THE WARREN ALPERT Medical School
BROWN UNIVERSITY

Jointly Provided By

Comprehensive Stroke Center
Rhode Island Hospital
BROWNHealth
UNIVERSITY

Time is Vision – Emergent Evaluation & Management of CRAO

Tatiana Bakaeva, MD, PhD
Assistant Professor of Surgery
Assistant Professor of Neurology
The Warren Alpert Medical School at Brown University
Service Chief, Neuro-Ophthalmology
Brown University Health Ophthalmology
Providence, RI

Financial Relationship Disclosure(s)

Tatiana Bakaeva, MD, PhD

- Nothing to disclose

Learning Objectives

- Recognize the clinical presentation, underlying pathophysiology, and types of ocular stroke

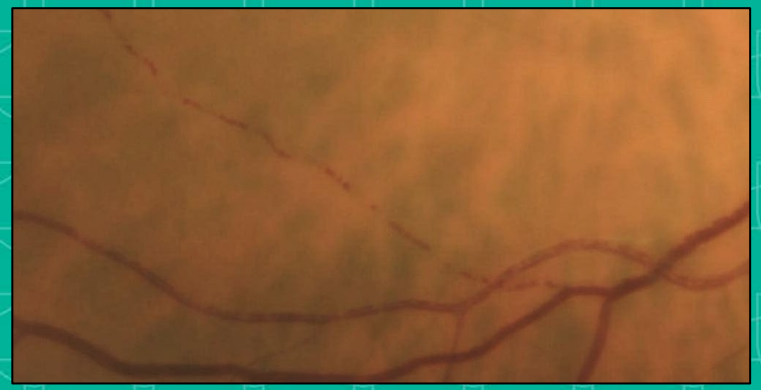
Learning Objectives

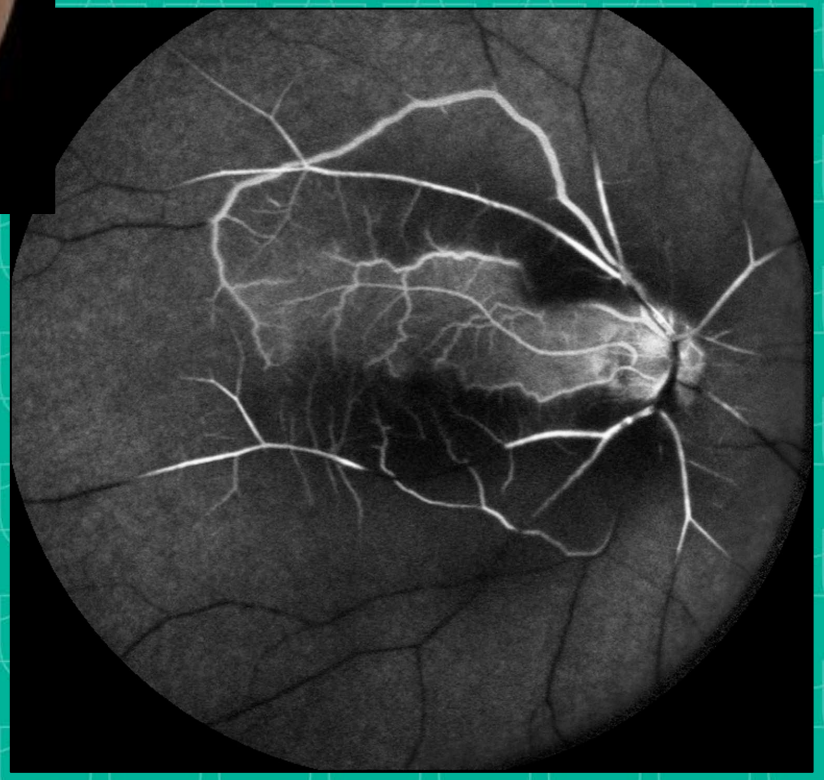
- Recognize the clinical presentation, underlying pathophysiology, and types of ocular stroke
- Evaluate current and emerging strategies for the emergent management of CRAO, including modifications to existing stroke protocols ("Code Stroke Vision") and the role of thrombolytic therapy.

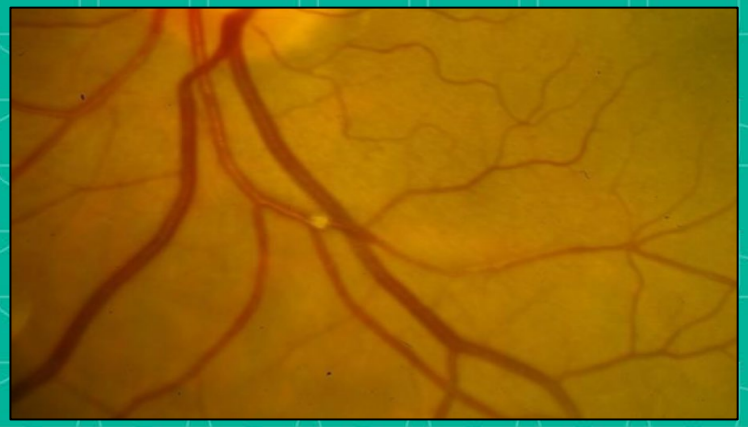
Learning Objectives

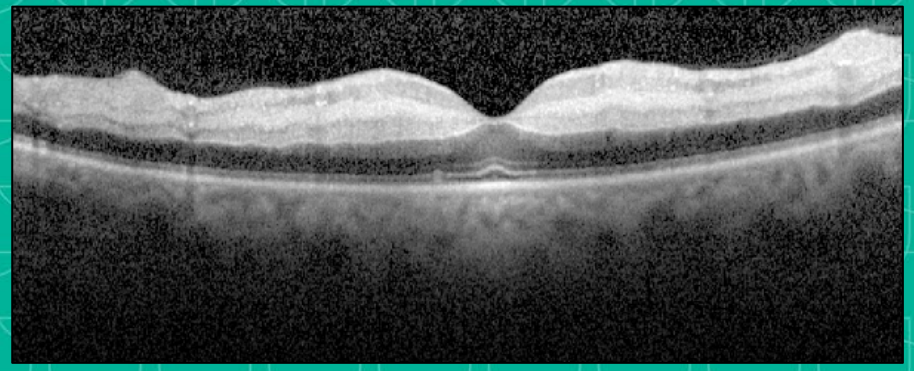
- Recognize the clinical presentation, underlying pathophysiology, and types of ocular stroke
- Evaluate current and emerging strategies for the emergent management of CRAO, including modifications to existing stroke protocols ("Code Stroke Vision") and the role of thrombolytic therapy.
- Assess the evidence supporting intravenous and intra-arterial thrombolysis in CRAO, understand limitations of traditional therapies, and review ongoing clinical trials shaping future management

Central Retinal Artery Occlusion (CRAO)







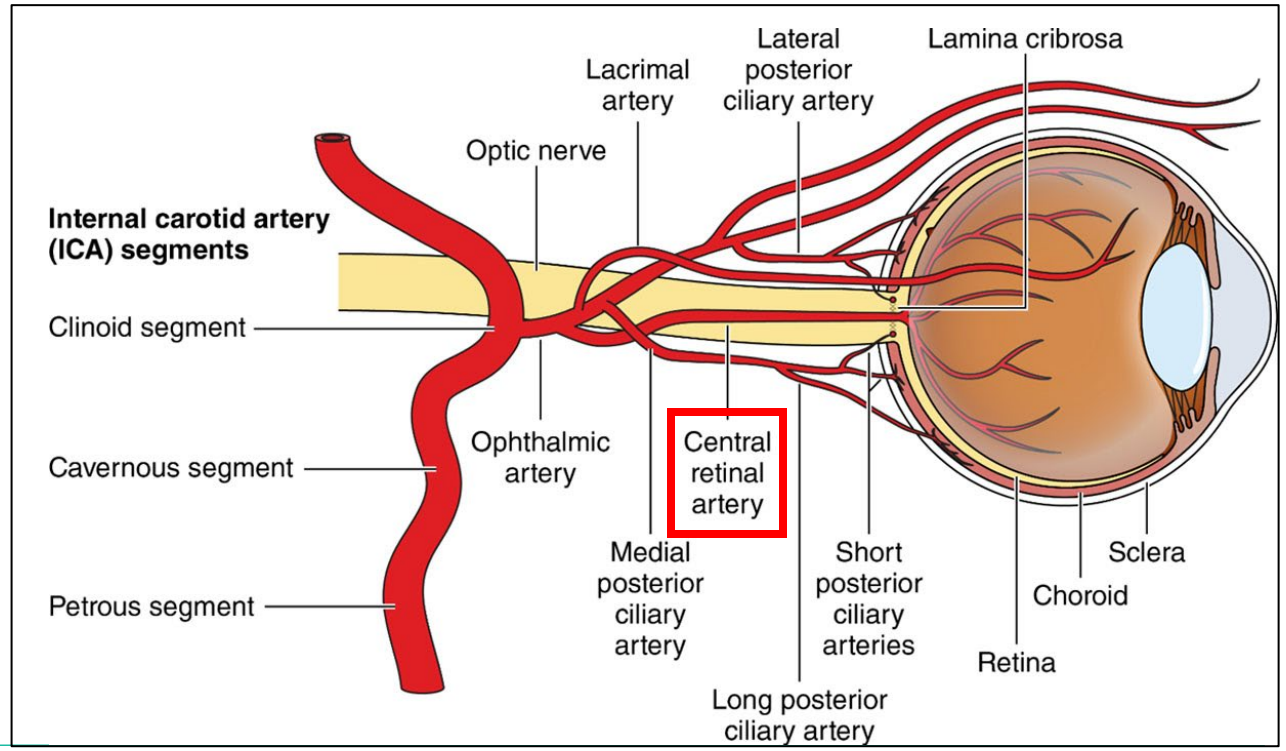


BROWNHealth UNIVERSITY

Central Retinal Artery Occlusion (CRAO)

