# Blood Pressure To Blockages: Ophthalmic Cardiovascular Review

**Jesal Haribhakti, OD, FAAO**

**University Hospitals / Case Western Reserve University Medical School**

- No financial disclosures

## Course Objectives

- Discuss high blood pressure in medical offices and staging criteria per American Heart Association
- Review stages of hypertensive retinopathy and common clinical ophthalmic findings associated with cardiovascular changes
- Putting it all together – how does this show up in the clinic?

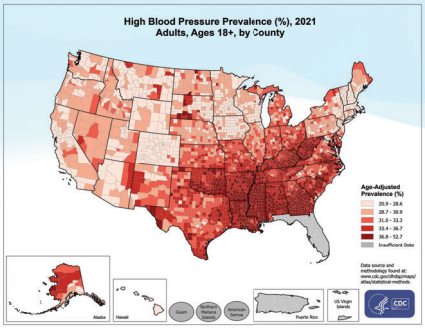
## High Blood Pressure Facts - CDC

- Nearly half of adults have high blood pressure (48.1%, 119.9 million). This is defined as a systolic blood pressure greater than 130 mm Hg or a diastolic blood pressure greater than 80 mm Hg or are taking medication for high blood pressure.
- About 1 in 4 adults with high blood pressure has their blood pressure under control (22.5%, 27.0 million).
- About half of adults (45%) with uncontrolled high blood pressure have a blood pressure of 140/90 mmHg or higher. This includes 37 million U.S. adults.
- About 1 in 5 deaths related to COVID-19 were people who had a history of hypertensive disease.

https://www.cdc.gov/high-blood-pressure/data-research/facts-stats/index.html

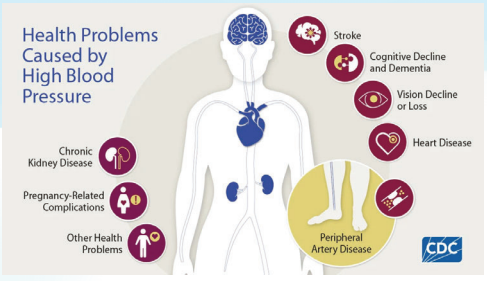
## High Blood Pressure Facts - CDC

- A higher percentage of men (50%) have high blood pressure than women (44%).
- High blood pressure is more common in non-Hispanic black adults (58%) than in non-Hispanic white adults (49%), non-Hispanic Asian adults (45%), or Hispanic adults (39%).




https://www.cdc.gov/high-blood-pressure/data-research/facts-stats/index.html

## High Blood Pressure Facts - CDC



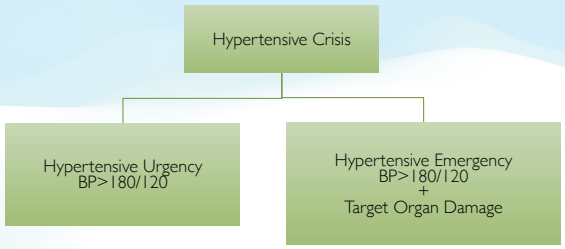

https://www.cdc.gov/high-blood-pressure/data-research/facts-stats/index.html

## American Heart Association - Blood Pressure Chart

| BLOOD PRESSURE CATEGORY | SYSTOLIC mm Hg (upper number) | and/or | DIASTOLIC mm Hg (lower number) |
|---|---|---|---|
| **NORMAL** | LESS THAN 120 | and | LESS THAN 80 |
| **ELEVATED** | 120 – 129 | and | LESS THAN 80 |
| **HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1** | 130 – 139 | or | 80 – 89 |
| **HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2** | 140 OR HIGHER | or | 90 OR HIGHER |
| **HYPERTENSIVE CRISIS (consult your doctor immediately)** | HIGHER THAN 180 | and/or | HIGHER THAN 120 |

