

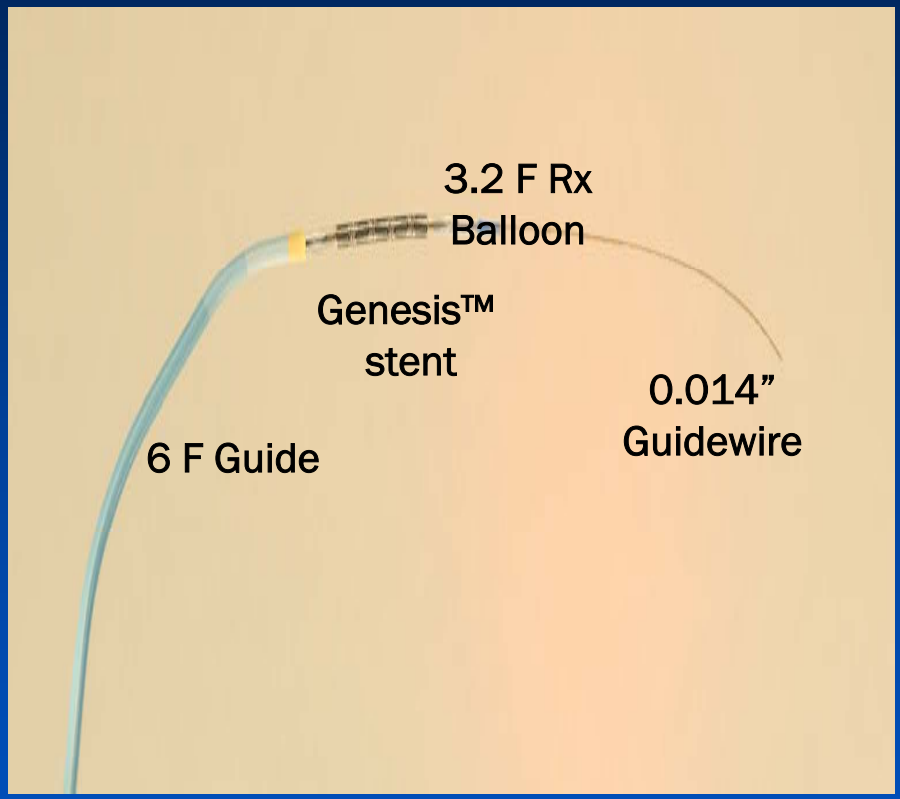
Techniques of Renal Intervention



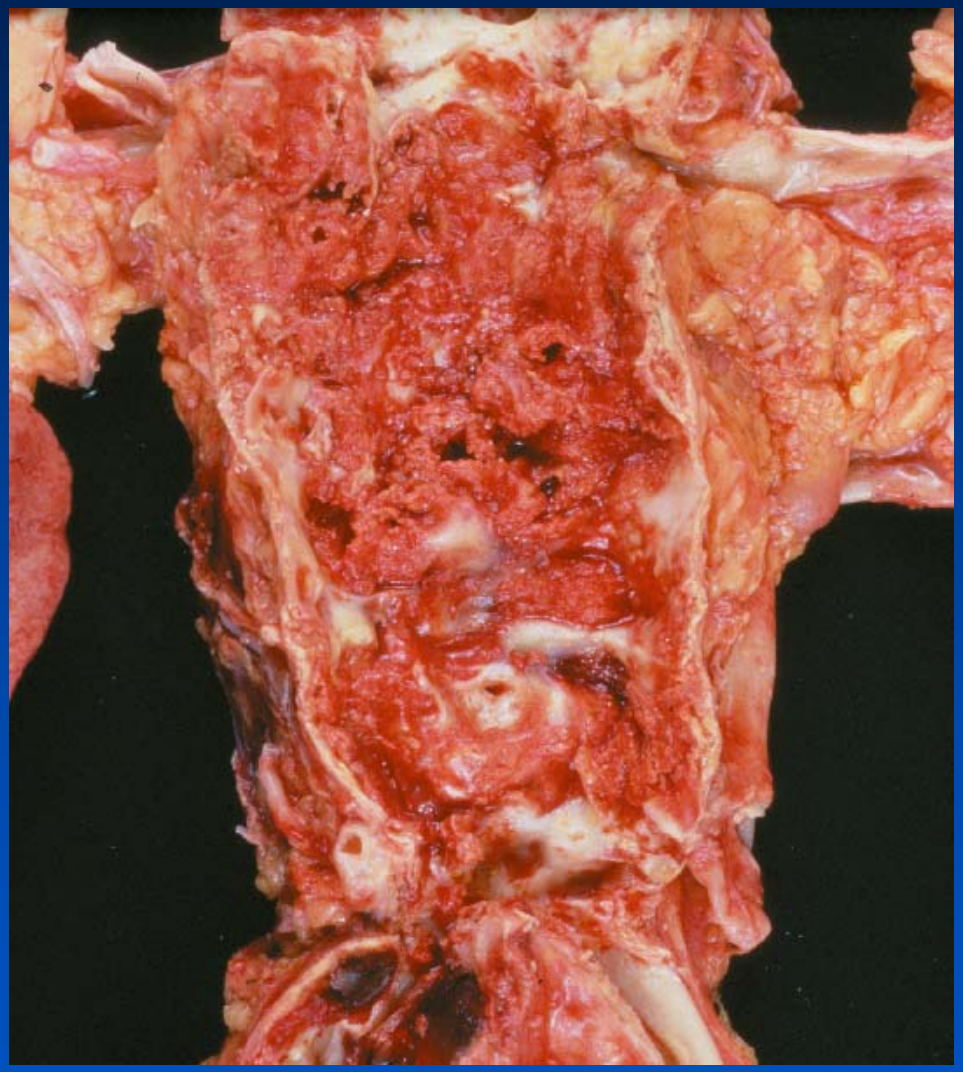
Renal Artery Stenting - 1993

