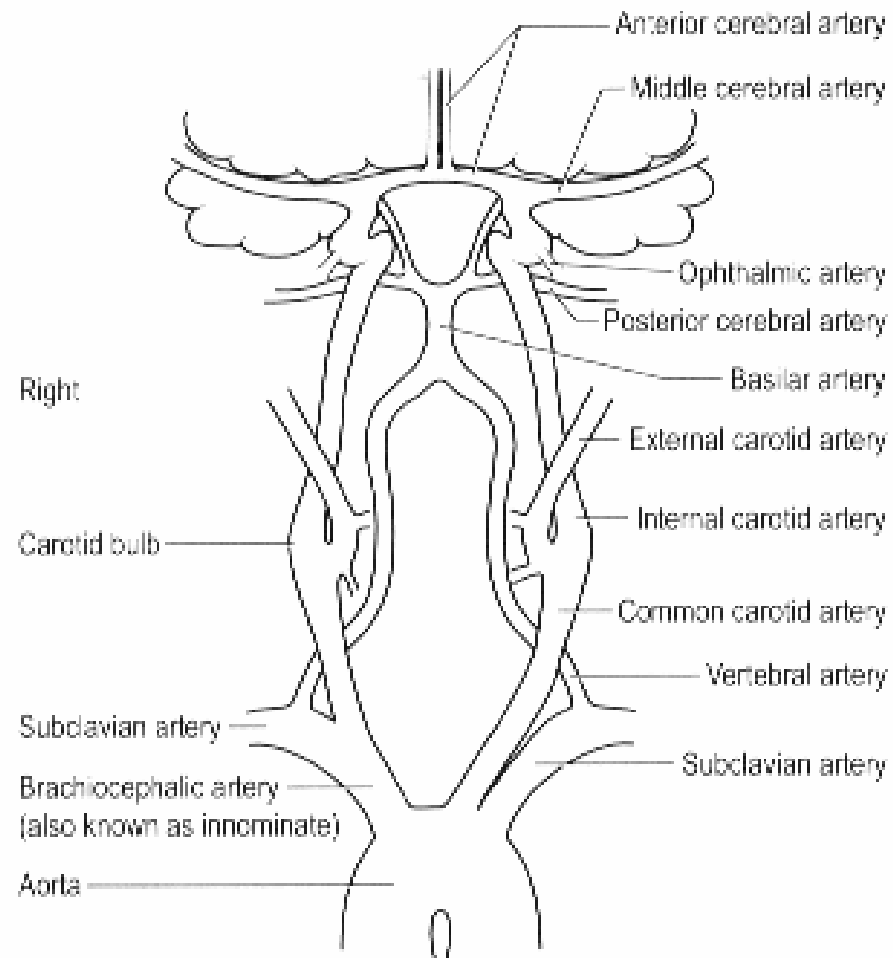


Carotid Artery Stenosis

David Stultz, PGY 5

December 16, 2004



Some Facts

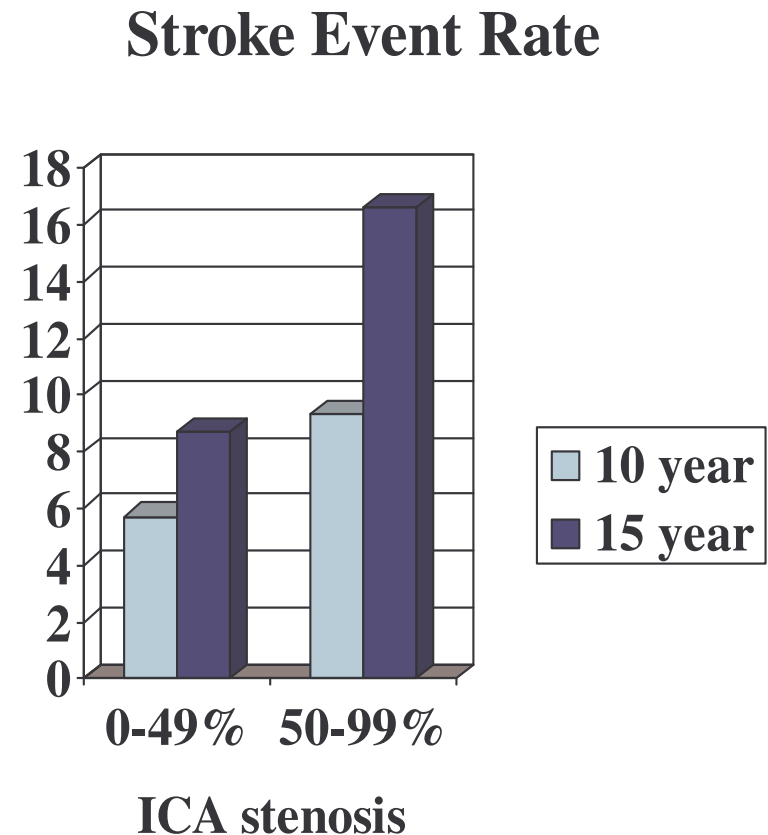
- Internal Carotid Artery Stenosis is responsible for 30% of ischemic strokes
- 4-8% of 50-79 year old patients have ICA stenosis >50%
- ICA stenosis causes mostly (90%) embolic strokes, rarely failure of perfusion

