대한 순환기학회
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Carotid and Renal Artery Stenting

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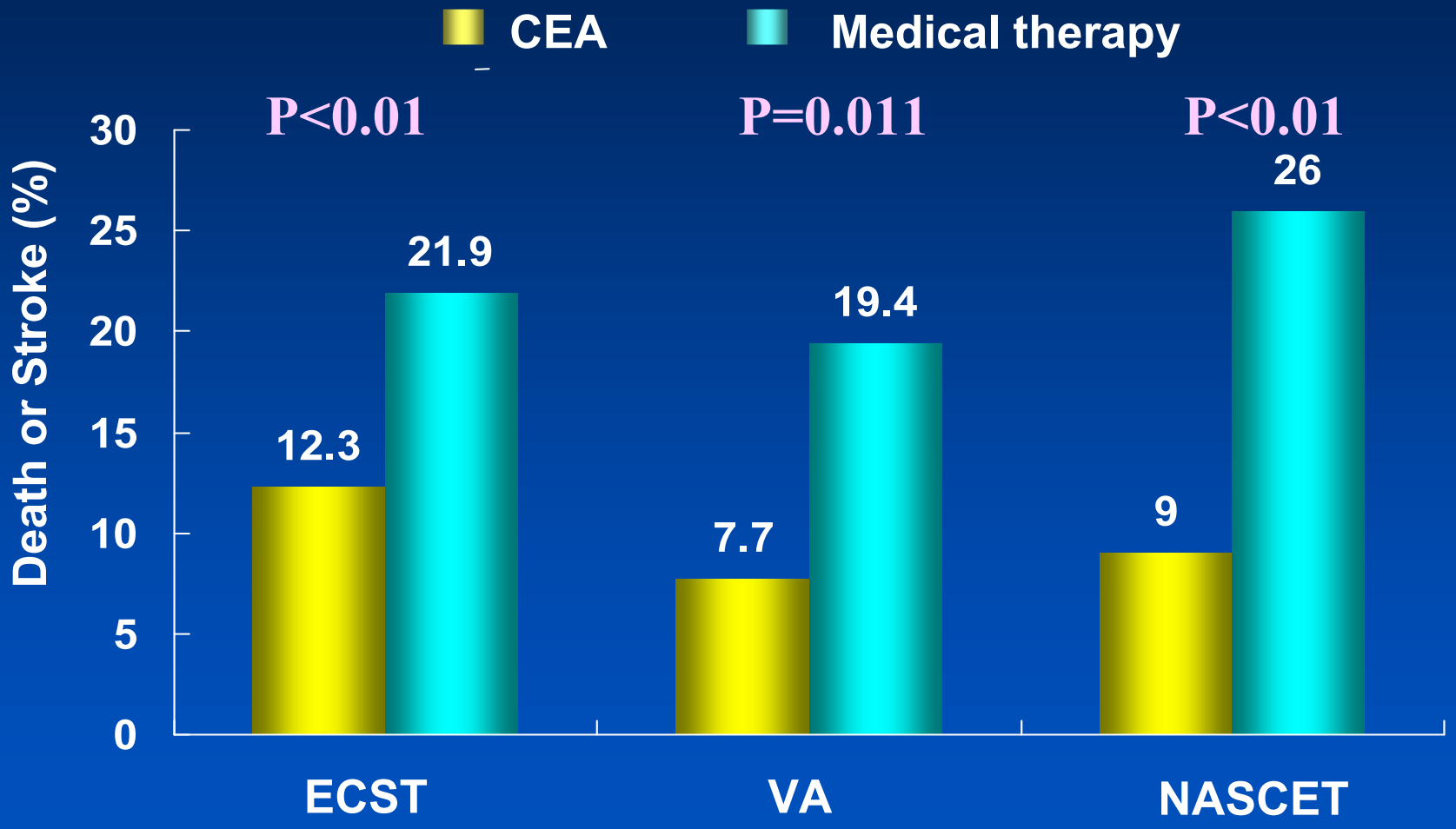
Natural Incidence of CVA In Carotid Stenosis

- Asymptomatic 80% carotid stenosis
  - 1.9%/ year (ECST registry)
  - 12% / 5 year (ACAS, ACST)
- Symptomatic 50% carotid stenosis
  - 10% / year
  - 40% / 5 years

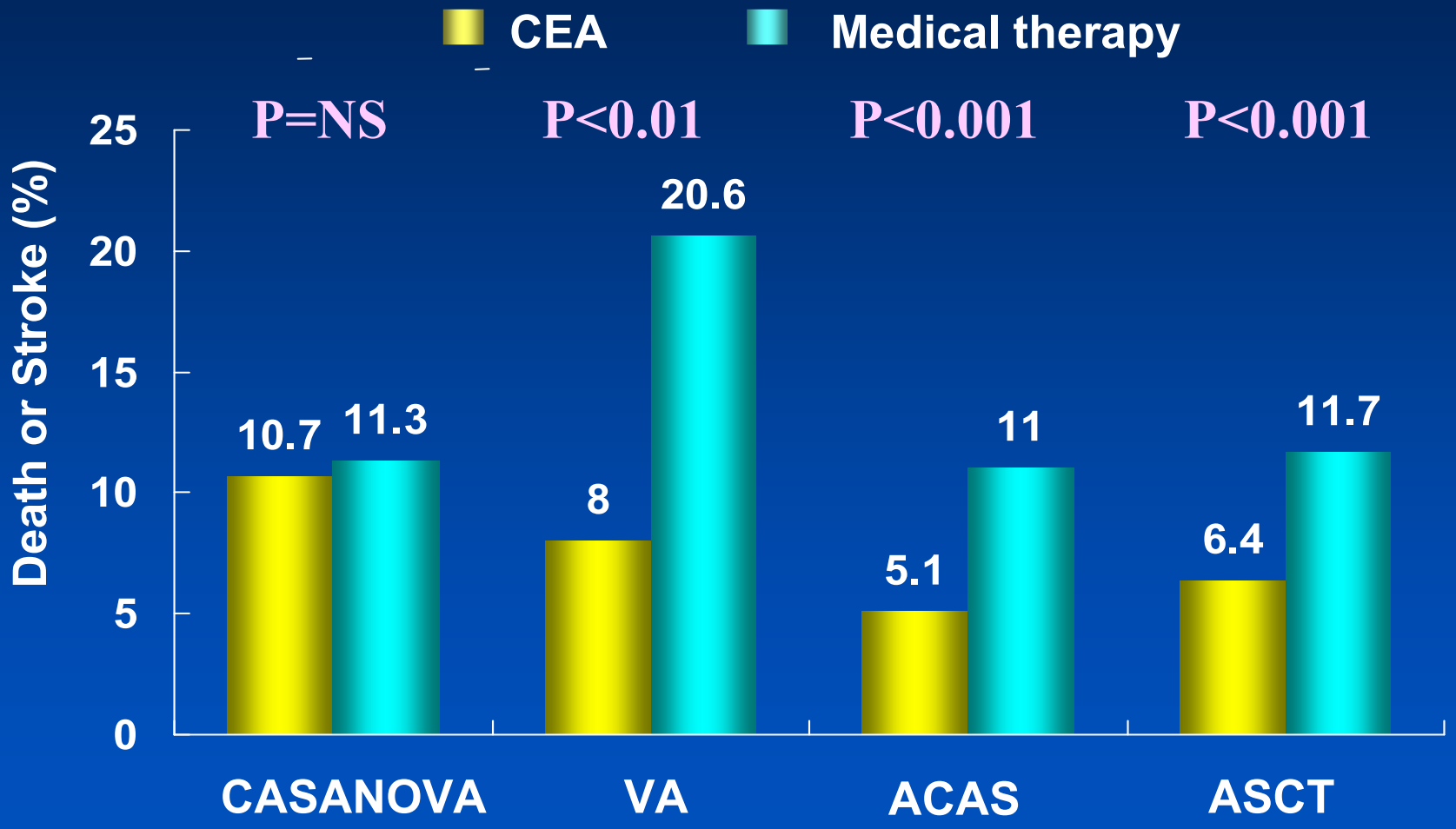
CEA vs. Medical Rx

Symptomatic Patients (DS≥ 70%)



CEA vs. Medical Rx

Asymptomatic Patients (DS > 60%)



Indications for carotid artery revascularization

Indication level	Symptomatic stenosis	Asymptomatic stenosis
Proven	• 70-99% stenosis • Periprocedural complication risk <6%	• > 60% stenosis • Periprocedural complication risk <3% •Life expectancy > 5yrs
Acceptable	• 50-69% stenosis • Periprocedural complication risk <6%	• > 60% stenosis • Periprocedural complication risk <3% • Planned CABG
Unacceptable	• <29% stenosis, or • Periprocedural complication risk > 6%	• < 60% stenosis or • Periprocedural complication risk >3% • No indication for CABG

Circulation 2006;113:2021-2030

Carotid Stenting:

- Currently, the only use of carotid stenting that has been approved by FDA is in **symptomatic patients with stenosis of the internal carotid artery exceeding 70%** who are at high risk for complications after surgery.

- The limited FDA approval of stenting is largely based on the results of SAPPHIRE trial, involving patients who had **symptomatic stenosis of the internal carotid artery exceeding 50% or asymptomatic stenosis exceeding 80%** and who were at high surgical risk mainly owing to severe coronary artery disease.

Current Goal of Carotid stenting based on NASCET[1], ECST[2], ACAS[3], ACST[4]

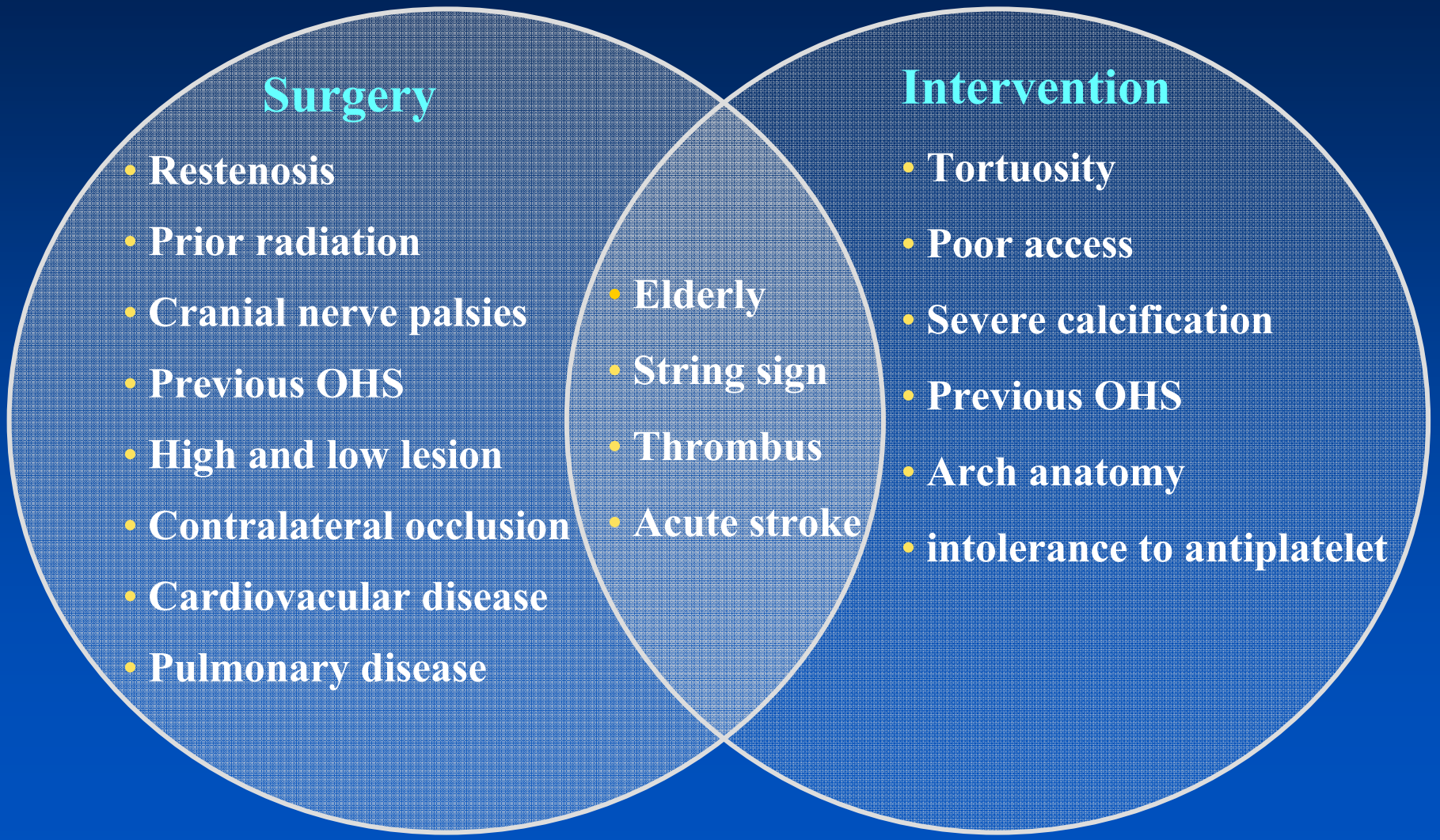
Morbidity and mortality after carotid intervention should be…

Symptomatic < 6%[1,2]
Asymptomatic < 3%[3,4]

Carotid Artery stenosis

High risk group for surgery
High risk group for stenting

High Risk Features of Surgery vs. Stenting for Carotid Stenosis



Features a/w increased procedural risks after carotid stenting

	Risk factors	Features
Clinical	Advanced age	Age ≥ 80 yrs
	Decreased cerebral reserve	-Dementia -Prior (remote) stroke -Multiple lacunar infarcts -Intracranial microangiopathy
Angiographic	Excessive tortuosity	≥ 2 90˚ bends within 5 cm of the lesion
	Heavy calcification	-Concentric circumferential calcification -Width ≥ 3mm

Circulation 2006;113:2021-2030

Carotid Artery Stenting

Current status

Embolic protection device (EPD)

Why Embolic Protection?

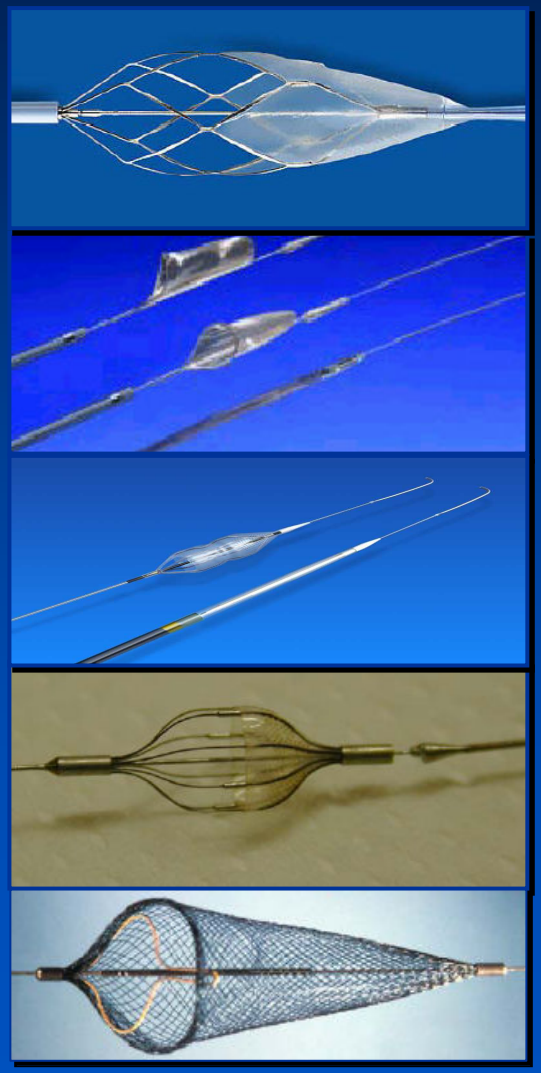
Embolic Protection Device

Distal Occlusion

PercuSurge GUARDWIRE ™

Embolic Protection Devices (EPD)