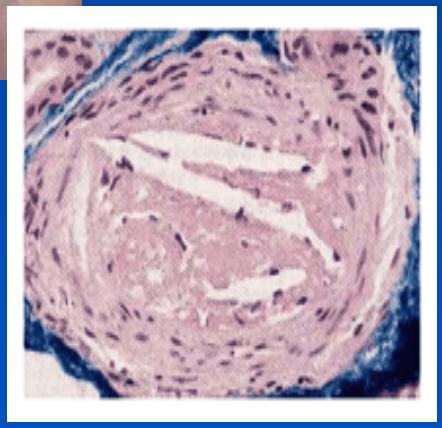


Renal Artery Stenting - 2006



Atheroembolism



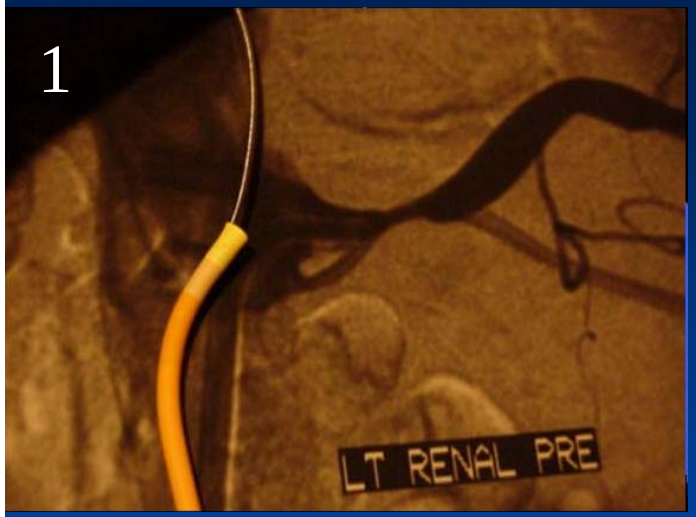