Stroke
Volume 52, Issue 6, June 2021; Pages e282-e294
https://doi.org/10.1161/STR.0000000000000366
AHA SCIENTIFIC STATEMENT

- Acute CRAO is a form of ischemic stroke
- ~2 per 100,000 person per year; 10 per 100,000 for >80 years of age
- Nonarteritic (95%) - ipsilateral ICA disease (~40-60%), cardiac emboli
- Arteritic (5%, usually GCA)

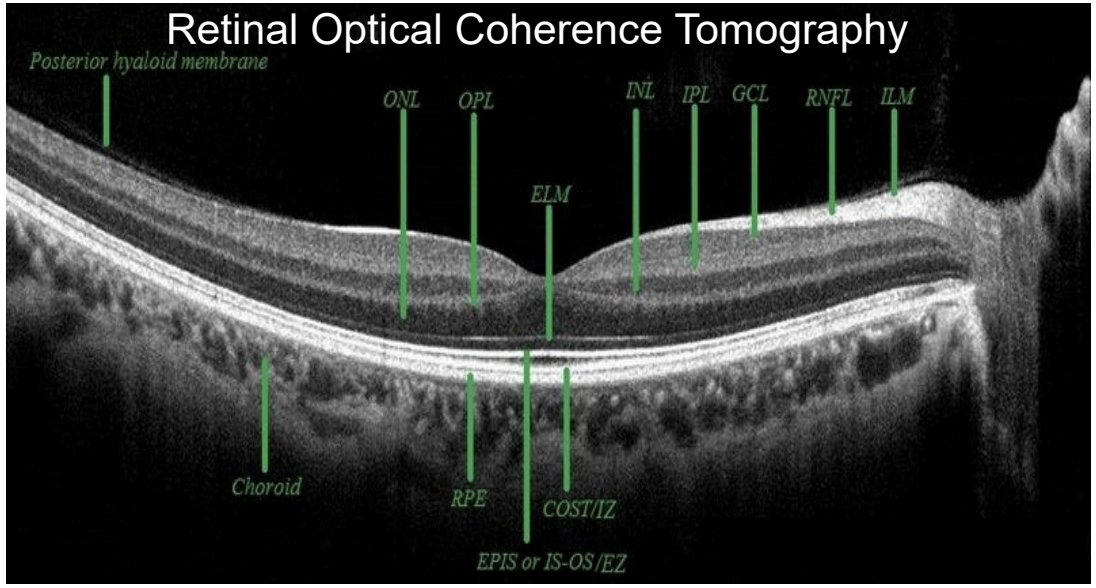


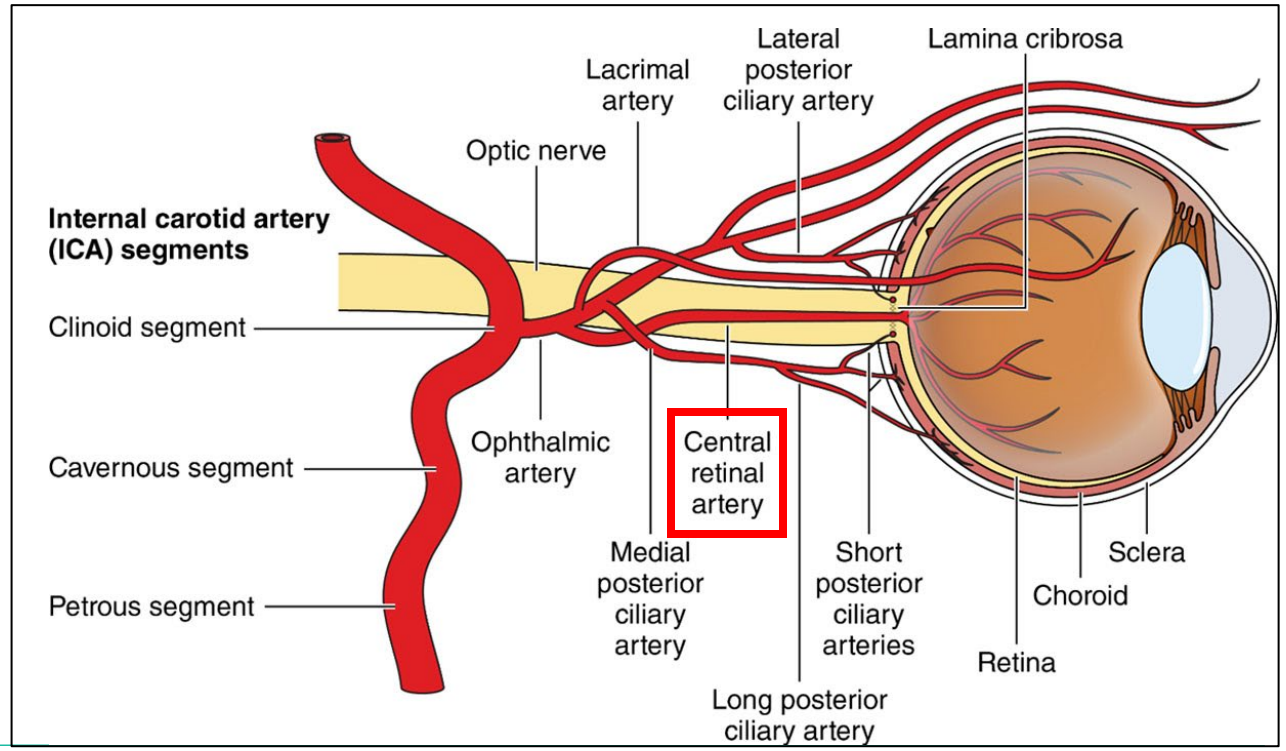
Mac Grory B, et al; Stroke. 2021

Central Retinal Artery Occlusion (CRAO)

Stroke
Volume 52, Issue 6, June 2021; Pages e282-e294
https://doi.org/10.1161/STR.0000000000000366
AHA SCIENTIFIC STATEMENT

- Acute CRAO is a form of ischemic stroke
- ~2 per 100,000 person per year; 10 per 100,000 for >80 years of age
- Nonarteritic (95%) - ipsilateral ICA disease (~40-60%), cardiac emboli
- Arteritic (5%, usually GCA)



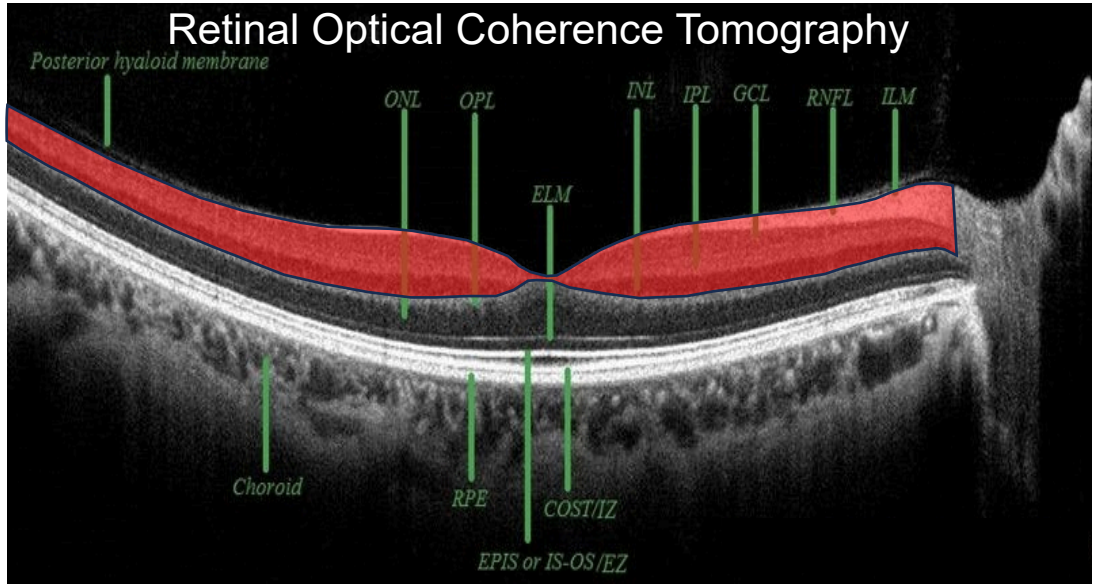


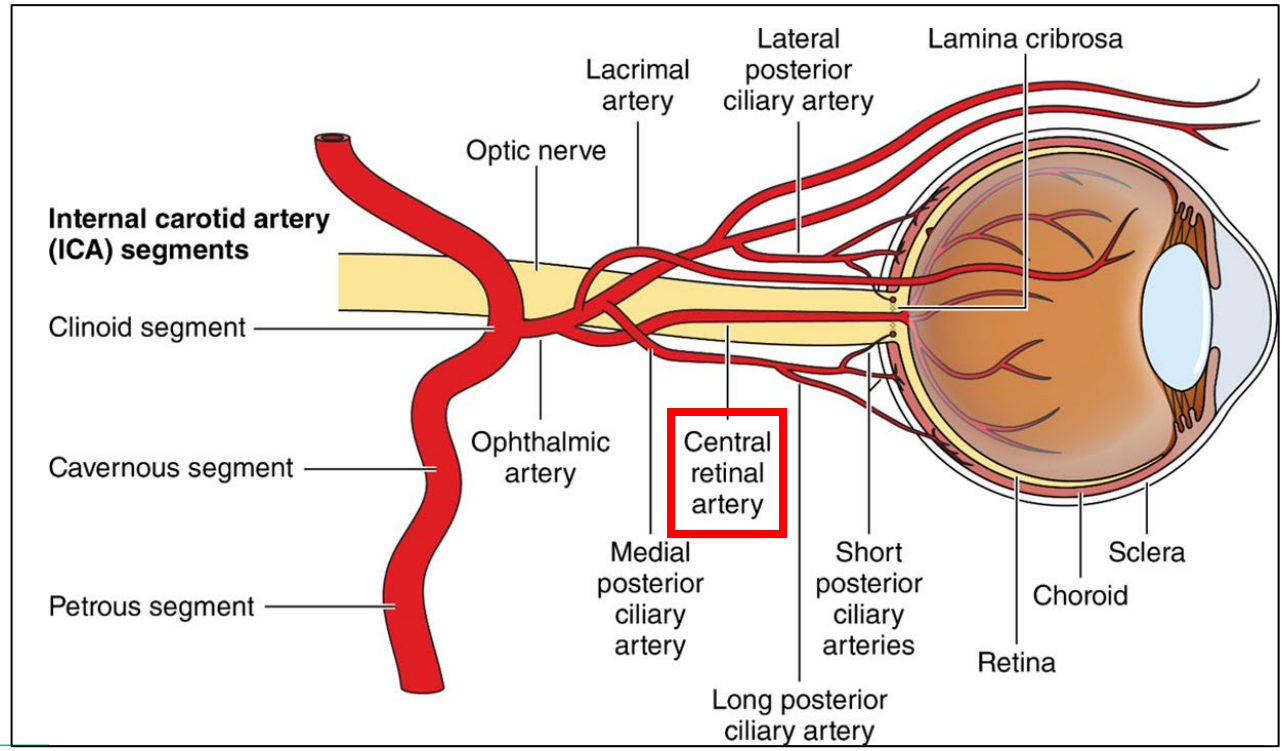
Mac Grory B, et al; Stroke. 2021

Central Retinal Artery Occlusion (CRAO)