Carotid Artery Stenosis

- Asymptomatic
- Symptomatic

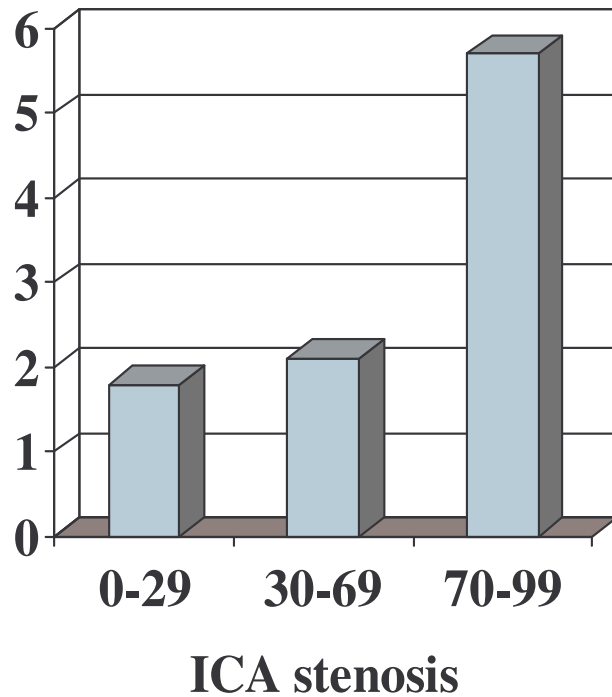
Natural History

- Short term (2-3 years)
1-3% incidence of
unheralded ipsilateral
CVA
- Approximate event
rate of <1%/year for
<50% stenosis
- Approximate event
rate of 1%/year for
>50% stenosis

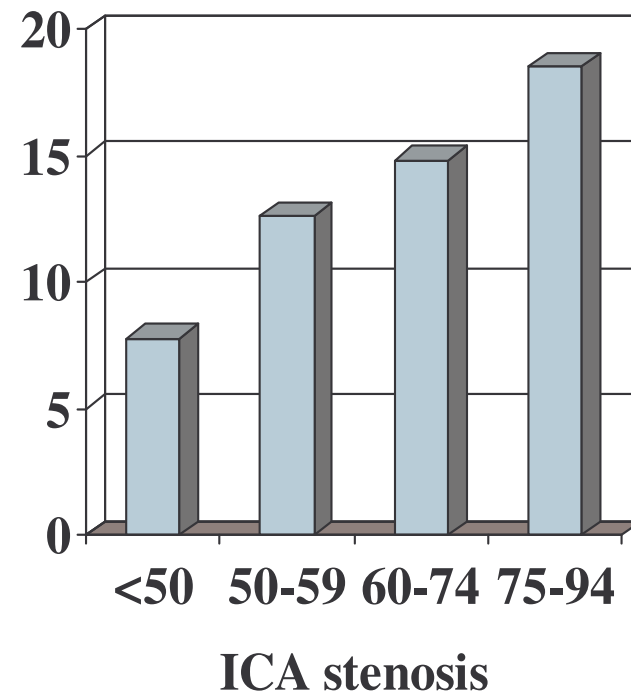


Ipsilateral Event Rate

3 year, ECST



5 year, NASCET



CASANOVA

(Carotid artery stenosis with asymptomatic Narrowing: Operation vs. Aspirin)

- 410 patients, 3 years
- Asymptomatic ICA 50-90%
- Overall, CEA not beneficial for ICA stenosis <90%

VA Study

- 444 patients, 4 year followup
- Asymptomatic ICA 50-99%
- ASA 1300mg/day vs CEA + ASA 1300
- TIA reduction in CEA + ASA
- No stroke reduction in CEA group