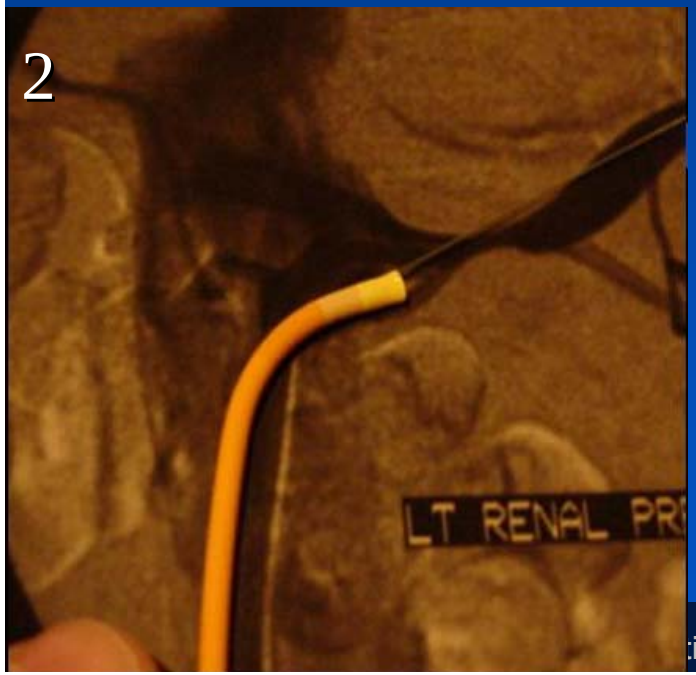
Optimal Technique

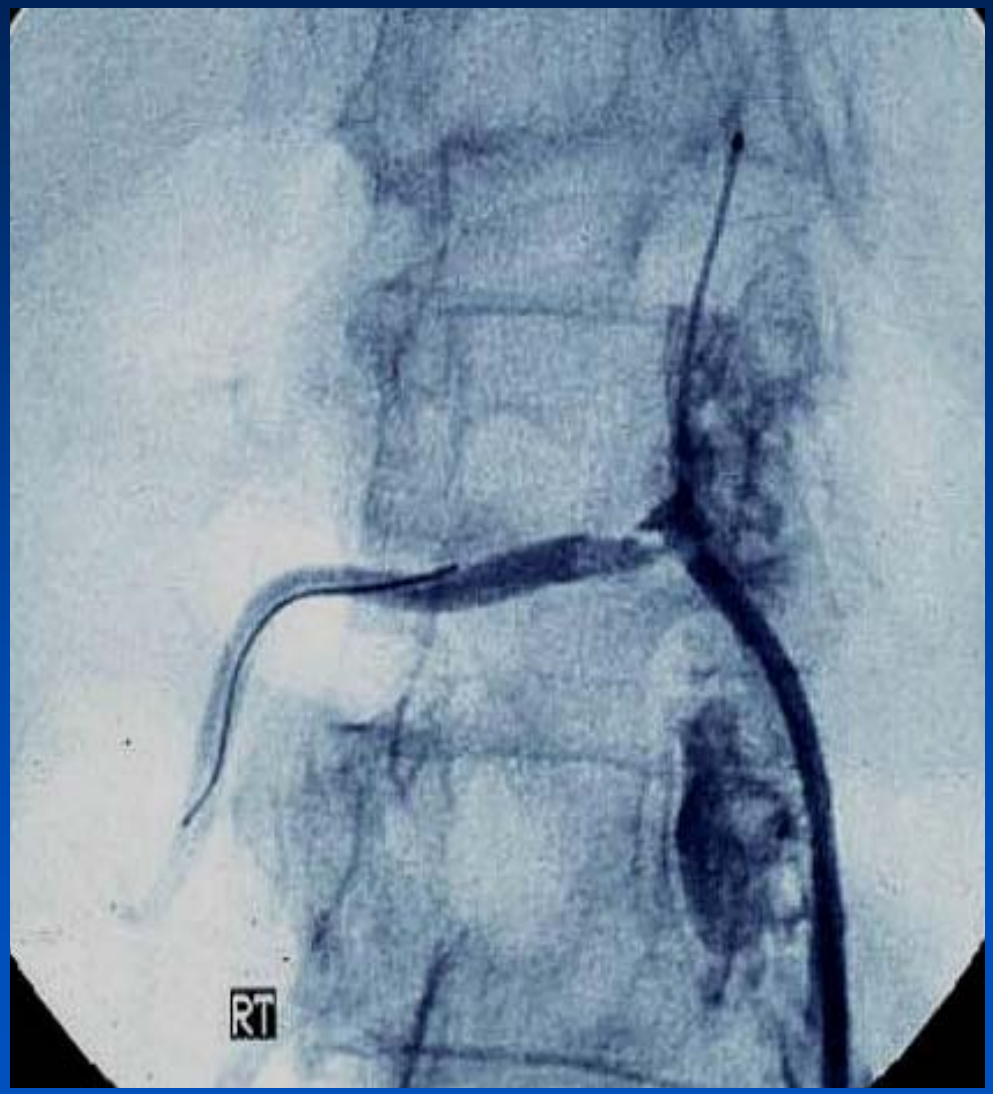
Severe atherosclerotic disease of abdominal aorta

