HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Transcranial Doppler (TCD) Case Presentations

Scott Silverman, MD
MGH Stroke Service
June 5, 2021

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Disclosures

- None

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCD Cases

- Intracranial Stenosis
- Collateral evaluation
- HITS (with and without saline injection)
- CVR
- Vertebral artery compression
- Vasospasm in SAH

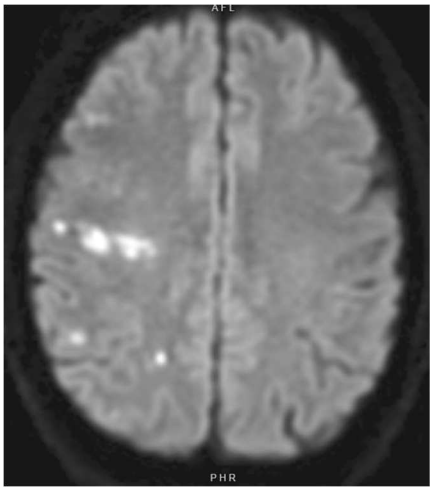
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #1: Intracranial Atherosclerotic Disease (ICAD)

55 yr old man with HL p/w dysarthria and L facial droop

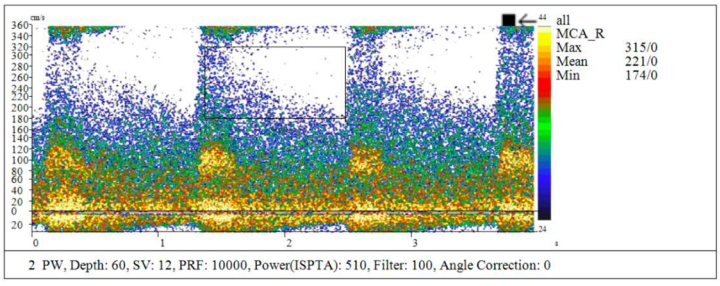
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

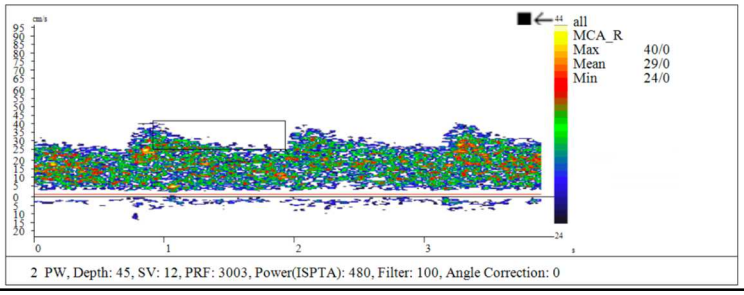
MRI/A



GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCD: R MCA severe symptomatic stenosis





CENTER

Case #1: Management

- DAPT x 90 days followed by ASA
- Risk factor control
- Plans to repeat TCD in few months

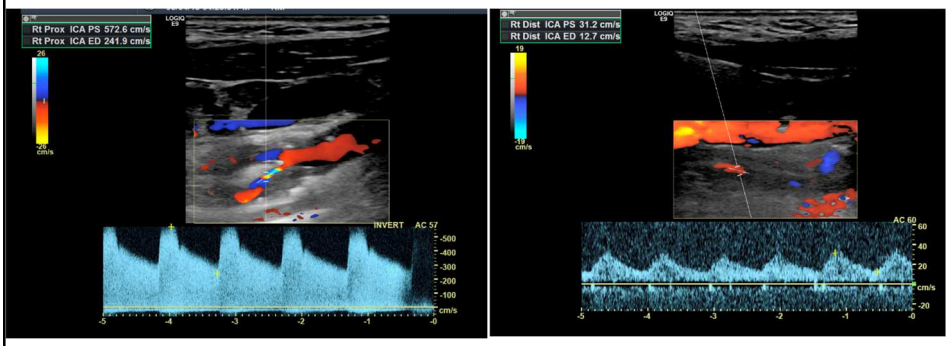
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #2: Collateral Circulation

