

# Duplex vs CTA vs Catheter Arteriography for Carotid Imaging : How Do They Compare

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# DISCLOSURE

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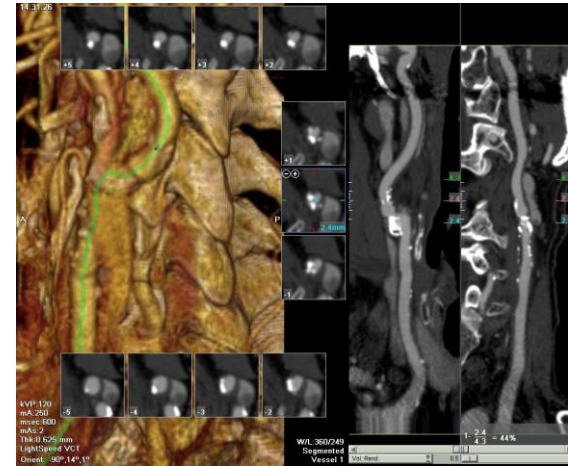
# Introduction

- Many correlative studies published
- Differing accuracies
- Dependent on technology, experience, diagnostic criteria, patient symptoms, vascular territory
- Bias of study



# Duplex Criteria vs CTA

- 431 arteries in 230 patients
  - SRU Consensus Criteria
  - Modified U of Washington (mUW) criteria
  - CTA NASCET derived measurements
- Accuracy
  - mUW 64.5%
  - SRU 71.7%
- Frequency of overestimation
  - mUW 22.3% NASCET 12.3% ECST
  - SRU 15.3% NASCET 9.0% ECST



Kim AH, et al. J Vasc Surg 2016; 64: 864-865

# Duplex US and MRA vs DSA in Carotid Stenosis : A Systematic Review

- 63 publications published between 1994 – 2001
- Analysis of <70%, 70-99%, occlusion
- Multiple variables identified ie equipment, bias
- MRA better discriminatory power for 70-99%
- No difference for carotid occlusion

**TABLE 2. Pooled Weighted Sensitivity and Specificity Calculated in a Random-Effects Model**

	Pooled Sensitivity, % (95% CI)		Pooled Specificity, % (95% CI)	
	MRA	DUS	MRA	DUS
70%–99% vs <70%	95 (92–97)	86 (84–89)	90 (86–93)	87 (84–90)
<100% vs 100%	98 (94–100)	96 (94–98)	100 (99–100)	100 (99–100)

Nederkoorn PJ, et al. Stroke. 2003;34:1324-1332



# Carotid Artery Stenosis: Accuracy of Non-invasive Tests

- Meta-analysis of 12 data sets with 1456 patients
- DUS, CTA and MRA compared to IA angiography
- Research and audit data

Imaging and Stenosis Group	Ipsilateral Artery*	Contralateral Artery*	Bland-Butland <sup>†</sup>	Thomson <sup>‡</sup>
<b>Sensitivity</b>				
<b>Doppler US</b>				
70%–99%	0.83 (431/521)	0.67 (46/68)	.043	.006
50%–69%	0.31 (48/153)	0.48 (19/40)	.048	.044
0%–49%,100%	0.53 (71/135)	0.88 (267/303)	<.001	<.001
<b>CT angiography</b>				
70%–99%	0.65 (17/26)	0.72 (6/8)	.21	.629
50%–69%	0.41 (6/15)	0.45 (4/9)	.378	.841
0%–49%,100%	0.53 (10/19)	0.79 (32/40)	.016	.045
<b>MR angiography</b>				
70%–99%	0.79 (16/20)	0.58 (3/5)	.173	.135
50%–69%	0.34 (6/18)	0.28 (2/8)	.474	.924
0%–49%,100%	0.72 (24/33)	0.92 (77/83)	.01	.009
<b>CE MR angiography</b>				
70%–99%	0.85 (30/35)	0.83 (7/8)	.496	.929
50%–69%	0.44 (11/25)	0.88 (3/3)	.055	.121
0%–49%,100%	0.82 (44/53)	0.93 (89/95)	.22	.104
<b>Specificity</b>				
<b>Doppler US</b>				
70%–99%	0.54 (156/288)	0.93 (319/343)	<.001	<.001
50%–69%	0.84 (553/656)	0.90 (334/371)	.006	.009
0%–49%,100%	0.96 (650/674)	0.83 (90/108)	.007	<.001
<b>CT angiography</b>				
70%–99%	0.56 (19/34)	0.91 (45/49)	≤.001	.001
50%–69%	0.84 (38/45)	0.85 (41/48)	.276	.913
0%–49%,100%	0.87 (36/41)	0.75 (13/17)	.106	.249
<b>MR angiography</b>				
70%–99%	0.70 (36/51)	0.94 (86/91)	<.001	≤.001
50%–69%	0.82 (44/53)	0.95 (84/88)	.082	.057
0%–49%,100%	0.94 (36/38)	0.61 (8/13)	.005	.01
<b>CE MR angiography</b>				
70%–99%	0.85 (67/78)	0.98 (97/98)	.008	.004
50%–69%	0.87 (77/88)	0.95 (98/103)	.219	.097
0%–49%,100%	0.89 (54/60)	0.88 (10/11)	.477	.956