Filter



Guidant - ACCUNET

BSC - FilterWire

ABBOTT - Emboshield

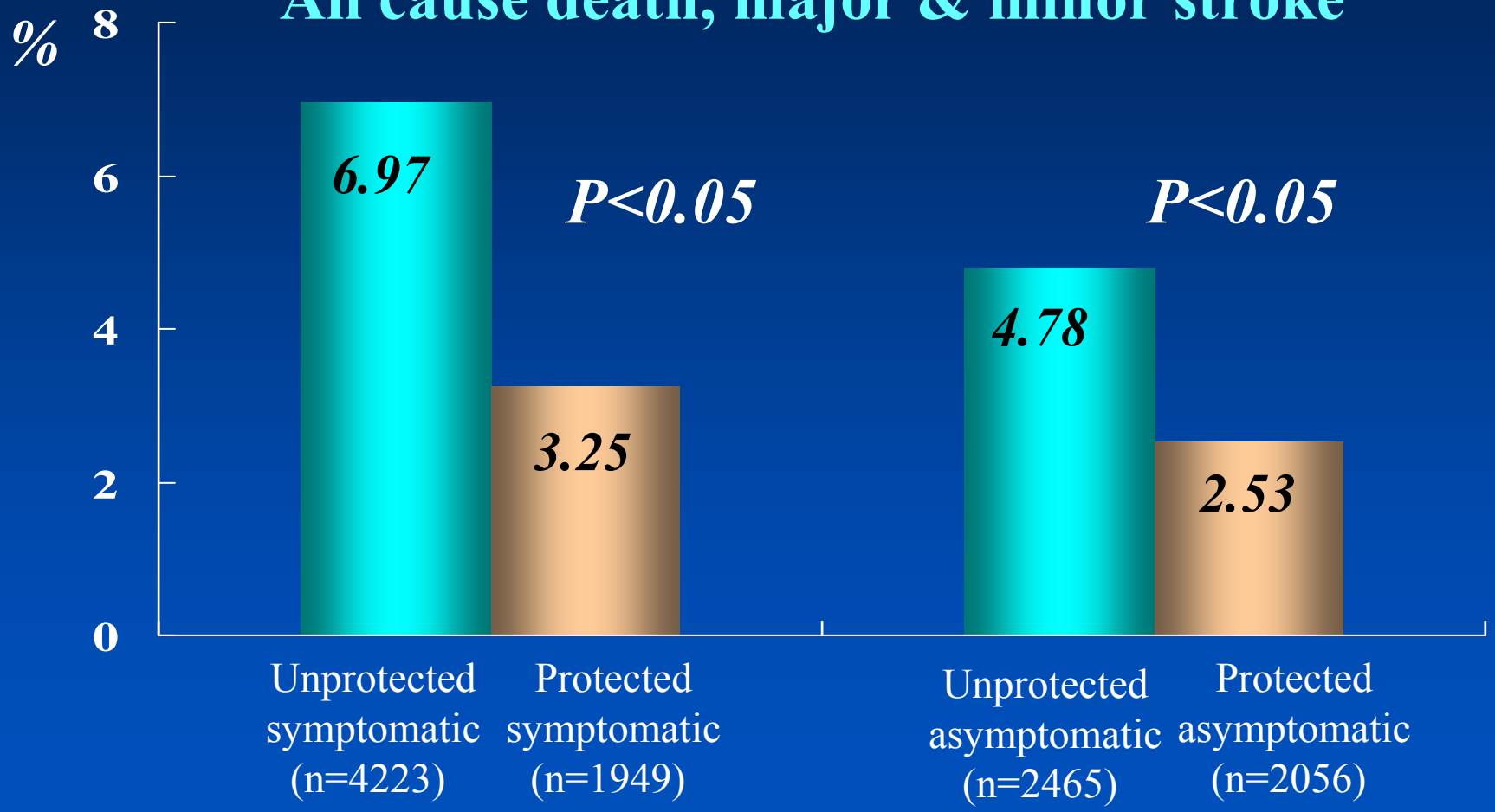
Cordis - Angioguard

EV3 - Spider

Benefit of Distal Protection

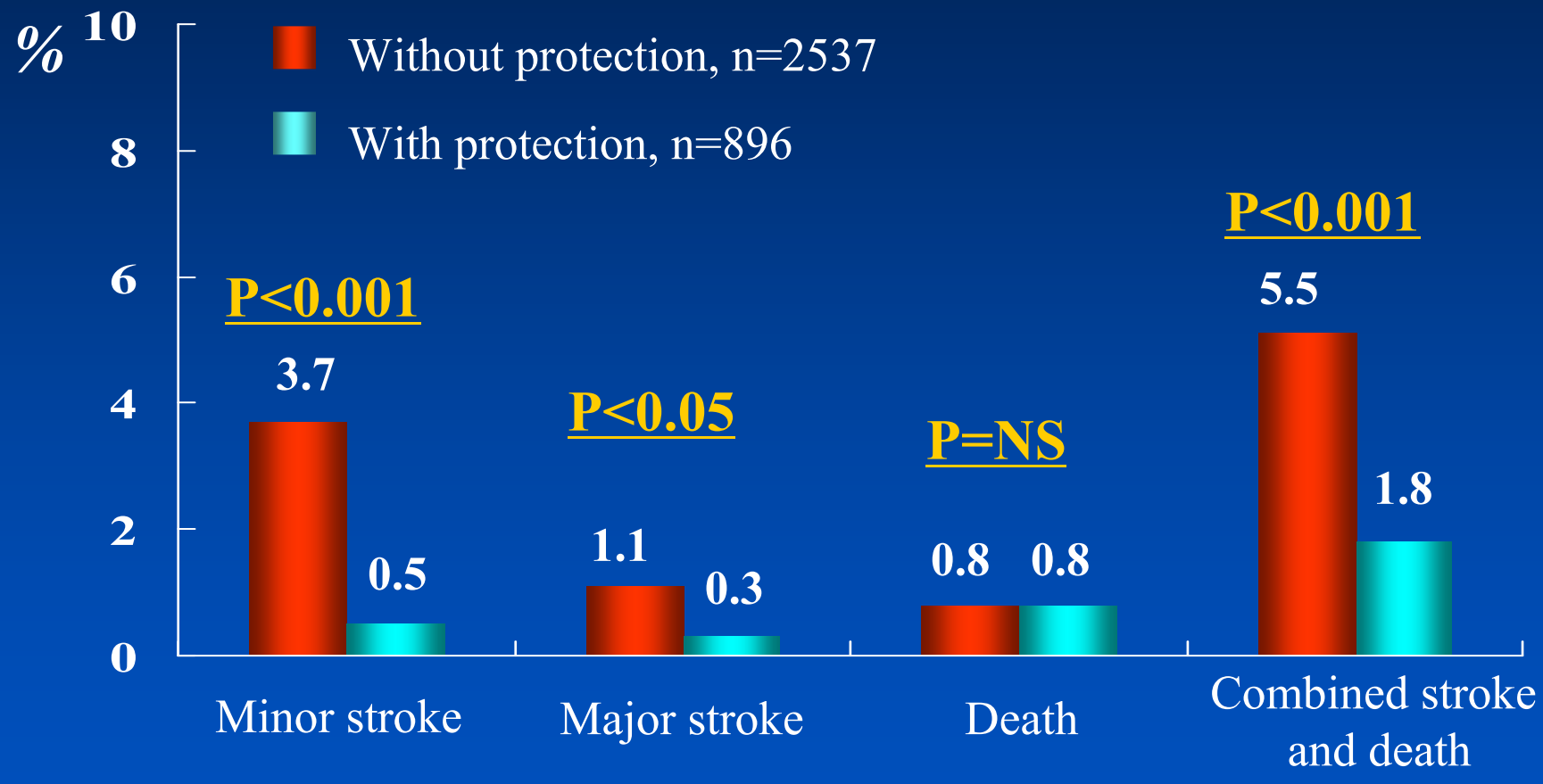
Periprocedural Outcomes

All cause death, major & minor stroke



Wholey MH et al. Catheter Cardiovasc Interv 2003;60:259-266

Benefit of Distal Protection
30-Day Outcomes



Stroke 2003;34:813-819

Carotid Artery Stenting

Current status

Embolic protection device (EPD) is mandatory in CAS

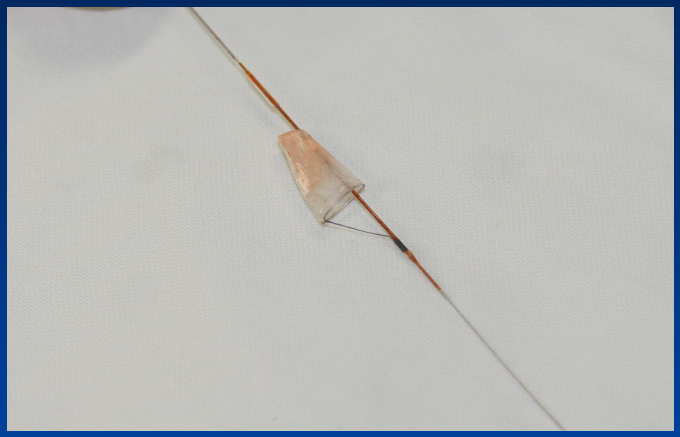
Symptomatic patients, M/72

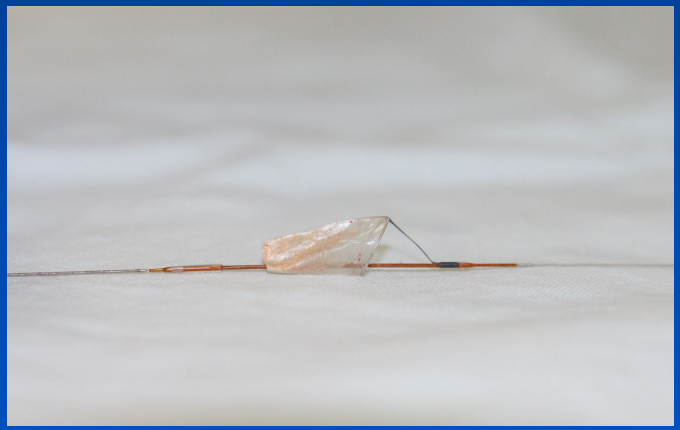
Baseline angiogram

Predilatation

Post-ballooning

Final results with large amount of emboli





Good final results

Carotid Stenting

How to improve Safety, Avoid Complications and optimize Outcomes

Reducing Embolic Risks

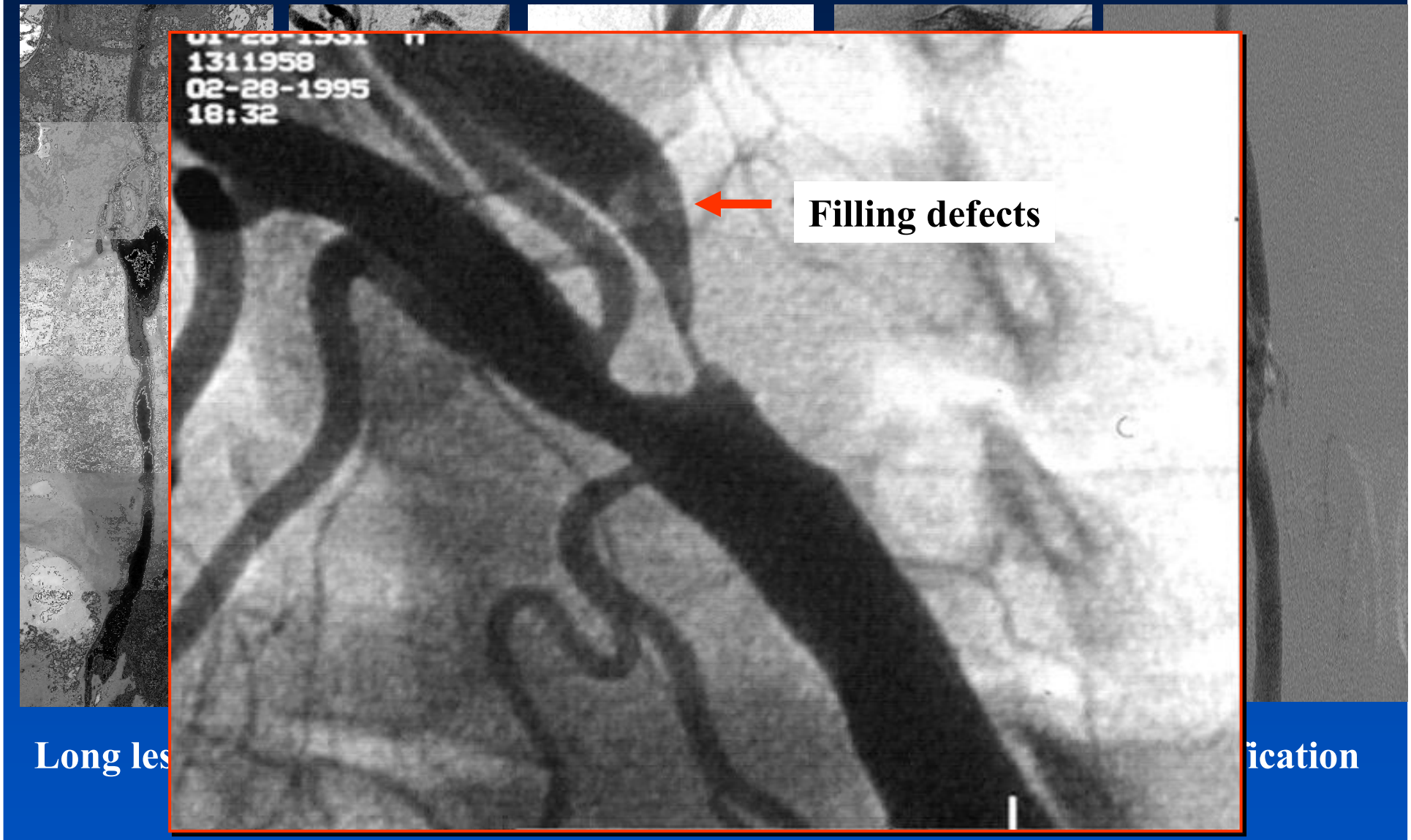
- Patient selection
- Lesion selection
- Operator technique
- Pharmacological adjuncts
- Mechanical adjuncts

Patient Exclusions

- Age > 80 years
- Access problems
- Intracranial microangiopathy
- Marked cerebral atrophy/ multiple lacunar infarcts
- Dementia

Lesion Exclusions

- Heavy concentric calcifications
- Obvious filling defect
- Total occlusion
- “String” sign
- Severe distal loops/kinks/bends



Long les ication

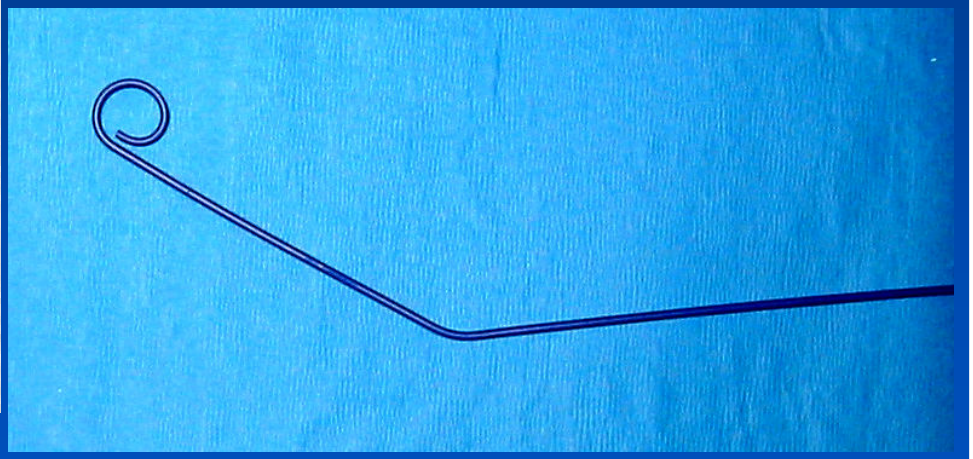
Technique is Important !

- External Carotid is the Anchor
- Do not instrument Internal Carotid till you actually cross the lesion
- Use low profile equipment
- Embolic protection device is mandatory
- Pre and Post Dilatation
- Be vigilant/aggressively treat bradycardia/ hypotension

Steps of carotid artery stenting

Arch angiogram:

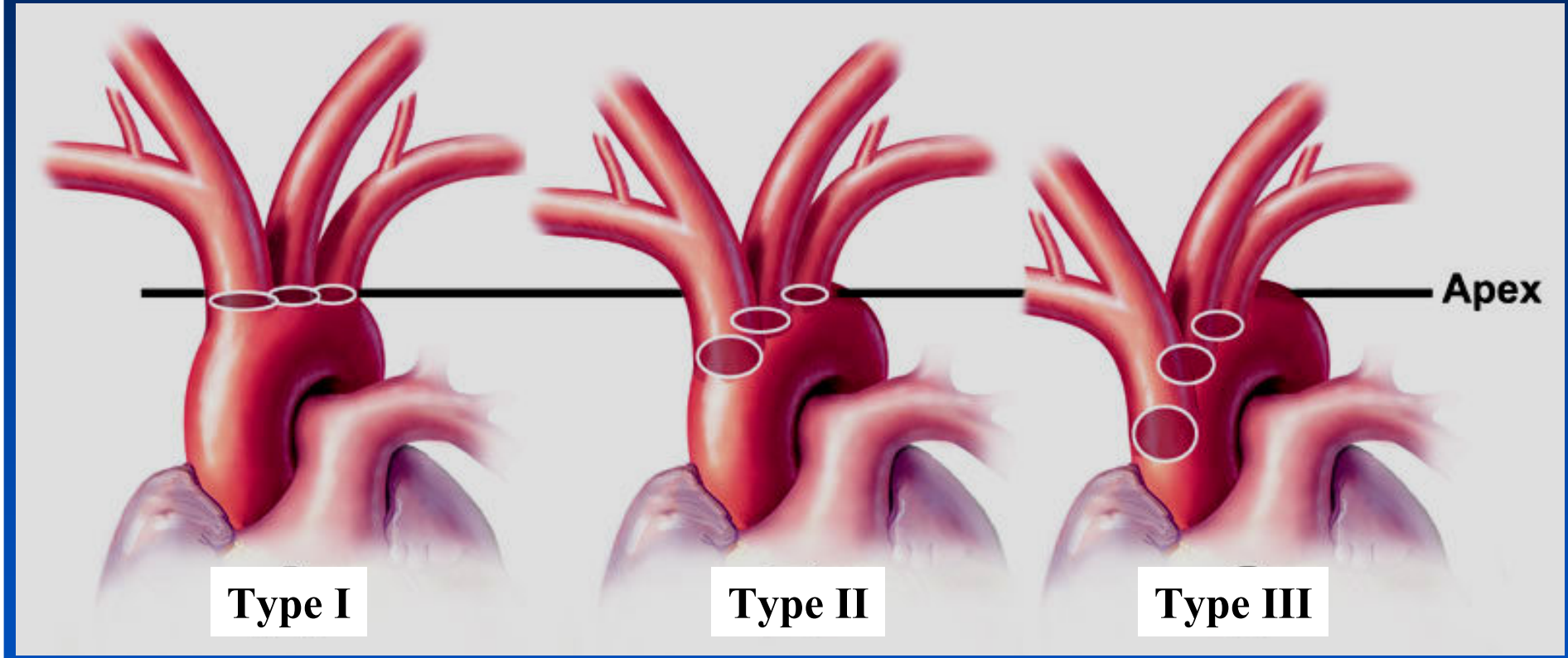
- 30-45 LAO
- inject 15x20-30ml



Aortic arch anatomy

AORTIC ARCH type III

(LAO Projection)