67 yr old man with HL, tobacco, prior stroke p/w asymptomatic right ICA stenosis

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

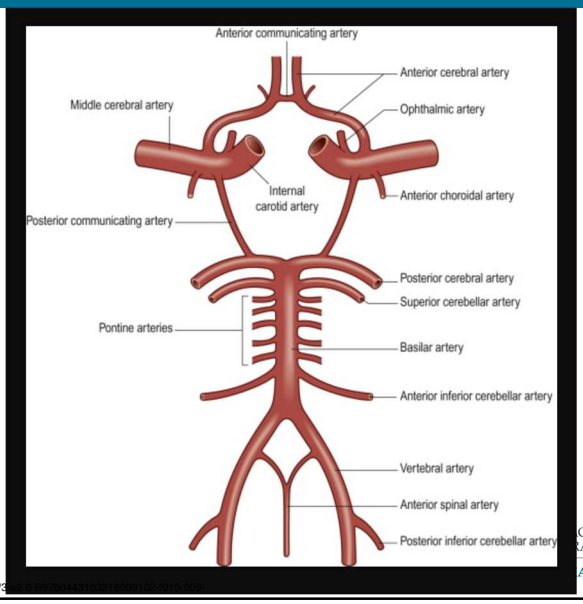
Carotid Duplex



ICA/CCA Ratio: 10.6

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

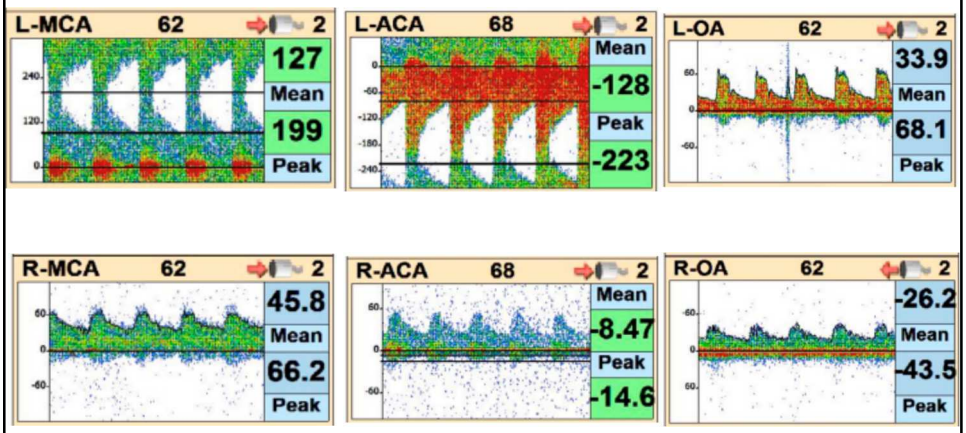
Circle of Willis



https://ars.els-cdn.com/content/image/3

CHUSETTS
AL HOSPITAL
AN VASCULAR CENTER

TCD



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #2: Management

- Enrolled in Crest – 2 trial

CREST-2

The Carotid Revascularization and Medical Management for Asymptomatic Carotid Stenosis Study

Health and Hope for Patients at Risk for Stroke

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCD HITS (High Intensity Transient Signals)

- HITS = platelet-rich microemboli
- Marker of asymptomatic embolization
- Increased risk stroke in symptomatic[1,2] and asymptomatic[3] carotid stenosis
- Simultaneous recording of both MCAs with 2 MHz transducers on TCD helmet
- Recording time 1 hour

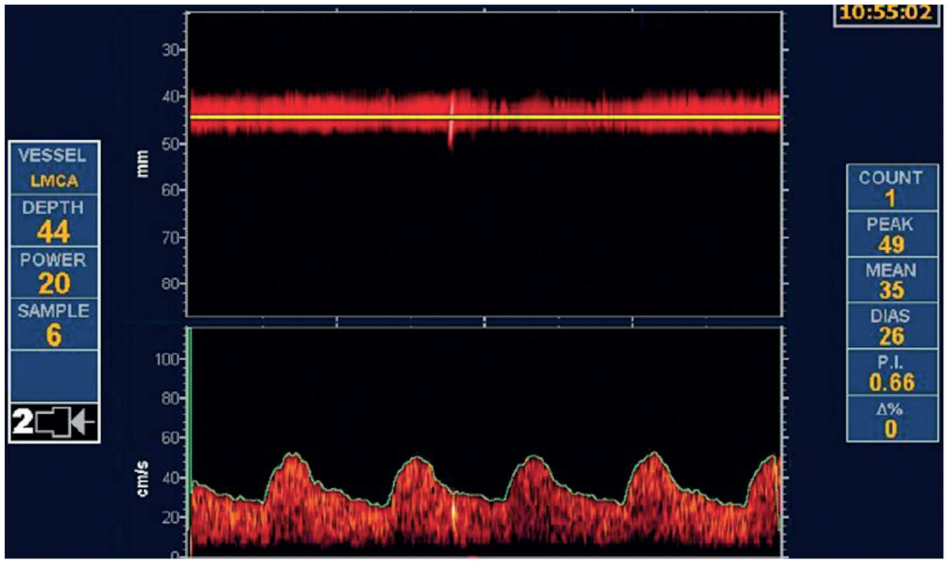
1. Markus, Stroke, 2005
2. King, Stroke, 2009
3. Markus et al, Lancet Neurol. 2010

Case #3: HITS

65 yr old man with HTN, HL, DM, Tobacco abuse with severe left ICA stenosis

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCD HITS



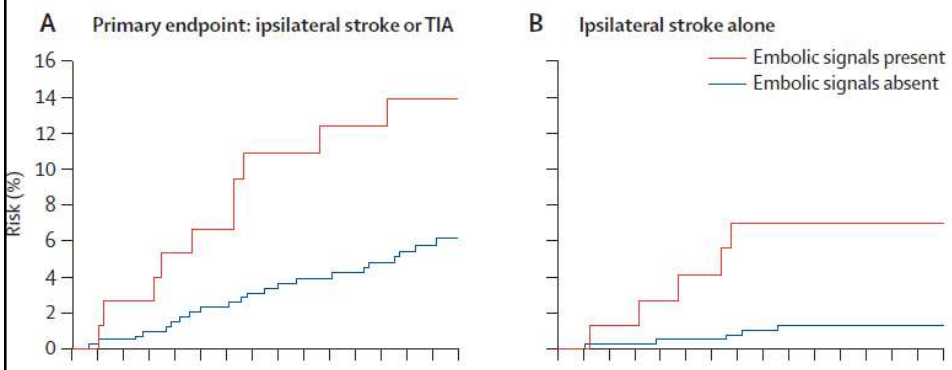
Paraskevas et al, Stroke and Vascular Neurology, 2018

HITS in Symptomatic Carotid

CARESS (2005)	107 pts, >50% sx ICA, +HITS RCT	ASA vs ASA/Plavix	DAPT 40% RRR HITS d7
CLAIR (2010)	100 pts, ≥50% sx intra- or extra-cranial large artery stenosis, +HITS RCT	ASA vs ASA/Plavix	DAPT 42% RRR HITS d2
Batchelder (2015)	100 pts, >50% sx ICA Observational	ASA + Plavix (12 hrs pre-CEA) vs ASA + Plavix (48-72hrs pre-CEA)	5x reduction recurrent events pre-CEA (3% vs 13%, OR 4.9) 4x reduction in HITS (5% vs 21%, OR 4.1) No sig diff bleeding

