CONTROVERSIES & UPDATES IN VASCULAR SURGERY
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Can we Operate a Carotid Stenosis Based on Duplex Scanning Only?

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Disclosure

Speaker name:

STAVROS KAKKOS.....

☑ I do not have any potential conflict of interest

History of Carotid Endarterectomy in Relation to Imaging

- 1953-late 1970's: exclusive use of arteriography

Risks of Carotid Arteriography

- Contrast-induced nephropathy
- Allergic reactions
- Stroke (0.4% in VA and 1.3% in ACAS)
- Access-related complications

  (dissection, pseudoaneurysm, etc)

History of Carotid Endarterectomy in Relation to Imaging

- 1982: "**Carotid endarterectomy without angiography"** by Blackshear W & Connar R.

  J Cardiovasc Surg (Torino) 1982;23:477-82.

  Four patients with five symptomatic carotid stenoses studied with Duplex Doppler alone (no colour) underwent endarterectomy, which confirmed preoperative imaging findings.

From Obligatory to Selective Arteriography

- Numerous studies published since the 1980's concluded that CEA can be safely performed **in selected patients** with adequate Duplex tests.

Flanigan, J Vasc Surg 1985

Hill, Ann Vasc Surg 1990

Chervu, Ann Vasc Surg 1990

Loftus, EJVES 1998

Collier, Cardiovasc Surg 1999

Kasper, Vasc Endovasc Surg 2003

From Obligatory to Selective Arteriography

- Prior to May 1992: routine arteriography
- Between May 1992 and December 1994: policy of selective carotid arteriography when Duplex testing was not satisfactory
  - Out of 148 patients, only 11 (7%) had arteriography; one postop stroke (0.7%).

Collier, Cardiovasc Surg 1999

From Obligatory to Selective Arteriography

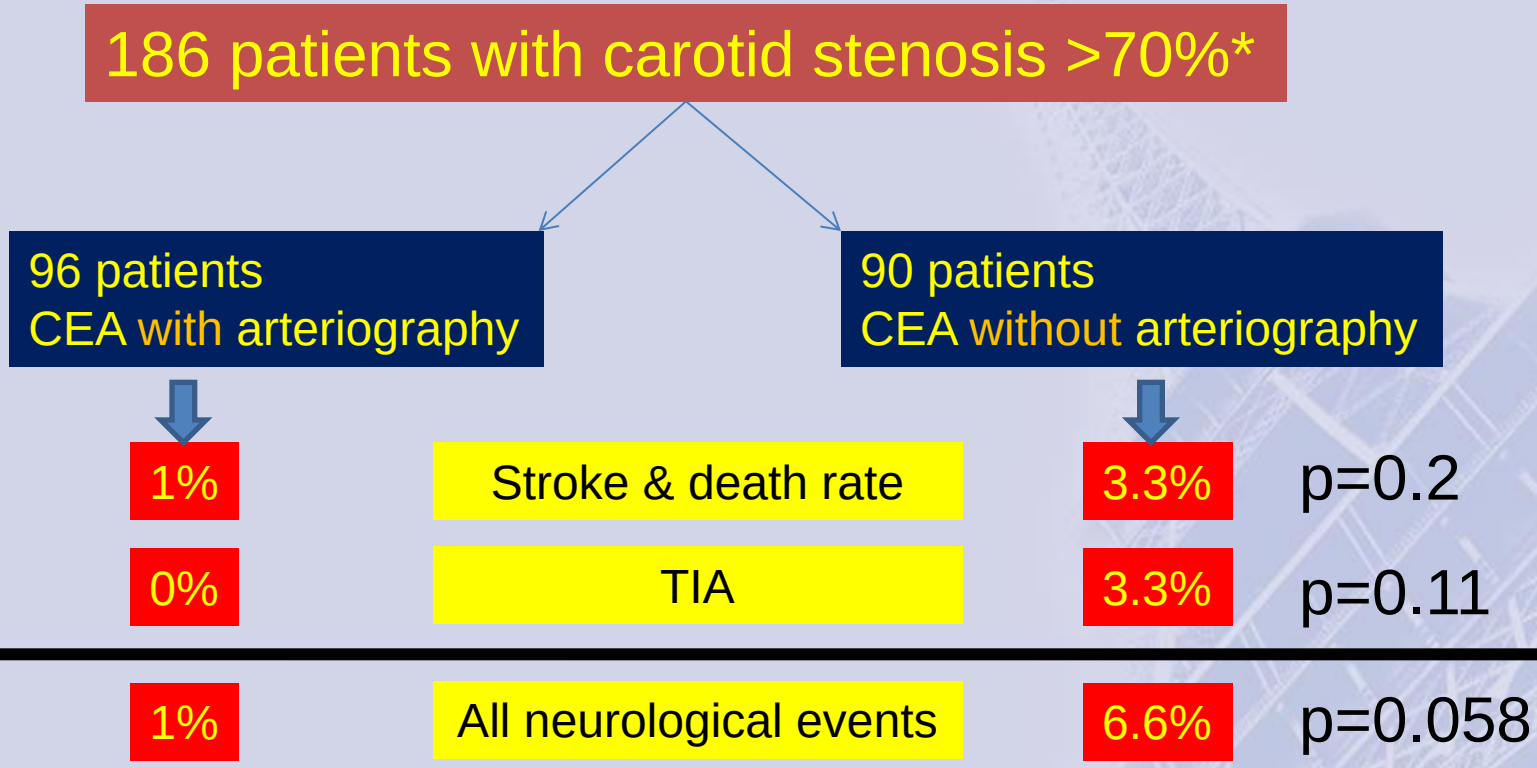
Indications for arteriography

- high bifurcation (n=2)
- indeterminate degree of stenosis (n=5)
- Ix for concomitant CCA stenosis (n=3)
- long, extremely tight stenosis (n=1)

- Non-operated group of three patients to confirm ICA occlusion on Duplex

Collier, Cardiovasc Surg 1999

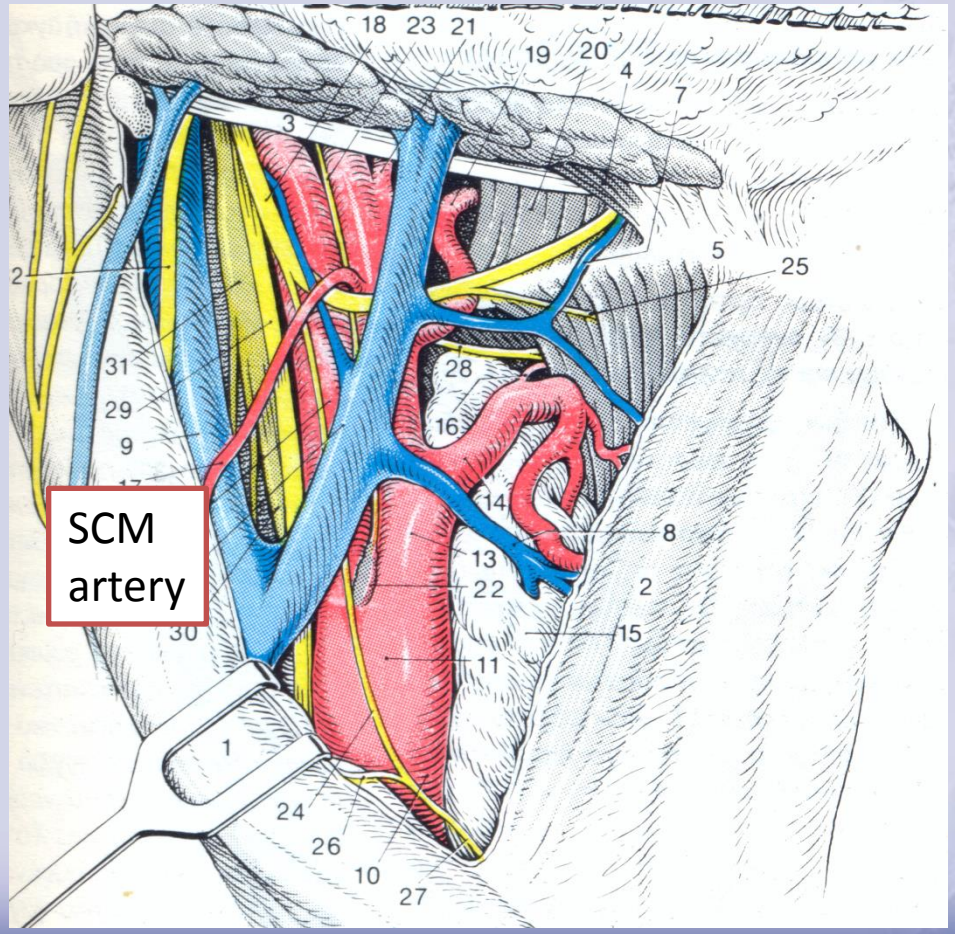
Carotid Endarterectomy Without Angiography: a Prospective Randomised Pilot Study