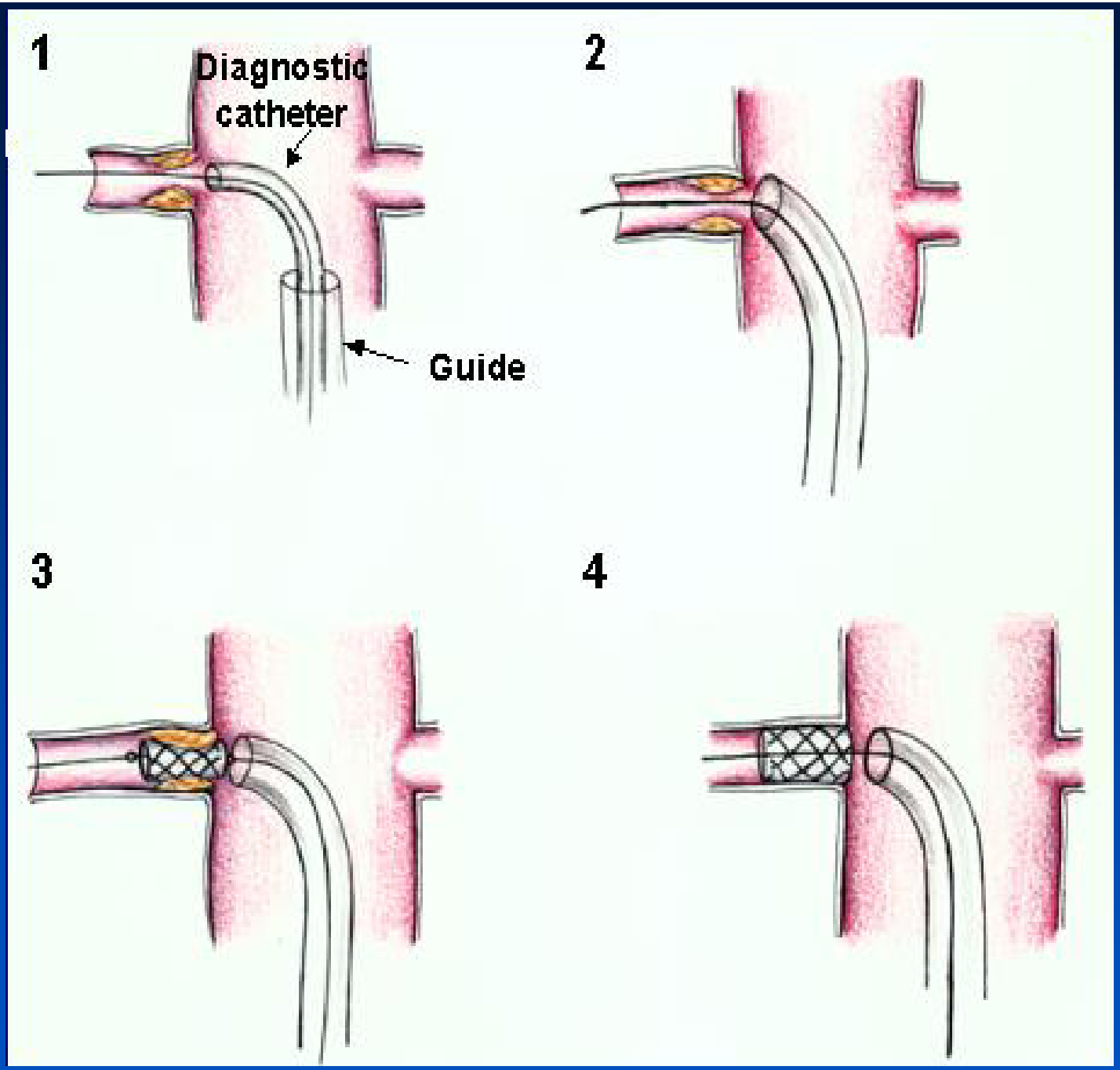
- Minimize catheter manipulation in the aorta
  - Engage renal artery with softer diagnostic catheter (telescoped inside guide catheter)
  - "No touch" technique
- Consider brachial artery approach for heavily diseased abdominal aorta or extreme downward take-off of renal artery
- Consider embolic protection for high risk cases with appropriate anatomy