Adapted from: Eur J Vasc Endovasc Surg. 2018;55:3-81

HITS in Asymptomatic Carotid Stenosis: (ACES study)



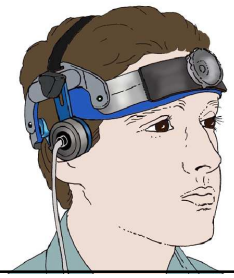
HR 5.57 for risk of
Ipsilateral stroke at 2 yrs

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

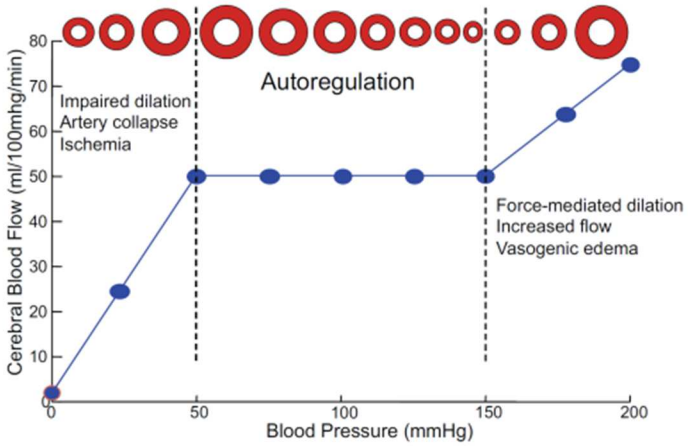
Markus et al, Lancet Neurol, 2010

TCD Cerebral Vascular Reserve (CVR)

- Vasomotor reactivity = measure of the cerebral circulation's response to vasomotor stimuli
- Stimuli – C02, acetazolamide, breath holding
- Inc C02 -> vasodilates arterioles -> increased CBF – reflected as increased MFV
- Simultaneous recording of both MCAs with 2 MHz transducers on TCD helmet



Autoregulation



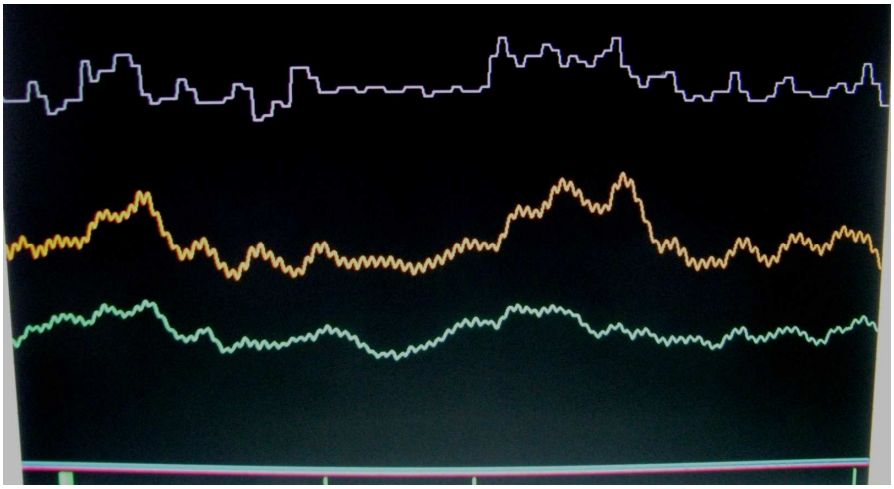
https://www.ukessays.com/essays/biology/report-cerebral-autoregulation-9328.php

Breath Holding Index

- BHI = % change Vmca during BH divided by time of BH
- $BHI = \frac{MFV_{bh} - MFV_{rest}}{MFV_{rest}} \times \frac{100}{Bh_{sec}}$
- Normal ≥ 0.69

Vernieri et al, Stroke, 1999

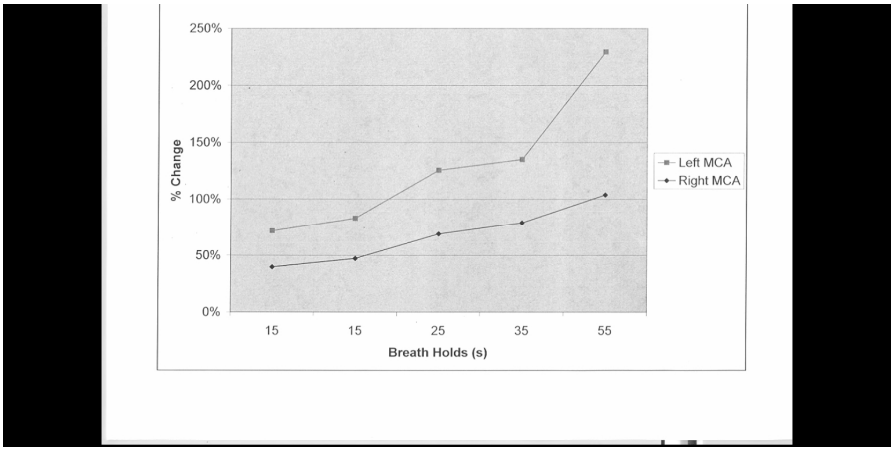
Normal CVR



Slide courtesy of Dr. Javier Romero

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Normal CVR



Slide courtesy of Dr. Javier Romero

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CVR in Asymptomatic Carotid Stenosis

Table 2 Association between impaired CVR and the development of stroke in patients with asymptomatic carotid stenosis

