

Current trends in Endovascular Treatment for acute strokes:

An overview with Preoperative, Intraoperative, and
Postoperative nursing considerations

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Disclosure

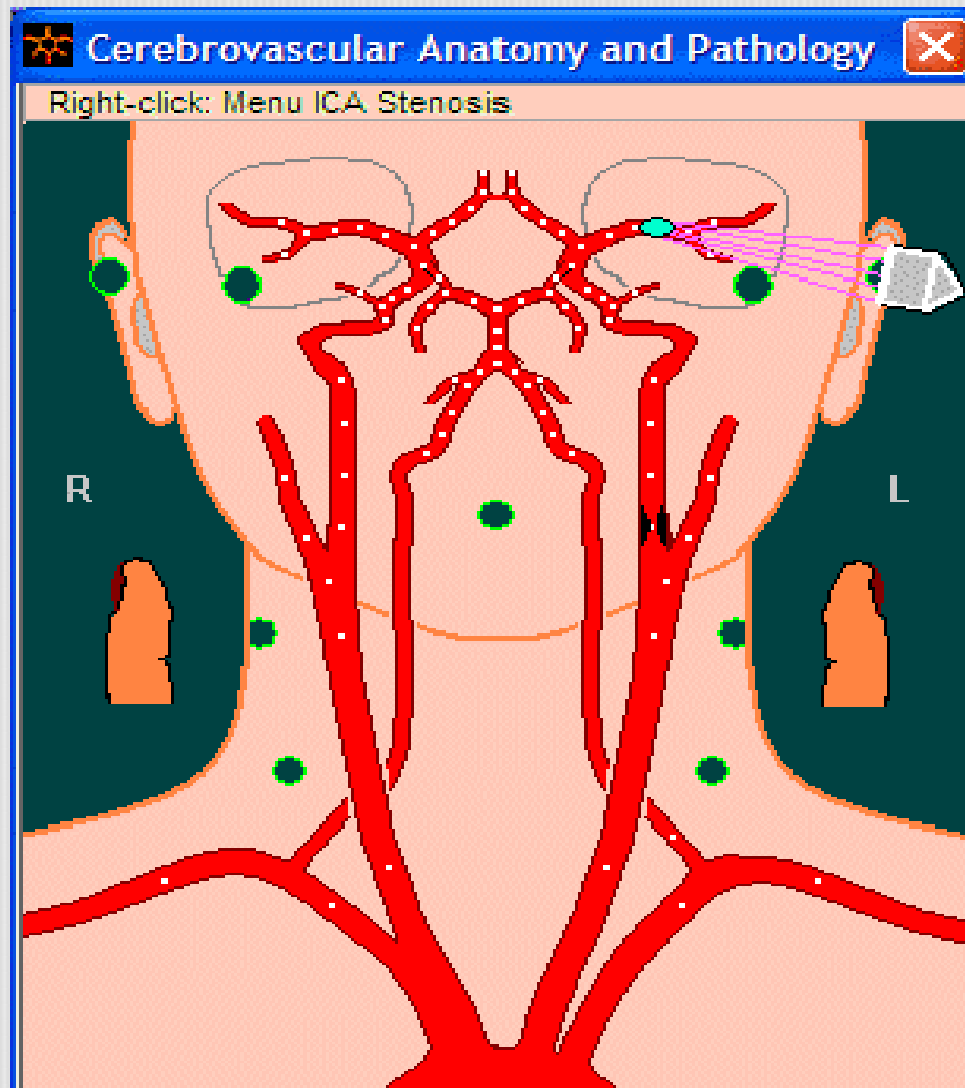
Conflict of Interest

1. I do not have any conflicts of interest associated with the content presented including:
 - a) Financial interest
 - i. Salaries
 - ii. Honoraria
 - iii. Consulting fees
 - b) Commercial interest
 - i. Familiar relationships
 - ii. Membership
 - iii. Speaking or teaching
2. Many of the interventions presented in the procedure are not FDA approved (off label)
 - a) Interventions include the use of humanitarian devices
 - b) Infusion of medications via the intra-arterial route