“No Touch” Technique








1
Diagnostic catheter
Guide
2
3
4

Optimal Technique

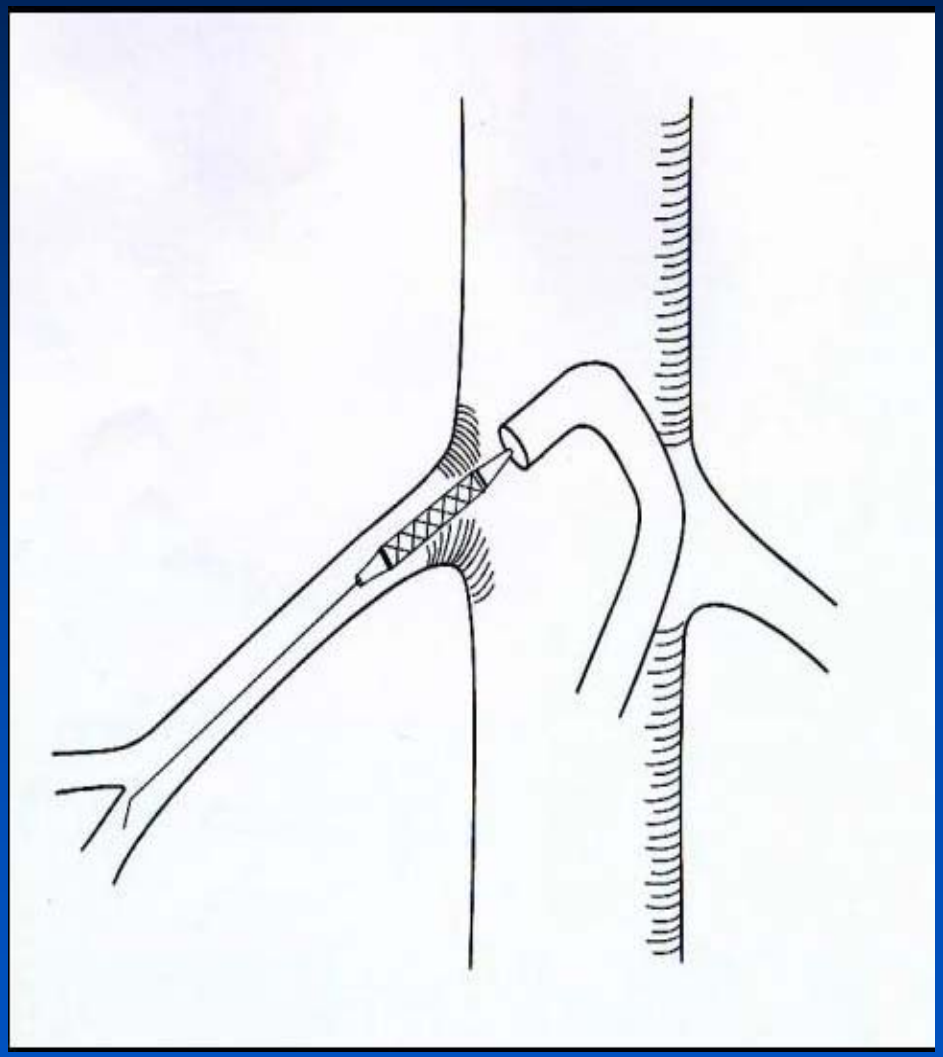
Severe Baseline Renal Insufficiency

- Pretreatment for contrast nephropathy:
  - Hydration
  - Mucormist
  - Sodium Bicarbonate
- Minimize contrast use:
  - DSA
  - Low or iso-osmolar contrast
  - Strict discipline with injections
  - Intraarterial Gadolinium or CO_2
  - IVUS
- Distal protection?

Optimal Technique

Ostial Disease

- Identify the true ostium – angulated views
- Adequate predilatation