Stroke
Volume 52, Issue 6, June 2021; Pages e282-e294
https://doi.org/10.1161/STR.0000000000000366
AHA SCIENTIFIC STATEMENT

- Acute CRAO is a form of ischemic stroke
- ~2 per 100,000 person per year; 10 per 100,000 for >80 years of age
- Nonarteritic (95%) - ipsilateral ICA disease (~40-60%), cardiac emboli
- Arteritic (5%, usually GCA)

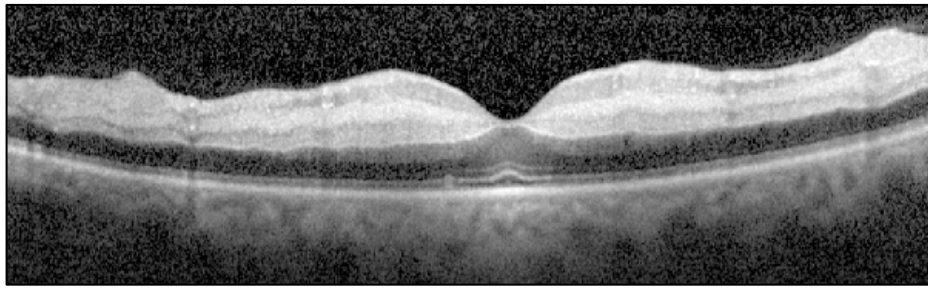


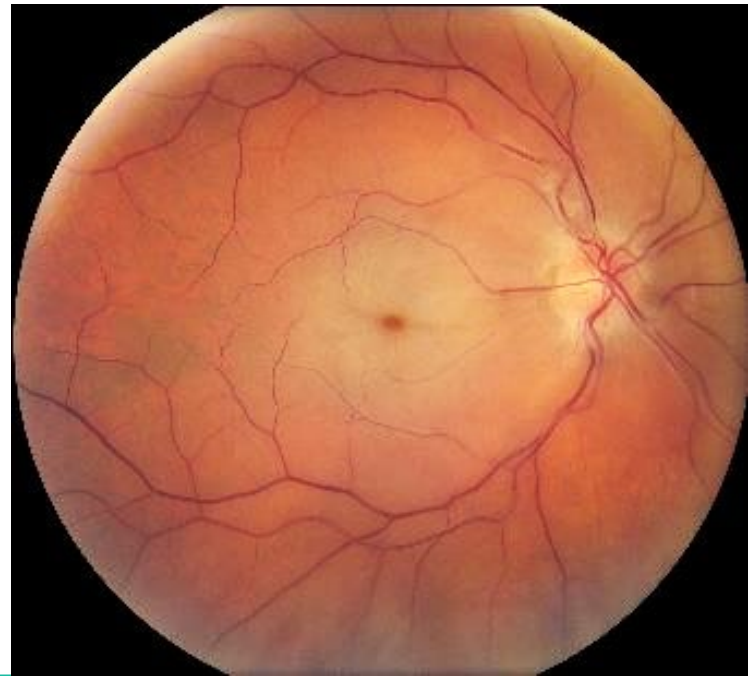


Mac Grory B, et al; Stroke. 2021

Central Retinal Artery Occlusion (CRAO) - Presentation

- Sudden monocular painless vision loss

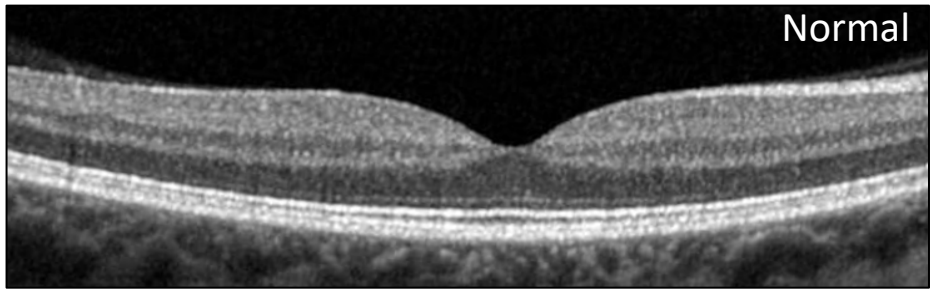


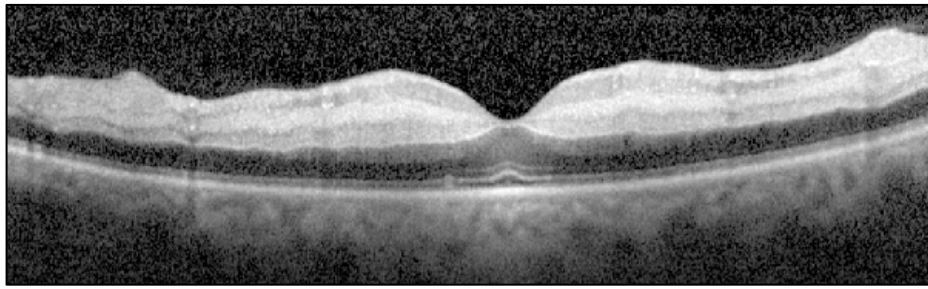


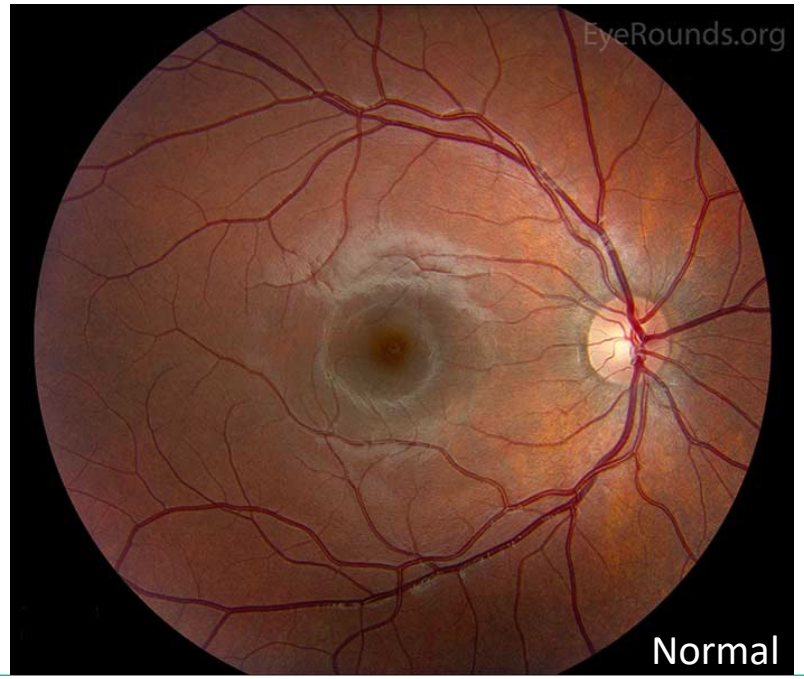
Images: Wills Eye Hospital, BMJ Case Reports *CP* 2022;**15:**e246293

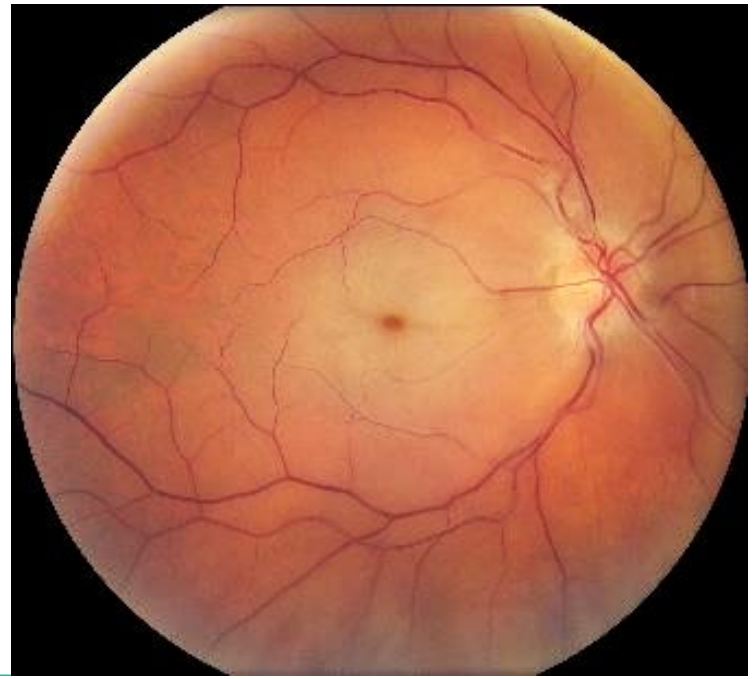
Central Retinal Artery Occlusion (CRAO) - Presentation