Objectives

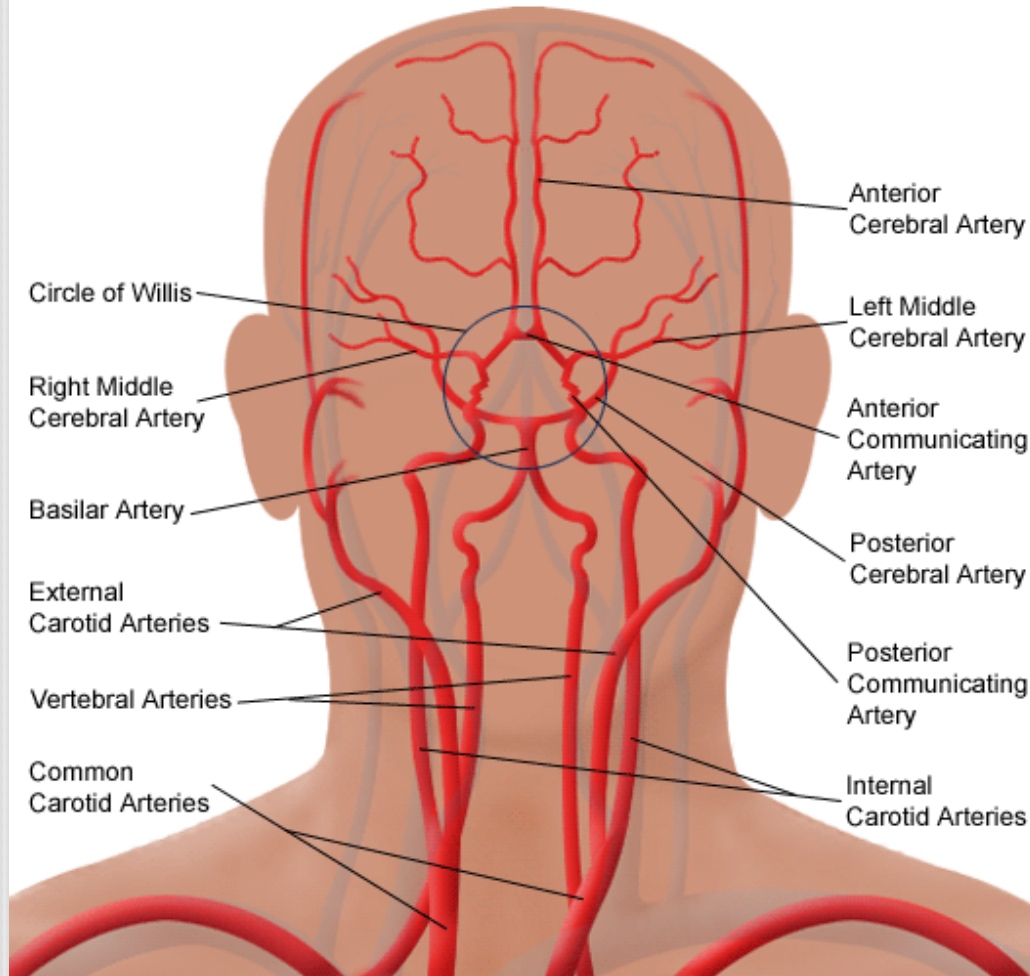
1. Discuss the pre-procedure preparation and patient/family teaching for the endovascular stroke patient.
2. Explanation of endovascular procedures of the brain.
3. Discussion of post-procedure care that includes monitoring and anticipated complications
4. Discussion of process improvement initiatives for optimal throughput for endovascular revascularization therapy (ERT).

Cerebrovascular Anatomy



Cerebrovascular Anatomy

Arterial Circulation of the Brain, Including Carotid Arteries



Differential Diagnosis

Hemorrhagic?