ACAS

Asymptomatic Carotid Atherosclerosis Study

- 1662 patients, mean 2.7 years; projected 5 years
- Asymptomatic ICA 60-99% (noninvasive or angiographic)
- ASA 325 vs. CEA + ASA 325
- 53% relative risk reduction in CVA/death, Absolute reduction of 5.9% over 5 years

Limitations of ACAS

- Absolute stroke risk reduction of 1.2%/year
 - Eg pt with 3%/year stroke risk now with 1.8%/year stroke risk
 - Risk of cardioembolic, lacunar CVA NOT reduced
- Perioperative complication rate 2.3%; death 0.1%
 - Good risks; 25 pts screened for every 1 enrolled
 - Other studies show 4.6-5.1% incidence of perioperative stroke/death in asymptomatic ICA with CEA
 - If 5% event rate applied, results of ACAS are nullified
- CEA not beneficial for women with ICA 60-99%!
- No incremental benefit for increasing stenoses
 - 60-69% stenosis had HIGHER benefit than 80-89%!

ACST

Asymptomatic Carotid Surgery Trial

- Largest prospective study to date, most recent (May 2004)
- 3120 patients, 5 year followup; 10 year period
- ICA >60% stenosis (ultrasound)
- Immediate CEA vs. Deferred CEA (+ 'usual therapy)
- 5 year stroke risk – 6.4% CEA; 11.8% medical
 - Men and women, all age groups, all stenosis subsets
 - 3% perioperative event rate

Meta-analysis

- 2206 patients, 2-4 years
- Ipsilateral/perioperative stroke or death
 - 4.9% CEA
 - 6.8% Medical
- Any stroke or death
 - 8.1% CEA
 - 10.4% Medical
- NNT: 53 patients undergo CEA to prevent 1 CVA over 3 years

Screening Asymptomatic Patients

- Risk factors for ICAS
 - Age
 - HTN
 - Smoking
 - PVD

Screening Aysmptomatic Patients

- Risk factors for CVA with ICAS
 - Age
 - Male
 - HTN
 - Smoking
 - HLP
 - DM
 - Degree of stenosis
 - Ulceration of plaque
 - Ischemic heart disease
 - PVD
 - Obesity

Screening Patients

A strategy

- Carotid US for population at risk (40-50% pre-test probability) in surgical candidates who would undergo surgery
- Follow up patients with >50% stenosis, especially with smoking + CAD or PVD

Cost Effectiveness

- Primary Prevention: To prevent 1 nondisabling stroke in 2 years
 - \$1.5 million

Screening Methods

- Carotid duplex US
 - 85% sensitivity/specificity for 70-99% vs <70%
- Digital Subtraction Angiography
 - Clinical periprocedure CVA rate of 1%
 - Gold standard
- MRA (Elliptic Centric Contrast Enhanced MRA)
 - 95% sensitivity/ 90% specificity for 70-99% vs <70%
- Spiral CTA
 - 74-100% sensitivity/ 83-100% specificity for 70-99% vs <70%

Summing up the Evidence

- 4-8% of patients age 50-79 with ICA stenosis
- Stroke risk increases with stenosis, esp. >80%
- Unheralded stroke risk is low (1-3%/year)
- Screening?
- **CEA supported with >60% stenosis in medically stable patient expected to live >5 years with a low surgical (<3% event) risk**

Secondary prevention

- TIA
- CVA

NASCET

- 2267 patients with TIA or nondisabling stroke within past 3 months
- 30-99% ICA stenosis
- Best medical tx vs CEA + best medical tx
- Stratified Moderate (30-69%) vs. Severe 70-99%
 - Severe: 9% ipsilateral stroke with CEA; 26% medical
 - 50-69%: 15.7% ipsilateral stroke with CEA; 22% medical
 - Higher risk (more surgical benefit) = male, CVA (not TIA), hemispheric sx, failure of ASA 650/day
 - 30-49%: 14.9% CEA; 18.7% medical at 5 years
- Surgical risk – 6-7% at 30 days (stroke, death) vs. 2.5-3% for medical tx.