Study (year)	Number of patients	Patients with impaired CVR	Mean follow-up (months)	OR (95% CI)
Gur *et al*[42] (1996)	44	21/44	24	22.50 (1.44 to 1054.40)
Silvestrini *et al*[43] (2000)	94	40/94	28.5	3.72 (1.05 to 14.85)
Markus and Cullinane[44] (2001)	107	NM	21.7	14.4 (2.63 to 78.74)
Kimiagar *et al*[45] (2010)	35	21/35	48	6.50 (0.65 to 315.02)
King *et al*[46] (2011)	106	32/106	22.7	3.62 (0.61 to 21.74)

Paraskevas et al, Stroke and Vascular Neurology, 2018

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

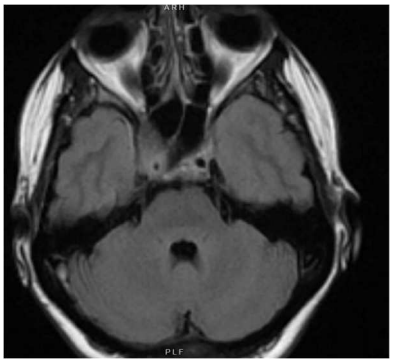
Case #4: Impaired CVR

55 yr old woman with

R cavernous sinus meningioma, s/p XRT

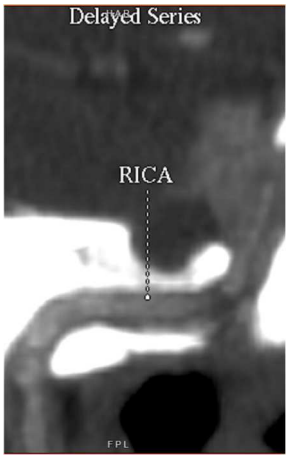
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

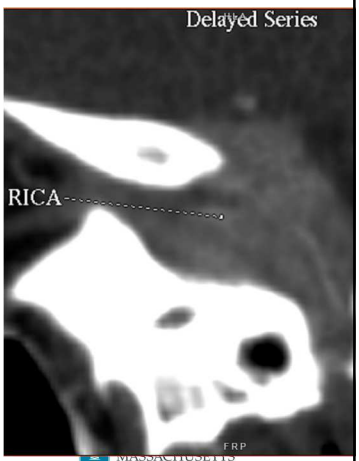
MRI



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CTA





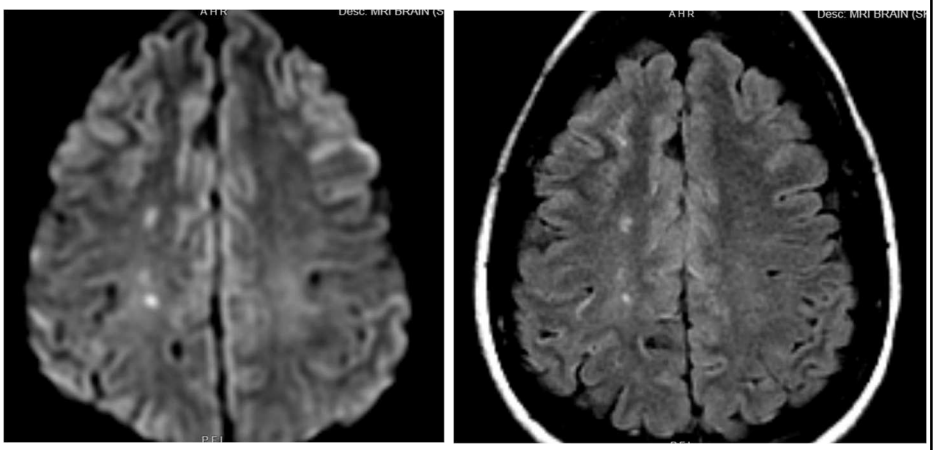
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #4 (cont):

Fall 2019: multiple, recurrent, transient episodes of LUE numbness

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

MRI 2019

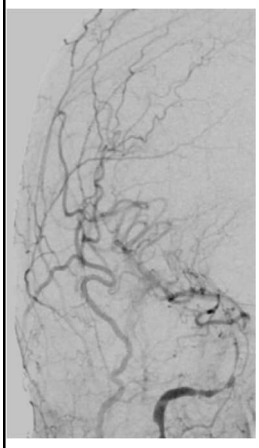


MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

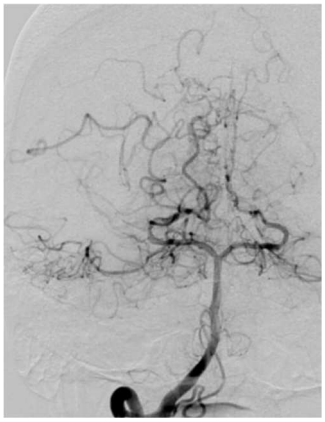
MRA H 2019

USETTS
HOSPITAL
VASCULAR CENTER

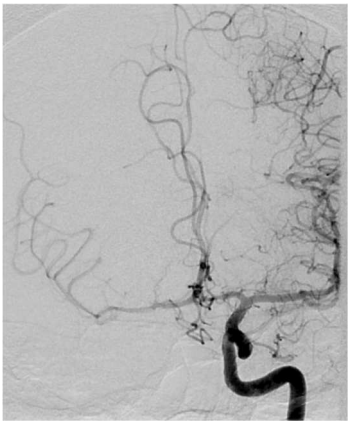
DSA 2019



R ICA



R Vert



L ICA

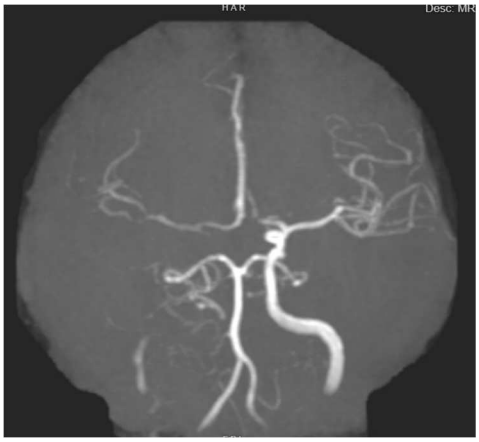
MASSACHUSETTS
GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #4 (cont)