- Leave stent 1-2 mm into aorta
- Account for stent shortening
- Confirm complete ostial coverage

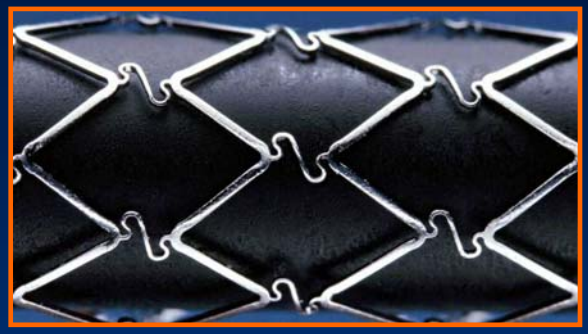


Improving Results of Renal Artery Stenting

- Drug Eluting Stents
- Distal Protection Devices

GREAT Trial

Palmaz® Genesis™ Peripheral Stainless Steel Balloon Expandable Stent: Comparing a Sirolimus-eluting stent versus an Uncoated Stent in REnal Artery Treatment



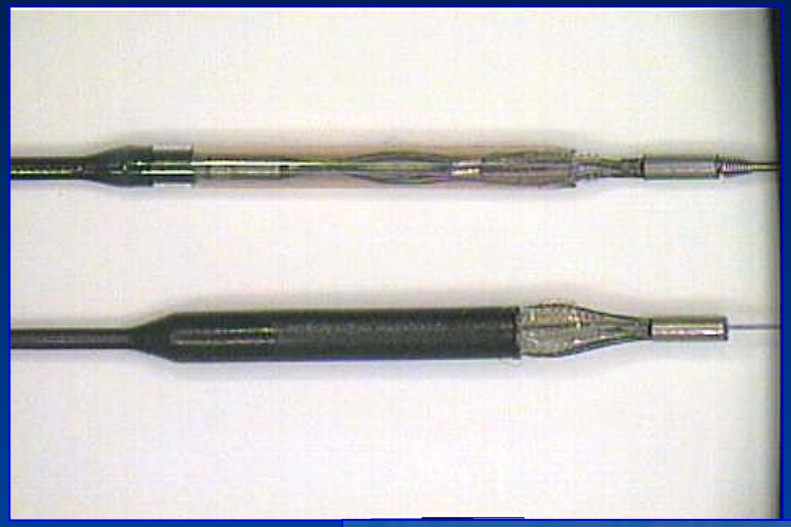
CYPHER™ Sirolimus-Eluting PALMAZ® GENESIS™ Balloon Expandable Stent