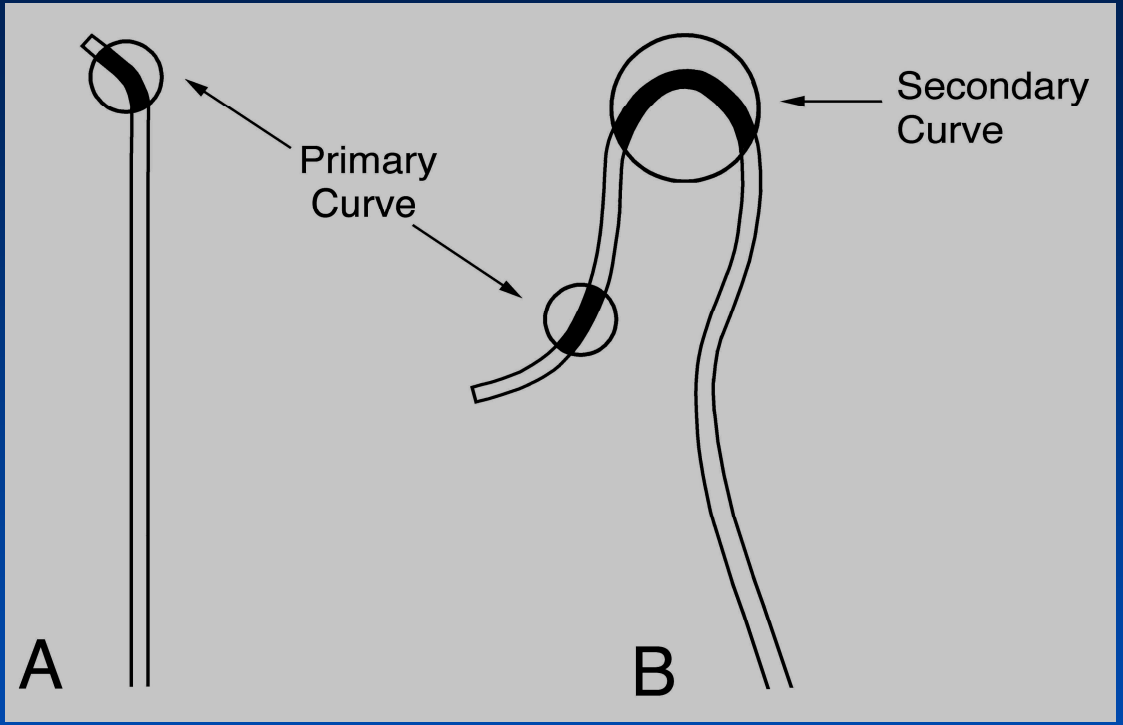
Type III : Predictors of Complications

Simple Curve

- JB-1, JB-2
- H1, JR-4
- Vert

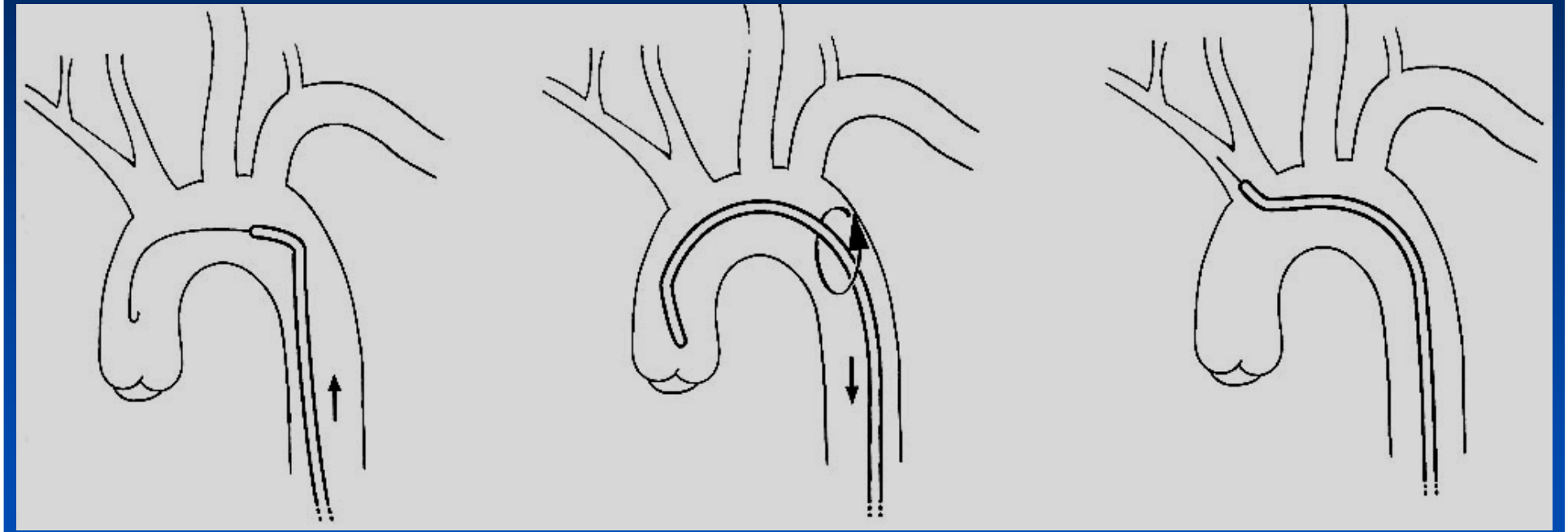
Complex Curve

- Simmons
- VTK, USL
- JB2



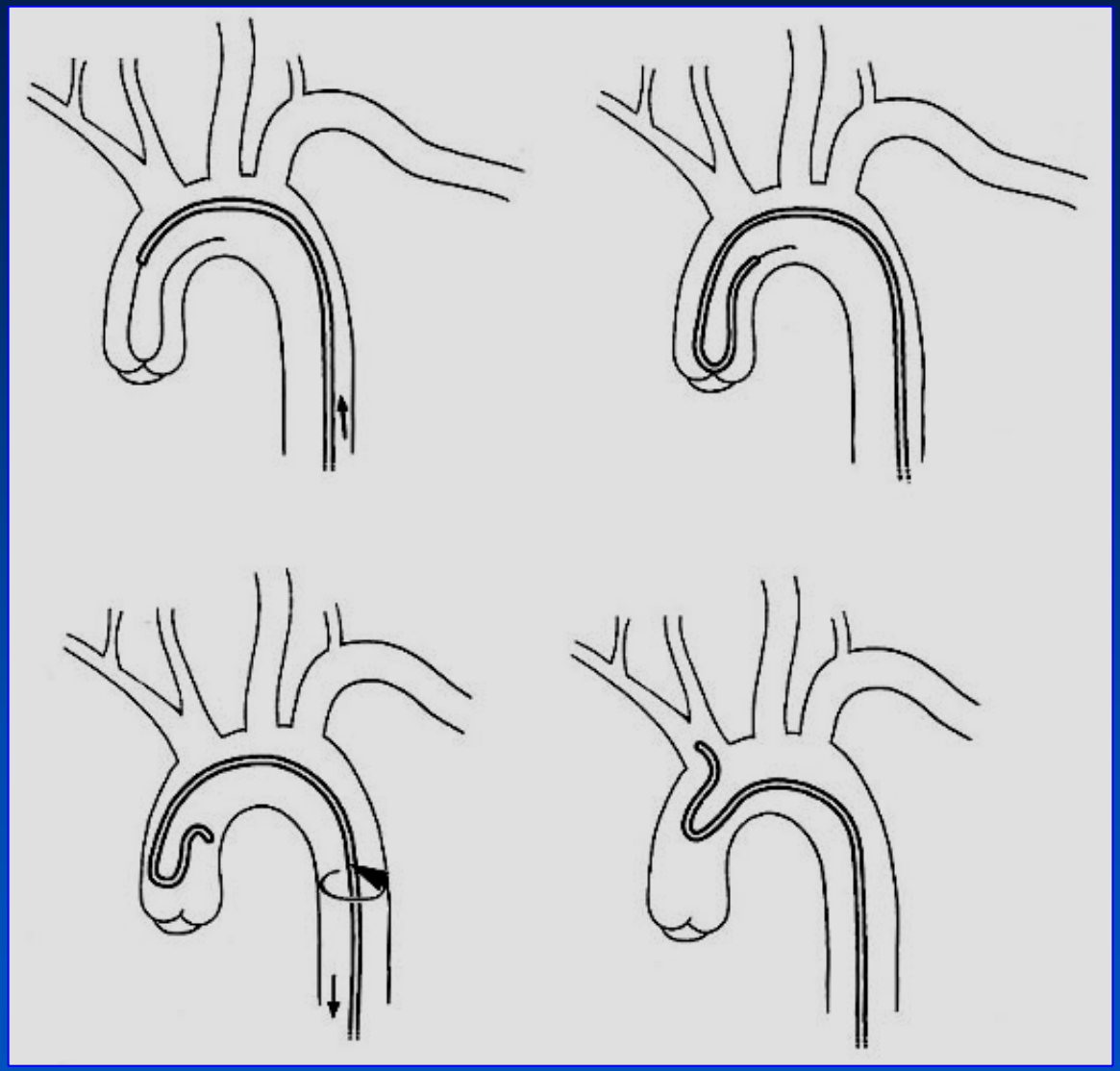
Think in terms of engagement and subsequent advancement!

Simple Catheters

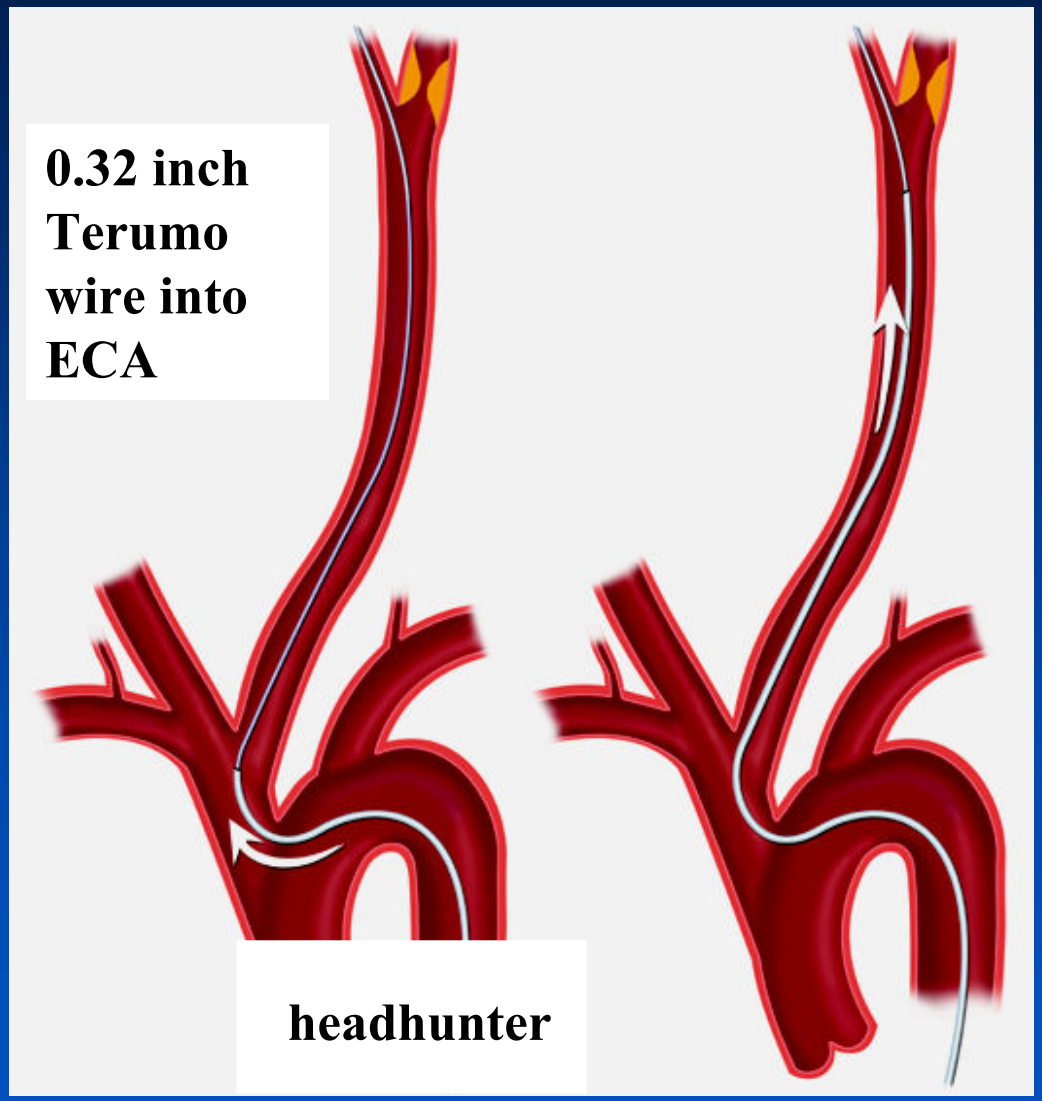


Can engage most arch branch origins
Conducive to advancement

Complex Catheters



- Can engage almost anything, but difficult to advance

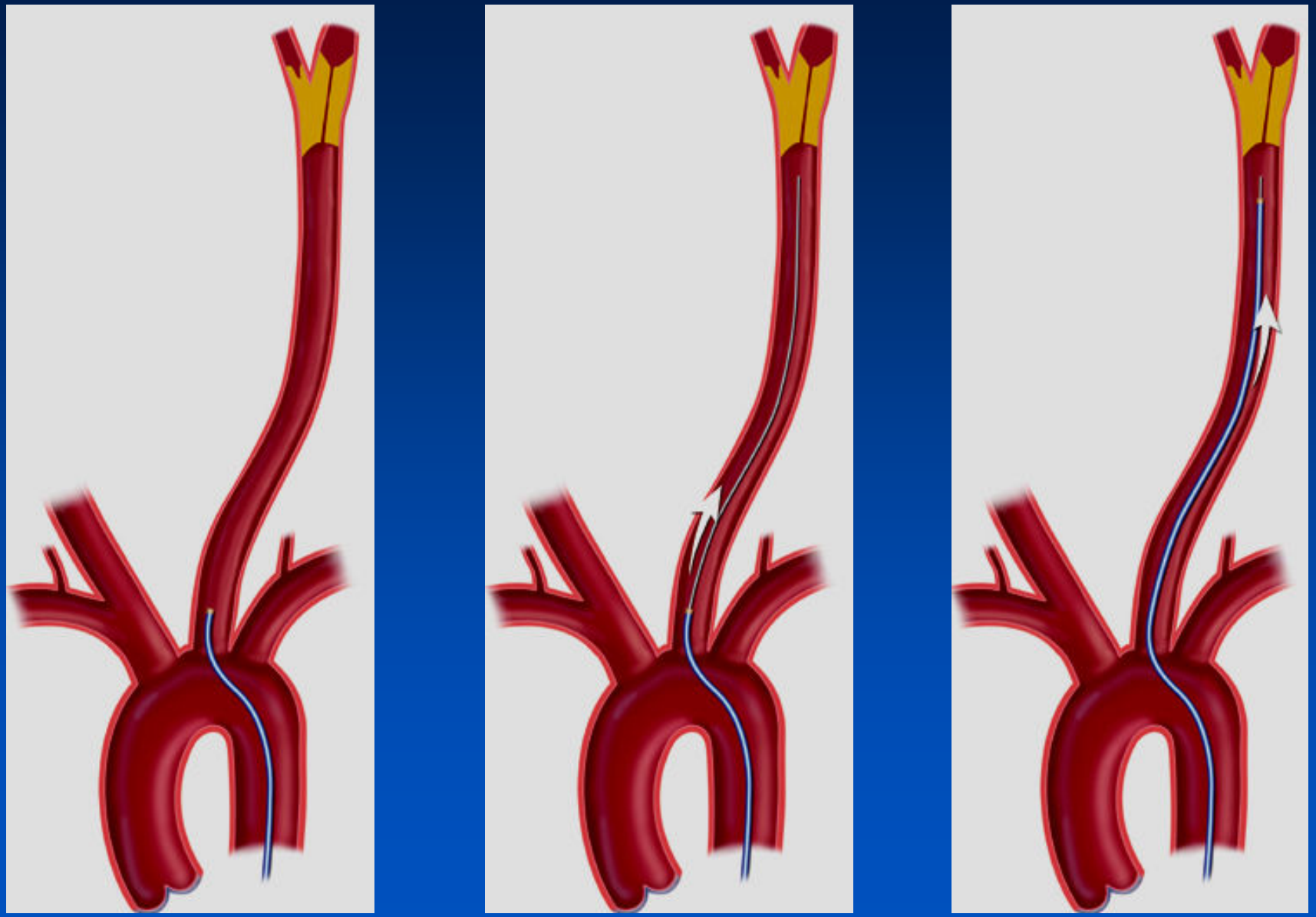

0.32 inch
Terumo
wire into
ECA
headhunter

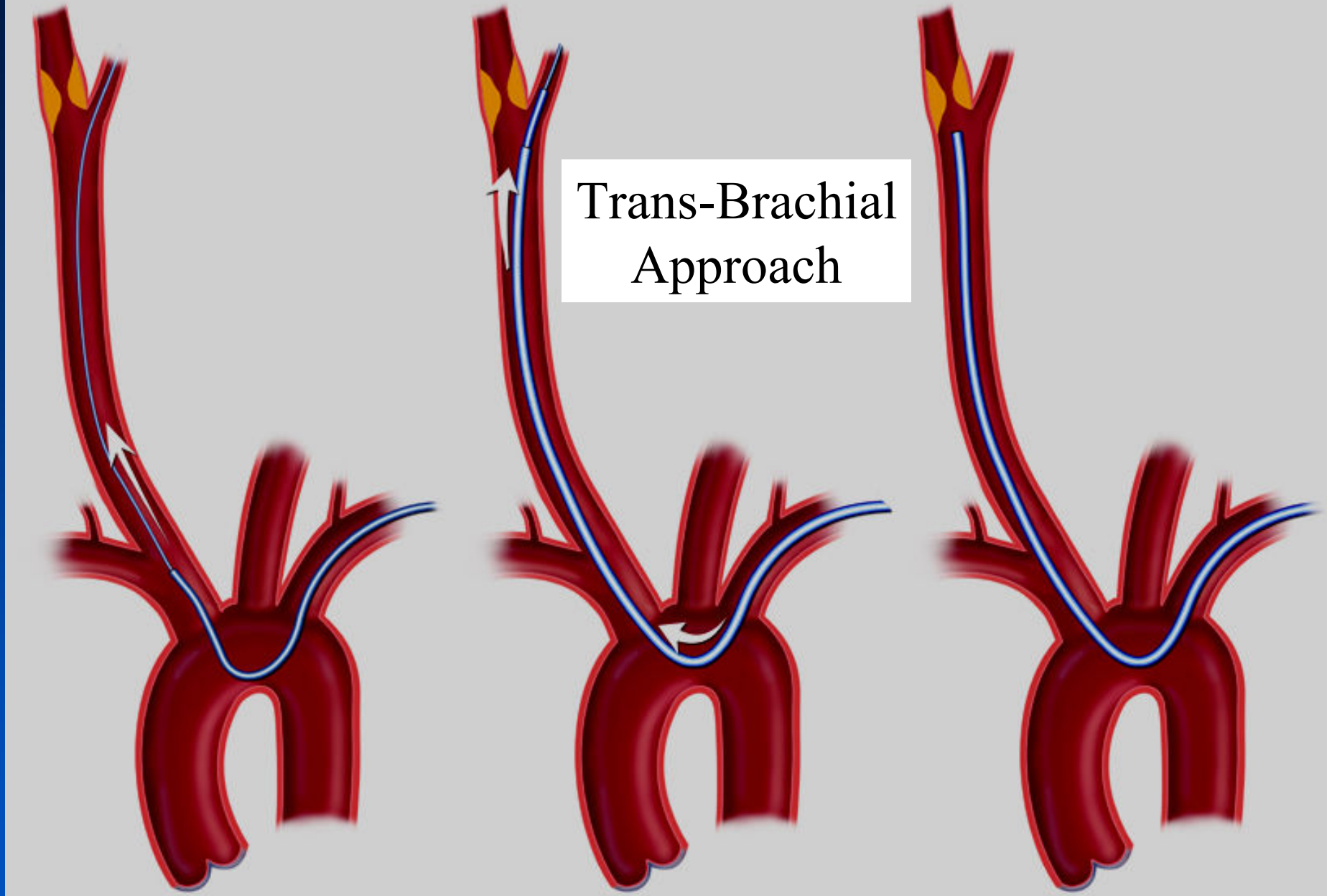

Headhunter
into ECA

Exchange Terumo wire with 0.35 inch Amplatz wire

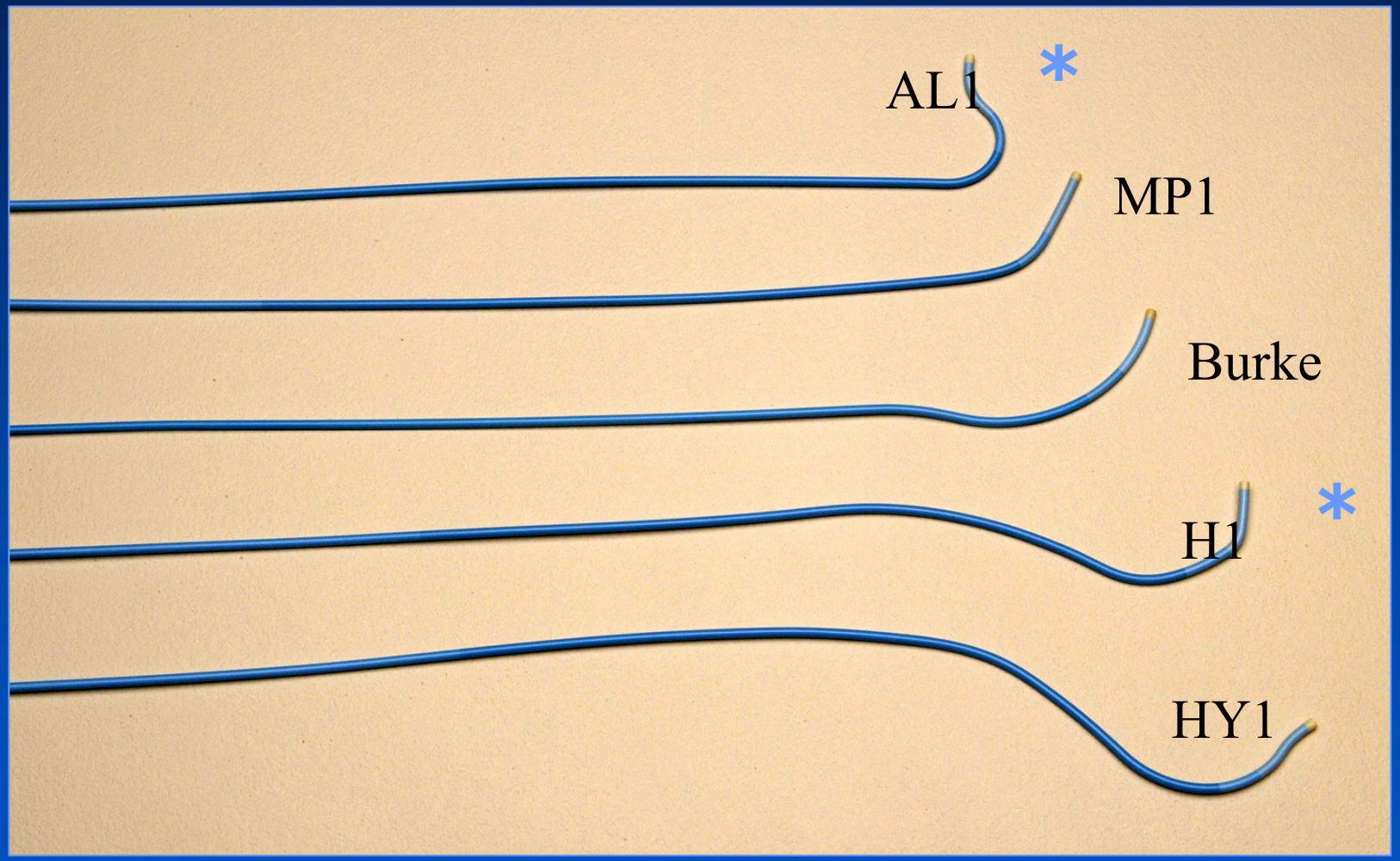
Advance guiding catheter or shuttle into common carotid artery

In case of CCA stenosis




Trans-Brachial
Approach

Carotid guide catheters



Medication

- Do not accept insufficient pre-treatment
  - Aspirin + Plavix should be given at least 5 days before, or 600 mg plavix (aspirin 300 mg) loading at least 4 hours before
    - To prevent fresh thrombus on the plaque
  - Modest anticoagulation: heparin 5000-7500 units: ACT of 200 to 250 seconds
  - Fluids!