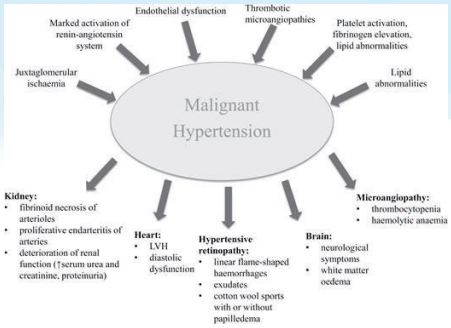
https://www.heart.org/en/health-topics/high-blood-pressure/understanding-blood-pressure-readings

## Classifying High Blood Pressure




## Classifying High Blood Pressure

- Malignant hypertension = Severe and aggressive form of hypertensive emergency
- Hallmark feature = retinal involvement??
- 1 year mortality rate with untreated hypertensive emergency is ~80%




## Classifying Retinopathy

**Table 1. Classification of Hypertensive Retinopathy on the Basis of Recent Population-Based Data.**

| Grade of Retinopathy | Retinal Signs | Systemic Associations* |
|---|---|---|
| None | No detectable signs | None |
| Mild | Generalized arteriolar narrowing, focal arteriolar narrowing, arteriovenous nicking, opacity ("copper wiring") of arteriolar wall, or a combination of these signs | Modest association with risk of clinical stroke,[41,43] subclinical stroke,[43] coronary heart disease,[44,49] and death[45] |
| Moderate | Hemorrhage (blot, dot, or flame-shaped), microaneurysm, cotton-wool spot, hard exudate, or a combination of these signs | Strong association with risk of clinical stroke,[41,43] subclinical stroke,[43] cognitive decline,[42] and death from cardiovascular causes[45] |
| Malignant | Signs of moderate retinopathy plus swelling of the optic disk† | Strong association with death |

* A modest association is defined as an odds ratio of greater than 1 but less than 2. A strong association is defined as an odds ratio of 2 or greater.
† Anterior ischemic optic neuropathy, characterized by unilateral swelling of the optic disk, visual loss, and sectorial visual-field loss, should be ruled out.

Wong Tien Y, and Paul Mitchell. "Hypertensive retinopathy." New England Journal of Medicine 351.22 (2004): 2310-2317.

**Keith-Wagner-Barker Classification**

Stage 1 – Arteriole constriction

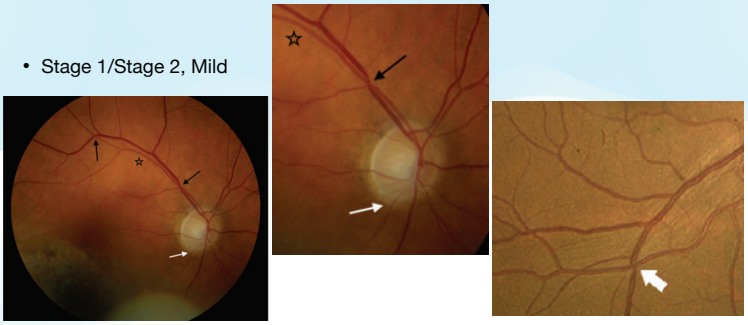
Stage 2 – Focal narrowing, crossing changes/nicking

Stage 3 – Flame hemorrhages, hard exudates, cotton wool spots

Stage 4 – Optic disc swelling, retinal edema

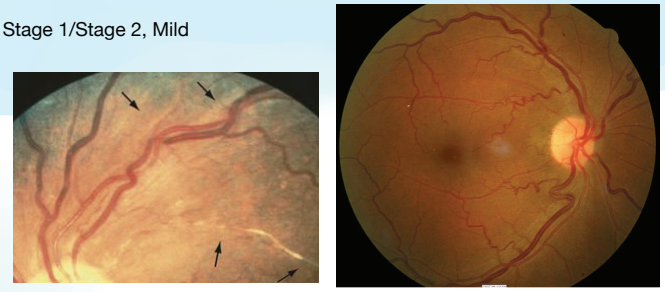
## Hypertensive Retinopathy - Clinical Findings

- Stage 1/Stage 2, Mild



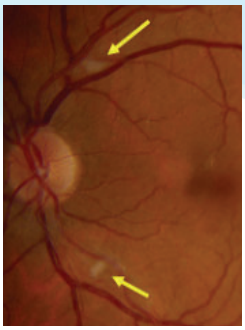
## Hypertensive Retinopathy - Clinical Findings