- Sudden monocular painless vision loss





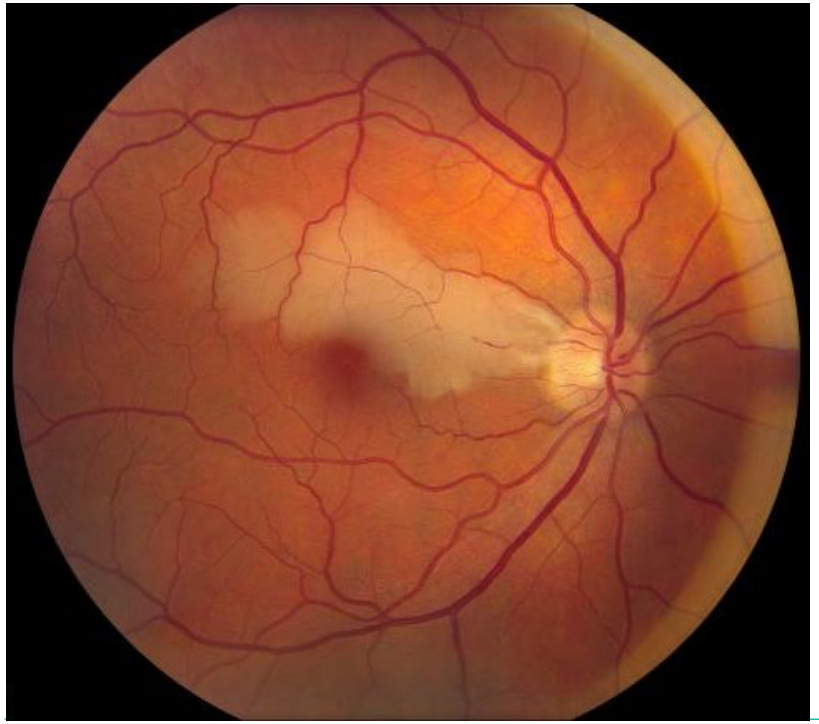


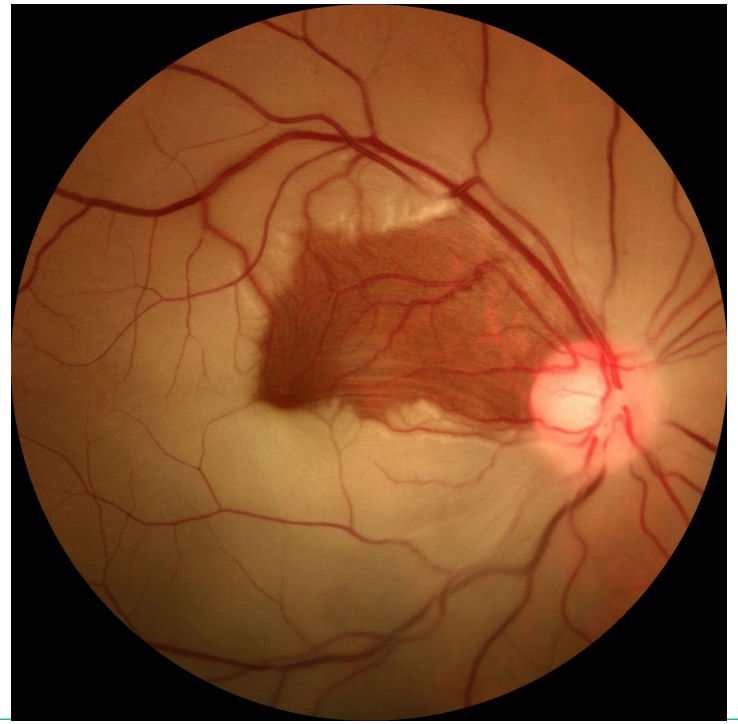


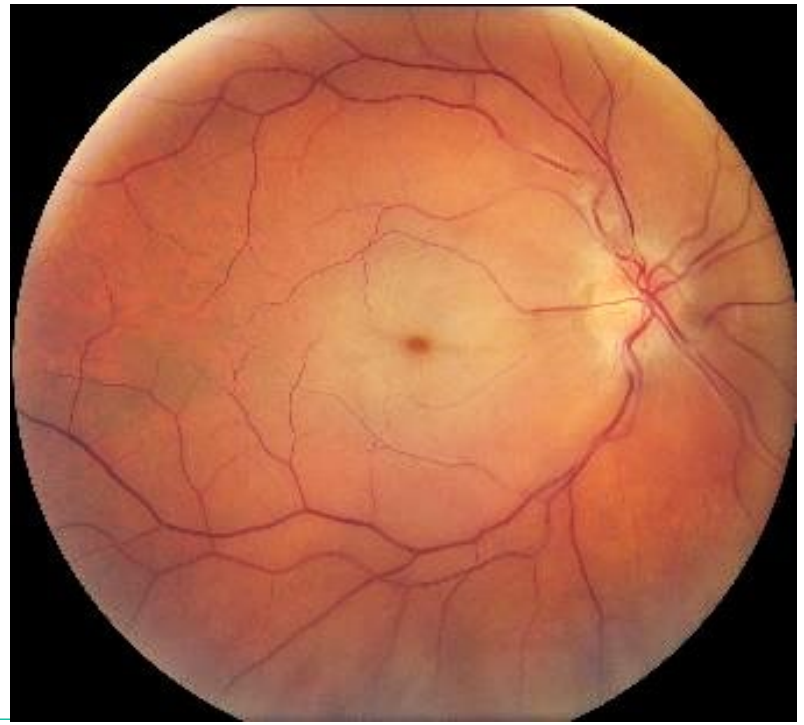
Images: Wills Eye Hospital, BMJ Case Reports *CP* 2022;**15:**e246293

Central Retinal Artery Occlusion (CRAO) - Presentation

- Sudden monocular painless vision loss
- ~30% patients have cilioretinal artery – sparing of central vision
- Can affect branch of the retinal artery (BRAO) – partial vision loss