Placement of embolic protection device

- EPD must be placed at least ≥ 2 cm cephalad to the stenosis to accommodate the tip of stent delivery system and to provide satisfactory coverage of the lesion.

- If the lesion crossing is technically difficult with EPD, placement of a second wire and gentle dilatation of the lesion with an undersized balloon can facilitate delivery of EPD system

Pre-dilatation

- Routine pre-dilatation with 3-4 mm diameter, 30 mm length PTA or coronary balloon
- Pre-dilatation reduce emboli during stenting

Stent selection

- Self-expanding stents
- At least 1 to 2 mm larger than the largest diameter of the treated segment, usally size to common carotid arterty (mostly 8-10mm)
- Stent length should be adequate to cover the entire lesion (30-40mm in length)

Stent deployment

- Give atropine
  - Atropine needs sometimes to prevent bradycardia
- Do not move the filter
  - because it may cause spasm
- De-air the sheath before you inject contrast
  - High risk of air embolism especially with monorail delivery systems
  - Let it bleed, do not aspirate!

Post-Dilatation

- Balloon
  - 20-40 mm long
  - Diameter not more than diameter of ICA
- Nominal pressure
- No need for post dilatation if residual stenosis is <20% after stent placement

Not necessary…

- … to postdilate the distal common
- … to dilate the stent to obliterate segments of contrast-filled ulcerations external to the stent
- … to over-expand the stent to produce zero residual stenosis
- … to dilate the external carotid artery

Bradycardia / Hypotension

- During balloon inflation
- Sinus bradycardia
- May last up to 48 hours
- May start after the procedure or may reoccur!

How to avoid and treat bradycardia/hypotension?

- Atropine! if necessary
  -0.5-1 mg
  -Start early! (3-5 min before balloon inflation)
- Fluids
- Dopamine
- Rarely needed but occasionally up to 48 hours
- Discontinue drugs inducing bradycardia
  -ß-Blocker, Ca Antagonists
- Pacemaker almost never needed!

Intracranial Bleeding

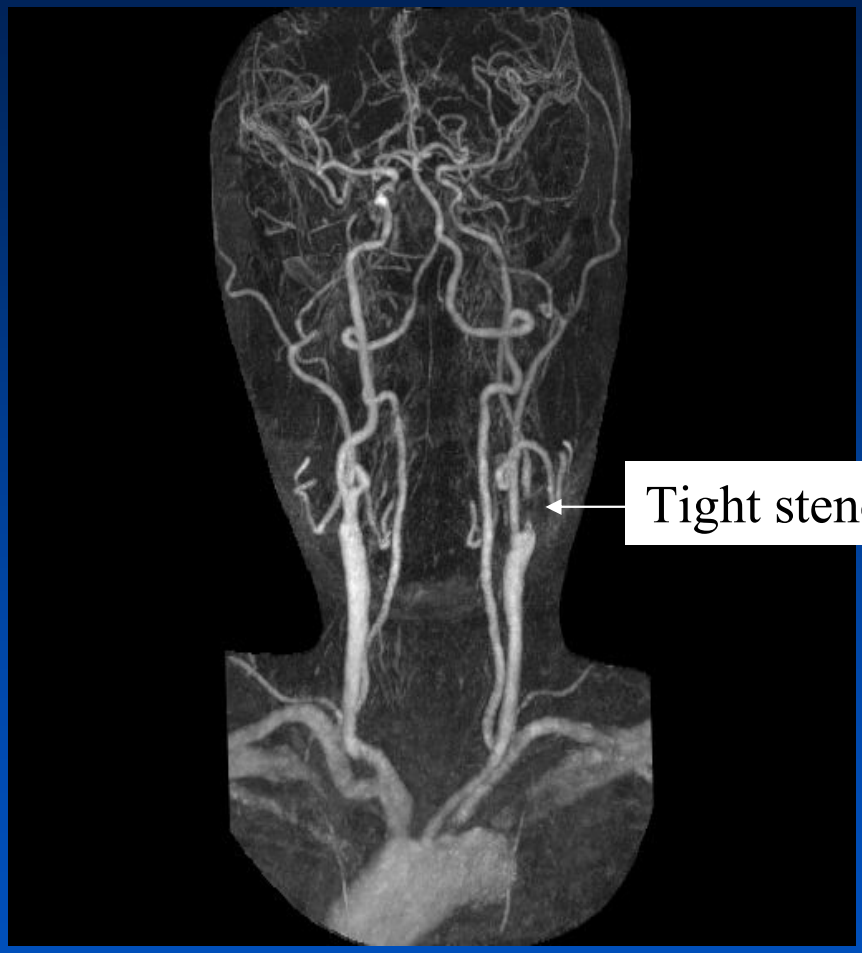
- Wire tip not beyond carotid siphon!!
- Heparin max 7,500
- No IIB-IIIA inhibitors!
- Blood pressure monitoring!

Hyperperfusion Syndrome

- Risk factors
  - High grade stenosis
  - Contralateral occlusion or high grade stenosis
  - Hypertension
- Symptoms
  - start hours – days after the procedure
  - Headache (like migraine)
  - CT: Diffuse intracranial bleeding
- Prevention and treatment
  - Keep BP as low as possible

CASE

- 57 yrs, male
- Diabetes mellitus
- CABG due to 3 vessel disease (2 months ago)
- Asymtomatic left carotid stenosis
- Carotid sonography: 80-95% stenosis, hypoechoic plaque



Pre-intervention MR angiography

Pre-intervetion

Baseline, tight left ICA stenosis

Insertion of filterwire

Predilatation

Delivery of predilatation balloon

Predilatation, Ultrasoft 4.0/20 mm upto 4.0 (6 atm)

Stent implantation

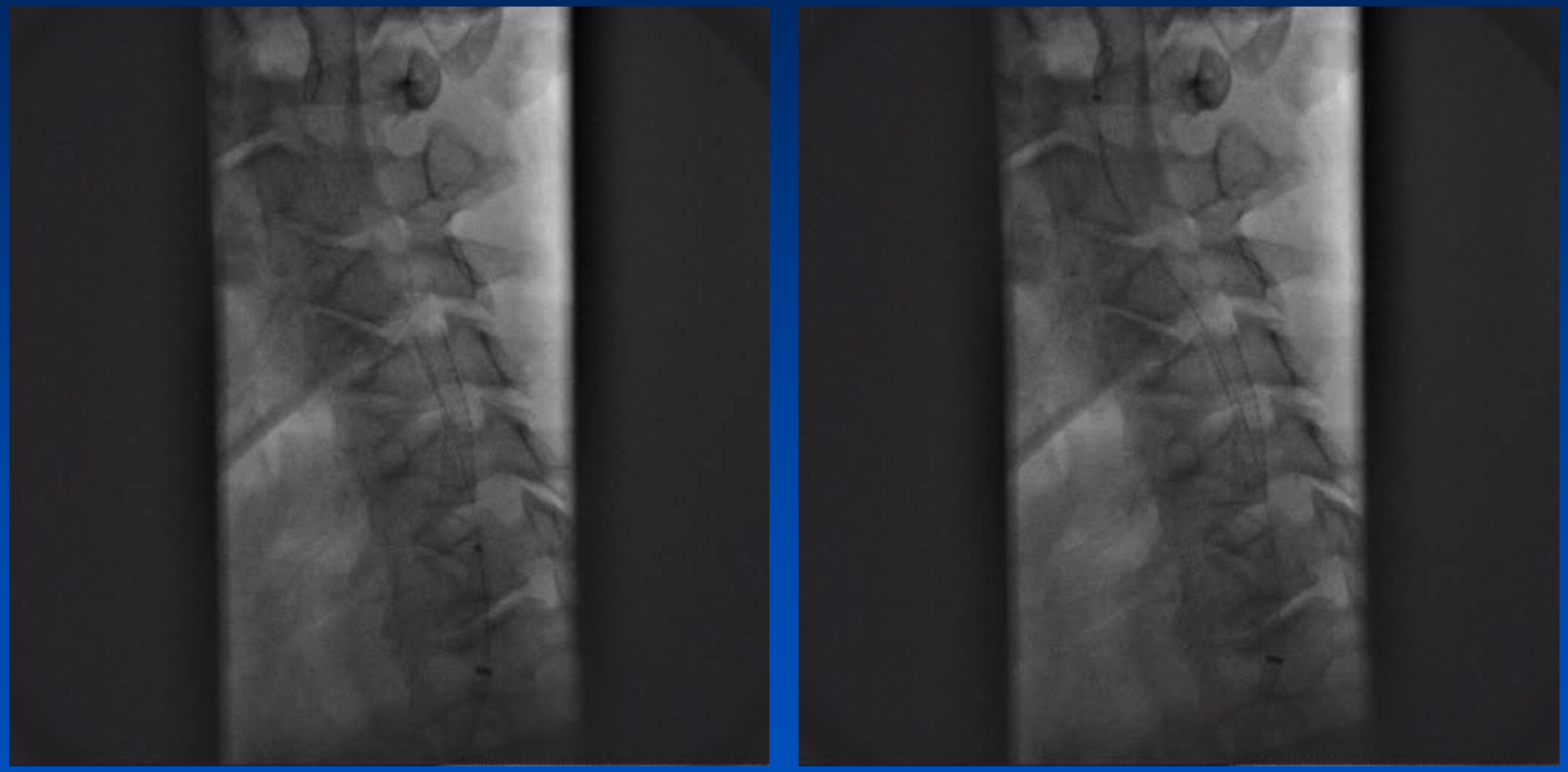
Delivery of stent balloon

Stent implantation,
Self expandible Smart stent 6.0/30 mm

Post-dilatation

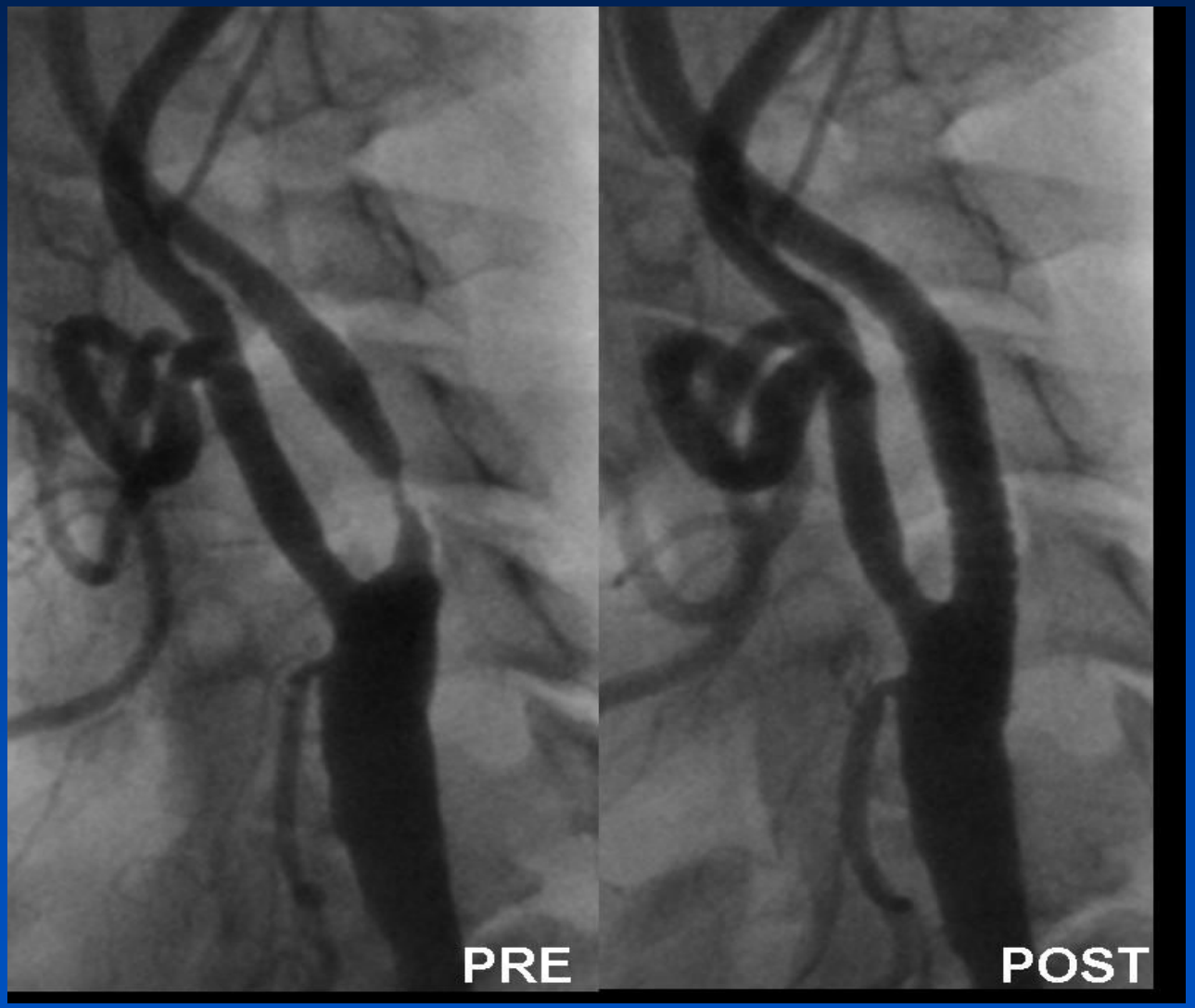
Ultrasoft 6.0/20 mm upto 6.0 (6 atm)