- Spring 2020: several transient episodes of L hand numbness
- Fall 2020: transient L hand weakness/numbness after vomiting and feeling dizzy

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

MRA 2020 v MRA 2019

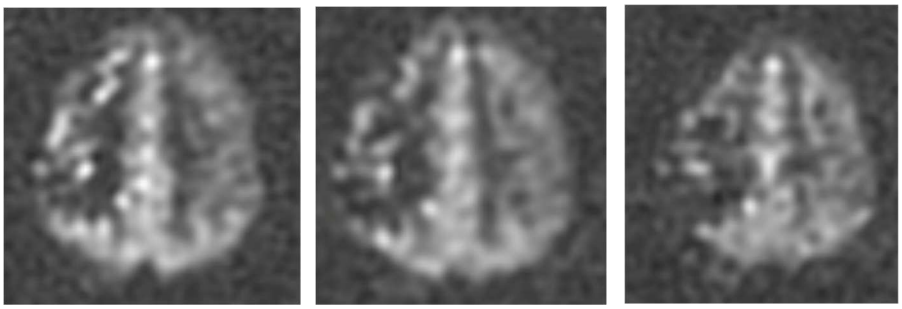


MRA 2020

MRA 2019

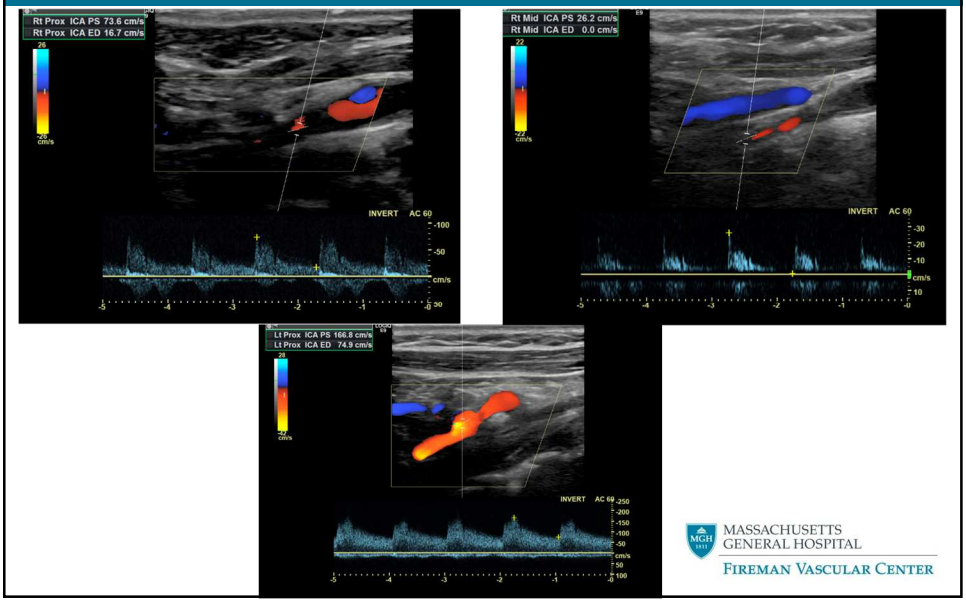
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

MRI 2020: decreased perfusion R MCA



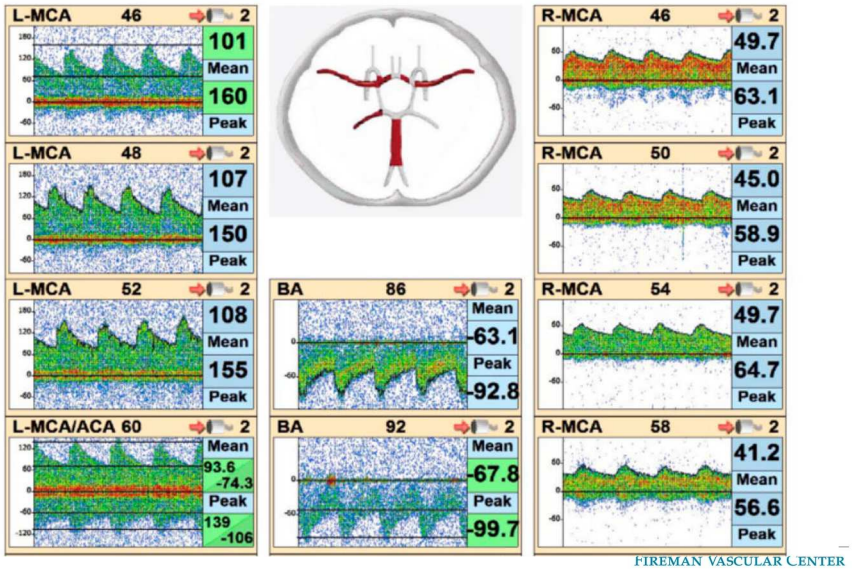
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CNIS 2020