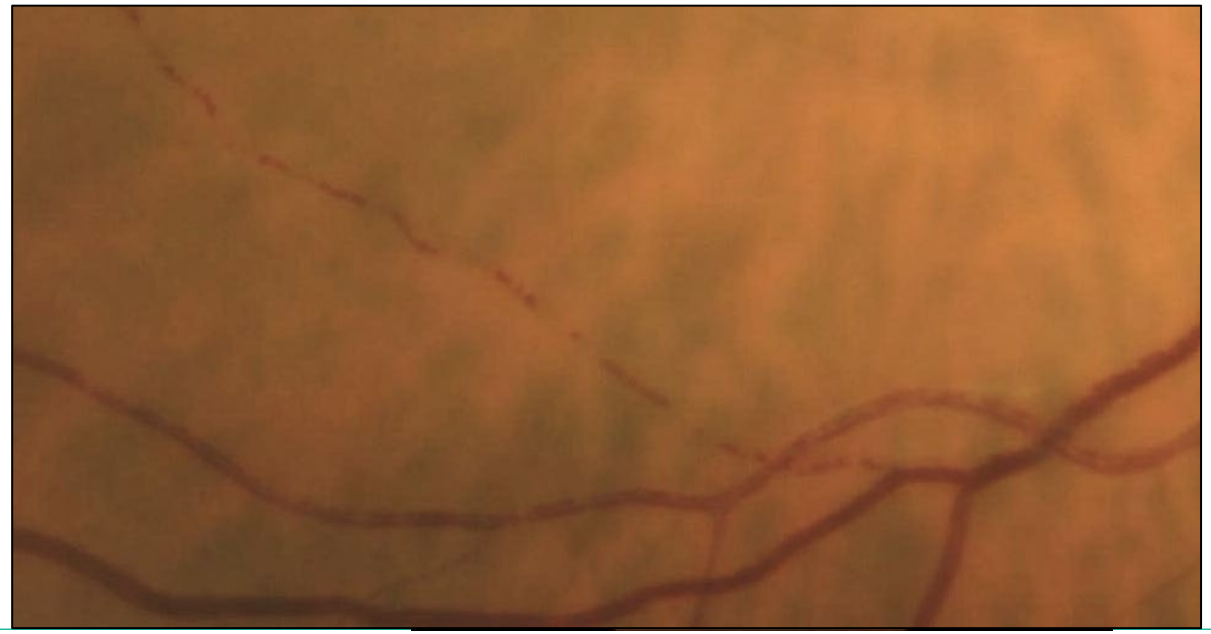


BROWNHealth UNIVERSITY

Images: Wills Eye Hospital, BMJ Case Reports *CP* 2022;**15:**e246293

Central Retinal Artery Occlusion (CRAO) - Presentation

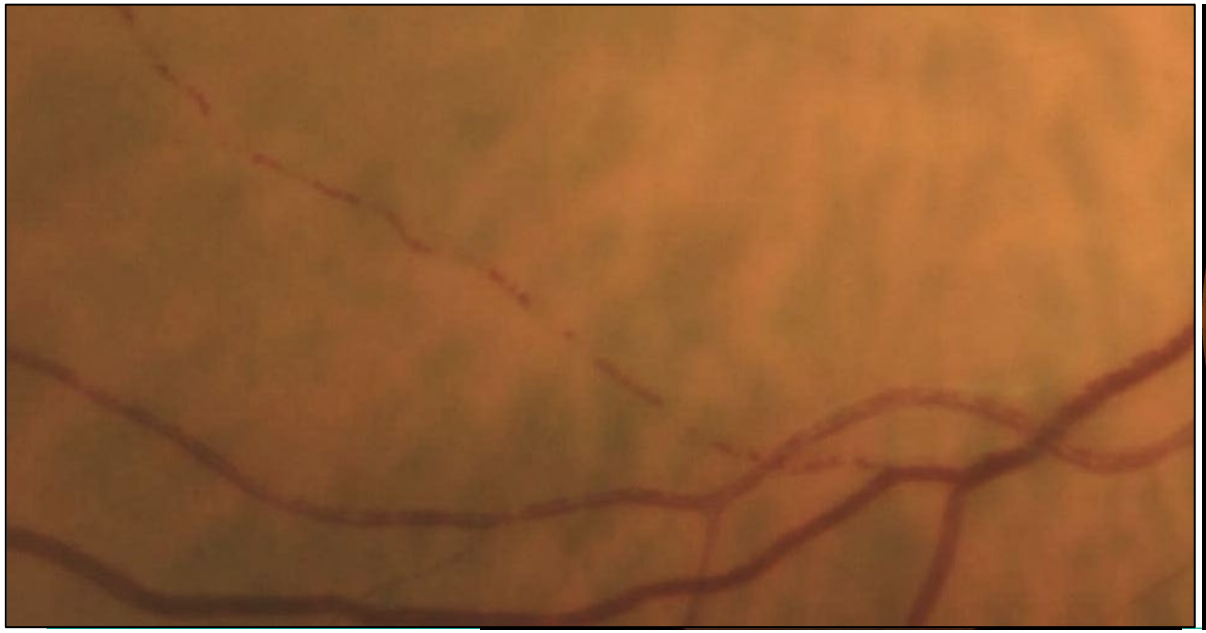
- Sudden monocular painless vision loss
- ~30% patients have cilioretinal artery – sparing of central vision
- Can affect branch of the retinal artery (BRAO) – partial vision loss



Images: Wills Eye Hospital, BMJ Case Reports *CP* 2022;**15:**e246293

Central Retinal Artery Occlusion (CRAO) - Presentation

- Sudden monocular painless vision loss
- ~30% patients have cilioretinal artery – sparing of central vision
- Can affect branch of the retinal artery (BRAO) – partial vision loss
- Poor spontaneous recovery ~18% regain functional visual acuity



Images: Wills Eye Hospital, BMJ Case Reports *CP* 2022;**15:**e246293

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

- IV thrombolysis, IA thrombolysis
- ~40-50% rate of clinical recovery when treated within 4.5 hours (IV) or 6 hours (IA) of onset

Stroke
Volume 51, Issue 7, July 2020; Pages 2018-2025
https://doi.org/10.1161/STROKEAHA.119.028743

American Heart Association.

CLINICAL AND POPULATION SCIENCES

Intravenous Fibrinolysis for Central Retinal Artery Occlusion

A Cohort Study and Updated Patient-Level Meta-Analysis

Brian Mac Grory, MB BCh BAO, MRCP, Alex Nackenoff, PhD, Sven Poli, MD, Martin S. Spitzer, MD, Max Nedelmann, MD, Benoit Guillon, MD, Cécile Preterre, MD, Celia S. Chen, MBBS, PhD, Andrew W. Lee, MBBS, MPH, Shadi Yaghi, MD, Christoph Stretz, MD, Idrees Azher, MD, John Paddock, MD, Tatiana Bakaeva, MD PhD, David M. Greer, MD, MA, Julie G. Shulman, MD, Robert G. Kowalski, MBB
Mistry, MBBS, Kiersten Espaillat, APRN,
and Matthew Schrag, MD, PhD

Intravenous Fibrinolytic Therapy in Central Retinal Artery Occlusion

A Patient-Level Meta-analysis

Matthew Schrag, MD[1]; Teddy Youn, MD[1]; Joseph Schindler, MD[1]; Howard Kirshner, MD[2]; David Greer, MD[1]

» Author Affiliations | Article Information

JAMA Neurol. 2015;72(10):1148-1154. doi:10.1001/jamaneurol.2015.1578

International Journal of Stroke
Volume 12, Issue 7, October 2017, Pages 720-723

https://doi-org.revproxy.brown.edu/10.1177/1747493016687578

SAGE journals

Research

Management of acute central retinal artery occlusion: Intravenous thrombolysis is feasible and safe

Cécile Préterre[1], Gaelle Godeneche[2], Xavier Vandamme[2], Thomas Ronzière[3], Matthias Lamy[4], Christophe Breuilly[5], Cédric Urbanczyk[6], Valérie Wolff[7], Pierre Lebranchu[8], Mathieu Sevin-Allouet[1], and Benoit Guillon[1]

RESEARCH ARTICLE

Intravenous thrombolysis in acute central retinal artery occlusion – A prospective interventional case series

Maximilian Schultheiss[1,2], Florian Härtig[3], Martin S. Spitzer[1,2], Nicolas Feltgen[4], Bernhard Spitzer[5], Johannes Hüsing[6], André Rupp[7], Ulf Ziemann[3], Karl U. Bartz-Schmidt[2], Sven Poli[3]*

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

- IV thrombolysis, IA thrombolysis
- ~40-50% rate of clinical recovery when treated within 4.5 hours (IV) or 6 hours (IA) of onset

Stroke
Volume 51, Issue 7, July 2020; Pages 2018-2025
https://doi.org/10.1161/STROKEAHA.119.028743

American Heart Association.

CLINICAL AND POPULATION SCIENCES

Intravenous Fibrinolysis for Central Retinal Artery Occlusion

A Cohort Study and Updated Patient-Level Meta-Analysis

Brian Mac Grory, MB BCh BAO, MRCP, Alex Nackenoff, PhD, Sven Poli, MD, Martin S. Spitzer, MD, Max Nedelmann, MD, Benoit Guillon, MD, Cécile Preterre, MD, Celia S. Chen, MBBS, PhD, Andrew W. Lee, MBBS, MPH, Shadi Yaghi, MD, Christoph Stretz, MD, Idrees Azher, MD, John Pa
Shulman, MD, Robe
Mistry, MBBS, Kierst
and Matthew Schrag

Intravenous Fibrinolytic Therapy in Central Retinal Artery Occlusion

A Patient-Level Meta-analysis

Matthew Schrag, MD[1]; Teddy Youn, MD[1]; Joseph Schindler, MD[1]; Howard Kirshner, MD[2]; David Greer, MD[1]

» Author Affiliations | Article Information

JAMA Neurol. 2015;72(10):1148-1154. doi:10.1001/jamaneurol.2015.1578

RESEARCH ARTICLE

travenous thrombolysis in acute central etinal artery occlusion – A prospective nterventional case series

ximilian Schultheiss[1,2], Florian Härtig[3], Martin S. Spitzer[1,2], Nicolas Feltgen[4], rnhard Spitzer[5], Johannes Hüsing[6], André Rupp[7], Ulf Ziemann[3], Karl U. Bartz-Schmidt[2], n Poli[3]*

RESEARCH ARTICLE | Originally Published 20 August 2025

Check for updates

Early Thrombolysis and Outcomes in Central Retinal Artery Occlusion: An Individual Participant Data Meta-Analysis

Jim S. Xie, MD, Kirill Zaslavsky, MD, PhD, Yuri Chaban, MD, MSc, Adrien Lusterio, HBSc, Hargun Kaur, MD, Yasmin Motekalem, MD, Dena Zeraatkar, PhD, ... SHOW ALL ... for the Assessment Group for Interventional Lysis in Eye (AGILE) | AUTHOR INFO & AFFILIATIONS

Stroke • New online • https://doi.org/10.1161/STROKEAHA.124.049955

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

- IV thrombolysis, IA thrombolysis
- ~40-50% rate of clinical recovery when treated within 4.5 hours (IV) or 6 hours (IA) of onset

Time is vision!

Stroke
Volume 51, Issue 7, July 2020; Pages 2018-2025
https://doi.org/10.1161/STROKEAHA.119.028743

CLINICAL AND POPULATION SCIENCES

Intravenous Fibrinolysis for Cen

A Cohort Study and Updated Patient-Level Meta-Analysis

Brian Mac Grory, MB BCh BAO, MRCP, Alex Nackenoff, PhD, Sven Poli, MD, Martin S. Spitzer, MD, Max Nedelmann, MD, Benoit Guillon, MD, Cécile Preterre, MD, Celia S. Chen, MBBS, PhD, Andrew W. Lee, MBBS, MPH, Shadi Yaghi, MD, Christoph Stretz, MD, Idrees Azher, MD, John Pa
Shulman, MD, Robe
Mistry, MBBS, Kierst
and Matthew Schrag

Intravenous Fibrinolytic Therapy in
ry Occlusion
a-analysis

Schindler, MD[1]; Howard Kirshner, MD[2];

Author Affiliations | Article Information

JAMA Neurol. 2015;72(10):1148-1154. doi:10.1001/jamaneurol.2015.1578

RESEARCH ARTICLE

travenous thrombolysis in acute central
tinal artery occlusion – A prospective
terventional case series

ximilian Schultheiss[1,2], Florian Härtig[3], Martin S. Spitzer[1,2], Nicolas Feltgen[4],
rnhard Spitzer[5], Johannes Hüsing[6], André Rupp[7], Ulf Ziemann[3], Karl U. Bartz-Schmidt[2],
n Poli[3]*

RESEARCH ARTICLE | Originally Published 20 August 2025

Check for updates

Early Thrombolysis and Outcomes in Central Retinal Artery Occlusion: An Individual Participant Data Meta-Analysis

Jim S. Xie, MD, Kirill Zaslavsky, MD, PhD, Yuri Chaban, MD, MSc, Adrien Lusterio, HBSc, Hargun Kaur, MD, Yasmin Motekalem, MD, Dena Zeraatkar, PhD, ... SHOW ALL ... for the Assessment Group for Interventional Lysis in Eye (AGILE) | AUTHOR INFO & AFFILIATIONS

Stroke • New online • https://doi.org/10.1161/STROKEAHA.124.049955

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

Prospective randomized controlled studies

- THEIA (France) ID NCT03197194
  - IV Alteplase within 4.5 hours vs ASA 300 mg
  - N=70
  - Data collection completed, results not published yet