- Stage 1/Stage 2, Mild



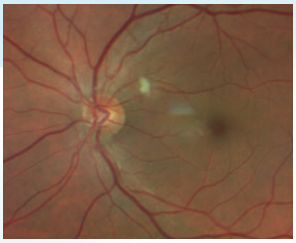
## Hypertensive Retinopathy - Clinical Findings

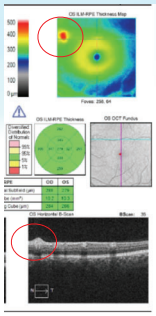
- Stage 3, Moderate

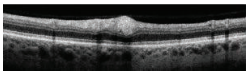
## Hypertensive Retinopathy - Clinical Findings

- Stage 3, Moderate



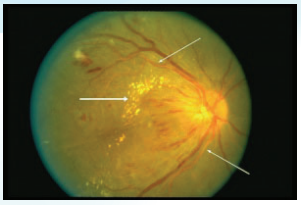


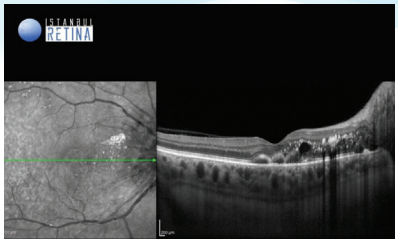
Cotton Wool Spots = Retinal ischemia



## Hypertensive Retinopathy - Clinical Findings

- Stage 3, Moderate

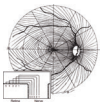





## Hypertensive Retinopathy - Clinical Findings

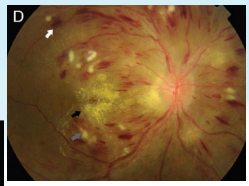
- Stage 3, Moderate

Dot/blot intraretinal hemorrhages



## Hypertensive Retinopathy - Clinical Findings

- Stage 4, Severe

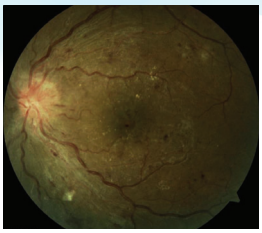




## Hypertensive Retinopathy - Clinical Findings

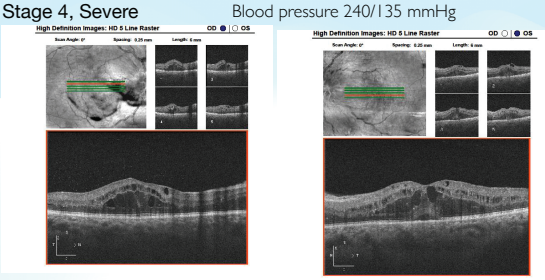
- Stage 4, Severe

Blood pressure 240/135 mmHg

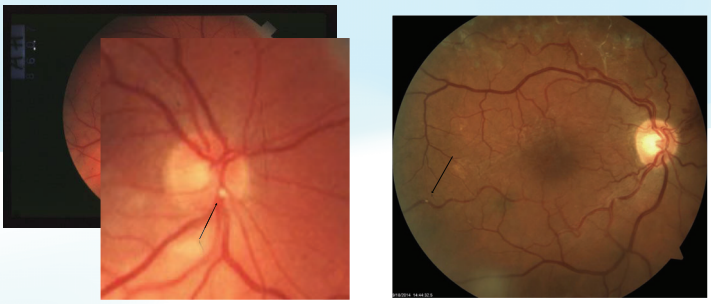


## Hypertensive Retinopathy - Clinical Findings

- Stage 4, Severe Blood pressure 240/135 mmHg

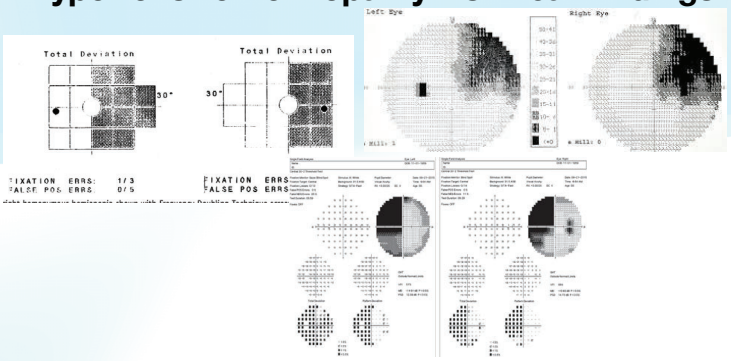



## Hypertensive Retinopathy - Clinical Findings



## Hypertensive Retinopathy - Clinical Findings


## Hypertensive Retinopathy - Clinical Findings



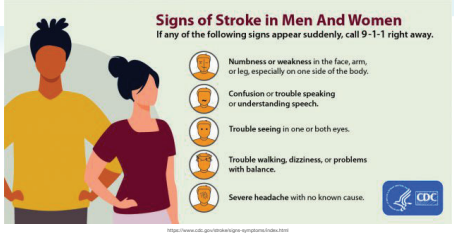