* exclusions: poor image quality, suspected ICA occlusion or tandem lesions

Deriu, EJVES 2000

Importance of Preoperative Imaging



Non-Invasive Carotid Angiography

- Magnetic Resonance Angiography (MRA)

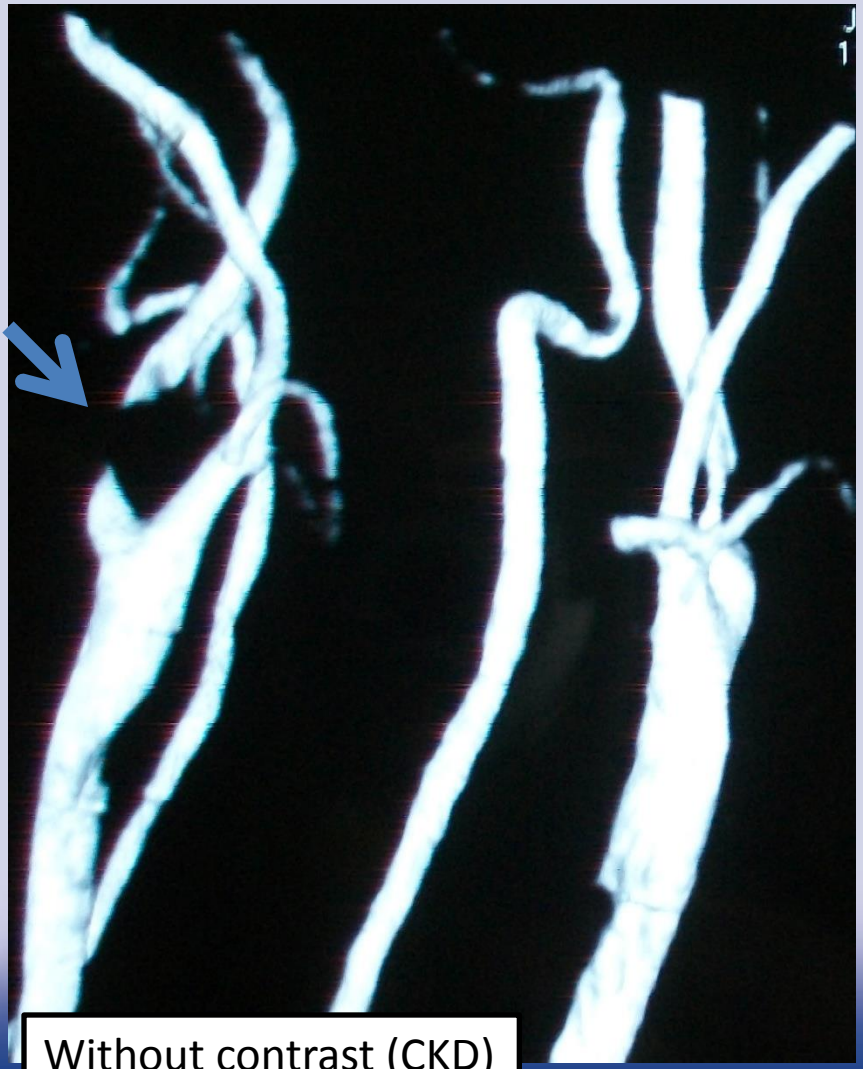
  Alfidi, AJR, 1987

- Computed Tomography Angiography (CTA)

  Castillo, Neuroradiology, 1994

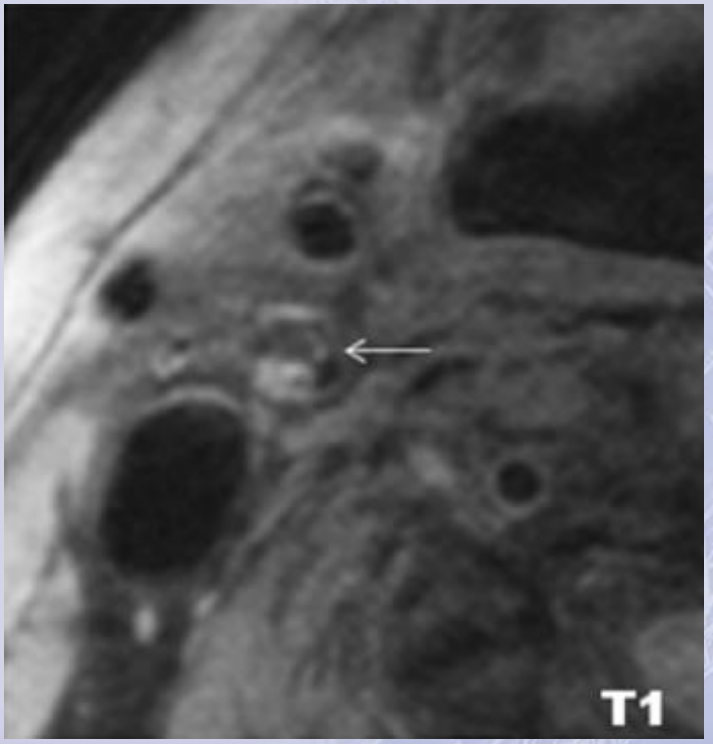
Further refinement of these methods in the following years

Carotid MRA



Without contrast (CKD)