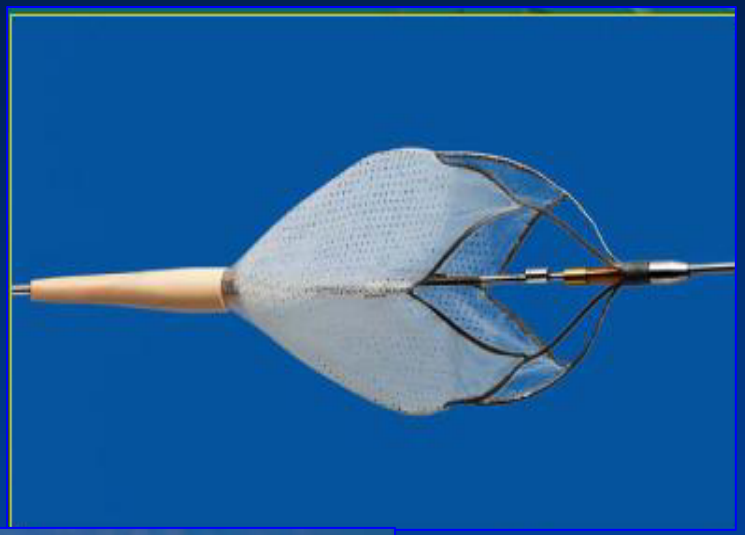
- Multi-center, prospective, non-randomized, European Feasibility Trial
- Sequential enrollment of 50 bare and 50 sirolimus-eluting stents
- Enrollment complete
- Results will be reported in 2004

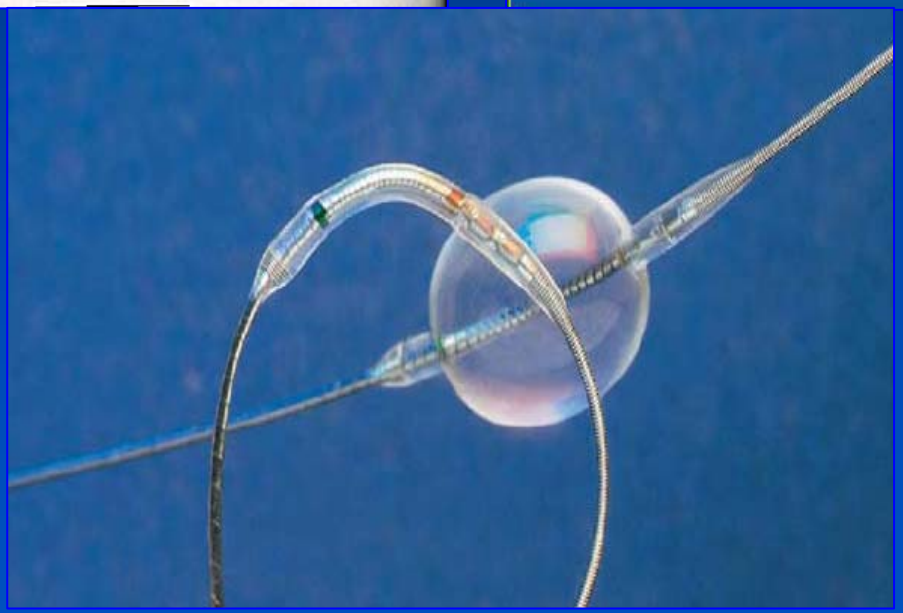
GREAT: Conclusions

- The Sirolimus-eluting Genesis stent results were encouraging with improved late loss, mean % DS, and restenosis rate at 6 months compared to the bare stent
- Restenosis was 14.3% in the BMS and 6.7% in the Sirolimus-eluting arm
- Sirolimus-eluting stent decreased TVR 50% from 7.7% to 3.8%
- Clinical trials are needed with more patients to investigate the effect of DES on outcomes