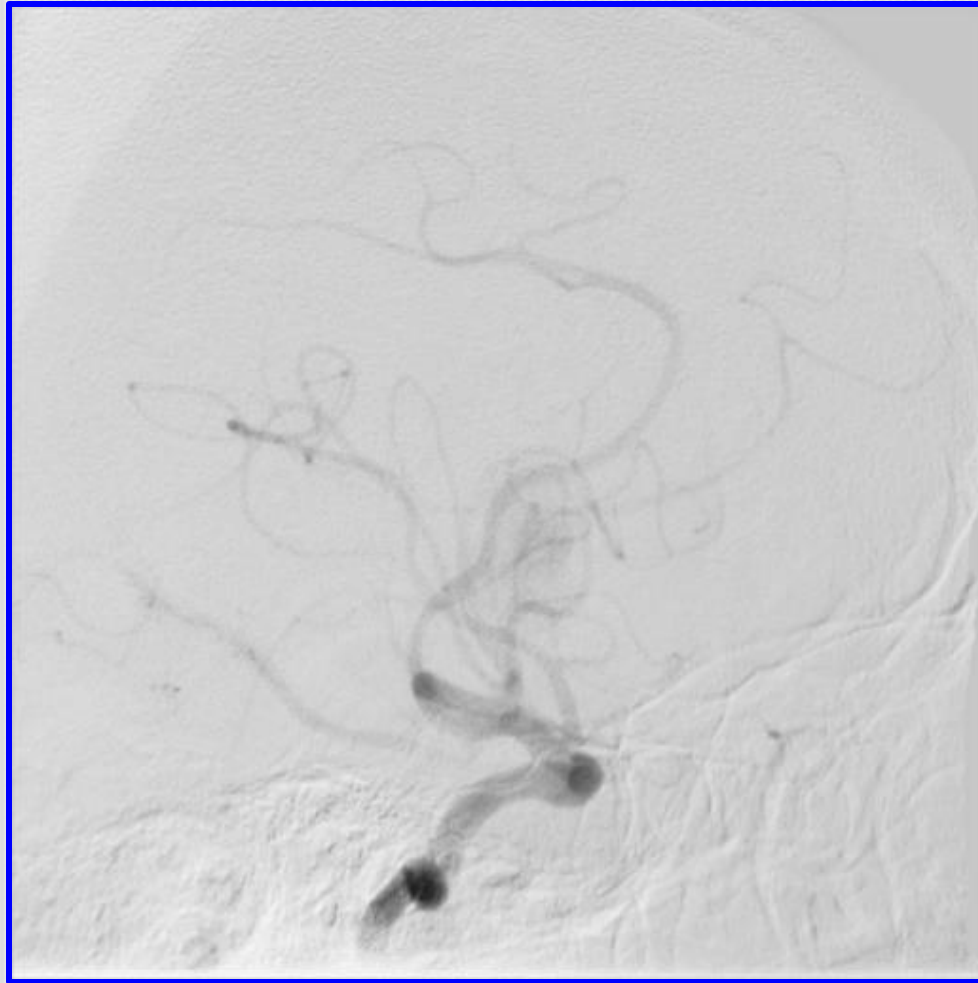
1. Causes
 - a. Aneurysm
 - b. Arteriovenous Malformation (AVM)
 - c. Fistula, tumor, trauma
2. Treatment-Surgical
 - a. Craniotomy
 - b. Clipping
 - c. Wrapping
 - d. Bypass
3. Endovascular Repair
 - a. Coiling
 - b. Stent assisted Coiling
 - c. Flow diversion (stenting)
 - i. Pipeline™/Pipeline Flex™
 - ii. Surpass™
 - iii. Lvis™
 - iv. WEB™
 - d. Combination
4. Monitoring

Embolic?

1. Causes
 - a. Thrombosis (clot)
 - b. Mechanical (clip placement)
2. Treatment
 - a. Intravenous tPA infusion
 - b. Monitoring
 - c. Surgery
 - d. ERT
 - i. Mechanical Retrieval
 - a. Trevo™
 - b. Penumbra™
 - c. Merci™
 - d. Solitaire™
 - ii. Intra-arterial thrombolytic infusions
 - a. tPA
 - b. Aggrastat

Rotational Angiogram

(University of Texas Southwestern Medical Center, 2010)



Right
Internal
Carotid
Artery

AP (front) View

(University of Texas Southwestern Medical Center, 2010).



Right
Internal
Carotid
Artery

Lateral (side) View

(University of Texas Southwestern Medical Center, 2010).