Stroke Events in NASCET

- Most Patients with ICAS have multiple risk factors
- In NASCET
 - In patients with symptomatic stenosis, 20% of ischemic CVA's were not related to ICA stenosis!
 - In asymptomatic patients, 45% of ischemic CVA's were unrelated to ICA
 - Other causes: Carioembolic, lacunar

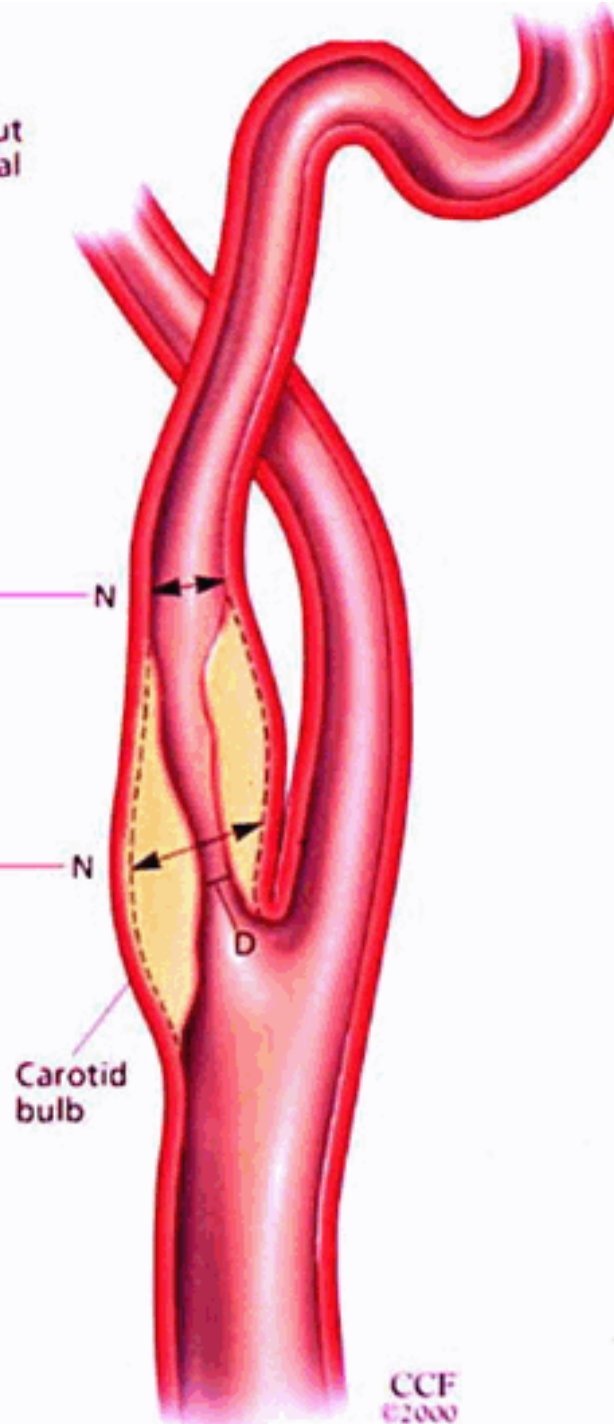
ECST

- 2518 patient with nondisabling stroke or TIA in past 3 months
- Angiographic method different than NASCET
 - 70-99%: 10.3% ipsilateral stroke or death CEA: 16.8% with medical at 3 years
 - Perioperative stroke/death rate of 7.5%
 - CEA harmful for <30% stenosis
 - 30-69% no benefit of CEA
- Recommend CEA for $\geq 80\%$ stenosis (60% by NASCET)

Both NASCET and ECST define D (the narrowest point) the same way but differ in how they define N (the normal diameter). This can lead to different stenosis measurements for the same lesion.

The **NASCET method** defines normal as the diameter just distal to the carotid bulb (not the bulb itself nor a region of poststenotic dilatation). In this example, the stenosis is 46% by the NASCET method.

The **ECST method** defines normal as the estimated diameter of the carotid bulb as it was before the disease narrowed the lumen. In this example, the stenosis is 75% by the ECST method.



Guidelines

A Moving Target

- 1997 NASCET (assume $\leq 6\%$ surgery risk)
 - CEA for symptomatic stenosis $\geq 70\%$
 - ? CEA for asymptomatic stenosis $\geq 60\%$
- 1998 AHA/Stroke
 - With $< 3\%$ risk, CEA for asymptomatic ICA $\geq 60\%$
 - With 3-5% risk, CEA for asymptomatic ICA $\geq 75\%$ with contralateral 75-100% stenosis
 - CEA for symptomatic stenosis $\geq 70\%$

2004 Hurst

- Symptomatic ICA stenosis
 - CEA for >80% stenosis
 - CEA probably indicated for 50-79% stenosis (closer to 79%), assess risk factors
 - CEA may be indicated with 50-79% stenosis (closer to 50%), assess risk factors
- Asymptomatic ICA stenosis
 - CEA for >80% stenosis
 - CEA may be indicated for 50-79% stenosis (closer to 79%), assess risk factors
 - CEA **not** indicated for 50-79% stenosis (closer to 50%)