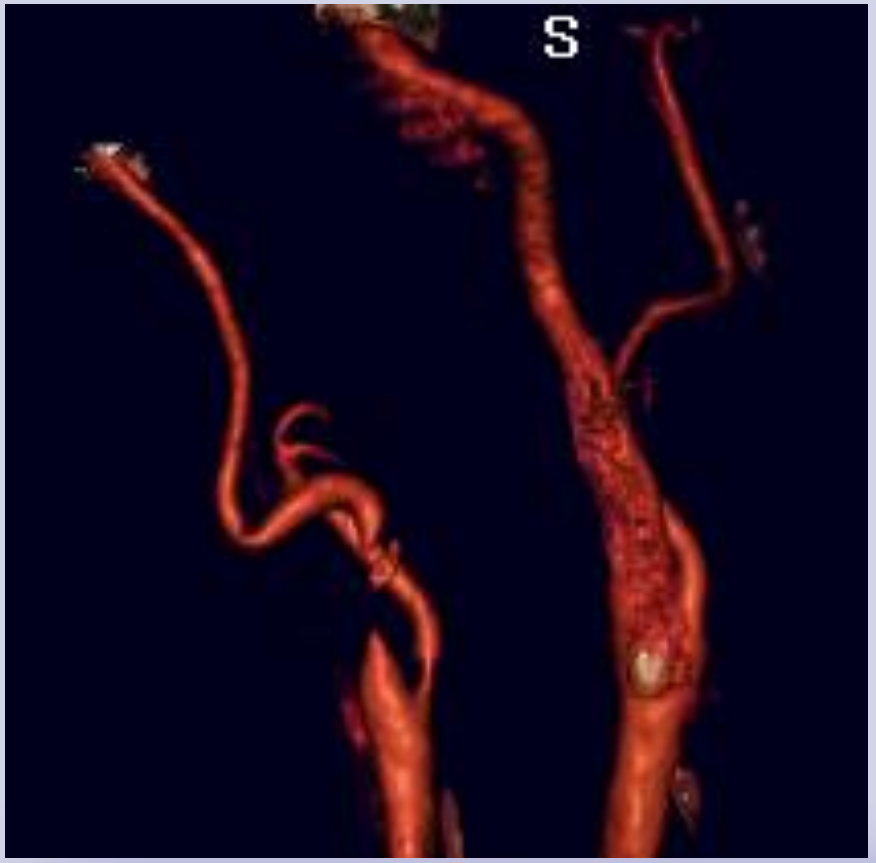
Cost & overestimation of stenosis



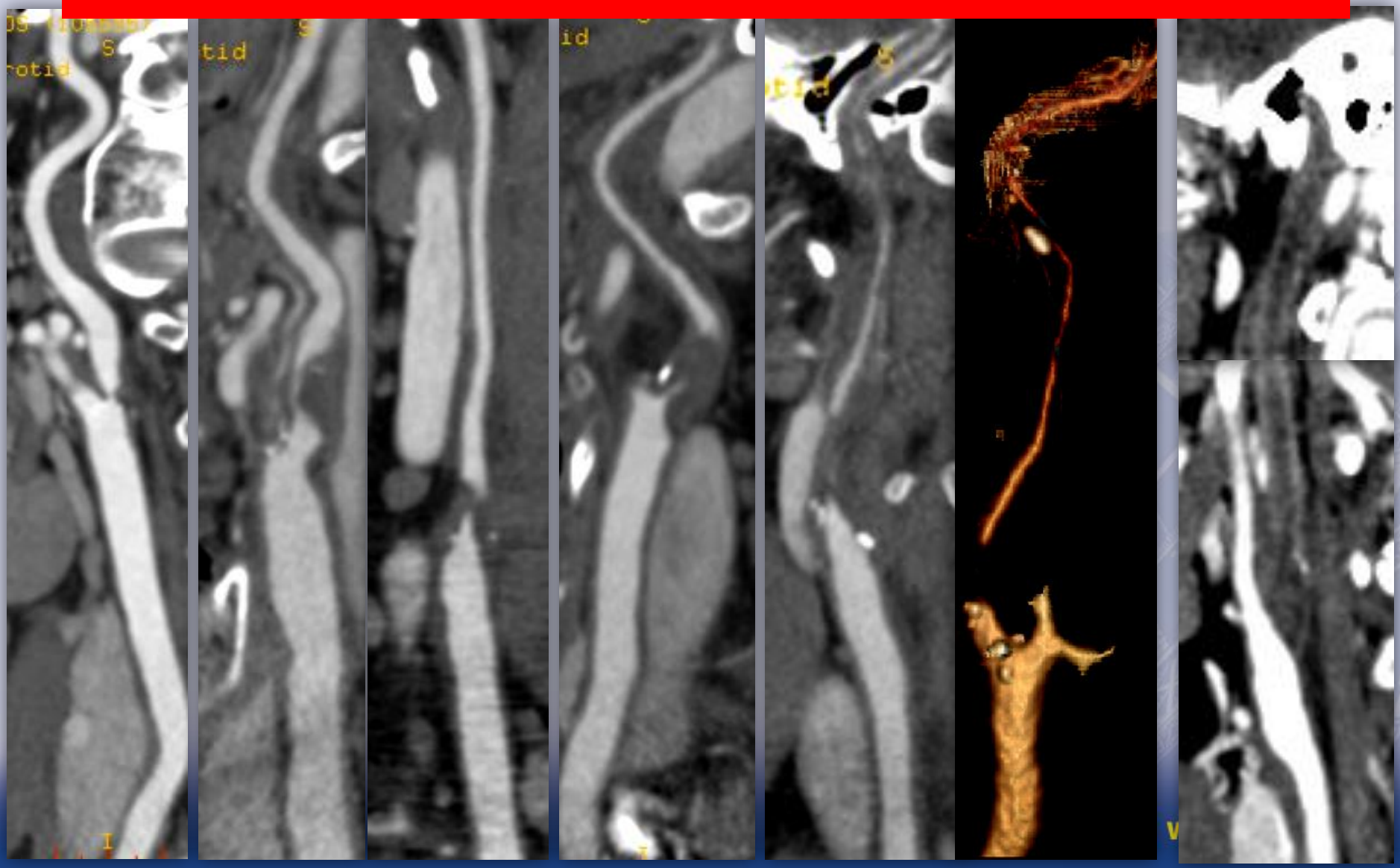
Plaque characterisation

Esposito-Bauer, PLOS ONE, 2013

Carotid CTA



Carotid CTA



Indications for preoperative angiography

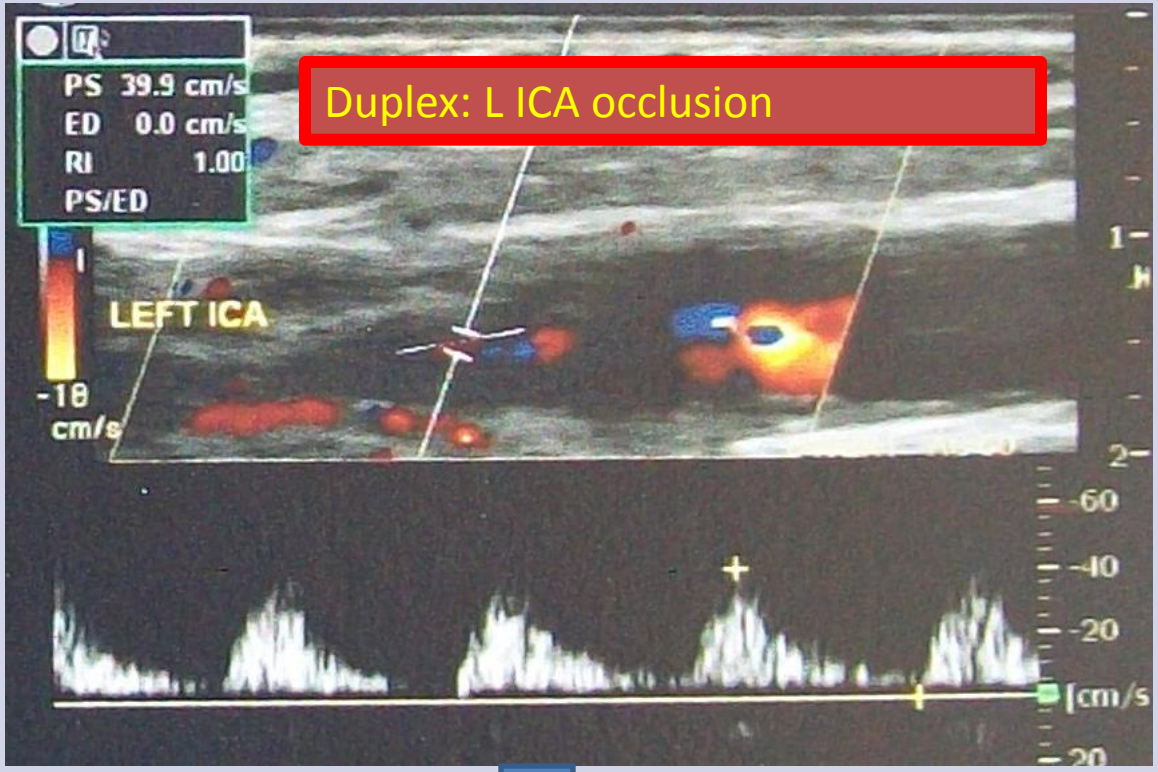
Complete or near occlusion of the carotid artery on Duplex should be confirmed by CTA