Filterwire removal

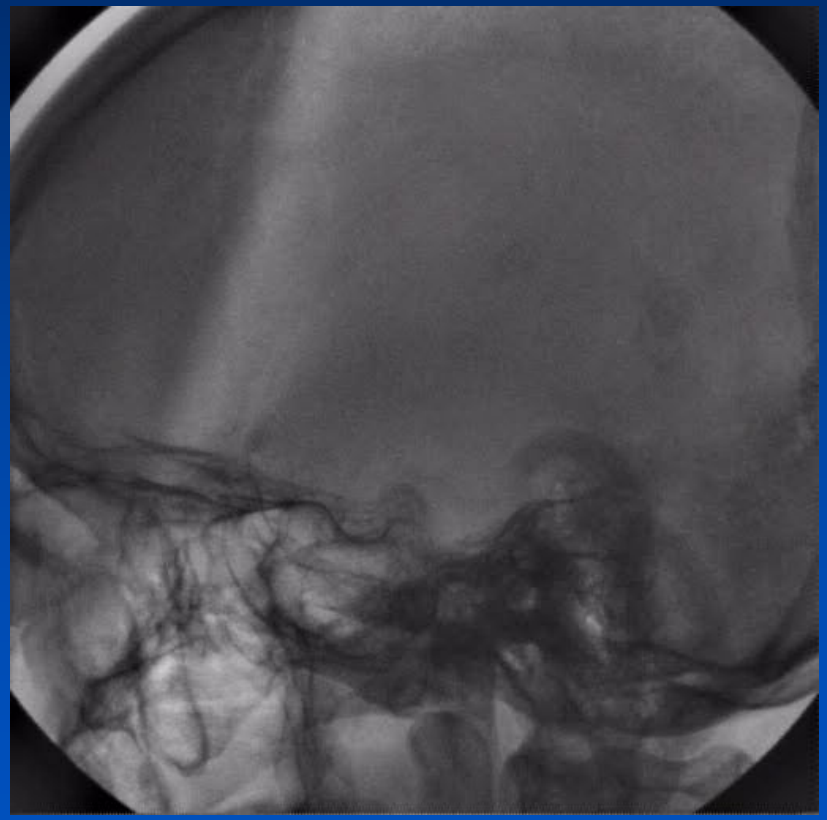


Filterwire removal with retrieval catheter

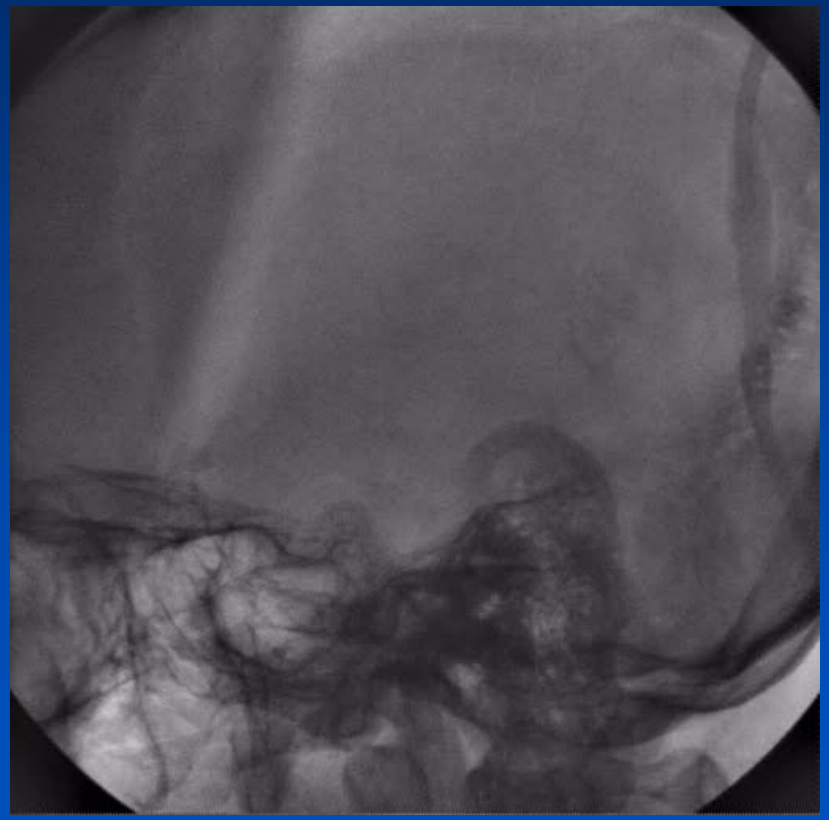
Good final results



Pre- & post-cerebral angiography

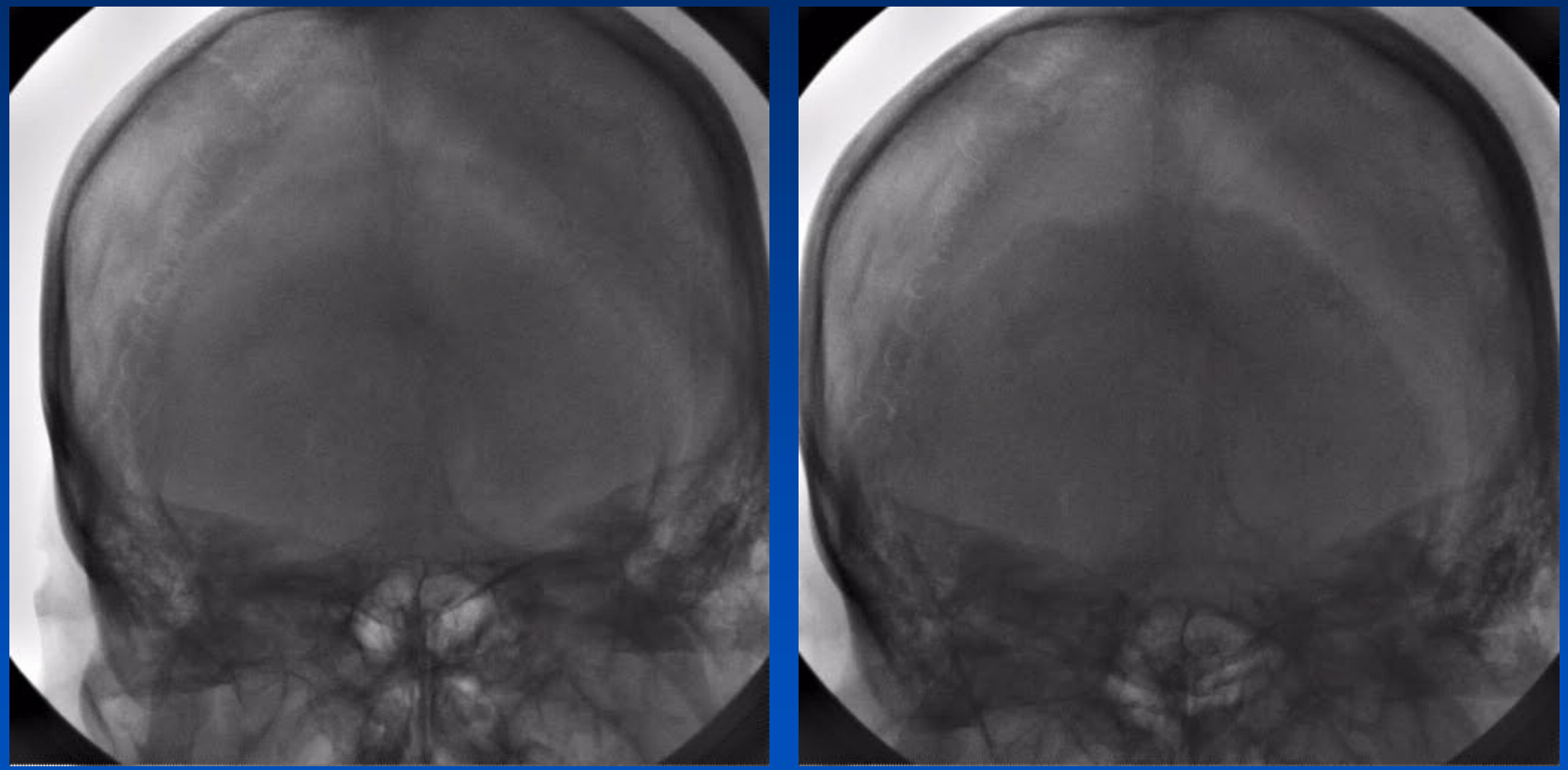


Pre



Post

Pre- & post-cerebral angiography



Pre

Post

AMC Experience

Carotid Stenting in AMC

- From 04/2001' to 04/2007'
- 102 consecutive patients (staged bilateral procedure in 6 patients)
- 108 lesions : bilateral stenting in 6 patients
- Use of EPD : 78/108 lesions (72.2%)
  Balloon type : 21/78 (26.9%)
  Filter type : 57/78 (73.1%)
- 104 severe (≥70%) ICA stenosis
- 4 moderate (50-70%) ICA stenosis

Baseline Characteristics

AMC

Variables	N=102
Age, years	66.1±7.3
Sex, men	80 (78.4%)
Diabetes	49 (48%)
Hypertension	71 (69.6%)
Dyslipidemia	30 (29.4%)
Hx. of Smoking	60 (58.9%)
Hx. of IHD	83 (81.4%)
Stable angina	30 (29.4%)
Unstable angina	45 (44.1%)
Recent or acute MI	2 (2.0%)
Old MI	9 (8.8%)
CHF	15 (13.9%)
PAD	8 (7.8%)
Renal insufficiency	12 (11.8%)
CRF	10 (9.8%)
ESRD	2 (2.0%)
COPD	2 (2.0%)

Neurologic Status / Underlying Coronary & Carotid Disease

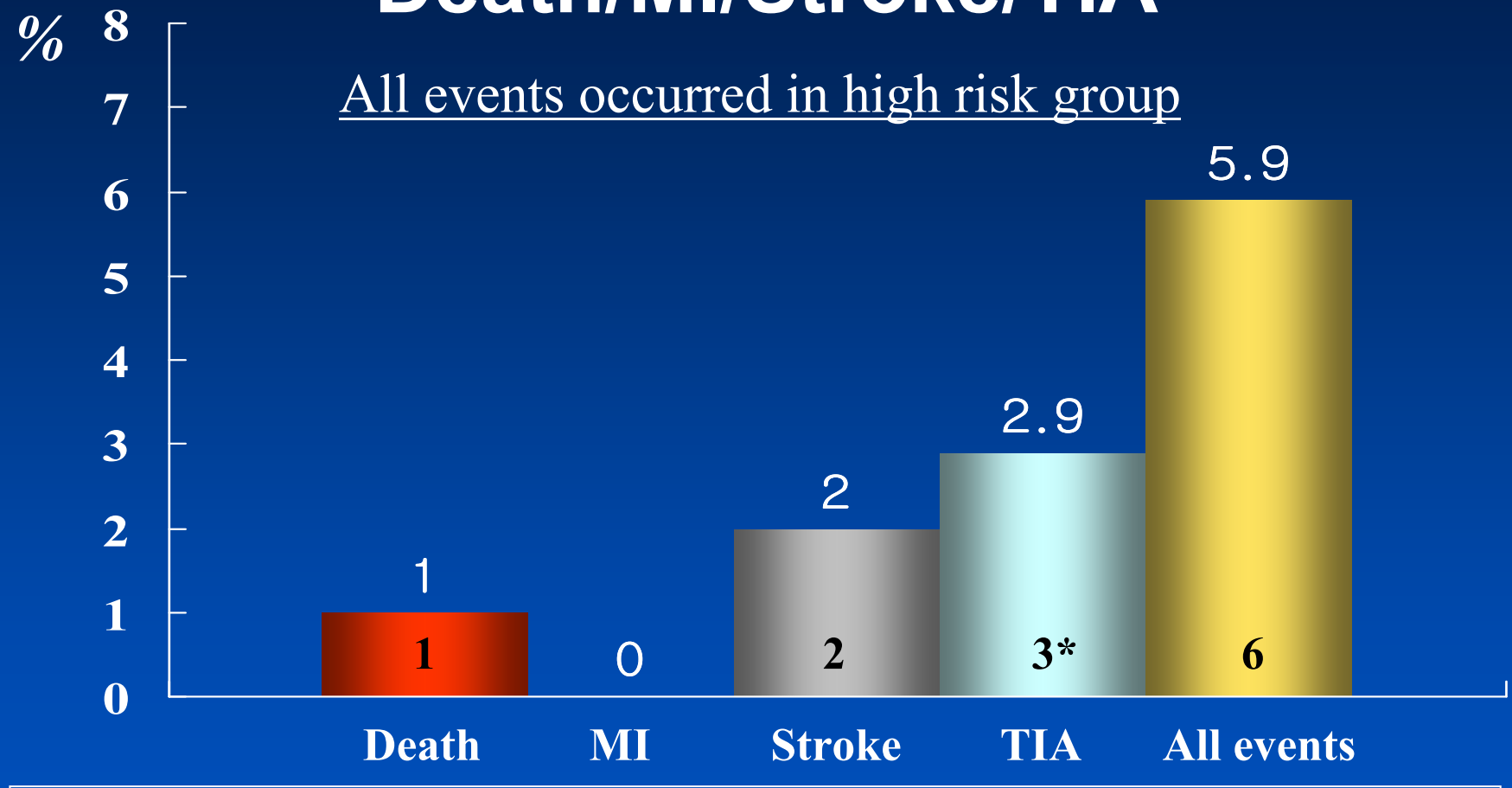
AMC

Variables	N=102
Prior history of CVA (>6months)	27 (26.5%)
History of TIA	6
History of stroke	21
Symptomatic (<6months)	28 (27.5%)
Amaurosis fugax	2
TIA	10
Minor stroke	1
Major stroke	15
Bilateral carotid stenosis (≥50%)	34 (33%)
Treated lesion	
Rt. ICA	51(50%)
Lt. CC/ICA	2 (2.0%) /43 (42.2%)
Both ICA	6 (5.9%)
Severe CAD requiring revascularization	80 (78.4%)

AMC

In-hospital outcomes

Death/MI/Stroke/TIA

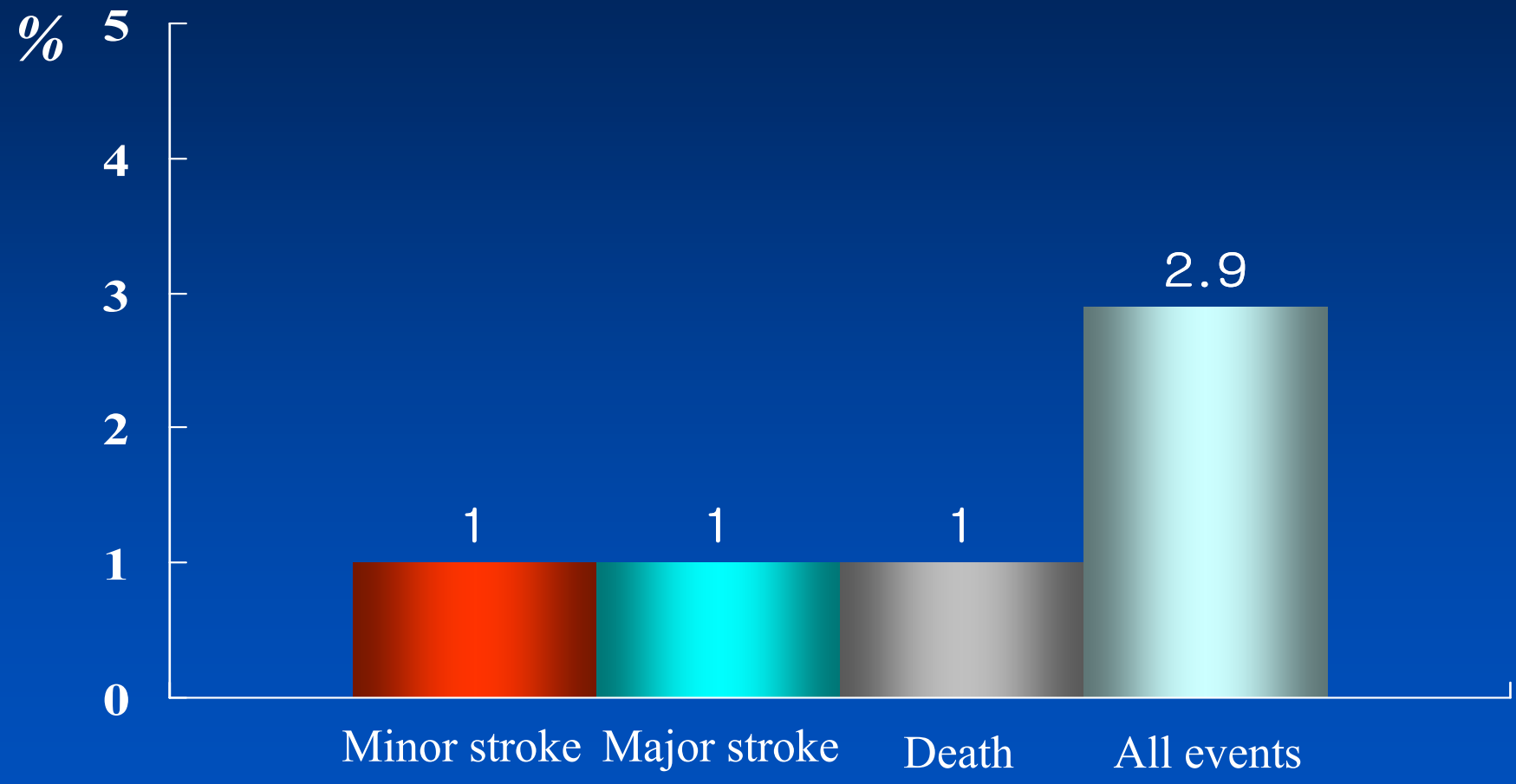


Death: Waiting CABG and AVR 15 days after stenting
Stroke: 1 minor, asx high risk without EPD, 1 major, asx high risk with EPD
TIA* : 2 symptomatic high risk with EPD, 1 asymptomatic high risk with EPD

AMC

30-day outcomes

Death/MI/Stroke

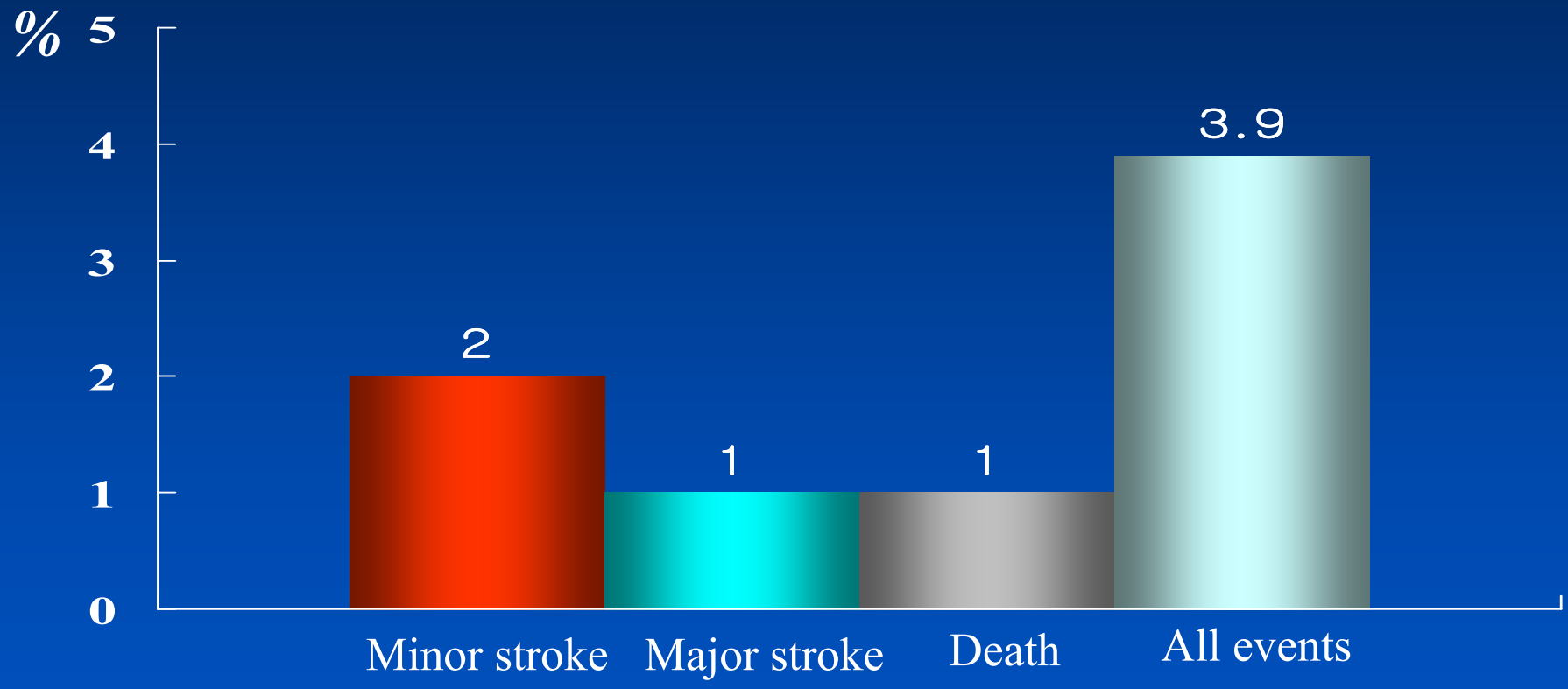


Long-term outcomes

AMC

Death/Stroke

Follow-up duration : mean 14.5±13.7 months



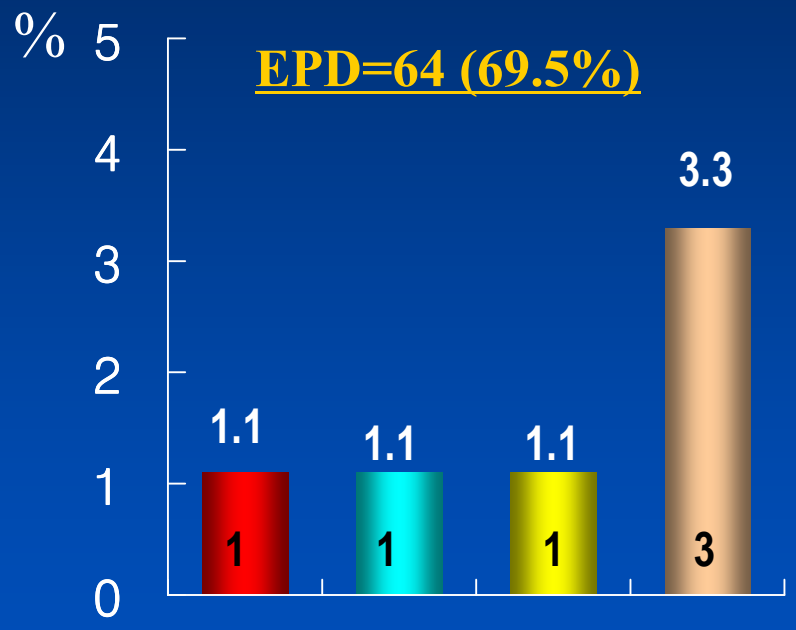
One additional minor stroke 40 days after stenting in symptomatic high risk group