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

Prospective randomized controlled studies

- THEIA (France) ID NCT03197194
  - IV Alteplase within 4.5 hours vs ASA 300 mg
  - N=70
  - Data collection completed, results not published yet

- TenCRAOS (Norway) ID NCT04526951
  - IV Tenecteplase within 4.5 hours vs ASA 300 mg
  - N=78
  - Data collection completed, results not published yet

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

Prospective randomized controlled studies

- THEIA (France) ID NCT03197194
  - IV Alteplase within 4.5 hours vs ASA 300 mg
  - N=70
  - Data collection completed, results not published yet

- TenCRAOS (Norway) ID NCT04526951
  - IV Tenecteplase within 4.5 hours vs ASA 300 mg
  - N=78
  - Data collection completed, results not published yet

- REVISION (Germany) ID NCT04965038
  - IV Alteplase within 4.5 hours vs Placebo
  - N=422
  - Currently recruiting

Central Retinal Artery Occlusion (CRAO) – Thrombolysis

Prospective ra

- THEIA (France
  - IV Alteplase v
  - N=70
  - Data collectio
- TenCRAOS (N
  -
  -
  -
- REVISION (Germany) ID NCT04965038
  - IV Alteplase within 4.5 hours vs Placebo
  - N=422
  - Currently recruiting

RESEARCH ARTICLE | Originally Published 20 August 2025

Check for updates

Early Thrombolysis and Outcomes in Central Retinal Artery Occlusion: An Individual Participant Data Meta-Analysis

Jim S. Xie, MD, Kirill Zaslavsky, MD, PhD, Yuri Chaban, MD, MSc, Adrien Lusterio, HBSc, Hargun Kaur, MD, Yasmin Motekalem, MD, Dena Zeraatkar, PhD, ... SHOW ALL ... for the Assessment Group for Interventional Lysis in Eye (AGILE) | AUTHOR INFO & AFFILIATIONS

Stroke • New online • https://doi.org/10.1161/STROKEAHA.124.049955

"A randomized controlled trial would require 95 participants per group to achieve 80% power to detect an odds ratio of 3.0 for recovery from severe vision loss".

BROWNHealth UNIVERSITY

Central Retinal Artery Occlusion (CRAO) – Conservative Treatments

- anterior chamber paracentesis
- topical intraocular pressure-lowering agents
- systemic β-blockade
- sublingual isosorbide dinitrate
- carbogen therapy
- breathing into a paper bag
- ocular massage

Central Retinal Artery Occlusion (CRAO) – Conservative Treatments

- anterior chamber paracentesis
- topical intraocular pressure-lowering agents
- systemic β-blockade
- sublingual isosorbide dinitrate
- carbogen therapy
- breathing into a paper bag
- ocular massage

No better than placebo

Central Retinal Artery Occlusion (CRAO) – Hyperbaric Oxygenation

- Under normal conditions: ~60% of retinal oxygen comes from the choroidal circulation
- Hyperbaric oxygen: choroidal diffusion can supply the entire retina
- Retrospective case series: early HBOT may improve visual outcomes in CRAO
- Higher risk of retinal neovascularization

AMERICAN JOURNAL OF OPHTHALMOLOGY®

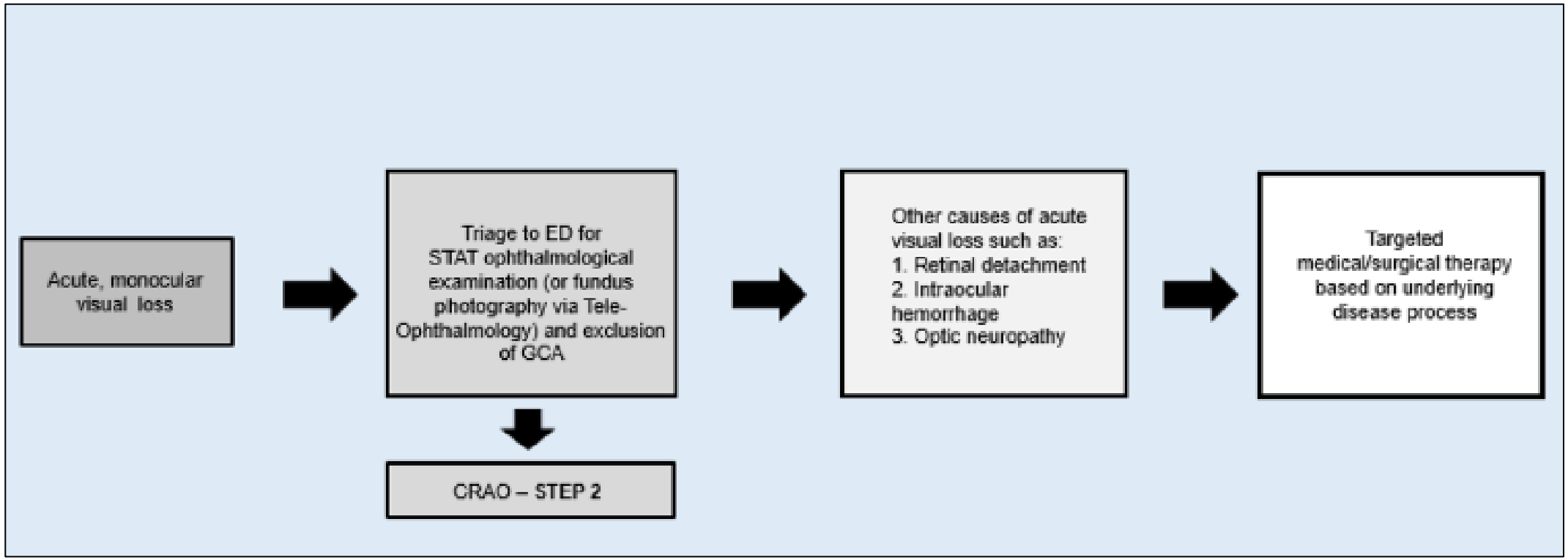
Outcomes of Hyperbaric Oxygen Treatment for Central Retinal Artery Occlusion: A Single Center Experience

BOYOUNG M. KIM[#], KENNY Y. WANG[#], TIMOTHY T. XU, SARA J. HOOSHMAND, GARY N. TOUPS, MARTHA P. MILLMAN, LAWRENCE W. STEINKRAUS, ANDREA A. TOOLEY, ANDREW J. BARKMEIER[$], AND JOHN J. CHEN[$]

BROWN Health UNIVERSITY

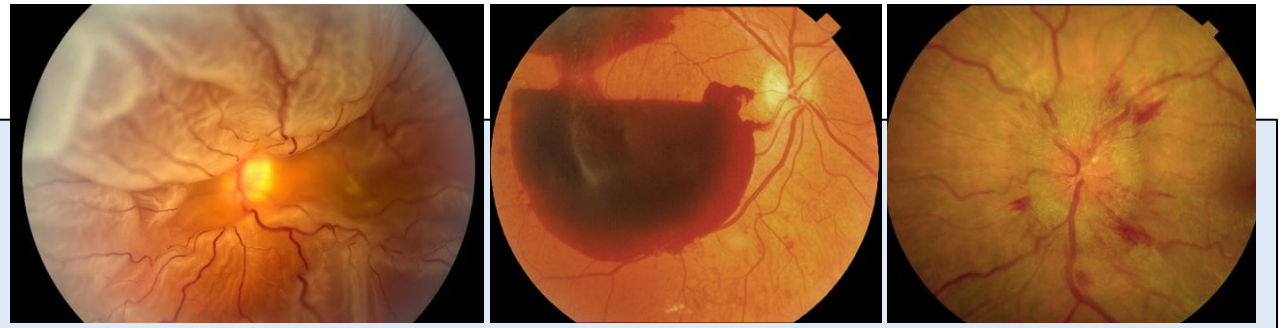
Am J Ophthalmol. 2025;269:393-40

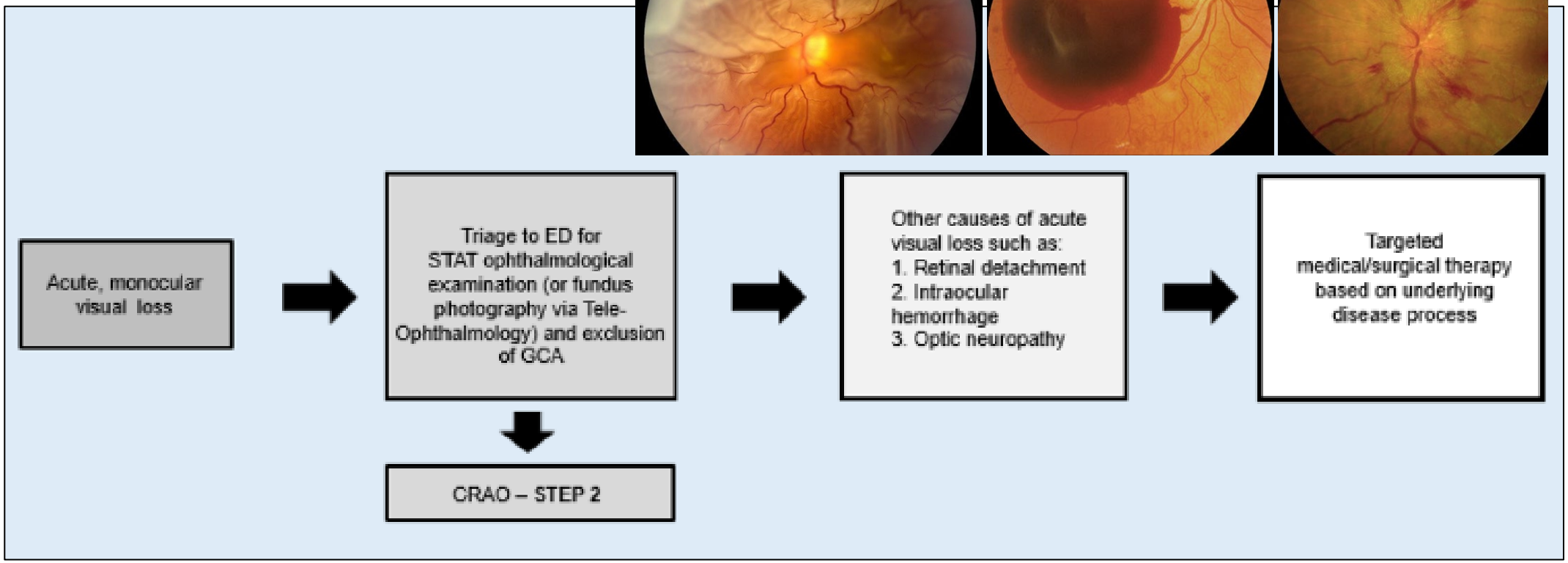
Central Retinal Artery Occlusion (CRAO) – Eye Stroke Code