Putting it all together

- Clear Indications for CEA
 - Symptomatic men and women, aged 80 years or younger, with 70% or greater carotid stenosis if surgical risk for stroke and death is 6% to 7% or less.
 - Asymptomatic men and women, aged 80 years or younger, with 80% or greater carotid stenosis if surgical risk for stroke and death is 3% or less.
- Possible indications for CEA
 - Symptomatic stenosis >50% with risk factors
 - Asymptomatic stenosis >60%
- CEA Clearly NOT indicated
 - Any stenosis $\leq 50\%$
 - Asymptomatic stenosis <60%

CEA vs Carotid Stenting

- Trials thus far demonstrate comparable short term (30 day) outcomes
- Stenting favored for high risk patients (heart failure, angina, COPD) or patients with difficult surgical anatomy (scar tissue, radiation, etc)
- Surgery favored in tortuous vessels

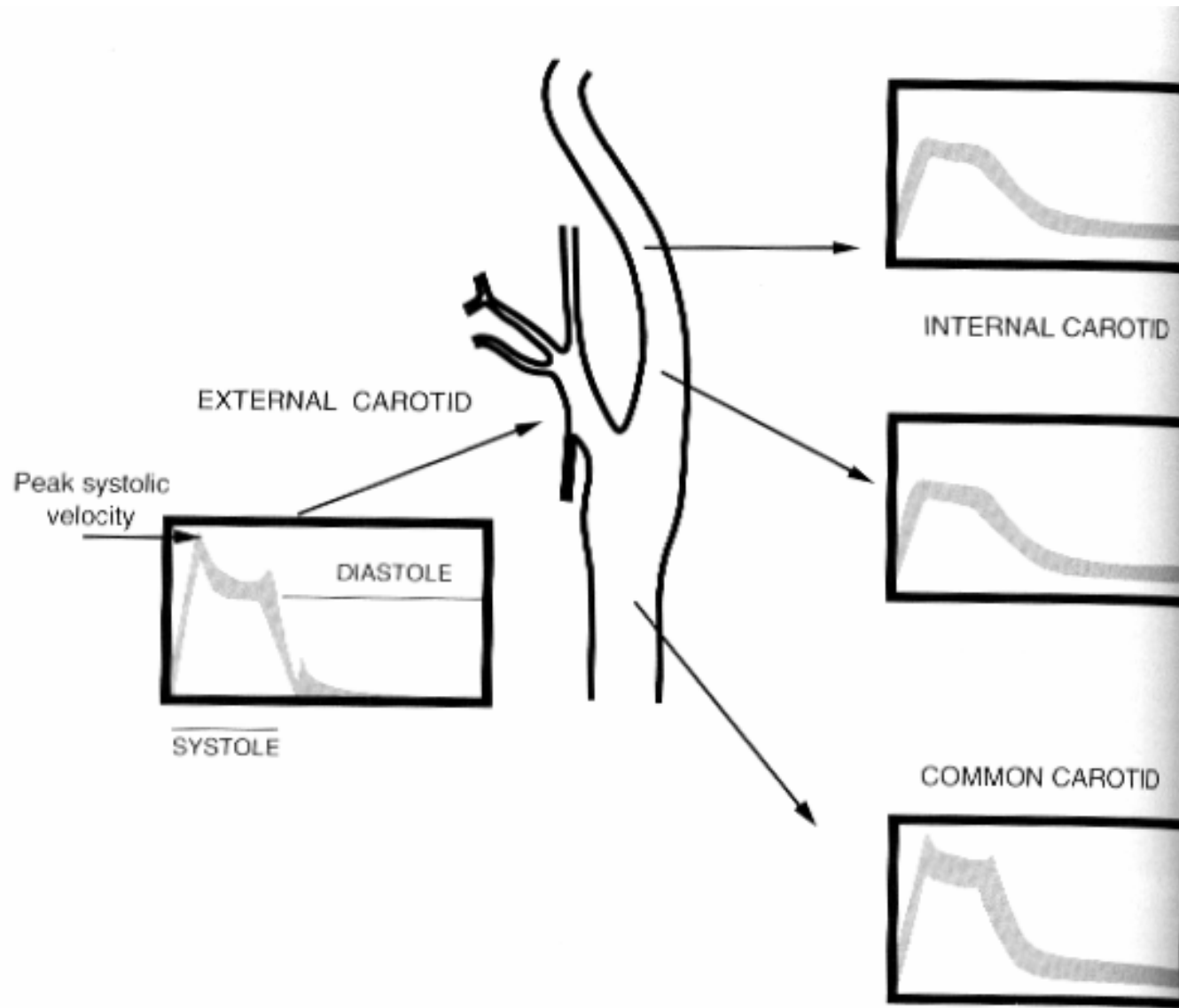
Concomitant Coronary and Carotid disease