Duplex can misdiagnose

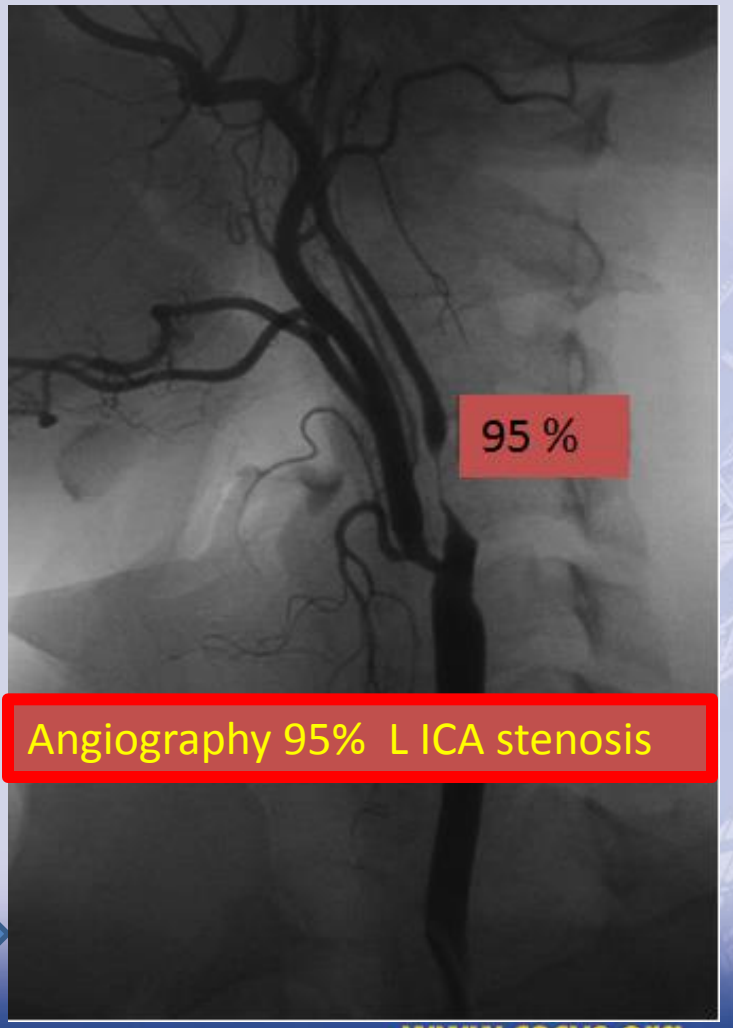
- a near occlusion for complete occlusion
- an occlusion for a patent carotid artery

Regina, Int Angiol 1997
Lubezky, EJVES, 1998

Symptomatic L ICA stenosis (AF & TIA) with brain infarction on MRI



Duplex: L ICA occlusion



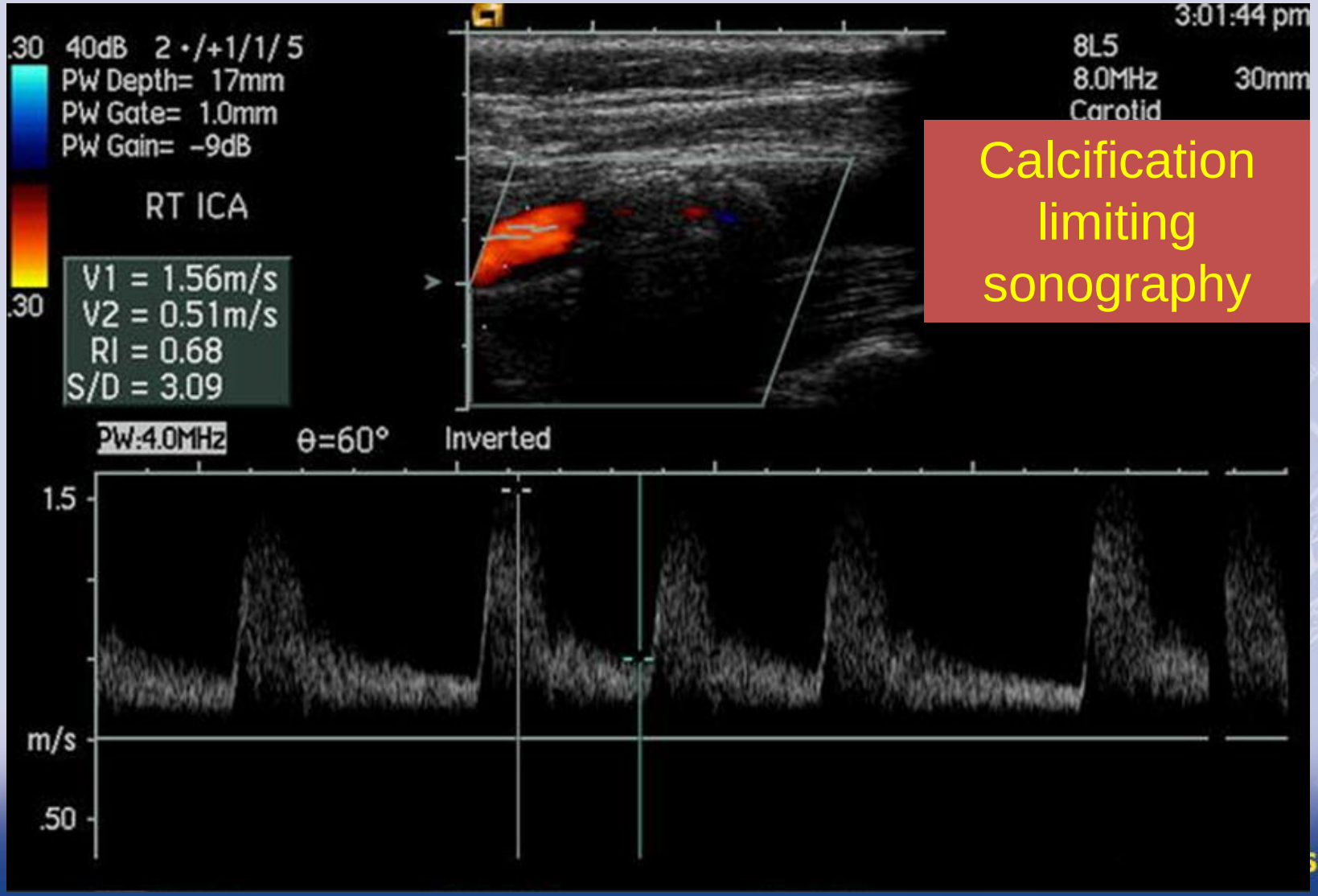
Angiography 95% L ICA stenosis

MRA: L ICA occlusion

Indications for preoperative angiography

Presence of extensive acoustic shadowing or vessel tortuosity on Duplex scanning that precludes an accurate assessment of the severity of stenosis.