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCDs 2020



FIREMAN VASCULAR CENTER

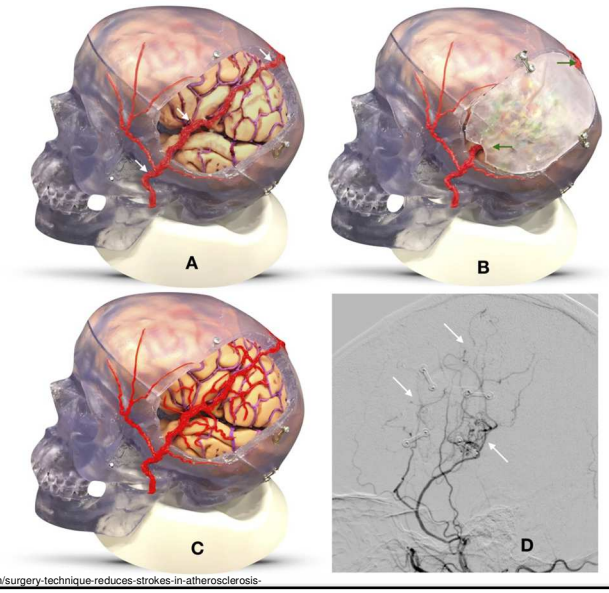
TCD CVR 2020

	R MCA	L MCA
BHI	29% at 55 sec	45% at 50 sec

Normal > 40% (MGH Neuroradiology lab)

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Encephaloduroarteriosynangiosis (EDAS)



https://www.cedars-sinai.org/newsroom/surgery-technique-reduces-strokes-in-atherosclerosis-

'S
ITAL
ULAR CENTER

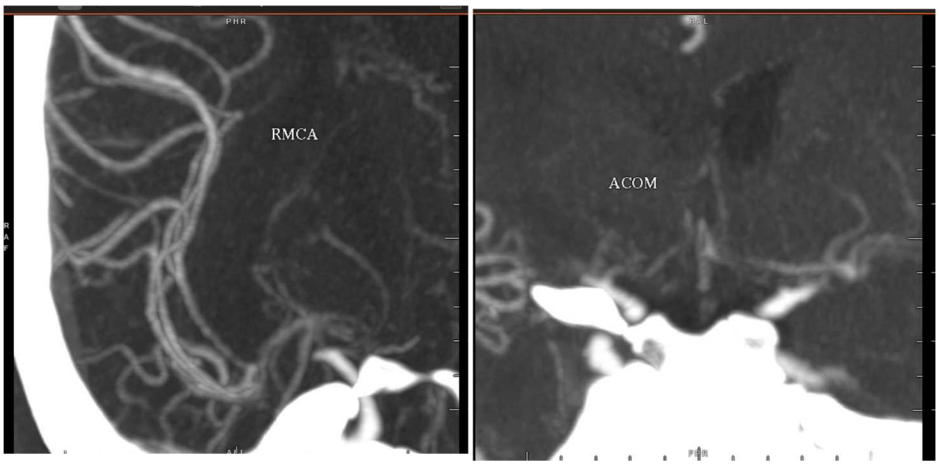
Case #5: Impaired CVR

60 yr old man with HTN/HL/DM/Obesity/

Tobacco abuse with R MCA/ACA borderzone stroke 2009

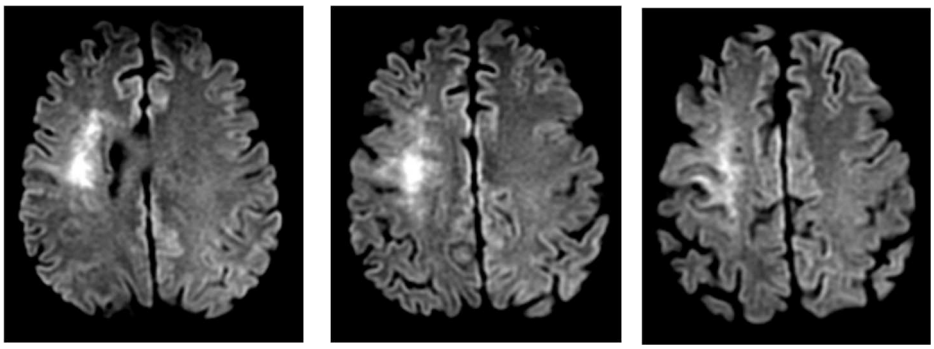
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CTA 2009



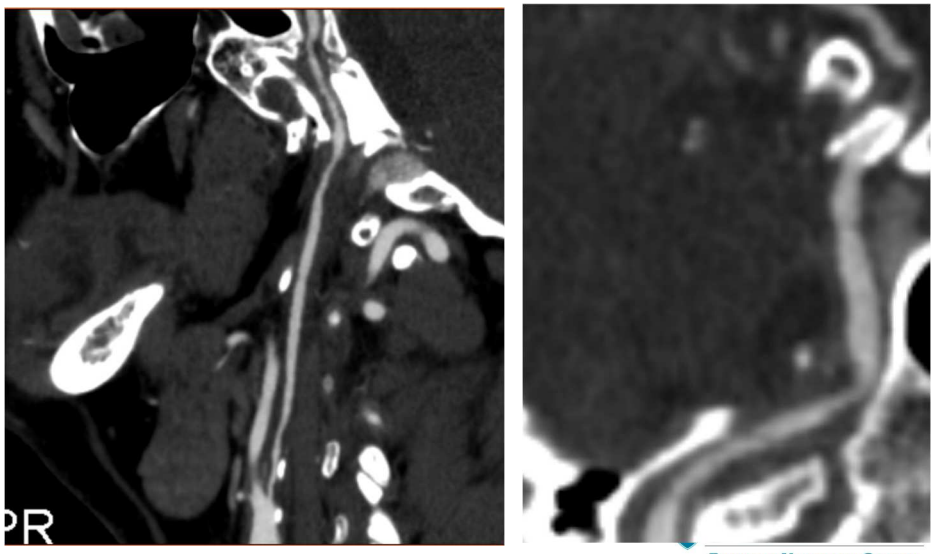
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