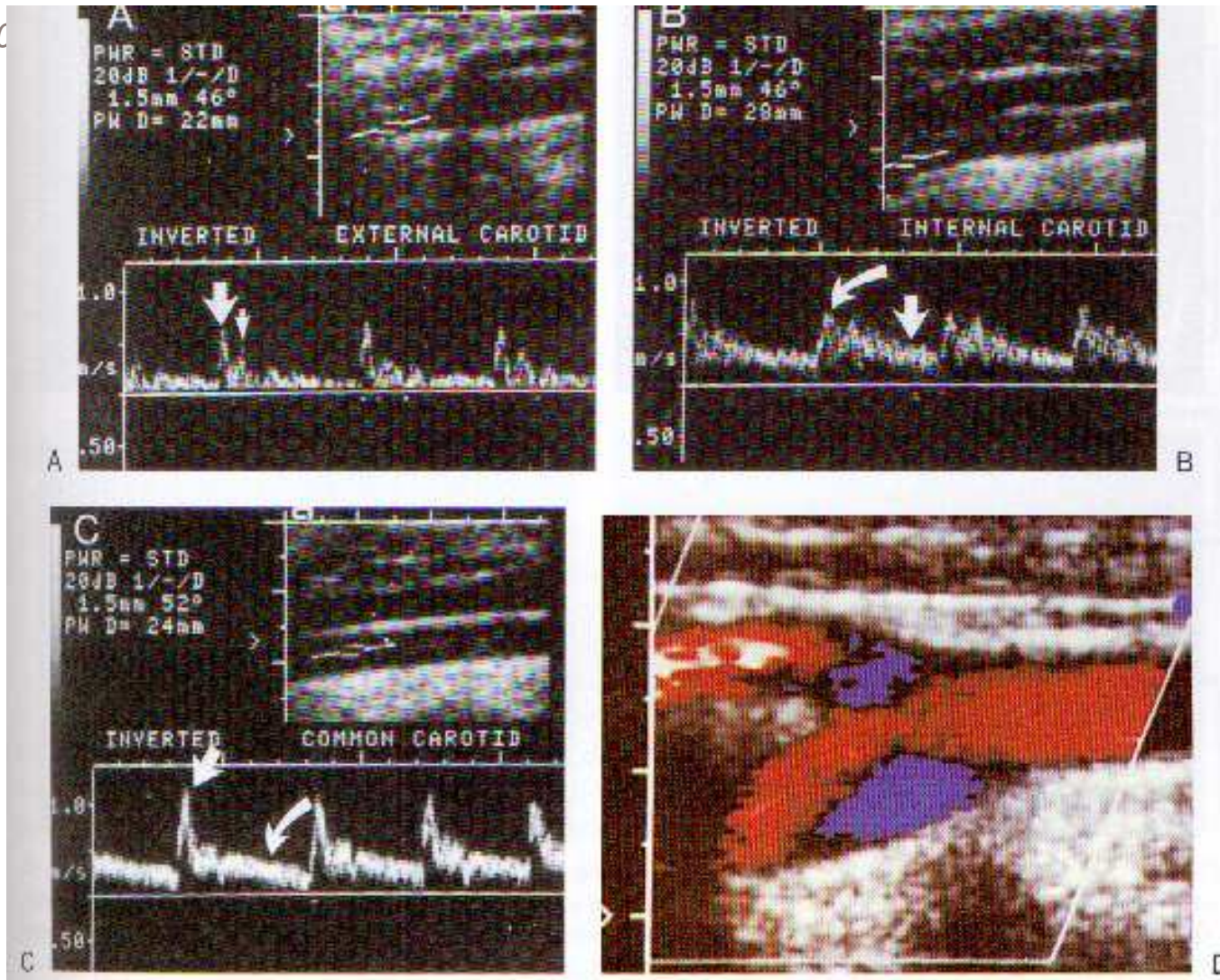
- Overall CABG CVA risk 1-3%
 - 9% risk with >50% ICA stenosis
 - 14% risk with >75% ICA stenosis

	Stroke Rate	Mortality
Staged (CEA then CABG)	3-4%	3-4%
Reverse Staged (CABG then CEA)	14%	5%
Combined (CEA and CABG)	3%	4%