## Identifying Stroke Symptoms

**F—Face:** Ask the person to smile. Does one side of the face droop?

**A—Arms:** Ask the person to raise both arms. Does one arm drift downward?

**S—Speech:** Ask the person to repeat a simple phrase. Is the speech slurred or strange?

**T—Time:** If you see any of these signs, call 9-1-1 right away.




## How does this show up in our clinics?

# Case 1

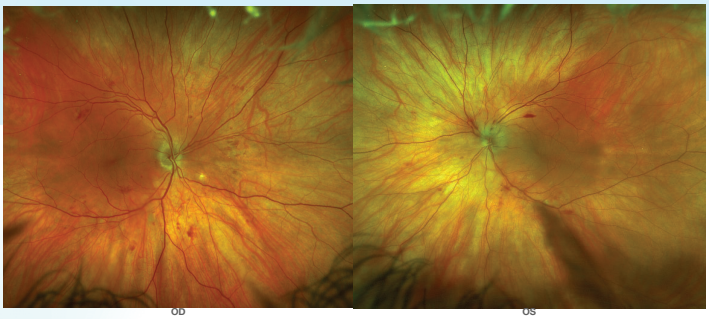
50 year old white male presents as referral from ER with acute, unilateral, painless vision loss with visual distortion in inferior-nasal quadrant OS. Patient reported to ER 1 day ago with BP of 222/140mmHg. Denies any headache, jaw pain, scalp tenderness, dyschromatopsia.

Medical history: Uncontrolled hypertension, diabetes mellitus, hyperlipidemia, obesity

BCVA OD: 20/20, OS: 20/40-1 PH 20/25

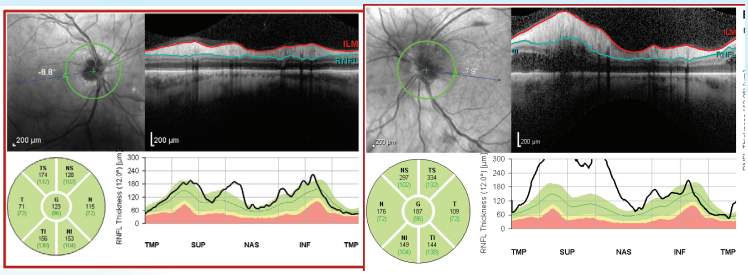
Pupils: PERRL OD/OS, 1+ APD OS

# Case 1



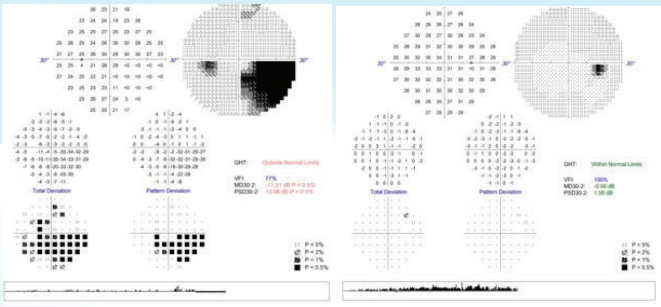
OD OS

# Case 1




OD OS

# Case 1



OS OD

# Case 1

50 year old white male presents as referral from ER with acute, unilateral, painless vision loss with visual distortion in inferior-nasal quadrant OS. Patient reported to ER 1 day ago with BP of 222/140mmHg. Denies any headache, jaw pain, scalp tenderness, dyschromatopsia.