AMC

30-Day Outcomes

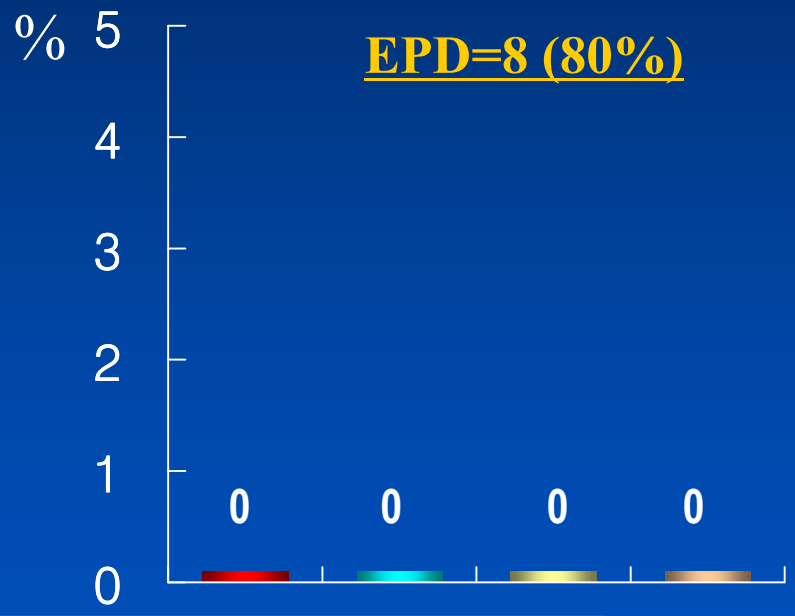
High risk (n=92 pts)

Death/Stroke



Normal risk (n=10 pts)

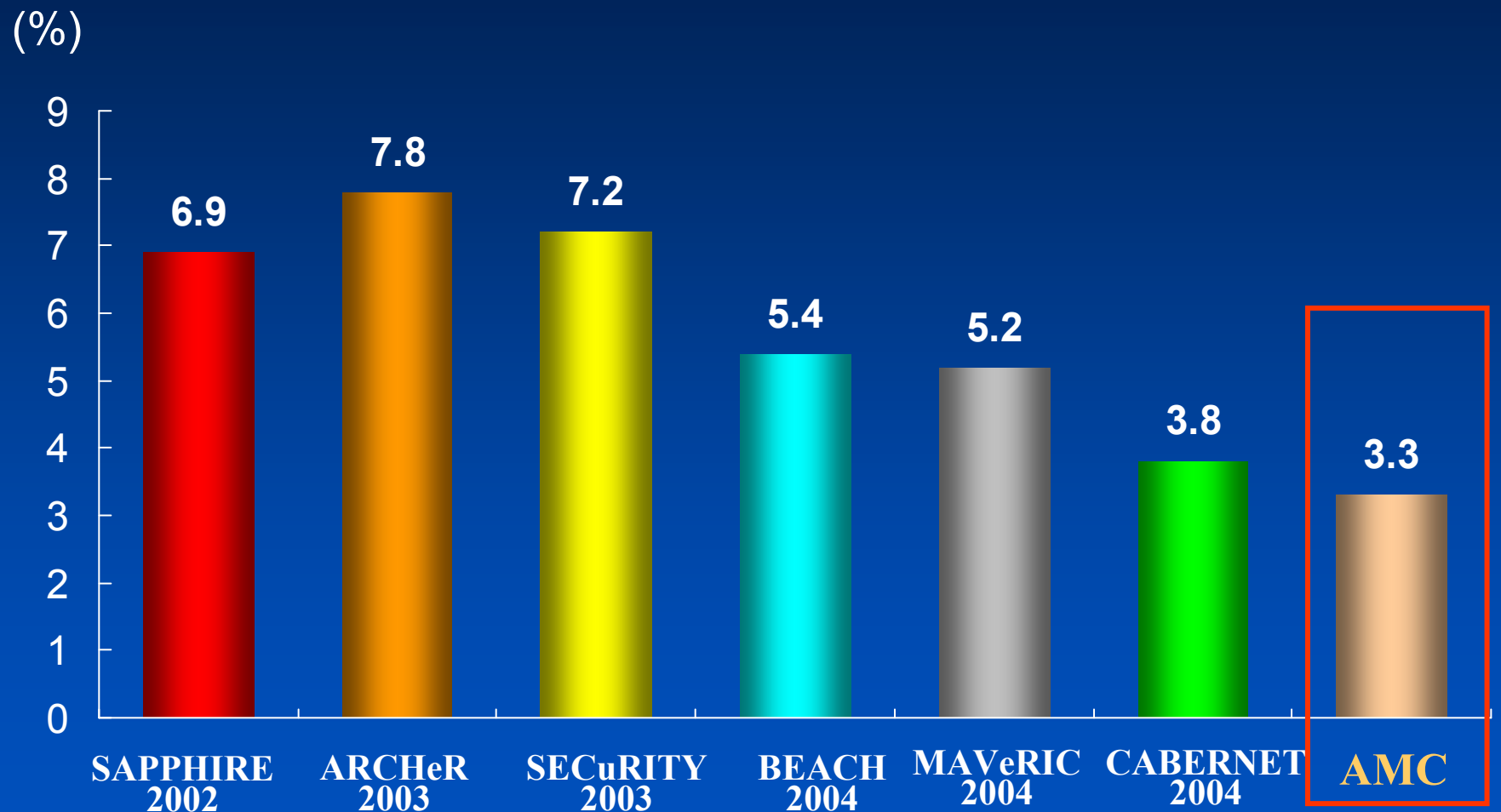
Death/Stroke



Minor stroke
Major stroke
Death
All events

AMC

30 Day Stroke/Death/MI in high risk Registry



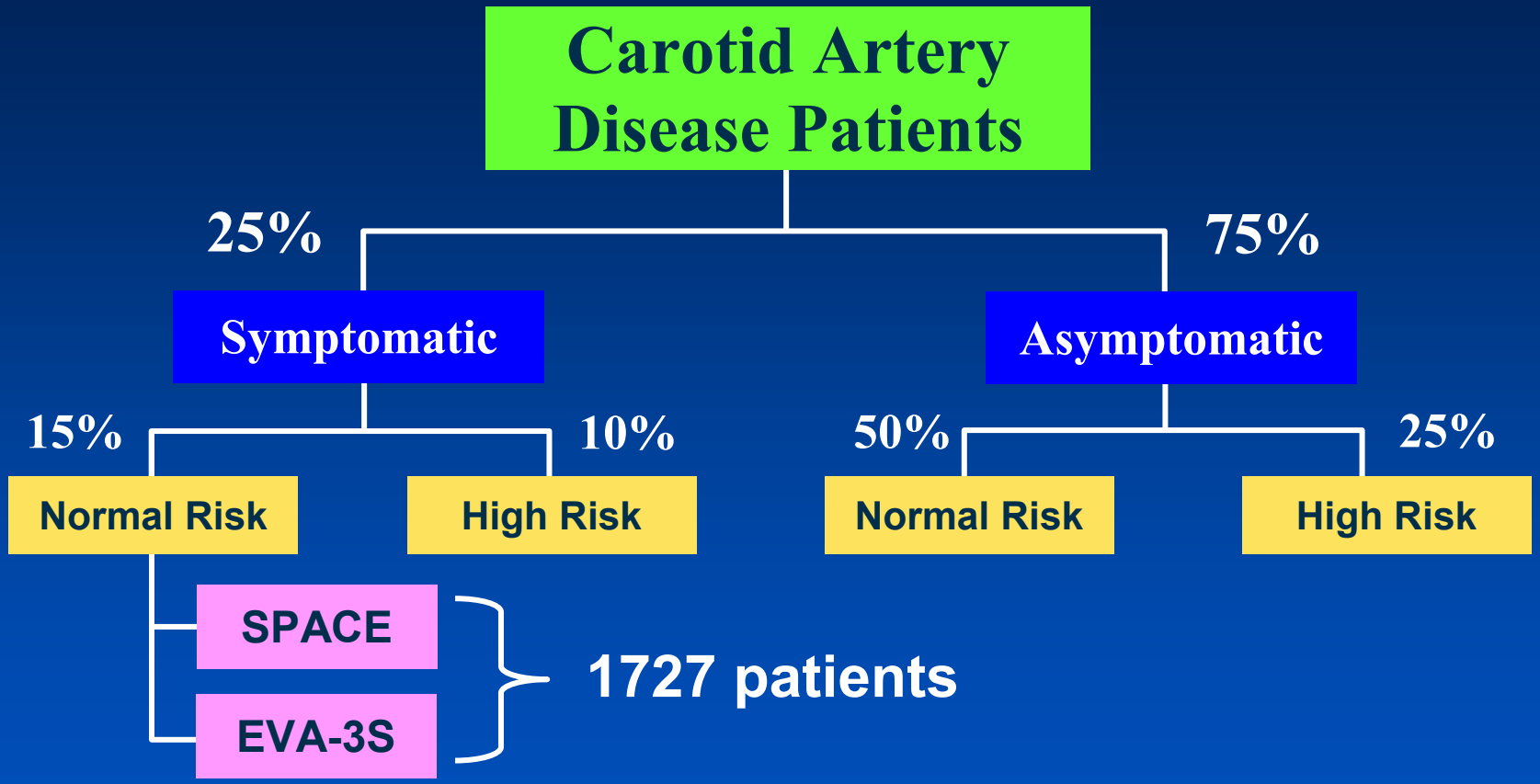
TCT 2005

Carotid stenting….

- Carotid stenting with the use of an EPD is an efficacious method for carotid revascularization
- According to the previous randomized and registry studies, in high-risk CEA patients, carotid stenting is superior or equivalent to CEA.
- For standard-risk CEA patients, randomized trials comparing both procedures are in various stages of progress.

Carotid Stenting

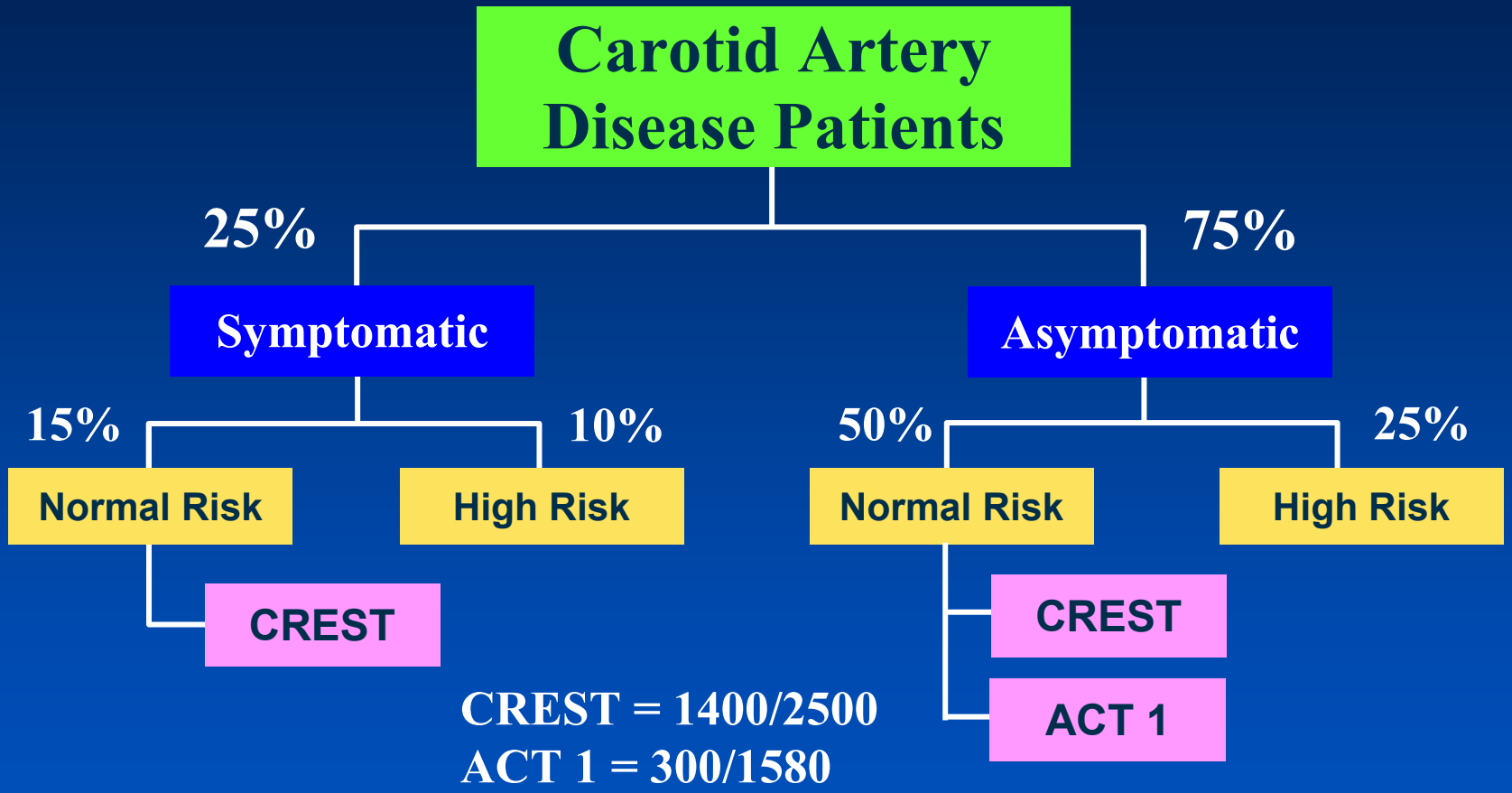
Clinical trials for normal risk



Recent NEGATIVE RCT's ???

Carotid Stenting

Clinical trials for normal risk



CREST = 1400/2500
ACT 1 = 300/1580

On going trials ascertain this issues

Now. Carotid Stenting

- Up to date, CS is at least equivalent results and a more preferred therapy to CEA with appropriate learning curve and the use of the protection device in *symptomatic and asymptomatic high surgical risk group*
- Technical progress, advance in technical expertise and *patients selection* are important to reduce the risk of CS
- CS may be extended to all patients subsets, such as symptomatic, asymptomatic, high risk, and low risk subgroups.

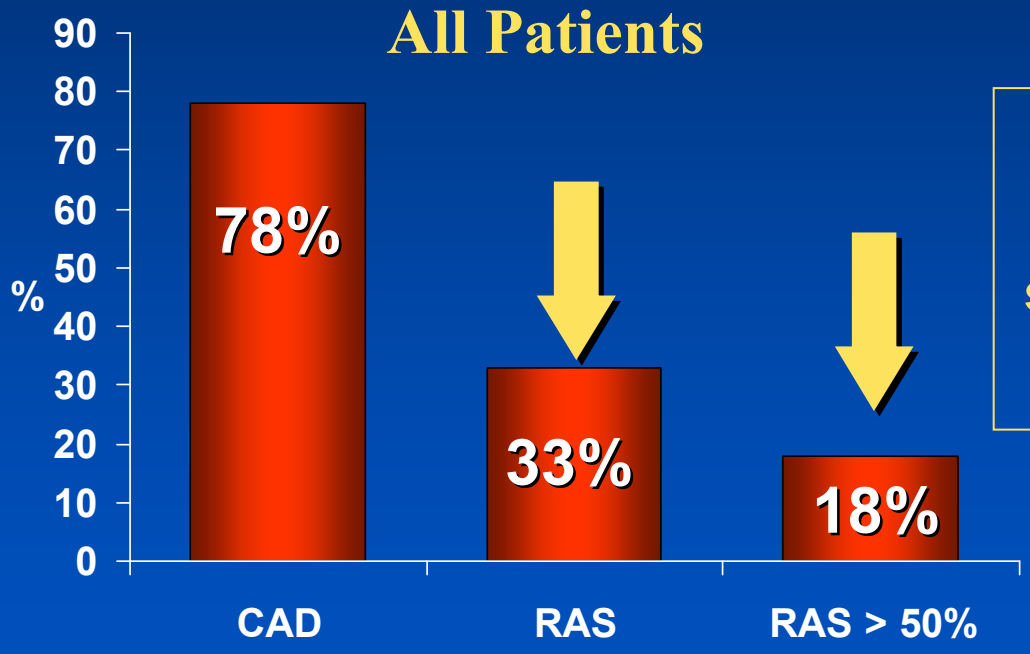
Renal Artery Stenting

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.

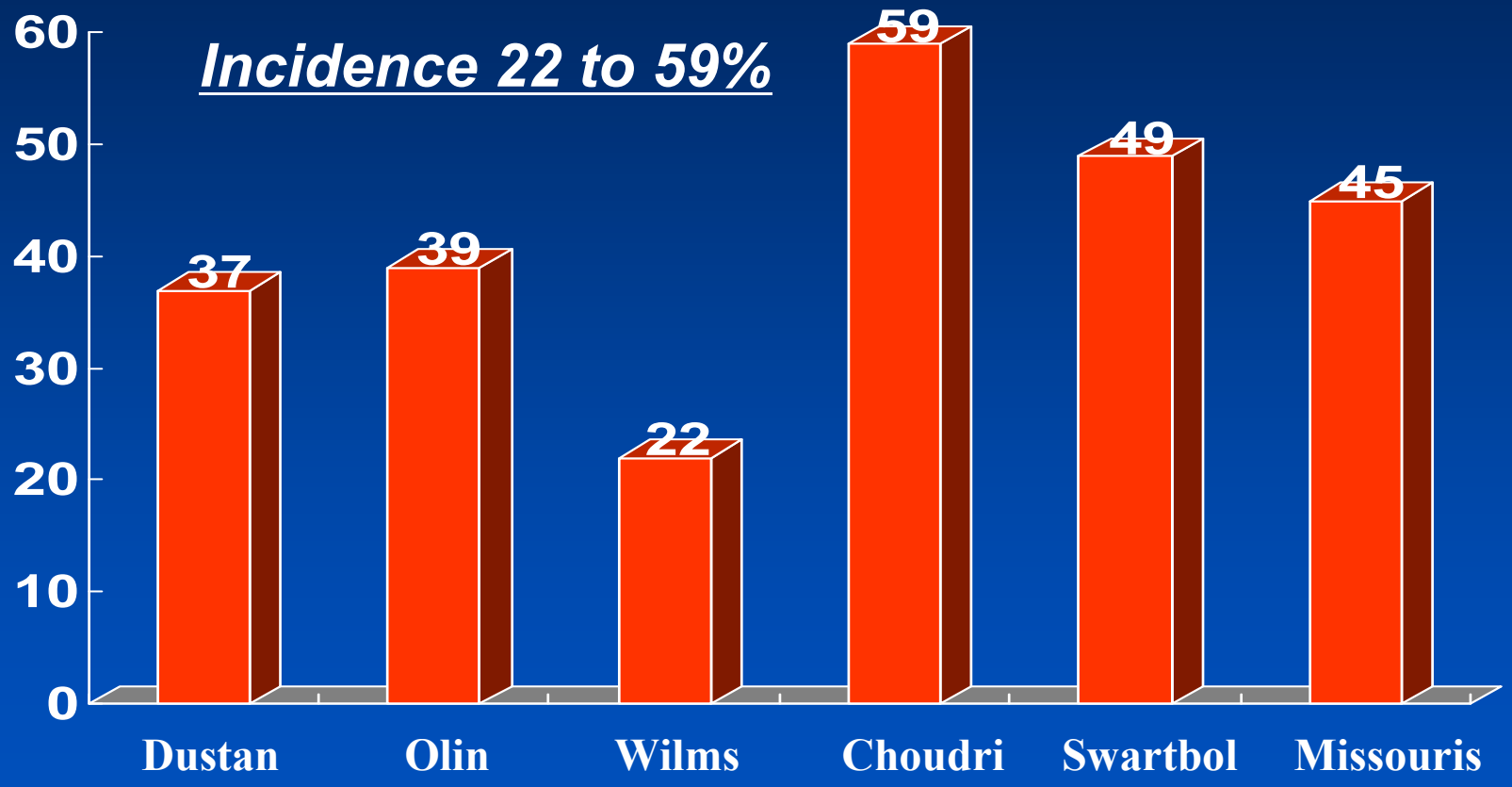


22% (1 in 5) of the patients with CAD had significant (> 50%) renal artery stenosis.