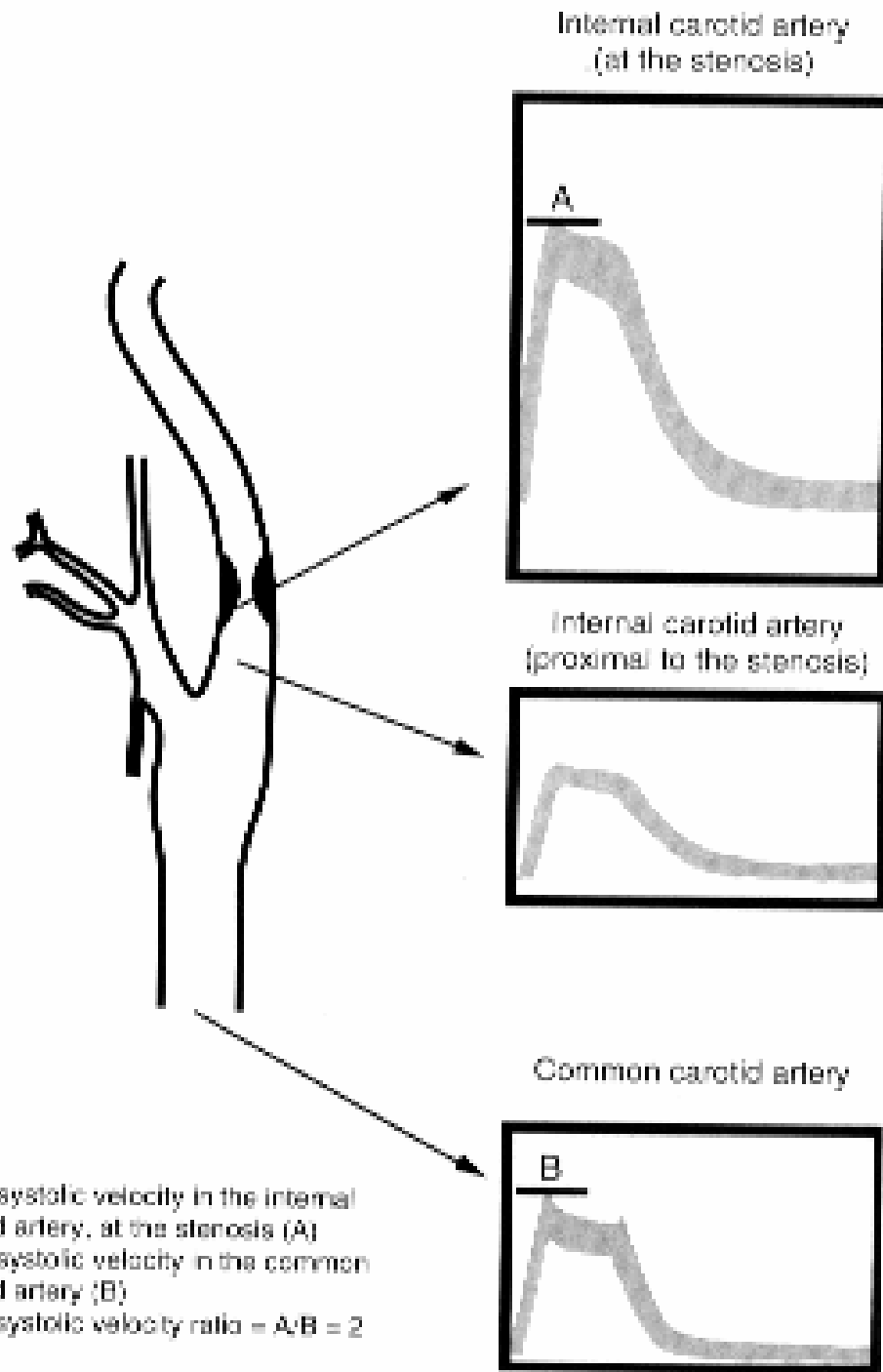
Carotid Ultrasound

- Right then left side
- Transverse imaging
 - Visualize plaque, calcium
- Longitudinal imaging
 - Visualization of plaque
 - Duplex sonography
 - Left of screen = cephalid, right = caudal
- (Subclavian), CCA, ECA, ICA, (vertebral)