Distal Protection During Renal Stenting



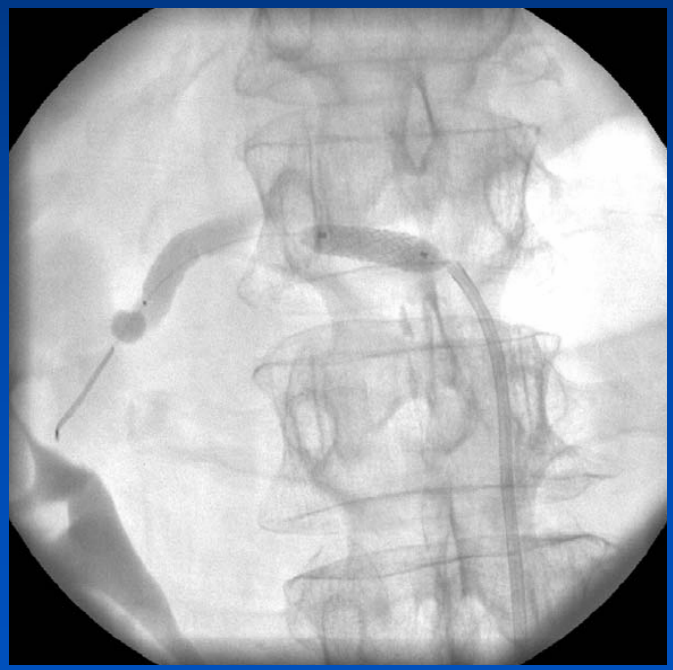




Distal Protection

N = 27, 32 procedures

- 24 (92%) patients had renal insufficiency
- Technical success : 100%
- Mean pre-& post-intervention Cr : 1.9 vs 1.6 mg/dL (p<0.001)
- Improved renal function :52%, worsened in none

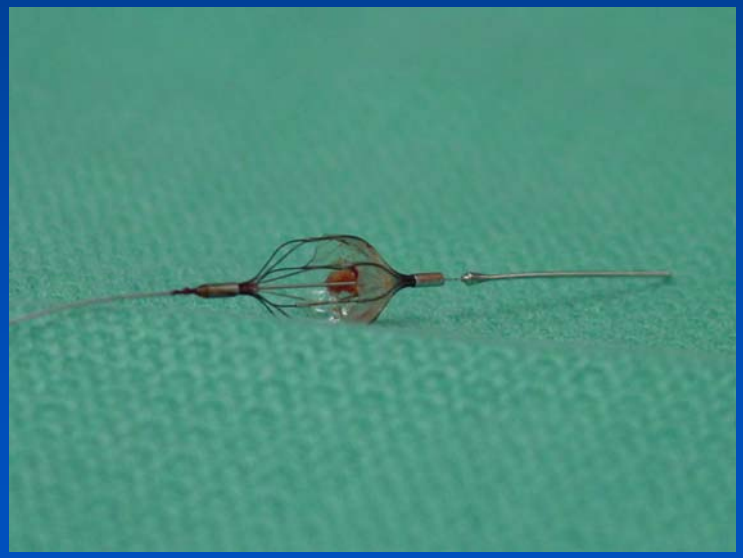


Edward MS, et al: J Vasc Surg 2006;44:128-35.

Distal Protection

C Cooper

- Distal protection has a powerful effect on adverse events during SVG intervention
  - preliminary data suggest that distal protection may prevent renal insufficiency after renal intervention
  - However, anatomy may limit utility in renal application



Edward MS, et al: J Vasc Surg 2006;44:128-35.

Conclusions

- With modern equipment and skilled operators, renal artery stenting can be performed with high technical success (>98%) and low restenosis (15-20%)
- Following successful renal stenting there is slowing of deterioration of renal function and prevention of renal atrophy

Conclusions

- HTN is rarely cured (<10%-15%) in patients with atherosclerotic RAS
- The majority (>50%) will have some benefit with regards to HTN control and/or decreased anti-hypertensive meds following renal stenting

Conclusions

- Preliminary results showed favorable outcomes for use of DES or protection devices, but more larger data is required to use them routinely in renal artery stenting