Gibraltar sign



Calcification limiting sonography

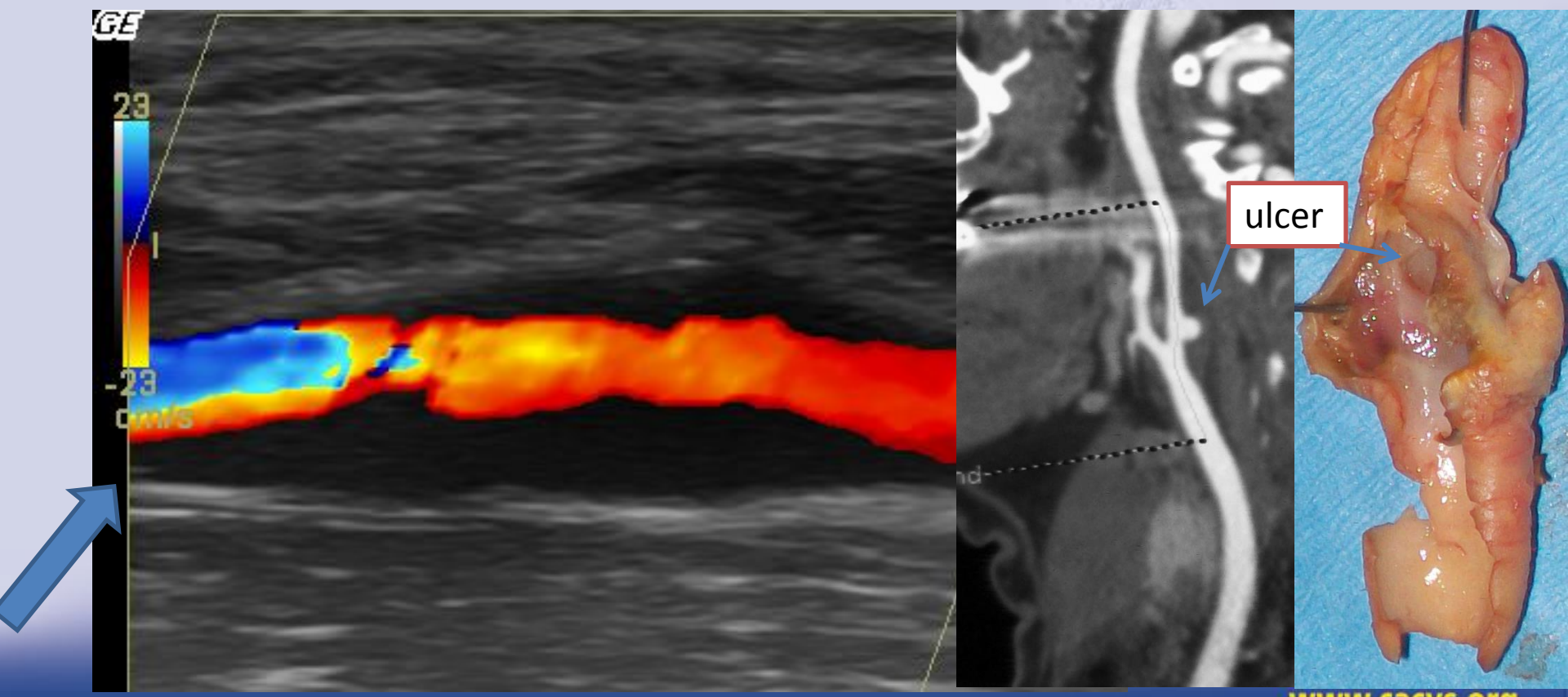
Indications for preoperative angiography

- Proximal and/or distal extension of the carotid plaque outside the field of view the ultrasound
- High carotid bifurcation—above the angle of the mandible

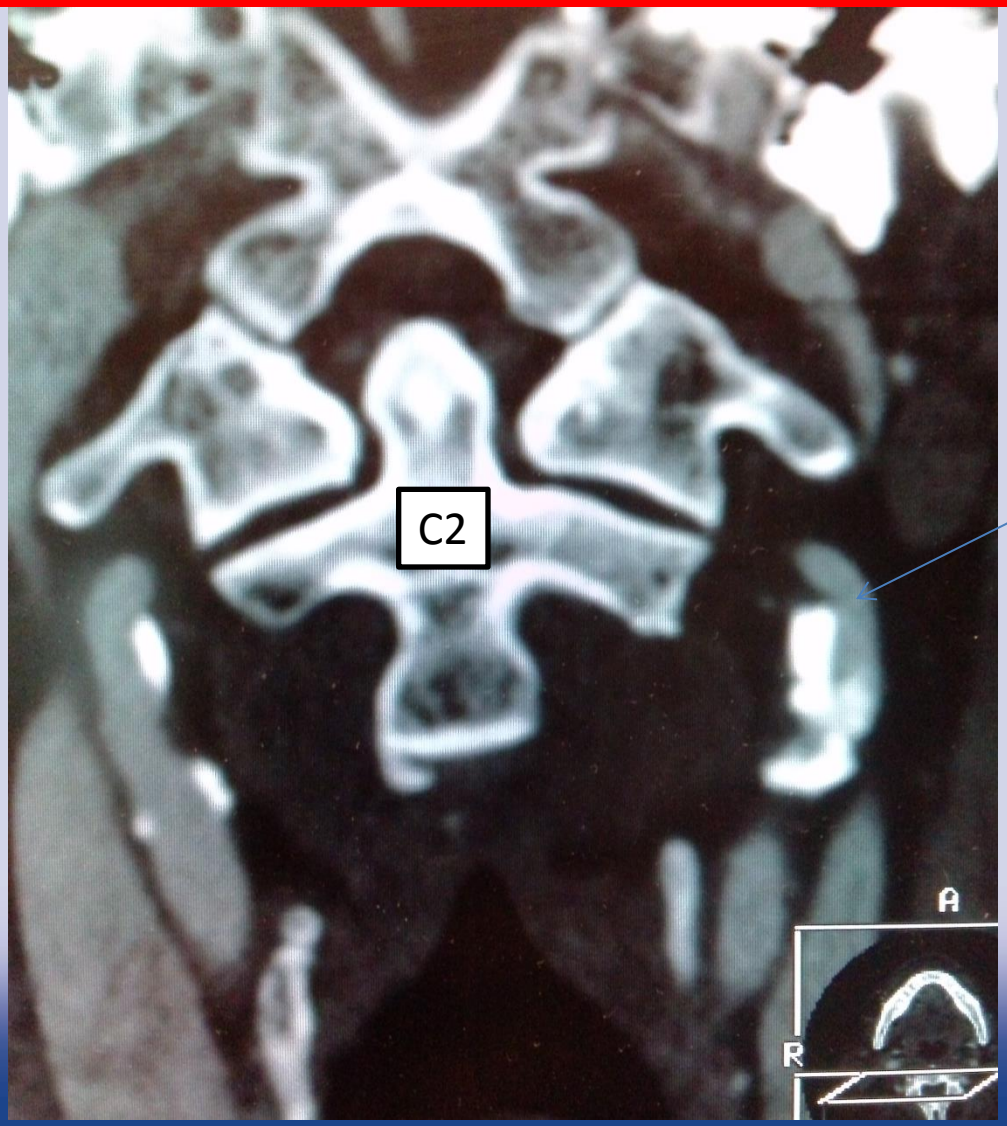
Wagner, Ann Vasc Surg 1991

Indications for preoperative angiography

Distal extension of the carotid plaque outside the field of view



Symptomatic – 80% L ICA stenosis – extending up to C2 vertebra on CTA



Upper border of stenosis

Indications for preoperative angiography

In summary, the presence of technical limitations on Duplex in surgical candidates should prompt further evaluation with angiography!

MRA can modify operative planning in the presence of technical limitations of Duplex

Inadequate duplex scans (n=138)

- Incomplete imaging of the carotid bifurcation

  (high bifurcation, long -3 cm- ICA plaque, or calcific shadows (53%)
- Borderline severe ICA disease (23%)
- Extracervical disease (supra-aortic trunk, vertebral, or intracranial, 22%)
- ICA near- occlusion (13%)
- Diffuse recurrent stenosis (7.5%)

Back et al. Magnetic resonance angiography minimizes need for arteriography after inadequate carotid duplex ultrasound scanning. J Vasc Surg 2003

MRA can modify operative planning in the presence of technical limitations of Duplex

- MRA enabled resolution of duplex scan inadequacies in 95% of patients with disease confined to the carotid bifurcation, and 90% of all patients, but was least accurate for delineation of extracervical lesions (77%) and near-occlusions (75%).

- In 5 of 8 patients (6%) arteriography was performed to determine operability of ICA near-occlusion or extracervical lesions.

Back et al. Magnetic resonance angiography minimizes need for arteriography after inadequate carotid duplex ultrasound scanning. J Vasc Surg 2003

MRA can modify operative planning in the presence of technical limitations of Duplex

- Planning of intraoperative technical adjustments
  - anatomy that precluded shunt use
  - ***extended endarterectomy length***
  - ICA shortening due to tortuosity

in 71% of patients (12 of 17) with MRA-defined anatomy, but In 36% of patients (4 of 11) with CEA on the basis of duplex results only (control group, *P= 0.08).*

Back et al. Magnetic resonance angiography minimizes need for arteriography after inadequate carotid duplex ultrasound scanning. J Vasc Surg 2003

Indications for preoperative angiography

- All patients with a symptomatic carotid stenosis, particularly in cases where the stenosis itself cannot explain the symptoms reported by the patient, for example a < 50% ICA stenosis in a patient with hemispheric neurologic symptoms despite antiplatelet therapy.