Diagnosis: Mixed mechanism Non-Arteritic Ischemic Optic Neuropathy and Hypertensive Crisis (Hypertensive urgency)
Plan: RTC 1 month for DFE f/u. Refer to cardiologist for complete work-up.

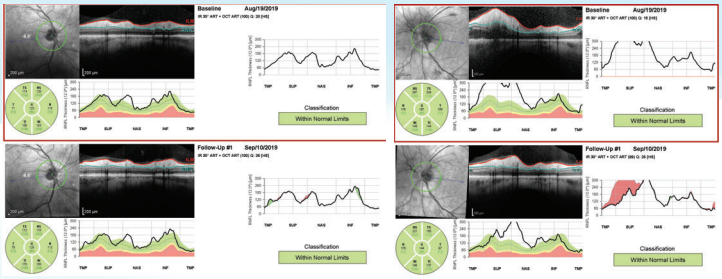
# Case 1

Lab Report: HbA1C = 8.7%
Recent lab work
- BUN: 15
- Creatinine: 1.41* (0.7-1.2 mg/dl)
- eGFR: 58* (>90)
- Average glucose: 203* (<125)
- HDL: 28* (>40)
- LDL: 103* (<100)

Intermittent right hip discomfort

Updated Diagnosis: Mixed mechanism Non-Arteritic Ischemic Optic Neuropathy and Hypertensive Crisis (Hypertensive emergency)

# Case 1




OD OS

# Case 1 - NAION

- Acute onset, unilateral, painless, vision loss
- Altitudinal defect (inferior altitudinal)
- Risk factors
  - "disk at risk"
  - OSA
  - Medications
    - V – Viagra (PDE-5i)
    - I – Imitrex
    - A – Amiodarone
  - Cardiovasculopathy
  - Smoking

- Clinical diagnosis
- Typical cases require no neuroimaging
- Consider ESR/CRP/platelet to rule out GCA
- Consider neuroimaging/ancillary labs in bilateral cases, atypical cases
  - <40 years old
  - Pain
  - No ONH edema
  - Atypical VF defect
  - No vasculopathic factors
  - Large CD's

# Case 1 - NAION

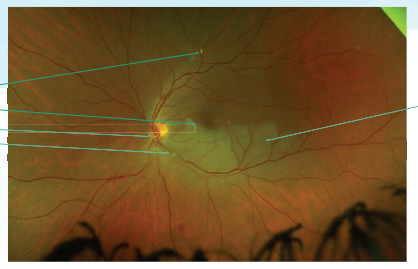
- Many proposed, none proven
- Proposed treatments:
  - Oral/intravitreal steroid therapy
  - Aspirin – 81mg daily
  - Optic nerve sheath decompression
  - "neuroprotection" – Ocular hypotensives
  - Intravitreal (anti-VEGF, erythropoietin, siRNA inhibiting caspase-2)
  - Hyperbaric oxygen
- **Treat underlying vasculopathic risk factors**

# Case 2

50 year old female presents for sudden onset vision loss superiorly OS after falling at night and hitting her head on the side of the table. Hx of hypertension, hyperlipidemia.

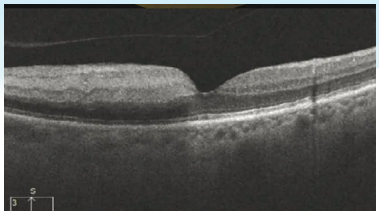
# Case 2

50 year old female presents for sudden onset vision loss superiorly OS after falling at night and hitting her head on the side of the table. Hx of hypertension, hyperlipidemia.




# Case 2

50 year old female presents for sudden onset vision loss superiorly OS after falling at night and hitting her head on the side of the table. Hx of hypertension, hyperlipidemia.