Mac Grory B, et al; Management of Central Retinal Artery Occlusion: A Scientific Statement From the American Heart Association. Stroke. 2021

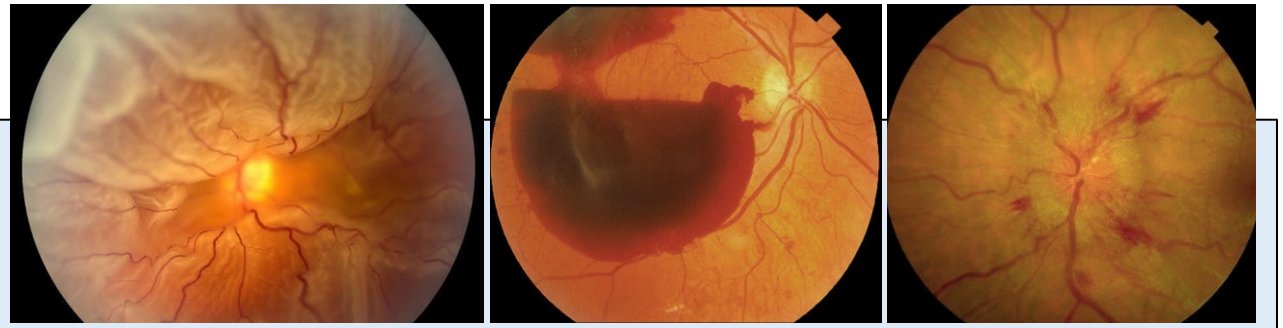
Central Retinal Artery Occlusion (CRAO) – Eye Stroke Code





Mac Grory B, et al; Management of Central Retinal Artery Occlusion: A Scientific Statement From the American Heart Association. Stroke. 2021

Central Retinal Artery Occlusion (CRAO) – Eye Stroke Code



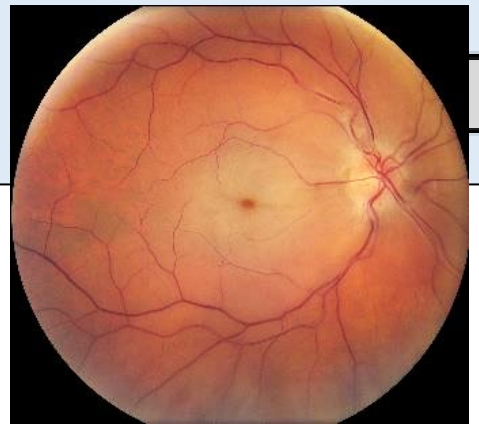
Acute, monocular visual loss

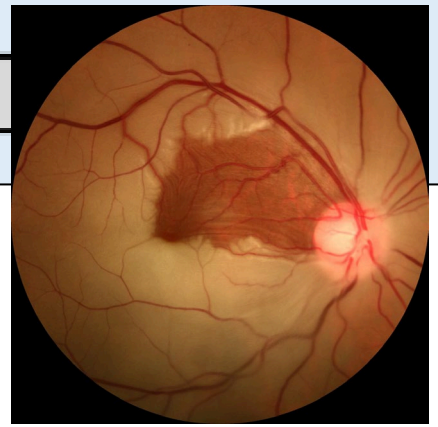
Triage to ED for STAT ophthalmological examination (or fundus photography via Tele-Ophthalmology) and exclusion of GCA

Other causes of acute visual loss such as:
1. Retinal detachment
2. Intraocular hemorrhage
3. Optic neuropathy

Targeted medical/surgical therapy based on underlying disease process

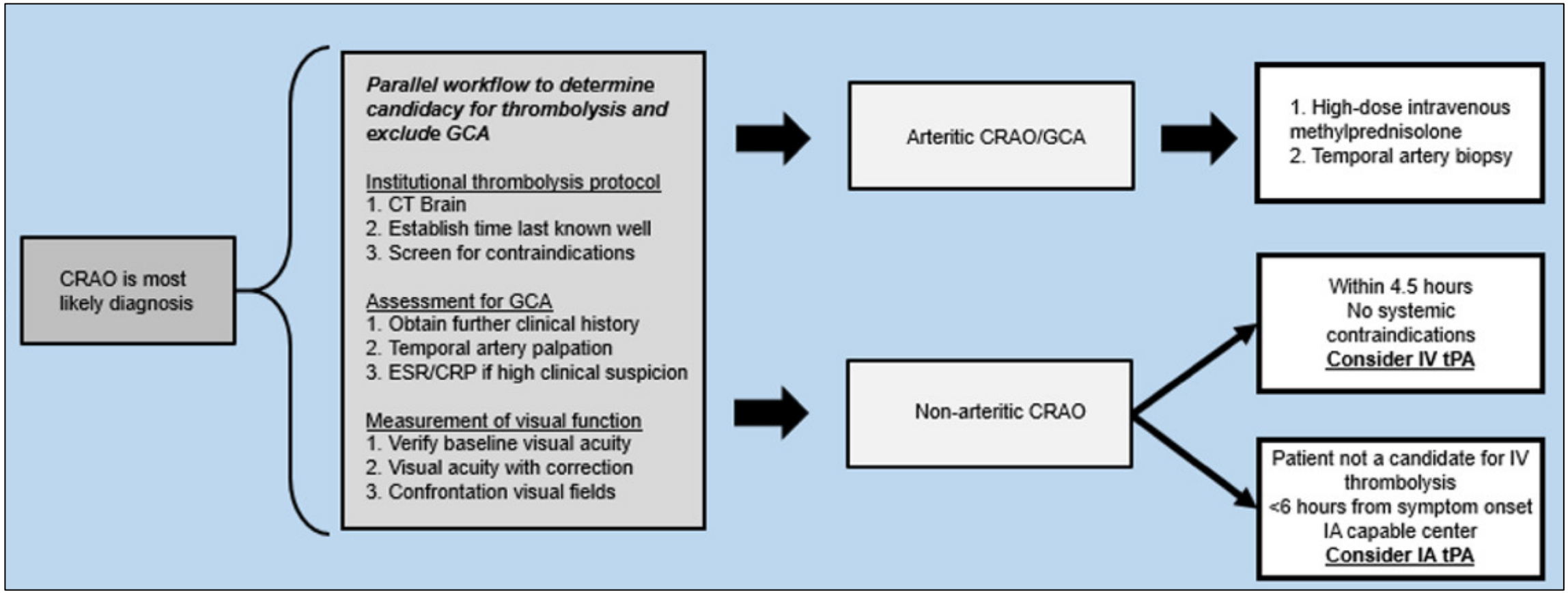
CRAO – STEP 2





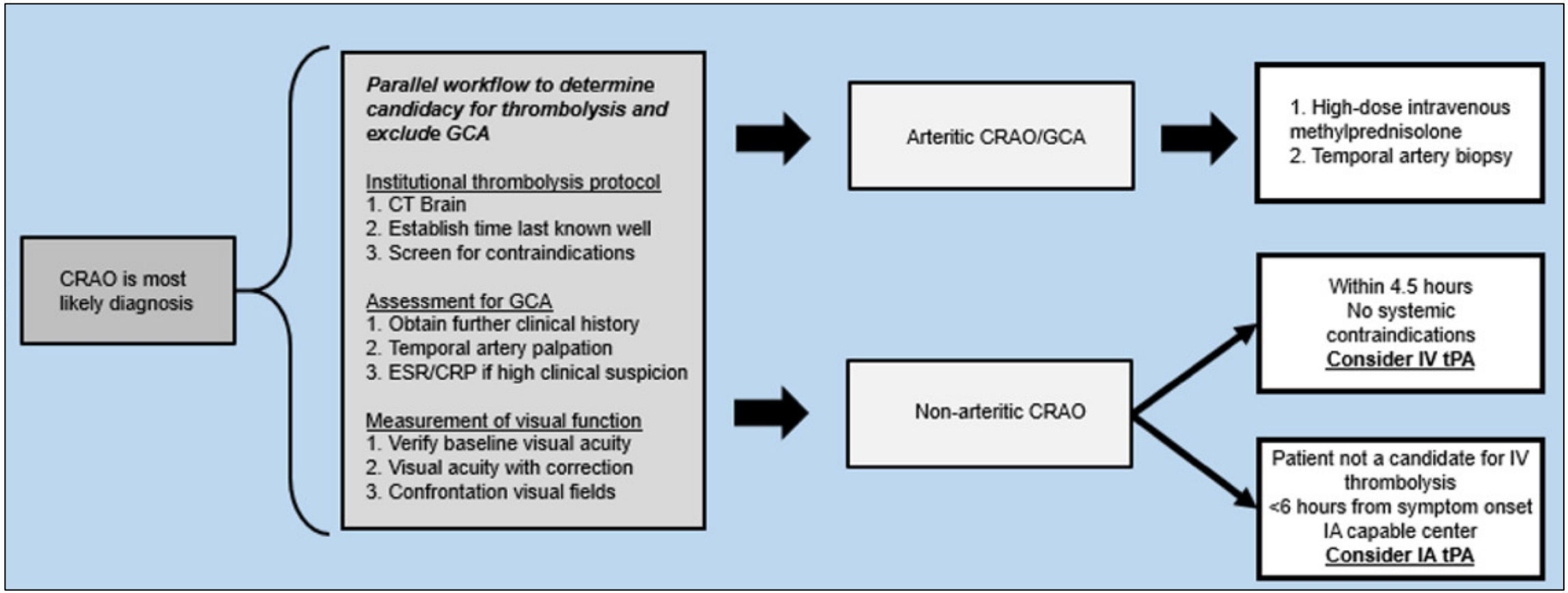
Mac Grory B, et al; Management of Central Retinal Artery Occlusion: A Scientific Statement From the American Heart Association. Stroke. 2021

Central Retinal Artery Occlusion (CRAO) – Eye Stroke Code



Mac Grory B, et al; Management of Central Retinal Artery Occlusion: A Scientific Statement From the American Heart Association. Stroke. 2021

Central Retinal Artery Occlusion (CRAO) – Eye Stroke Code



GCA ROS: headaches, amaurosis, jaw claudication, scalp tenderness, fever / chills / night sweats, unexplained weight loss, malaise, myalgia or polyarthralgia.