MRI 2009



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CTA 2018



Fireman Vascular Center

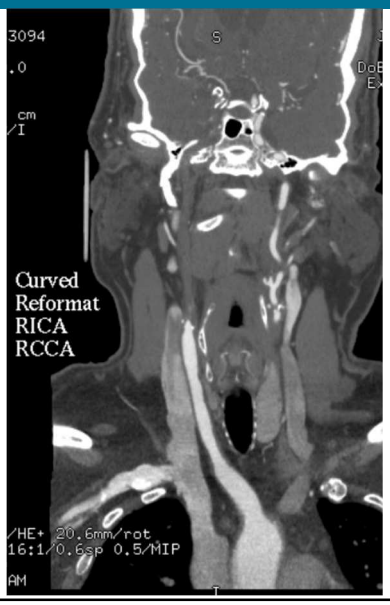
TCD CVR 2018

	R MCA	L MCA
BHI	25% at 15 sec	25% at 20 sec

Normal > 40% (MGH Neuroradiology lab)

Massachusetts General Hospital
Fireman Vascular Center

2020: Carotid duplex → occlusion of R ICA → CTA



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

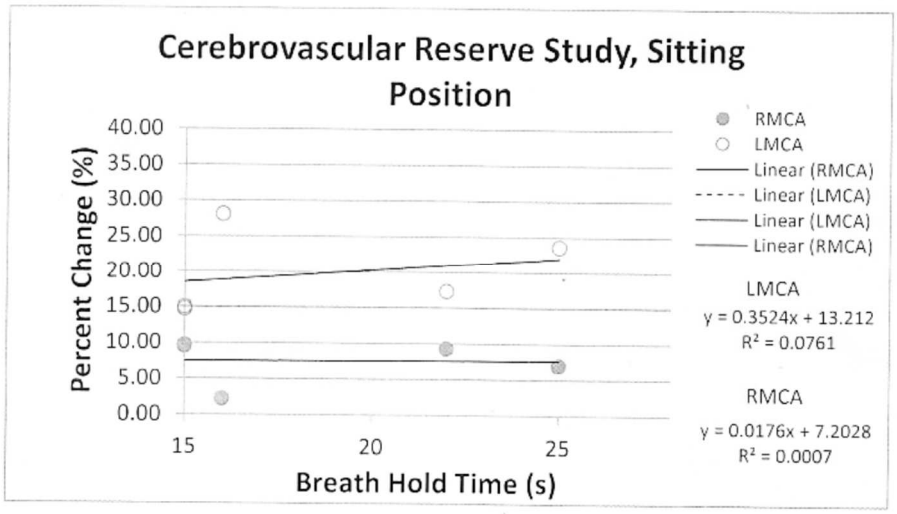
TCD CVR 2020

	R MCA	L MCA
BHI	9.7% at 15 sec	28% at 16 sec

Normal > 40% (MGH Neuroradiology lab)

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

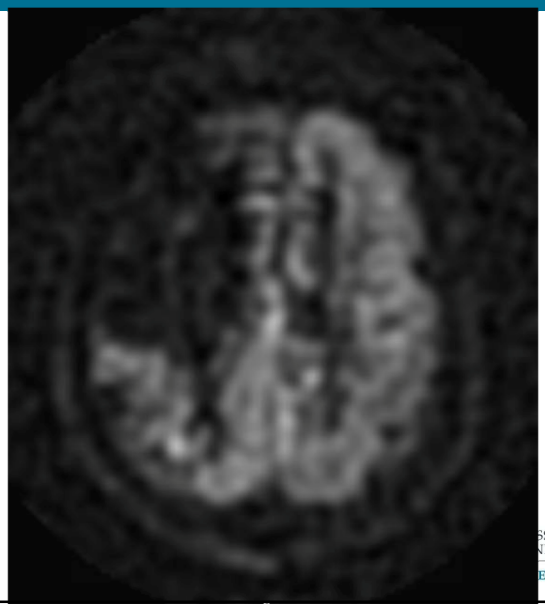
TCD CVR 2020



Case #5 (cont):

2021: Transient L arm/leg weakness

MRI 2021 – large perfusion deficit in R MCA



SSACHUSETTS
NERAL HOSPITAL
EMAN VASCULAR CENTER

Case #5 (cont): Management

- Plans for DSA
- Possible EDAS

MASSACHUSETTS
GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Bow Hunter's Syndrome

- Vertebro-basilar insufficiency due to rotation of the head
- First described in 1978, in 39 man who developed posterior circ stroke while practicing archery before hunting season

Sorensen, Neurosurgery, 1978

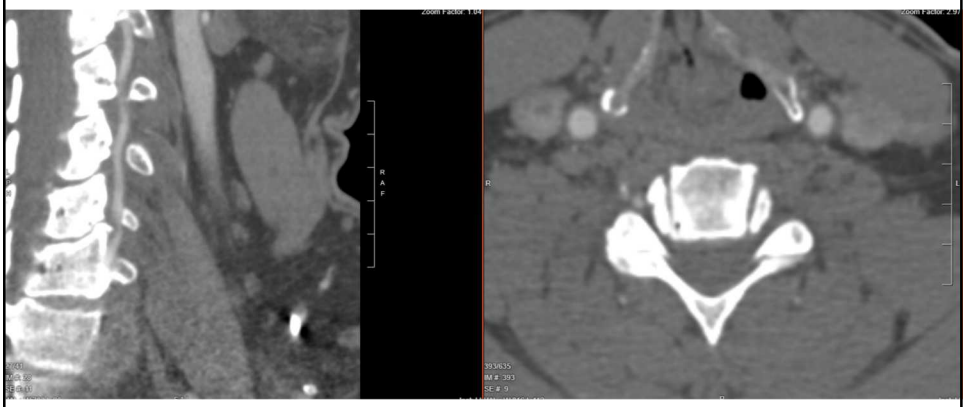
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #6: Bow Hunter's Syndrome