Diagnosis: Branch Retinal Artery Occlusion, OS

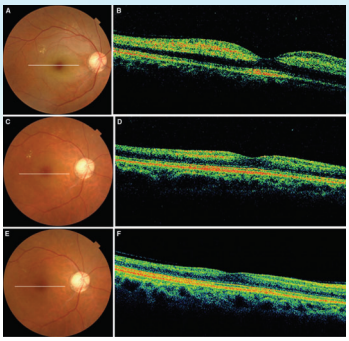
Plan: Refer to ER for stroke work-up. Order carotid duplex within 24 hours. Had heart procedure within 1 week.

# Case 2 - Artery Occlusion

- Vascular occlusive disorder
- Sudden onset, unilateral, painless vision loss
- NAION = Stroke in the optic nerve vs RAO = Stroke in the retina
- Cardiovasculopathies – Hypertension, diabetes, hyperlipidemia
- Types of emboli
  - Cholesterol (Hollenhorst plaque)
  - Calcific
  - Fibrin platelet

# Case 2 - Artery Occlusion

- Profound vision loss >20/400 with CRAO compared to BRAO
- APD
- Ischemic "white" retinal tissue
- Cherry-red spot
- Macular sparing with cilioretinal artery
  - Or could have cilioretinal artery occlusion
- Permanent vision loss, optic neuropathy



# Case 2 - Artery Occlusion

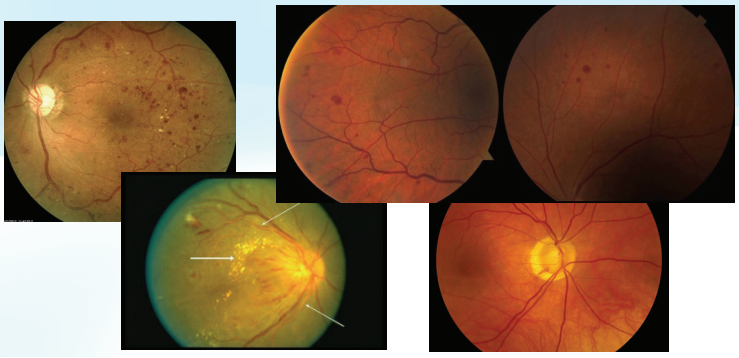
**Retinal Artery Occlusion – Management**

- No consensus with respect to CRAO/BRAO treatment
- Acute onset requires complete stroke work up
  - Increased risk of cerebral or myocardial infarction
- Consider starting 81mg Aspirin
- Hyperbaric oxygen
- Topical ocular hypotensive
- Digital massage
- Paracentesis
- Fibrinolytic therapy, tPA, TNK

# Case 3

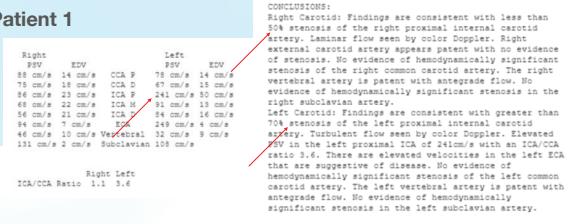
- **Patient 1** - 72 year old male presents for annual diabetic eye exam. A1C 6.8% BSL 118mg/dL. Near blur OU. Worsening night vision. Upper eyelid drooping has becomes bothersome. +Hx of hypertension, hyperlipidemia, Cardiac Hx of CAD and CABG.
  - Pertinent findings (initially encounter):
    - Dermatochalasis
    - BCVA OD 20/25, OS 20/30
    - 1+ NS, 3+ Cortical OU
    - OS with peripheral blot hemorrhages at 12:00
- **Patient 2** - 70 year old female presents for comprehensive eye exam. No distance or near blur. Had a single episode one summer ago where her vision in left eye went black for 30 seconds and then returned. No other changes. Hx of high cholesterol and hypertension.
  - Pertinent findings (initial encounter)
    - BCVA OD/OS 20/20
    - 2+ NS, 2+ Cortical, 2+ PSC OU