Mac Grory B, et al; Management of Central Retinal Artery Occlusion: A Scientific Statement From the American Heart Association. Stroke. 2021

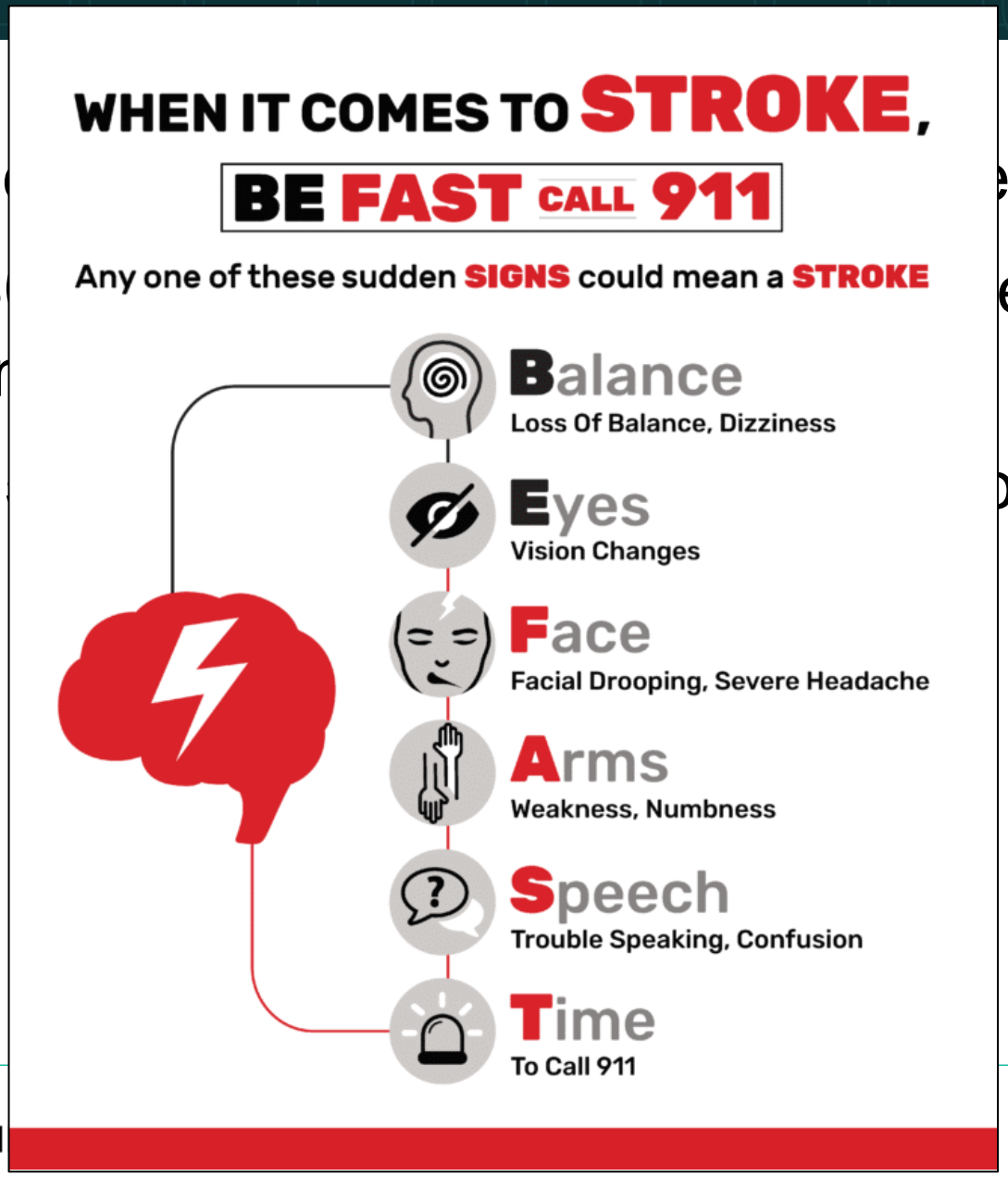
Central Retinal Artery Occlusion (CRAO) – Barriers to Care

- Lack of public awareness about the urgency of acute vision loss
- ~30% of patients present to outpatient ophthalmology or optometry clinics
- ~25% arrive at the ED within 4.5-hour window from last known well

Stretz et al. J Stroke Cerebrovascular Diseases 2024

Central Retinal Artery Occlusion (CRAO) – Barriers to Care

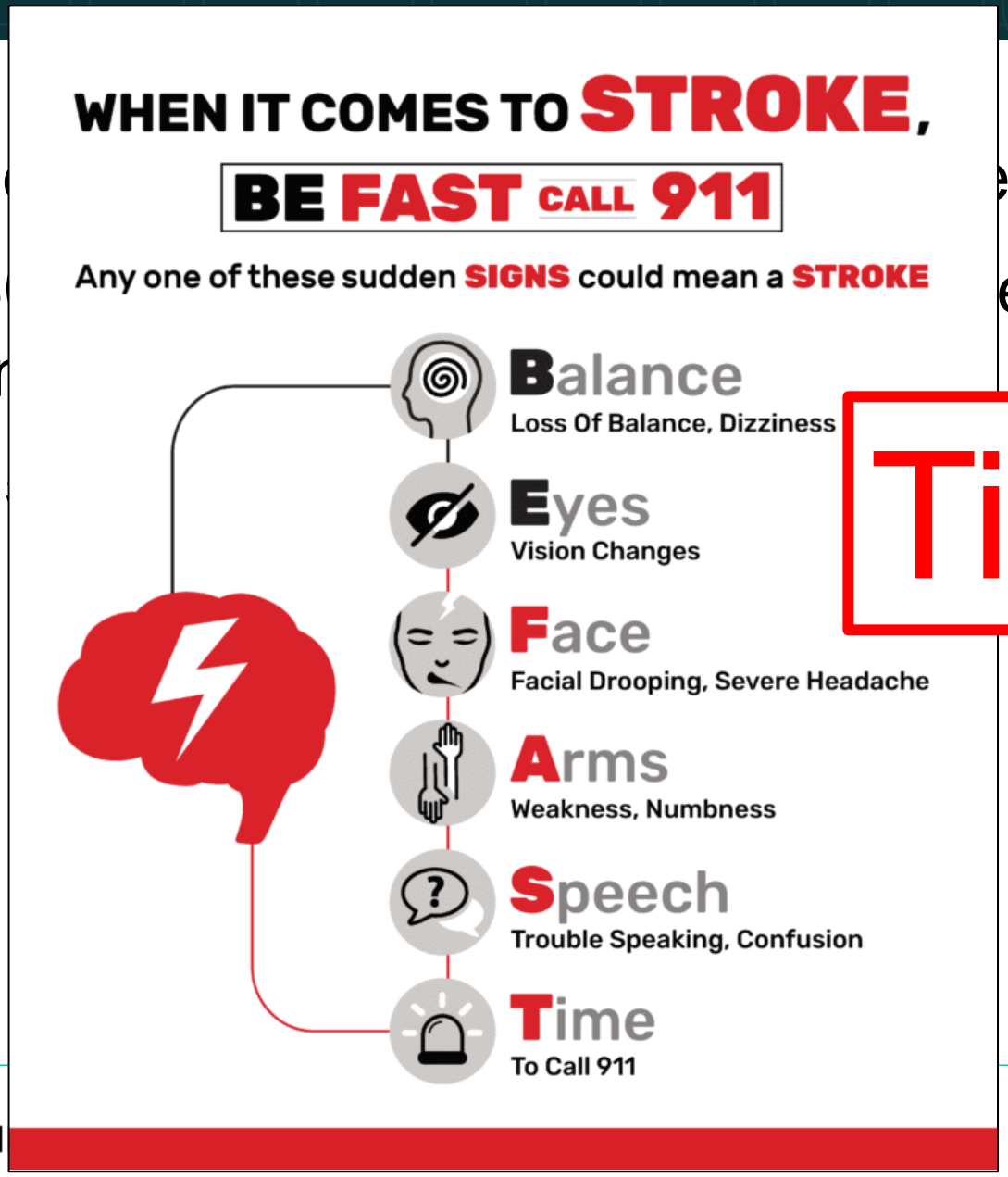
- La urgency of acute vision loss
- ~3 ent ophthalmology or optometry clin
- ~2 our window from last known well



Stretz et al. J Stroke Cerebrovascular Diseases 2024

Central Retinal Artery Occlusion (CRAO) – Barriers to Care

- La urgency of acute vision loss
- ~3 ent ophthalmology or optometry clin
- ~2



Time is vision!

Stretz et al. J Stroke Cerebrovascular Diseases 2024

Thank you!

BROWN Health
UNIVERSITY