Dawson, Am J Surg 1991

Indications for preoperative angiography

Symptomatic carotid stenosis: near-occlusion should be managed conservatively

Stenosis (%)	ARR (%, 95% CI)	*p*	RRR (95% CI)
Near-occlusion	−0.1 (−10.3 to 10.2)	0.6	0.98 (0.61 to 1.59)

Rothwell, Lancet 2003

Indications for preoperative angiography

Carotid endarterectomy when the distal internal carotid artery is poorly visualized

Postoperative occlusion rate

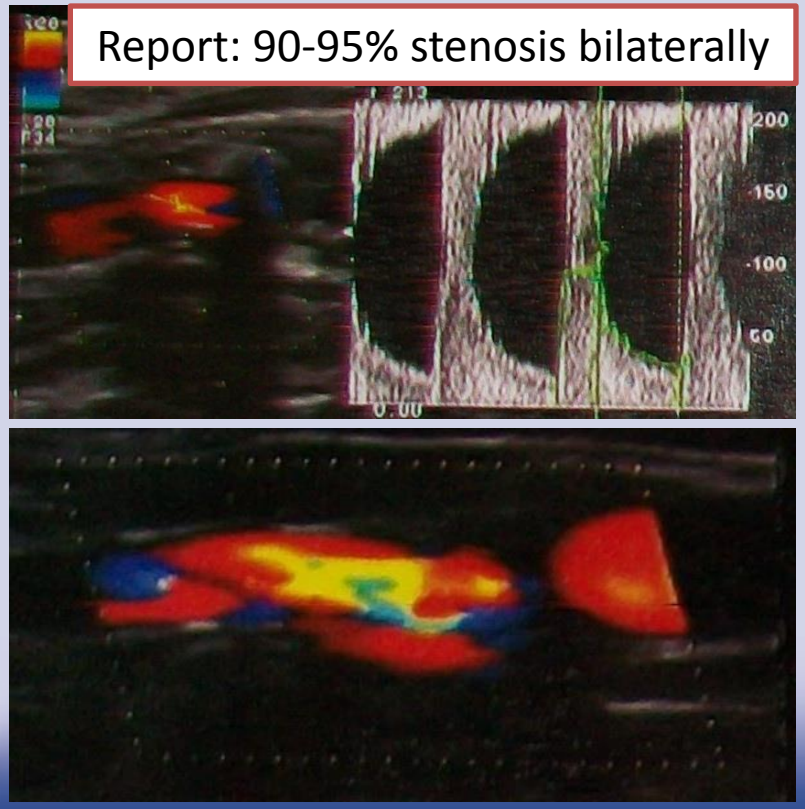
on Duplex:

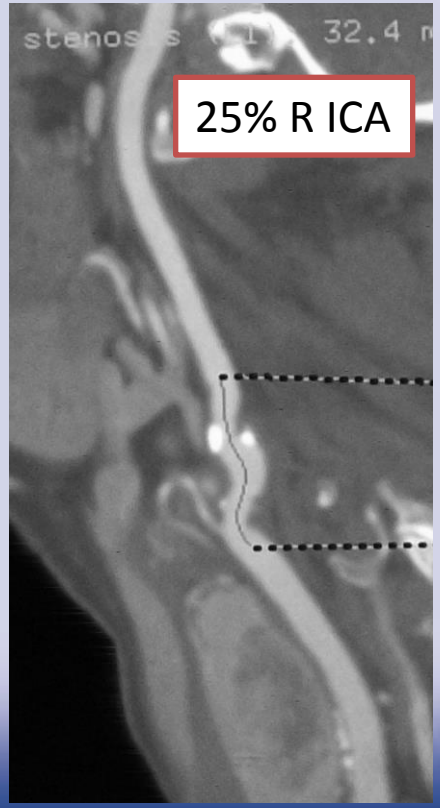
28% (5/18)

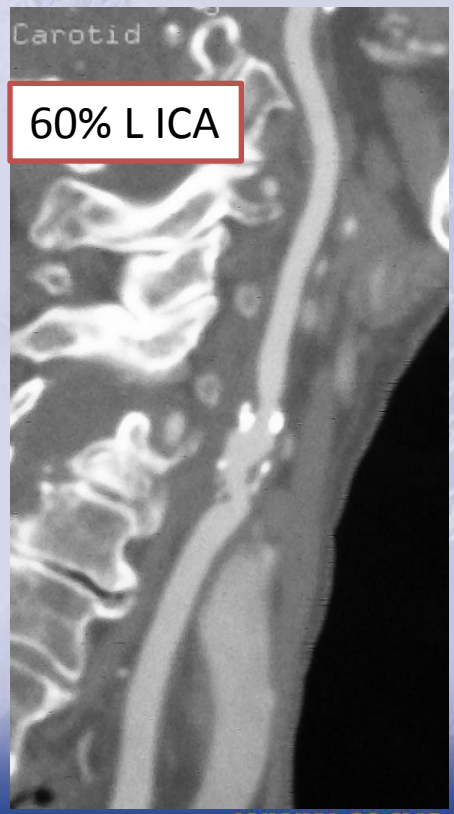
Archie, J Vasc Surg 1994

Indications for preoperative angiography

Duplex scans from vascular laboratories of unknown accreditation or validation!







Indications for preoperative angiography

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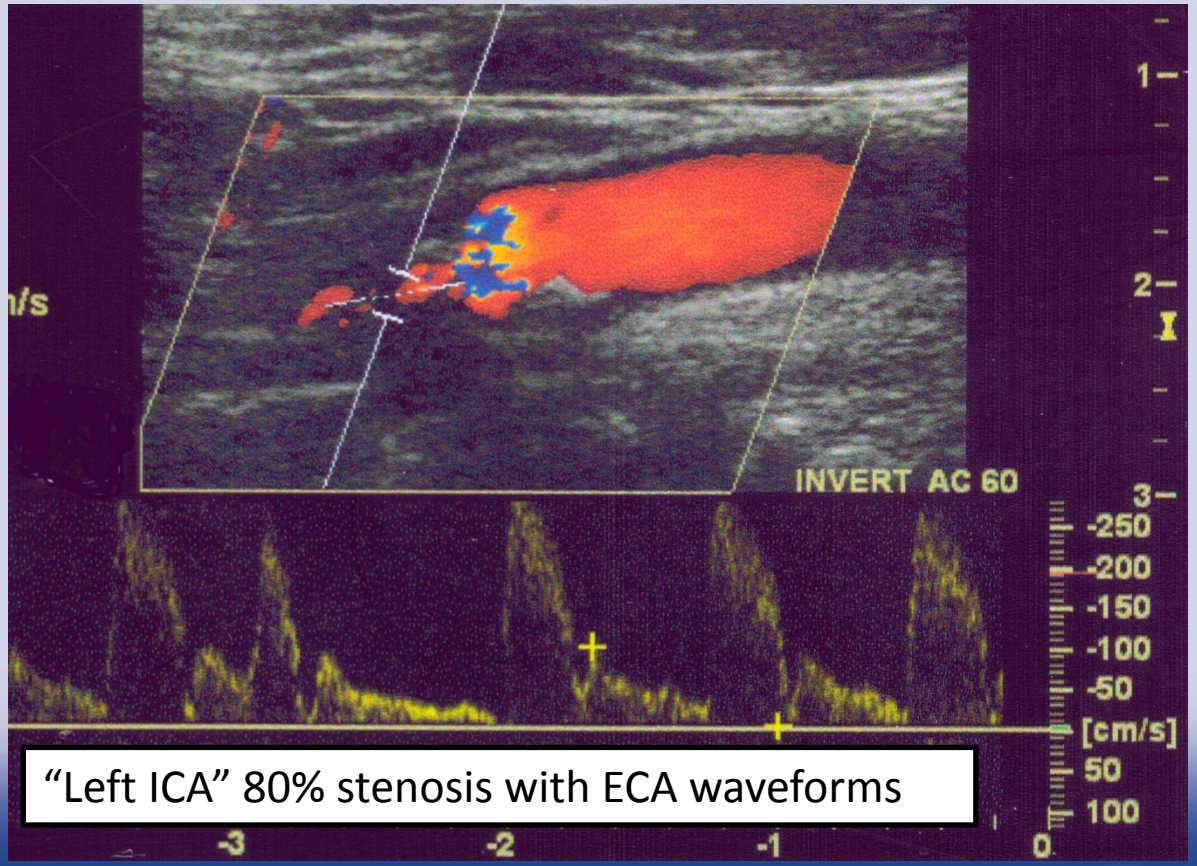


"Left ICA" 80% stenosis with ECA waveforms

Erroneous Duplex report!