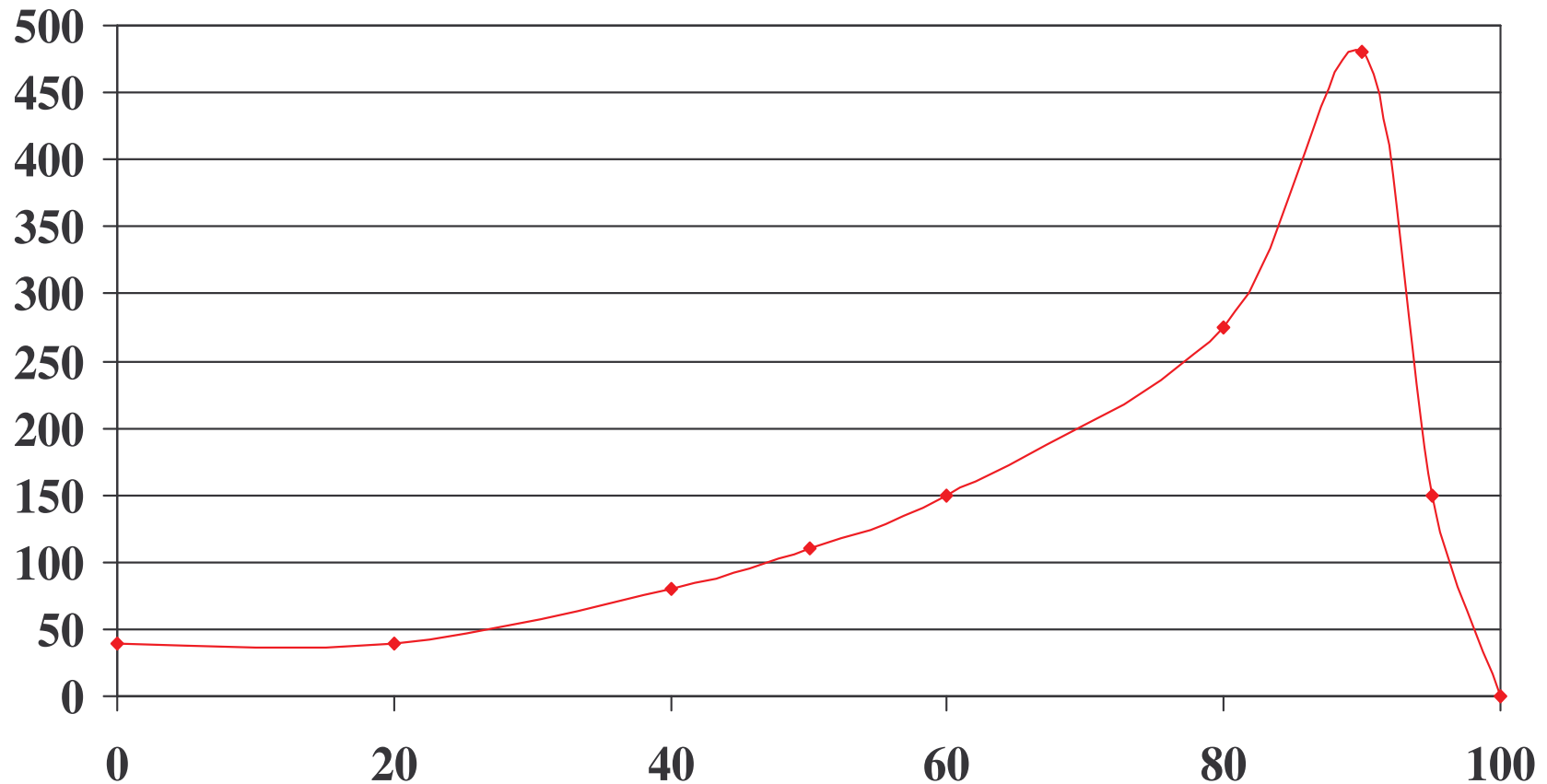


- A. Normal ECA (High resistance)
- B. Normal ICA (Low resistance)
- C. Normal CCA
- D. Normal Color Doppler at Bifurcation; Normal Flow reversal



Peak-systolic velocity in the internal carotid artery, at the stenosis (A)
Peak-systolic velocity in the common carotid artery (B)
Peak-systolic velocity ratio = $A/B = 2$

Stenosis >90%, velocity falls



Ultrasound Criteria for Stenosis

	Primary		Secondary	
	ICA PSV	Plaque (%)	ICA/CCA PSV ratio	ICA EDV
Normal	<125	None	<2	<40
<50	<125	<50	<2	<40
50-69	125-230	>=50	2-4	40-100
>=70	>230	>=50	>4	>100
Near Occlusion	Variable	Visible	Variable	Variable
Total Occlusion	Undetectable	Visible, no lumen	NA	NA

Carotid Doppler Report

- Plaque estimate (> or <50%)
 - Homogenous vs Heterogenous
 - +/- calcium
- ICA stenosis estimate
- Vertebral Artery
 - Antegrade v retrograde flow

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