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

Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

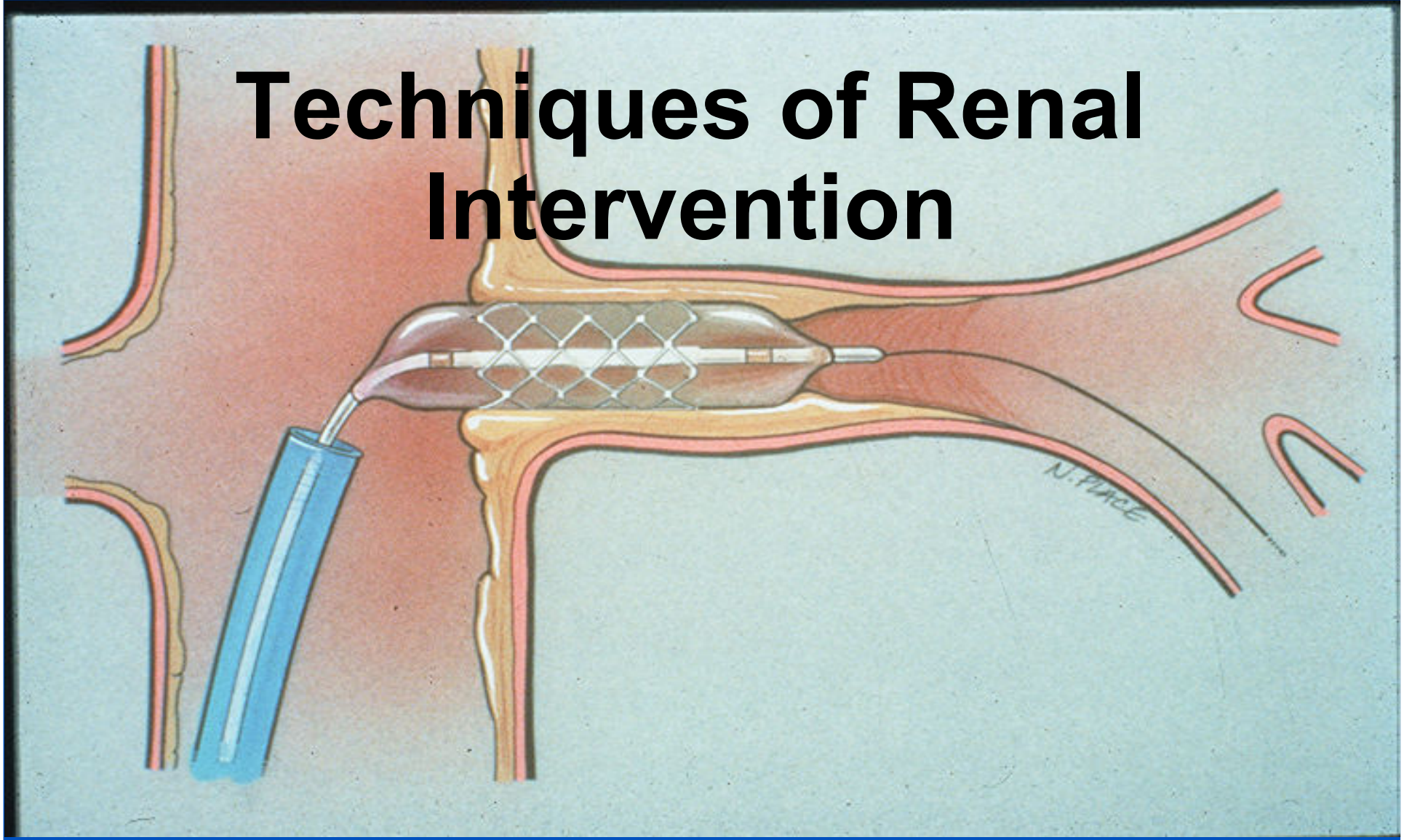
- Refractory/resistant hypertension and unilateral/bilateral > 70% RAS
  - Expect decrease in number of antihypertensive medications required
  - Easier to control blood pressure
  - Unlikely to "cure" hypertension

Atherosclerotic Renal Artery Stenosis:
Who Should Be Revascularized?

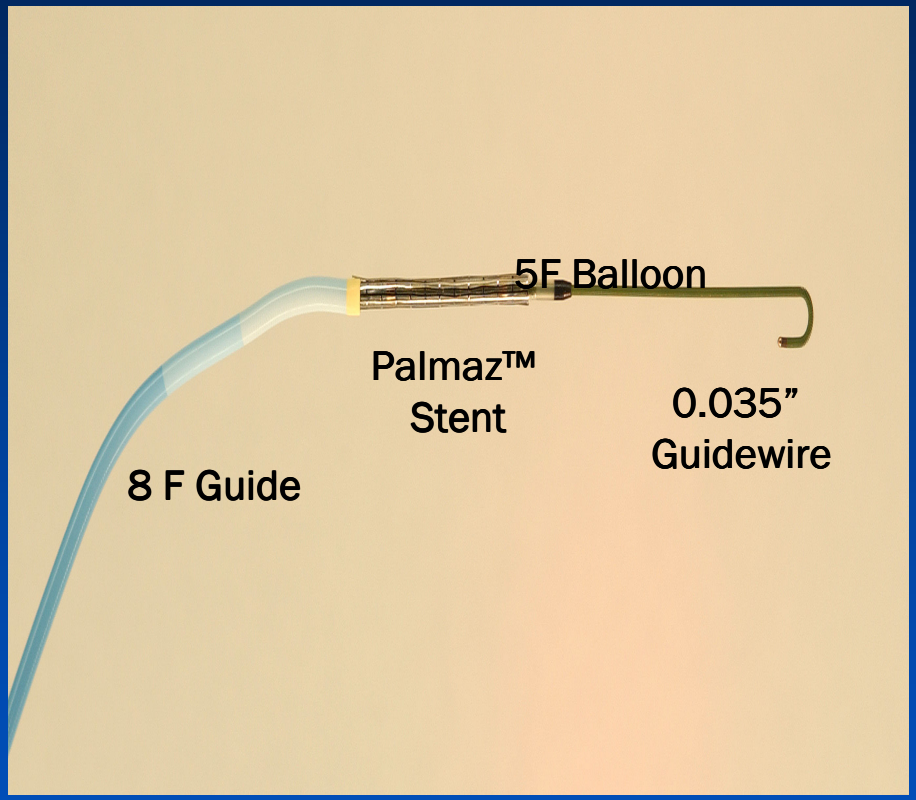
- Recurrent "flash" pulmonary edema
  - Solitary functioning kidney
  - Bilateral renal artery stenosis
  - Improvement in symptoms; blood pressure; reduction in hospitalizations for flash pulmonary edema

Renal Artery Stenting

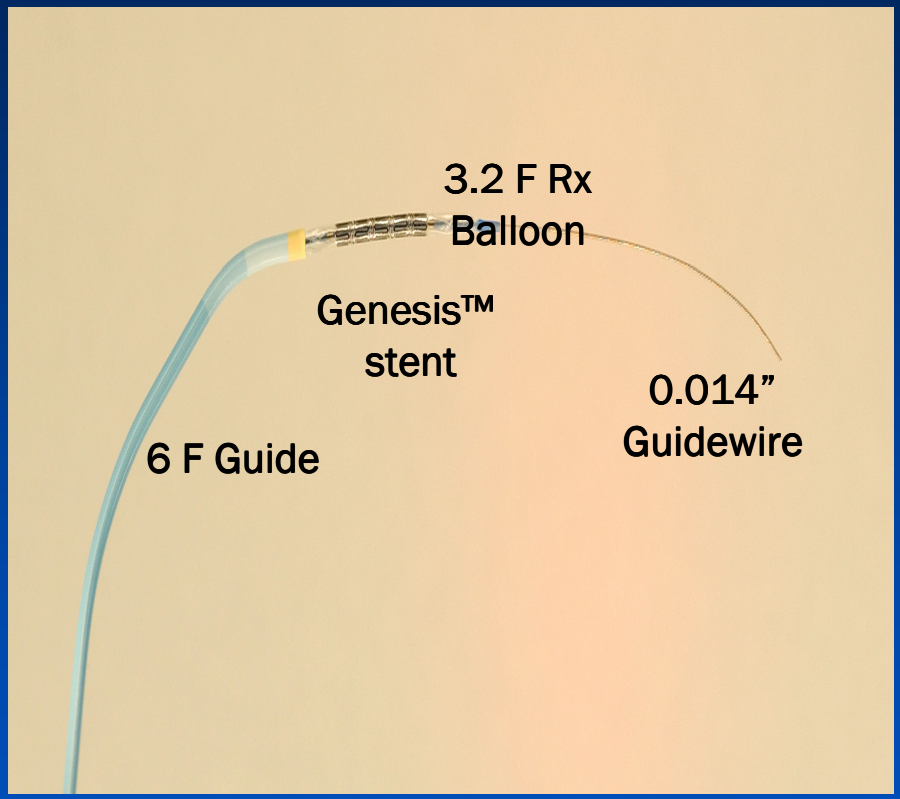
Techniques of Renal Intervention



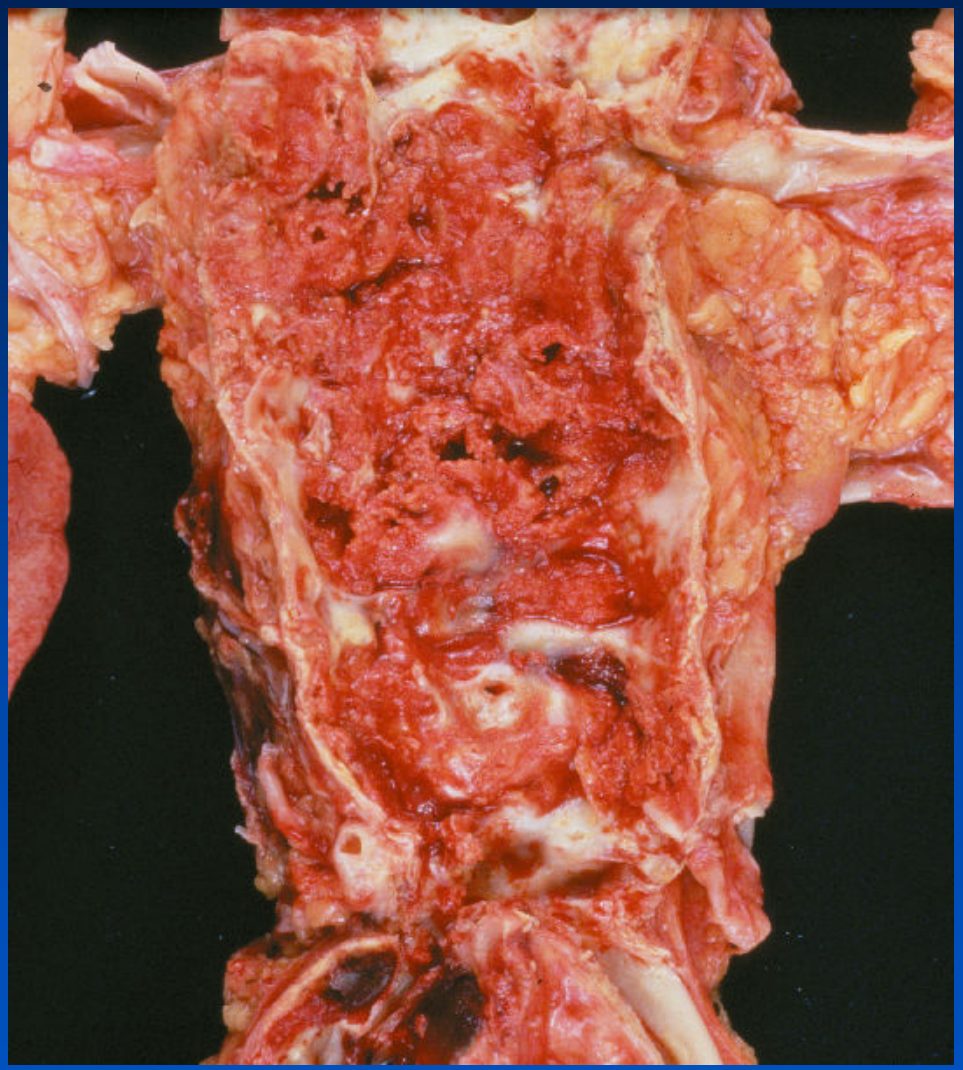
Renal Artery Stenting - 1993

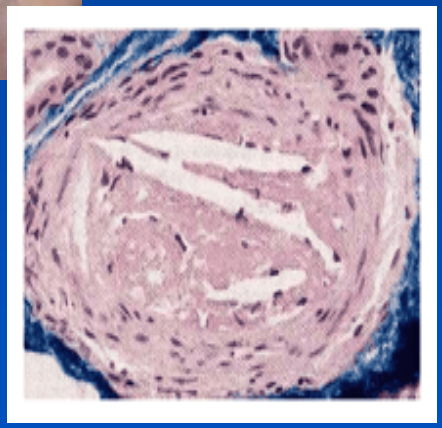


Renal Artery Stenting - 2006



Atheroembolism



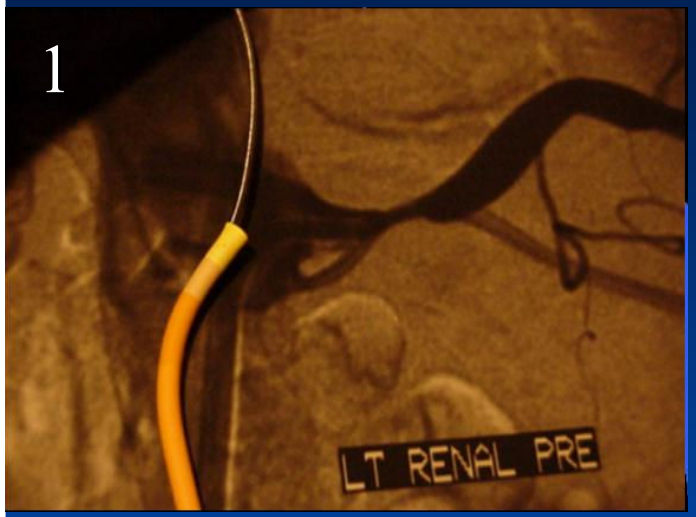


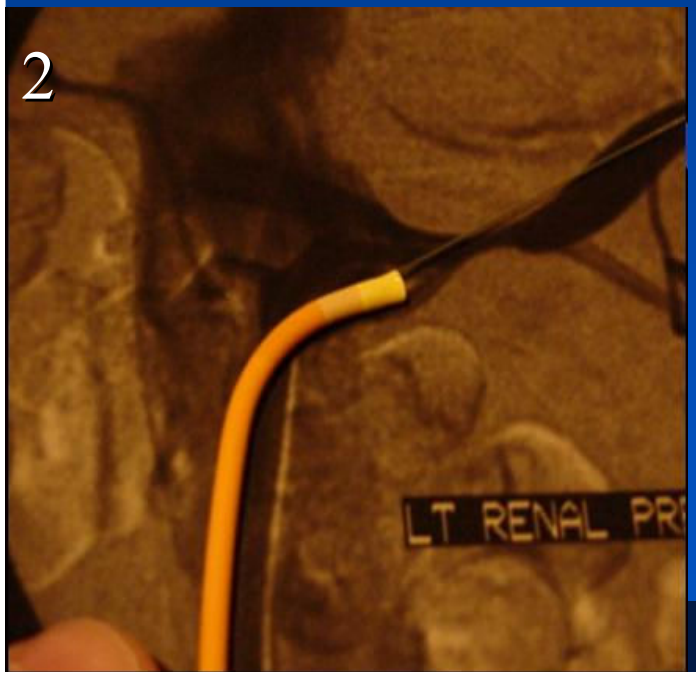
Optimal Technique

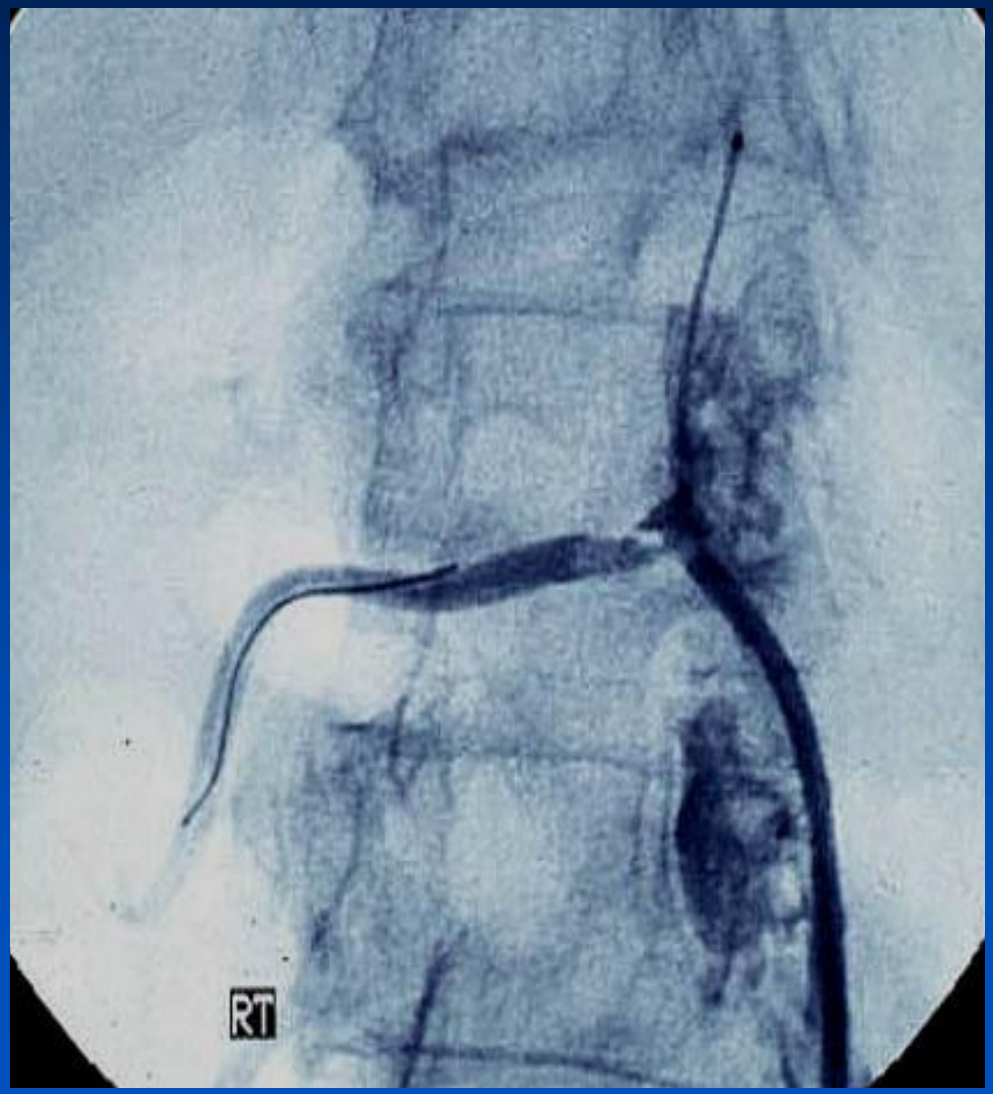
Severe atherosclerotic disease of abdominal aorta