67 yr old man with HL, obesity, OSA, TIA p/w dizziness turning head to right

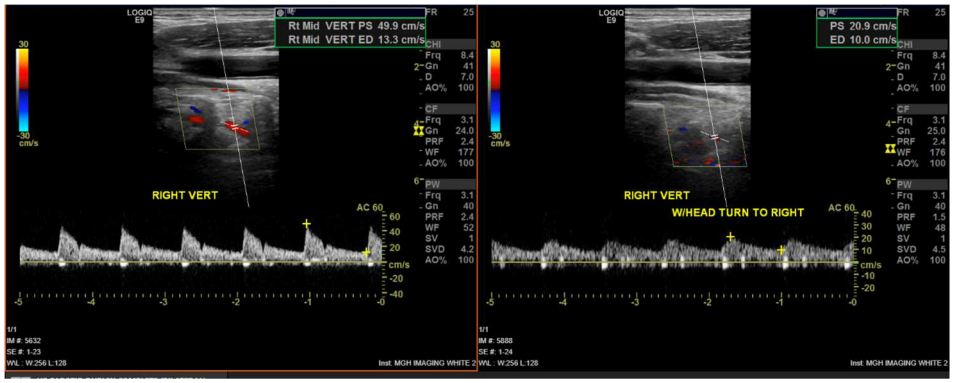
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

CTA H/N: external compression of R vertebral artery at C5-C6 from osteophyte



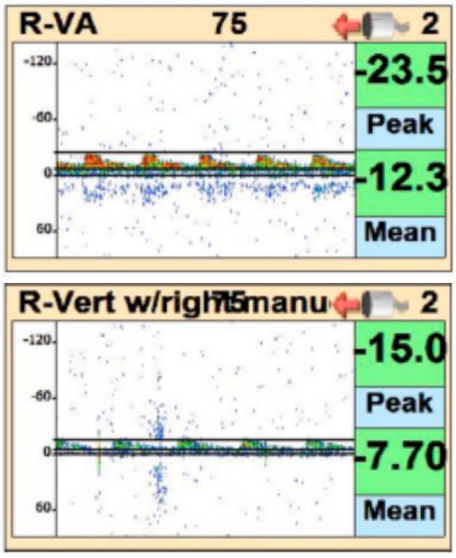
MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Duplex: Symptomatic with head turn to R



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

TCD: reduced R vert velocities with head turn



MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

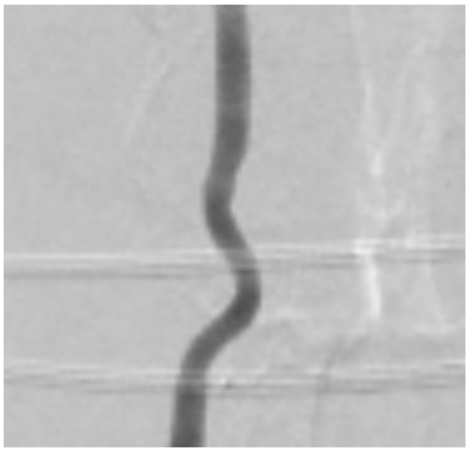
DSA

RVA, Cervical, AP

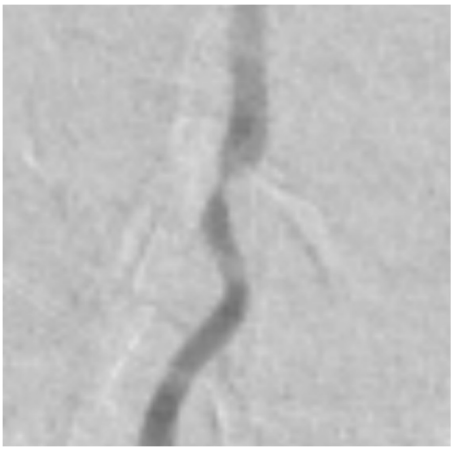
LVA, Cervical, AP

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

DSA: R vert with rotation



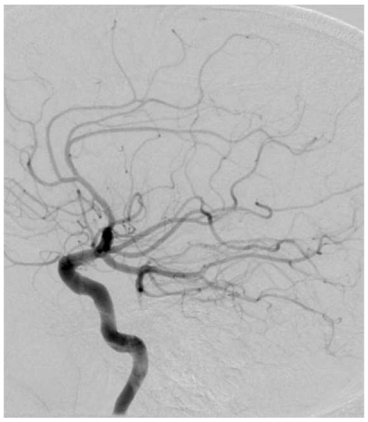
RVA, Cervical, AP



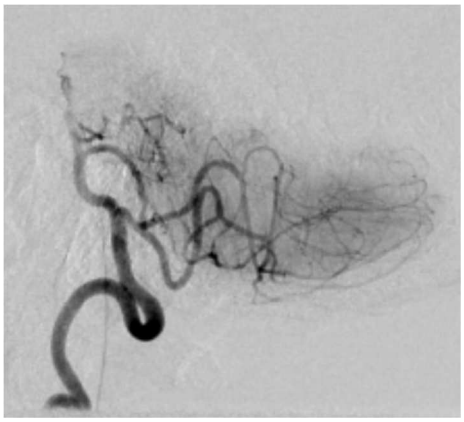
RVA, Cervical, Right Head Turn

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

DSA



RICA, Cranial, Lateral Position



RVA, Cranial, Lateral Position

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

Case #6 (cont): Management

- Observation

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER

HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

Thank you!

Scott Silverman, MD

MASSACHUSETTS GENERAL HOSPITAL
FIREMAN VASCULAR CENTER