Routine Additional Angiography?

Is duplex scanning sufficient evaluation before carotid endarterectomy?

The use of arteriography altered the management of eight (8%) patients in a group of 100.

- ✓ provided the correct diagnoses in the presence of symptoms where duplex scan results gave misleading information (minimal or no stenosis at all, n=3)
- ✓ altered the decision to operate (n=2)
- ✓ modified the surgical technique (n=3)

Geuder, J Vasc Surg 1989

Routine Additional Angiography?

- Two diagnostic tests are more accurate!
- Common practice: to obtain a second non-invasive test (CTA or MRA), in order to
  - ✓ grade carotid artery stenosis more accurately
  - ✓ avoid overtreatment in cases Duplex has overestimated the degree of stenosis or is erroneous

- Patel, J Neurol Neurosurg Psychiatry 2002
- Nederkoorn, ACP Journal Club 2003
- Makaryus, J Interven Cardiol 2009

Routine Additional Angiography?

- 101 patients referred for carotid intervention:

✓ 96% with >70% stenosis on Duplex

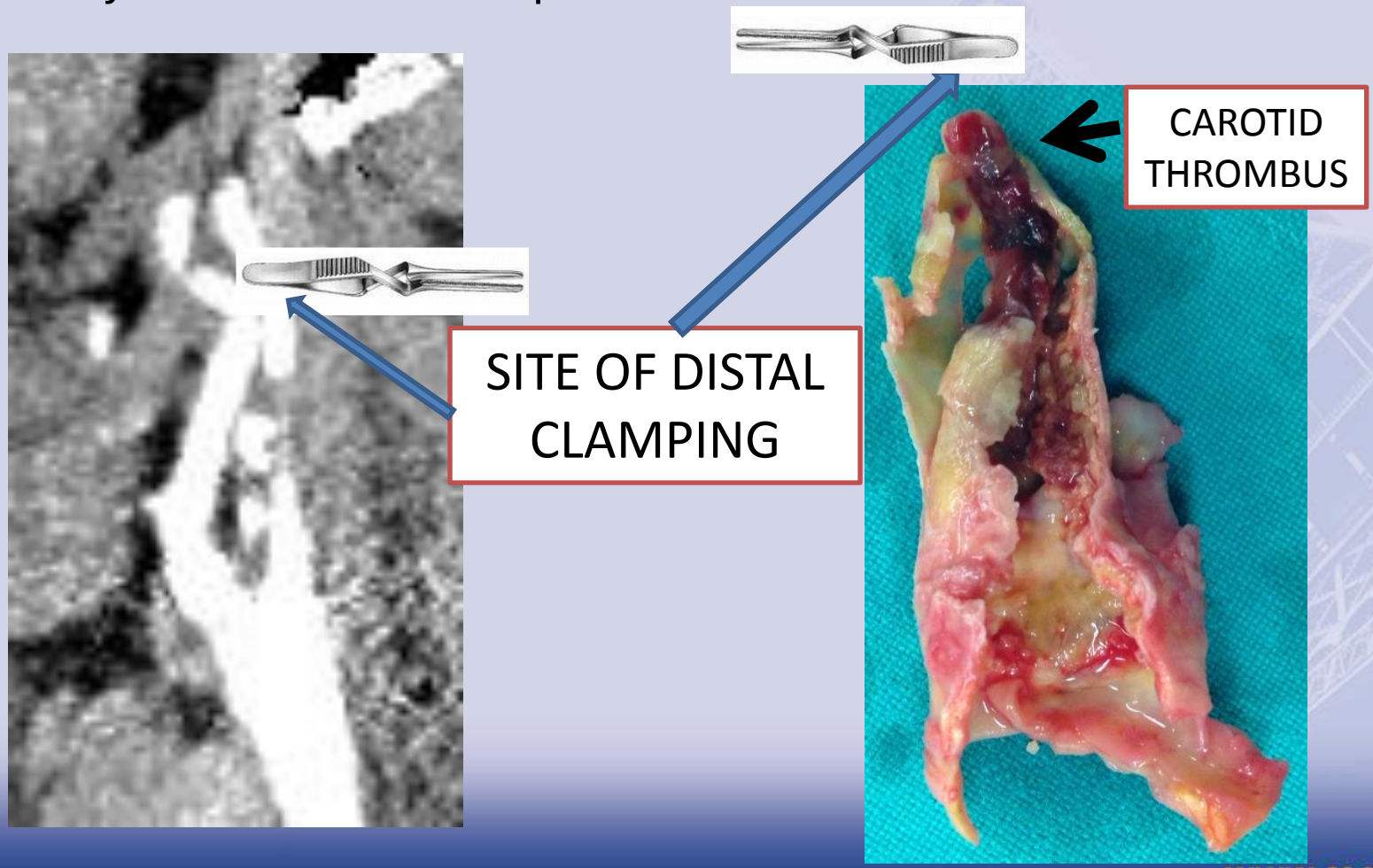
✓ 94% of them confirmed on MRA

36 (36%) were shown to have <70% stenoses on diagnostic angiography

Makaryus J Interven Cardiol 2009

Thorough preoperative imaging can facilitate operative planning!

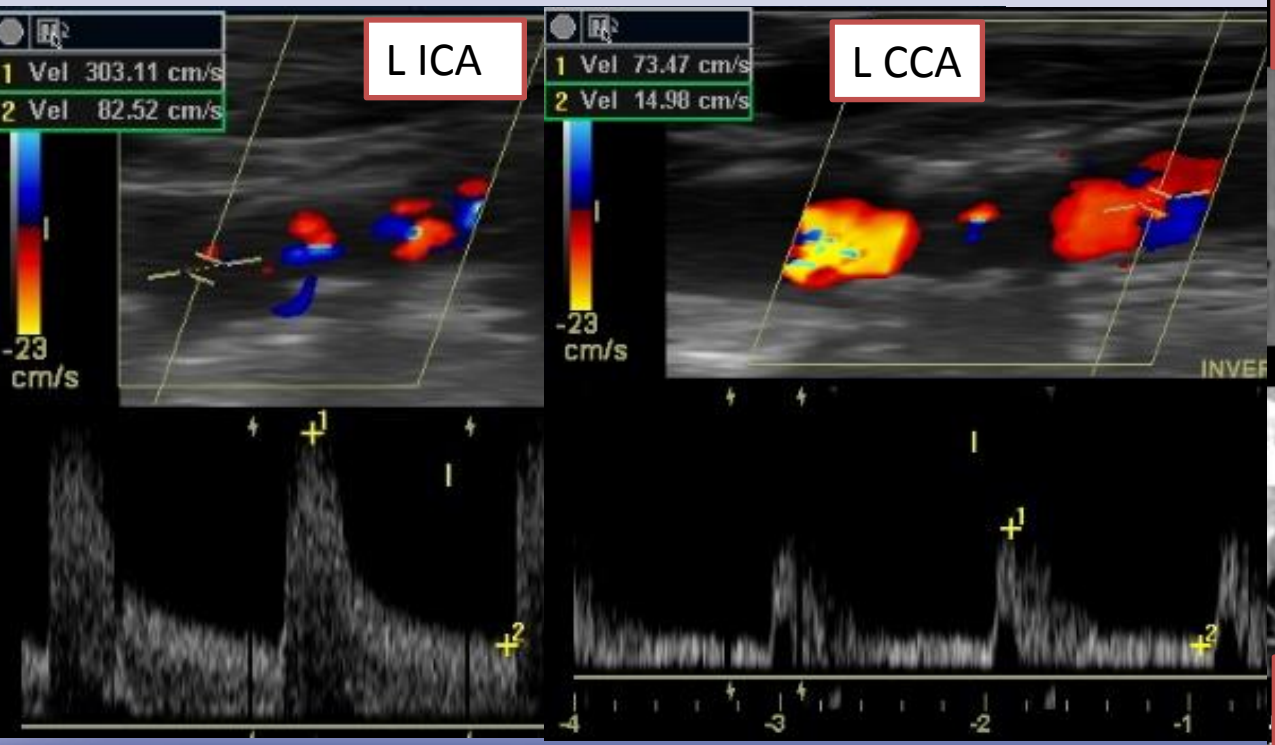
71 y.o. male with an Ax pre-occlusive R ICA stenosis