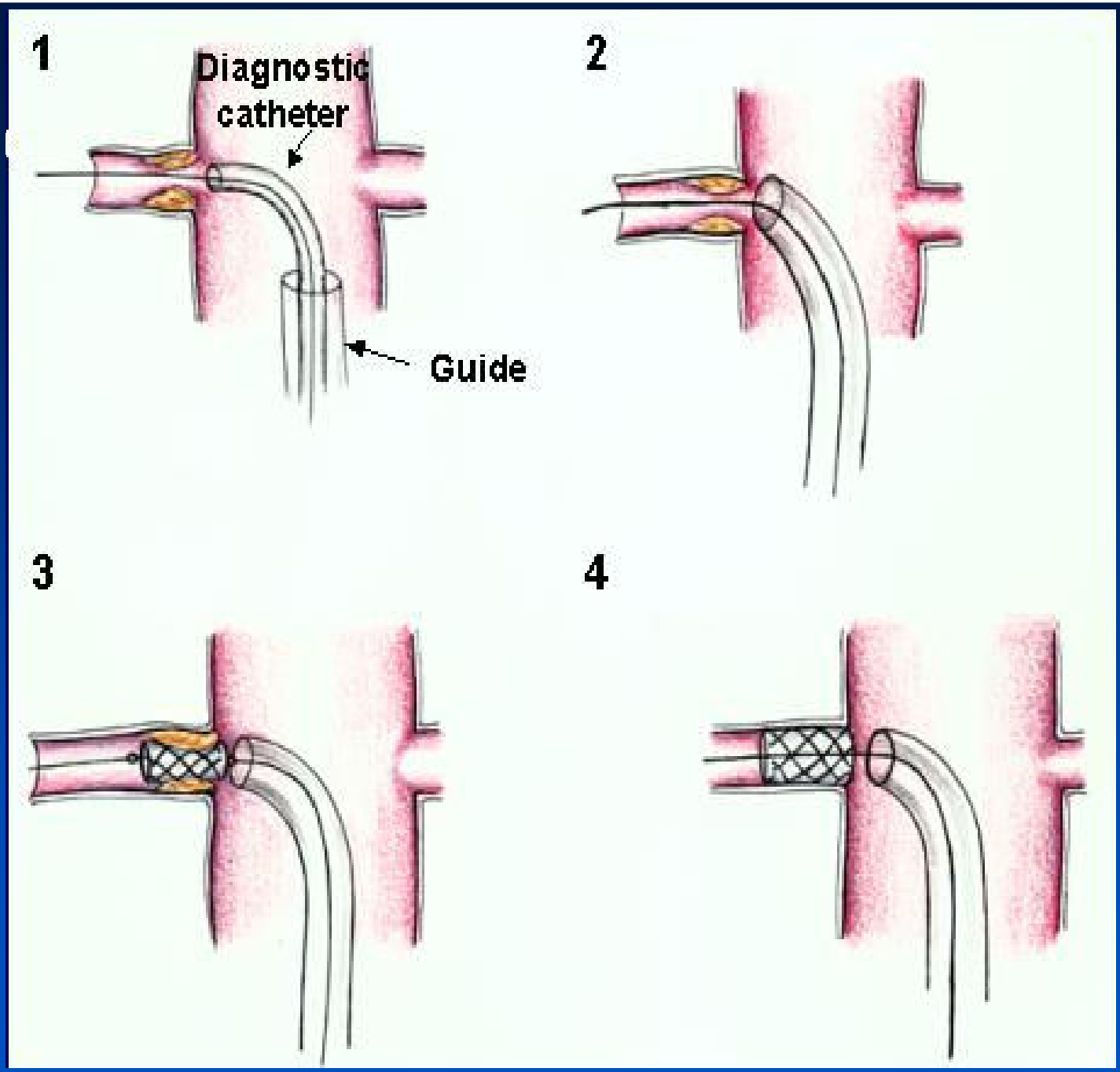
- Minimize catheter manipulation in the aorta
  - Engage renal artery with softer diagnostic catheter (telescoped inside guide catheter)
  - "No touch" technique
- Consider brachial artery approach for heavily diseased abdominal aorta or extreme downward take-off of renal artery
- Consider embolic protection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

“No Touch” Technique








1
Diagnostic
catheter
Guide
2
3
4

Optimal Technique

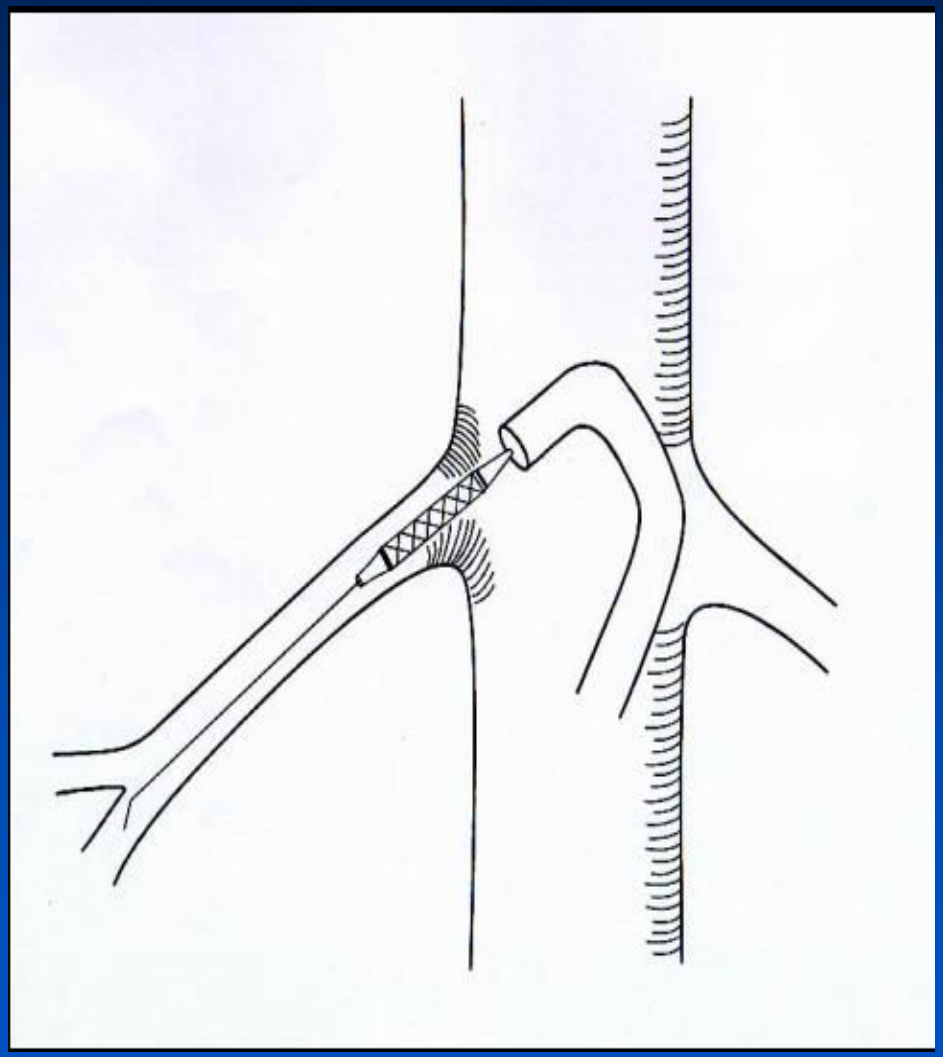
Severe Baseline Renal Insufficiency

- 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

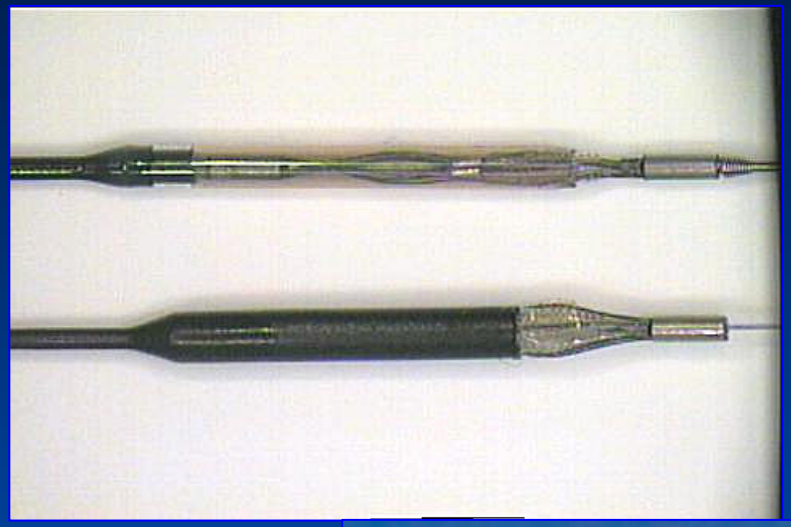
- Identify the true ostium – angulated views
- Adequate predilatation
- Leave stent 1-2 mm into aorta
- Account for stent shortening
- Confirm complete ostial coverage

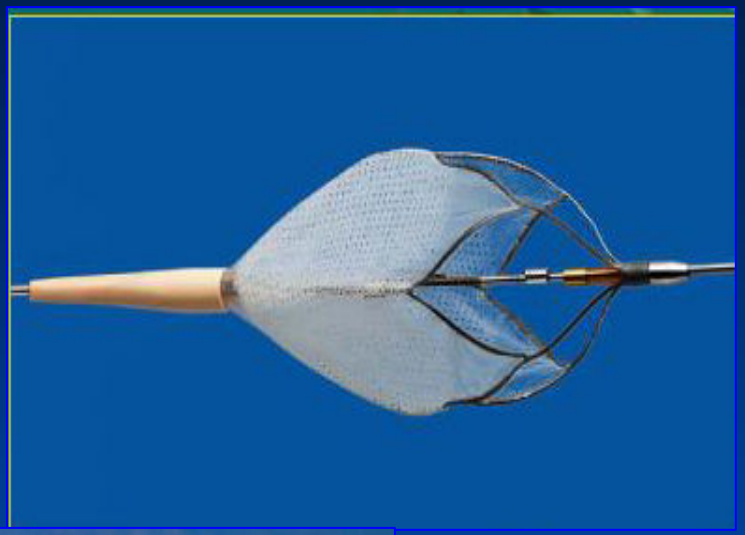


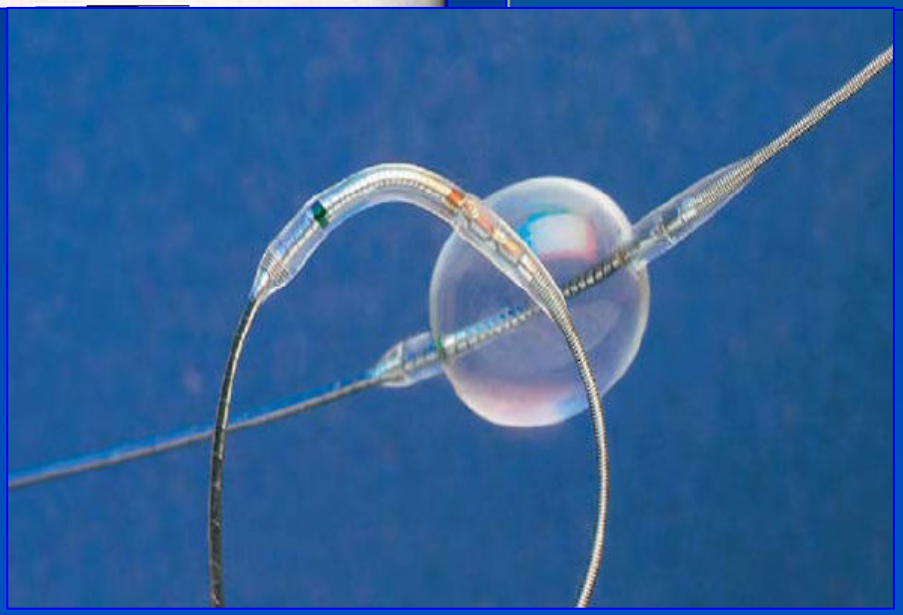
Improving Results of Renal Artery Stenting

- Drug Eluting Stents
- Distal Protection Devices

Distal Protection During Renal Stenting



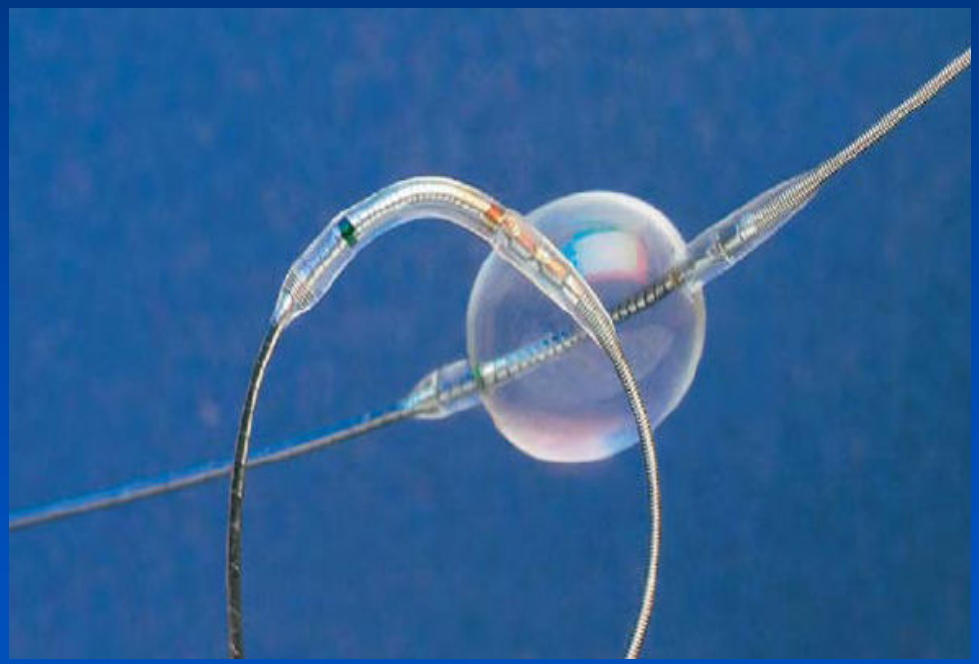


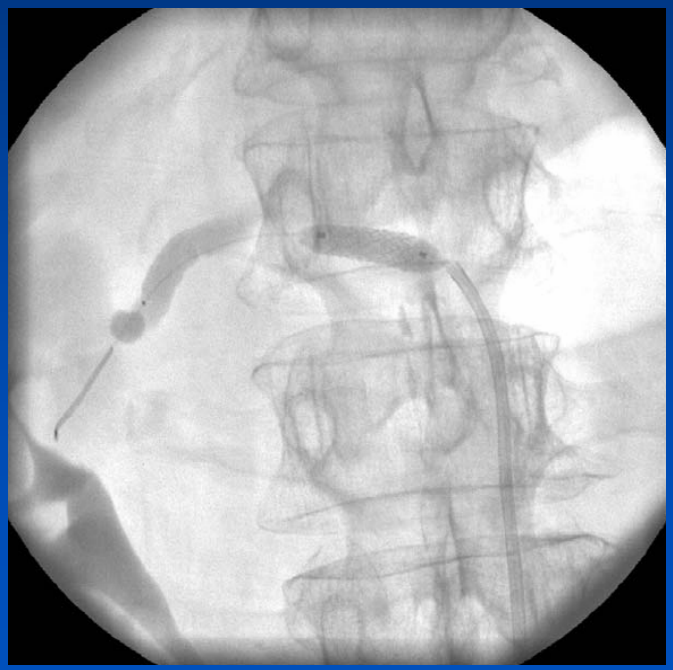


Distal Protection

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



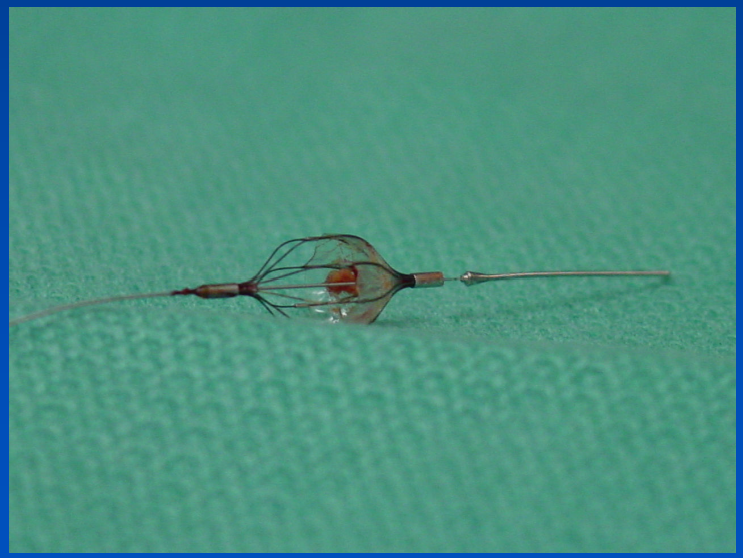


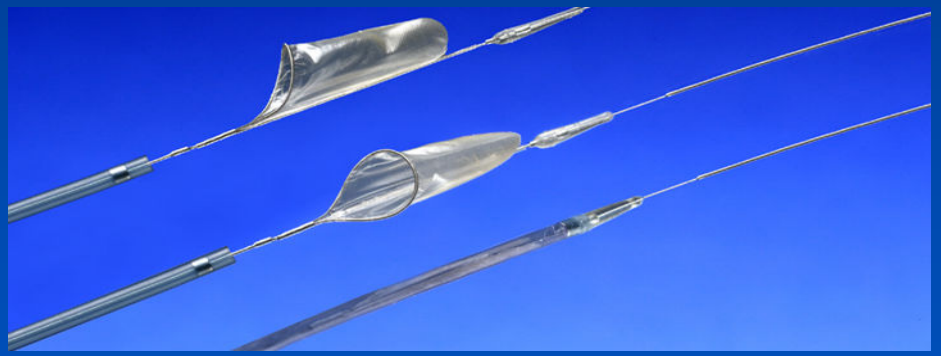
Edward MS, et al: J Vasc Surg 2006;44:128-35.

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