# Case 3 - Peripheral Retinal Hemorrhages



# Case 3 - Peripheral Retinal Hemorrhages

**Patient 1**



```
                Right                                   Left
                 PSV      EDV                           PSV      EDV
 88 cm/s  14 cm/s   CCA P    78 cm/s  14 cm/s
 75 cm/s  15 cm/s   CCA D    67 cm/s  15 cm/s
 86 cm/s  23 cm/s   ICA P   241 cm/s 50 cm/s
 68 cm/s  22 cm/s   ICA M    91 cm/s  13 cm/s
 56 cm/s  21 cm/s   ICA D    84 cm/s  16 cm/s
 94 cm/s   7 cm/s     ECA   249 cm/s  4 cm/s
 46 cm/s  10 cm/s Vertebral  32 cm/s   9 cm/s
131 cm/s   2 cm/s  Subclavian 108 cm/s

                Right Left
ICA/CCA Ratio   1.1   3.6
```

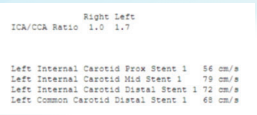
```
CONCLUSIONS:
Right Carotid: Findings are consistent with less than
50% stenosis of the right proximal internal carotid
artery. Laminar flow seen by color Doppler. Right
external carotid artery appears patent with no evidence
of stenosis. No evidence of hemodynamically significant
stenosis of the right common carotid artery. The right
vertebral artery is patent with antegrade flow. No
evidence of hemodynamically significant stenosis in the
right subclavian artery.
Left Carotid: Findings are consistent with greater than
70% stenosis of the left proximal internal carotid
artery. Turbulent flow seen by color Doppler. Elevated
PSV in the left proximal ICA of 241cm/s with an ICA/CCA
ratio 3.6. There are elevated velocities in the left ECA
that are suggestive of disease. No evidence of
hemodynamically significant stenosis of the left common
carotid artery. The left vertebral artery is patent with
antegrade flow. No evidence of hemodynamically
significant stenosis in the left subclavian artery.
```

**Patient 2**

| | Right | Left |
|---|---|---|
| CCA | 86.8 cm/s | 94.8 cm/s |
| ICA | 66.1 cm/s | 347.4 cm/s |
| ECA | 91.1 cm/s | 98 cm/s |
| ICA/CCA | 0.9 | 5.2 |

# Case 3 - Peripheral Retinal Hemorrhages

- Patient 1
  - Refer to cardiology - had stent placement in 2 months since encounter



```
                Right Left
ICA/CCA Ratio   1.0   1.7


Left Internal Carotid Prox Stent 1    56 cm/s
Left Internal Carotid Mid Stent 1     79 cm/s
Left Internal Carotid Distal Stent 1 72 cm/s
Left Common Carotid Distal Stent 1    68 cm/s
```

- Patient 2
  - Refer to cardiology - eventual referral for cardiovascular surgery - noncompliant patient

# Case 3 - Peripheral Retinal Hemorrhages

- **Carotid doppler ultrasound:** Using sound waves to image blood flow in the carotid arteries
  - Since flow volume through blood vessel is constant, if there is a stenotic segment, flow velocity will be faster

Table 1. Doppler criteria for diagnosis of ICA stenosis

| Diameter stenosis (%) | PSV (cm/sec) | EDV (cm/sec) | ICA/CCA PSV ratio |
|---|---|---|---|
| Normal | <125 | <40 | <2.0 |
| <50 | <125 | <40 | <2.0 |
| 50–69 | 125–230 | 40–100 | 2.0–4.0 |
| ≥70 | >230 | >100 | >4.0 |
| Near total occlusion | Variable | Variable | Variable |
| Total occlusion | Undetectable | Undetectable | Not applicable |

Reprinted with permission from Radiological Society of North America [20].
ICA, internal carotid artery; PSV, peak systolic velocity; EDV, end diastolic velocity; CCA, common carotid artery.

Lee, Whal. "General principles of carotid Doppler ultrasonography." Ultrasonography 33.1 (2014): 11-17.

# Key Take Aways!

- Be familiar with the various signs and symptoms hypertensive patients can present to clinic with
  - Differentiating various retinal hemorrhage presentations
- Symptoms drive referral and urgency
- Comanage with subspecialties vs referral to ophthalmology

# Thank you!


- jesal.haribhakti@uhhospitals.org