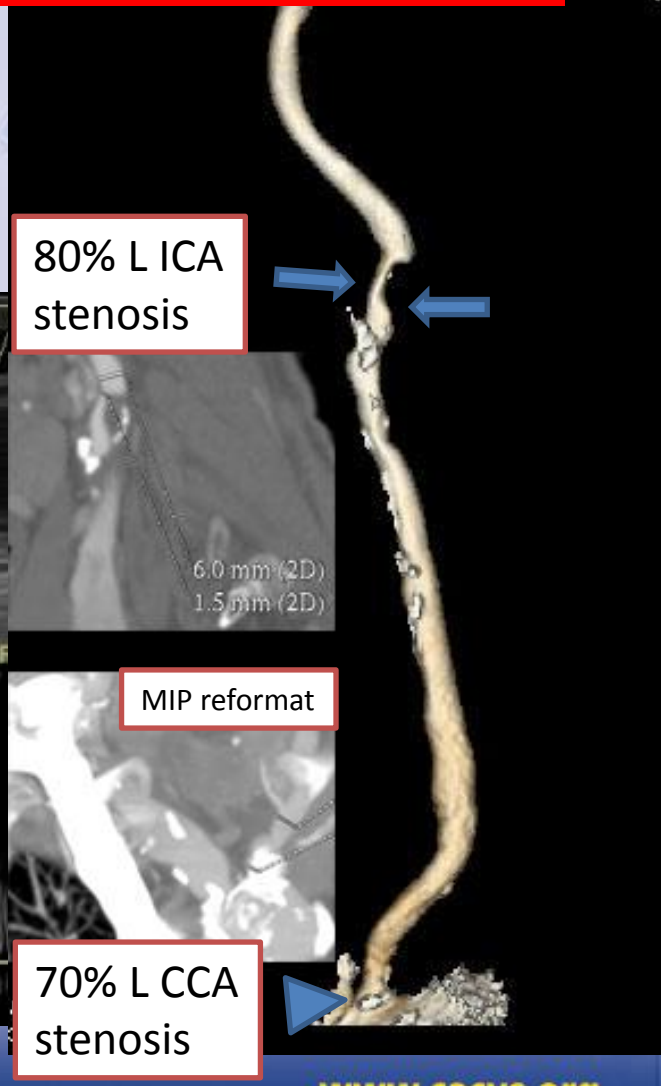


Routine Additional Angiography?

Proximal tandem lesions

70 y.o. patient with an Ax 80% L ICA stenosis and symmetric normal carotid pulses





Routine Additional Angiography?

- 439 patients with symptomatic and asymptomatic stenosis.

- Carotid CTA changed the therapeutic plan in 18%.

Zampakis et al. 2010 meeting,
British Society of Neuroradiology

Routine Additional Angiography?

- Cost implications
- Cost counterbalanced by a 10% reduction of procedures not required to be performed and perhaps a reduced complication rate.

Updated Society for Vascular Surgery guidelines for management of extracranial carotid disease

- CDUS in an accredited vascular laboratory is the initial diagnostic imaging of choice.

- When CDUS is nondiagnostic or suggests stenosis of intermediate severity (50% to 69%) in an asymptomatic patient, additional imaging with MRA, CTA or DSA is required before embarking on any intervention (GRADE 1, Level of Evidence B).

Ricotta, J Vasc Surg 2011

Updated Society for Vascular Surgery guidelines for management of extracranial carotid disease

- When evaluation of the vessels proximal or distal to the cervical carotid arteries is needed for diagnosis or to plan therapy, imaging with CTA, MRA, or catheter angiography in addition to CDUS is indicated. CTA is preferable to MRI or MRA for delineating calcium.

Ricotta, J Vasc Surg 2011

Updated Society for Vascular Surgery guidelines for management of extracranial carotid disease

- When there is discordance between two minimally invasive imaging studies (CDUS, MRA, CTA), DSA is indicated to resolve conflicting results.
- DSA is generally reserved for situations where there is inconclusive evidence of stenosis on less invasive studies or when CAS is planned.

  (GRADE 1, Level of Evidence B).

Ricotta, J Vasc Surg 2011

Conclusions

CEA can be safely performed based on Duplex scanning alone provided that

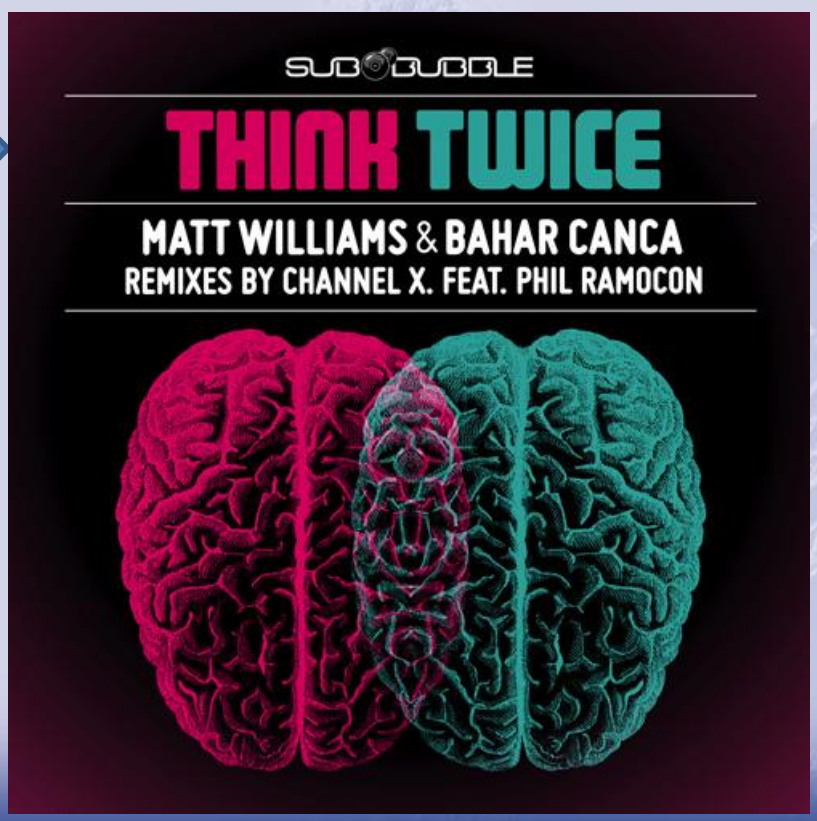
- the test is performed by an experienced and validated operator
- certain anatomical findings are present
- the examination has no technical limitations

Conclusions

- In all other cases, or as a routine preoperative requirement, the liberal use of additional angiography (preferably non-invasive CTA or MRA) is necessary.

Home take message

Can we Operate a Carotid Stenosis Based on Duplex Scanning Only?



Thank You!