# Carotid Artery Stenosis: Accuracy of Non-invasive Tests

- Sensitivity values of all modalities lower for detection of 50-69% stenosis
- Combinations of noninvasive tests do not improve sensitivity or specificity
- Current literature overestimates the sensitivity and specificity of noninvasive tests
- Accuracy is higher on the contralateral side

Chappell FM, et al. Radiology 2009; 51: 493-502



# Comparison of Noninvasive Imaging

- Multicenter trial of 249 vessels with angiography
- Overestimation in the 60-80% stenosis (at least 10% greater than DSA)
  - US 50%
  - CTA 67%
  - MRA 69%
- 15/30 occlusion reported instead of string sign
- 43% change in medical or surgical management with DSA
- Angiography should be considered before treatment

Felbaum DR, et al. World Neurosurg 2019; 121:e962-e966.





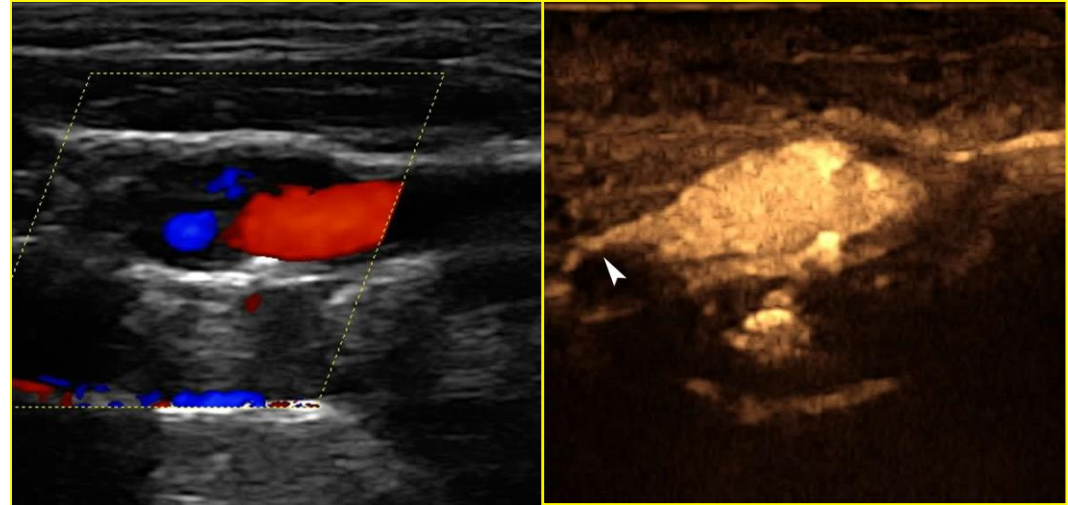
# Comparison of Noninvasive Imaging

- US had 73% concordance rate with DSA
  - 96% agreement for >70% stenosis
  - 45% agreement for <70% stenosis
- Initial investigation with US
- Confirmation with MRA and CTA as necessary

Felbaum DR, et al. World Neurosurg 2019; 121:e962-e966.



# Ultrasound Contrast

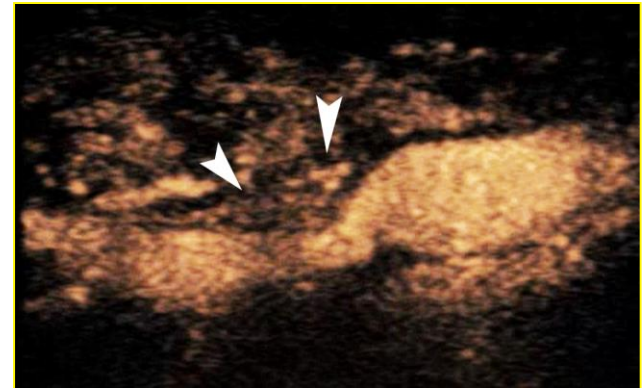
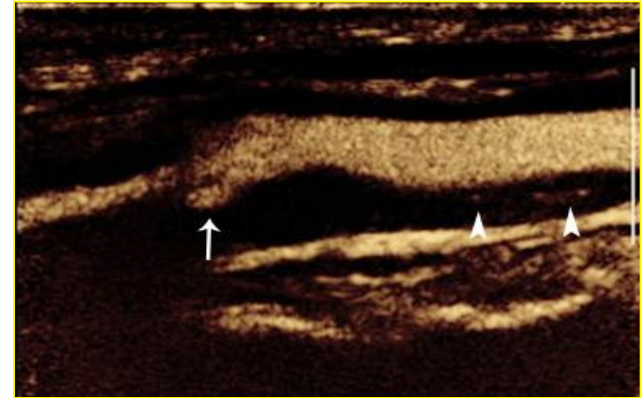


- Improve detection of near-total and complete occlusion
- “Doppler rescue” studies
- Strong correlation with angio for stenosis grading

From Introduction to Vascular Ultrasonography  
Pellerito, Polak 7<sup>th</sup> Edition

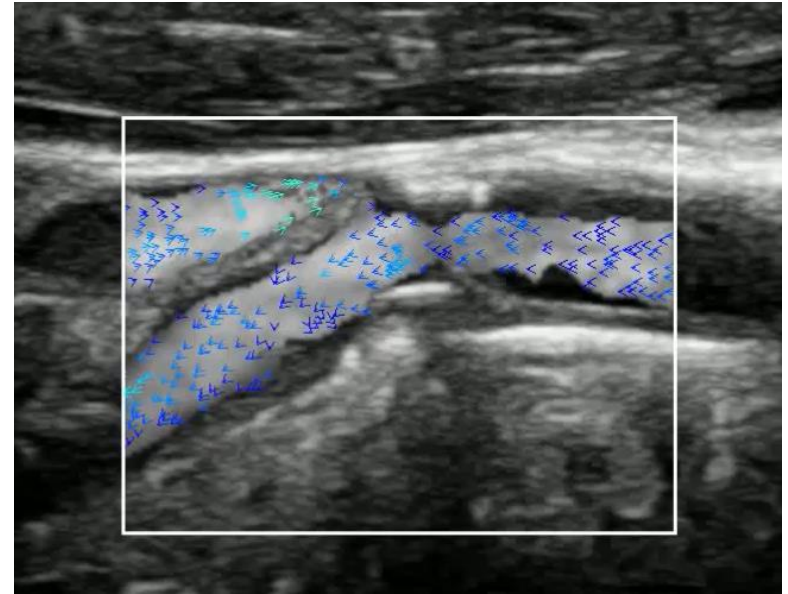
# Ultrasound Contrast

- Ulcerated plaque detection
- Intra-plaque vascularity in vulnerable plaques



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# Vector Flow Mapping



- Combining frequency, phase and amplitude changes
- Displays complex hemodynamic states
- Improve velocity estimation and flow directionality
- 3D vector flow field used to calculate volume flow

# Conclusions

- Most noninvasive studies provide rapid, accurate diagnosis of significant carotid disease
- Noninvasive tests overestimate stenosis in the 50-70% stenosis range
- US is first-line modality
- CTA or MRA recommended as confirmatory
- Contrast arteriography for difficult cases (“string sign”) prior to intervention