Right
Internal
Carotid
Artery

Definition: Aneurysm

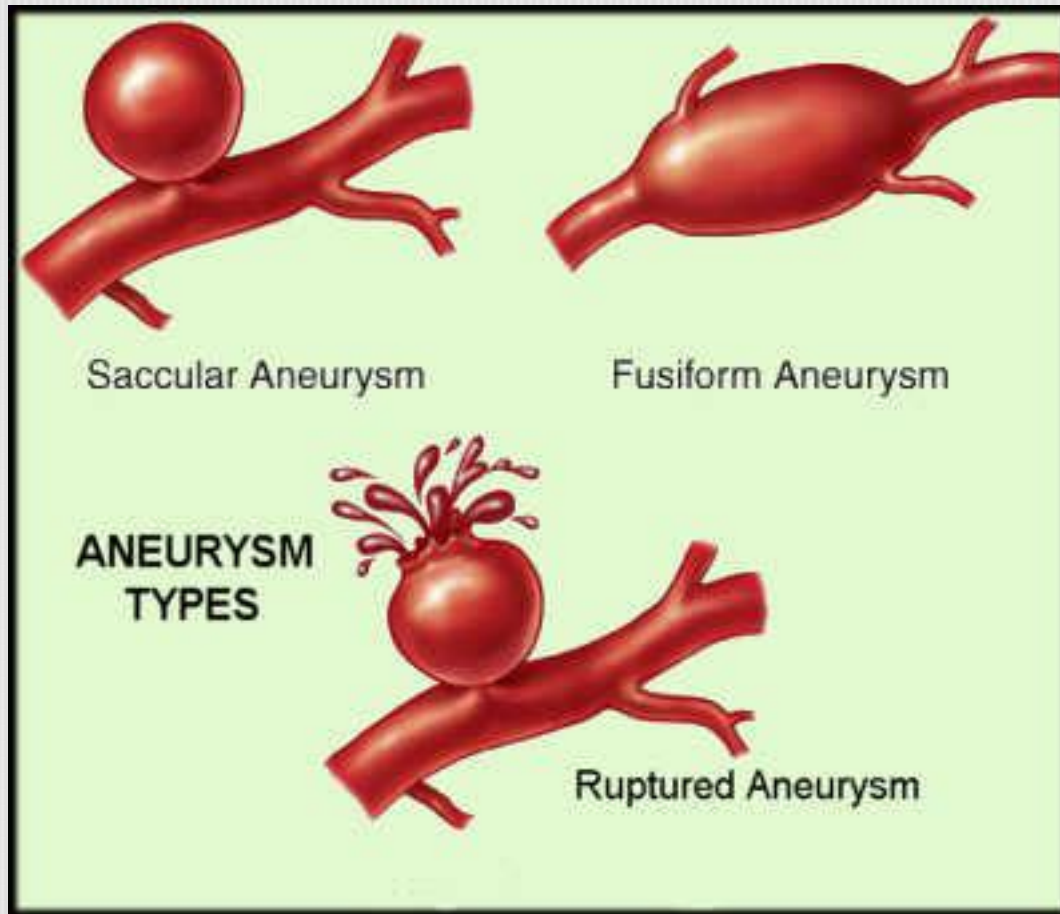
- Fox & Choi (2009) define a cerebral aneurysm as “a weakness or thin section of an artery in the brain which bulges and grows due to pressure of blood entering” the anomaly.
- Subarachnoid hemorrhage (SAH)
- Cerebrovascular accident (CVA)
- Vasospasm
- Brain damage or death
- (Fox & Choi, 2009)

Classification

- Three (+ one) basic classifications of cerebral aneurysms based on configuration of the aneurysm itself:
 - Saccular
 - Lateral
 - Fusiform
 - Giant
- (Fox & Choi, 2009;)

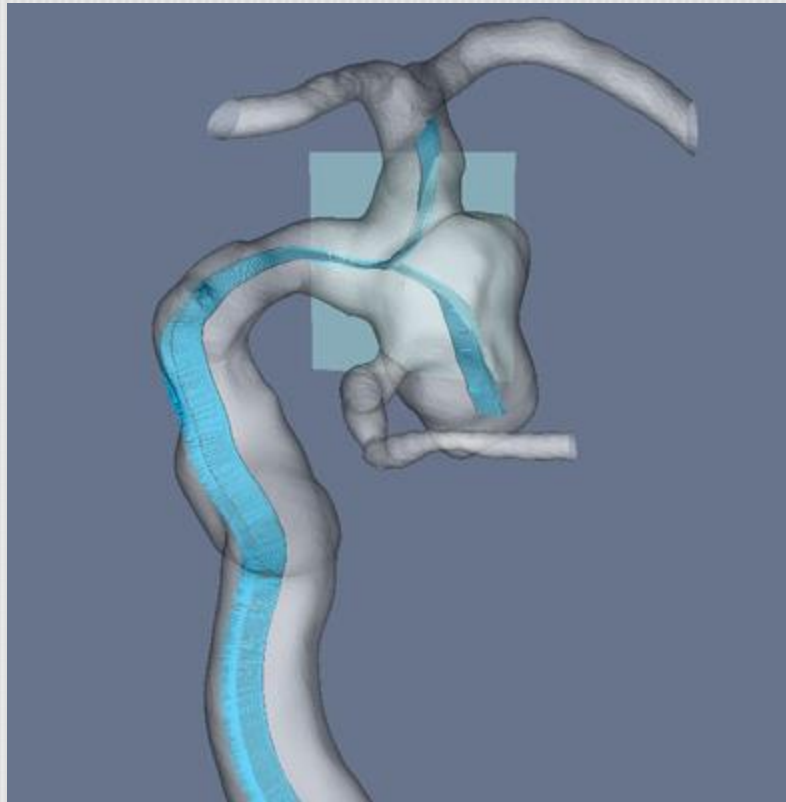
Illustrations Aneurysm Types

(Aneurysm Types [Image], 2010)



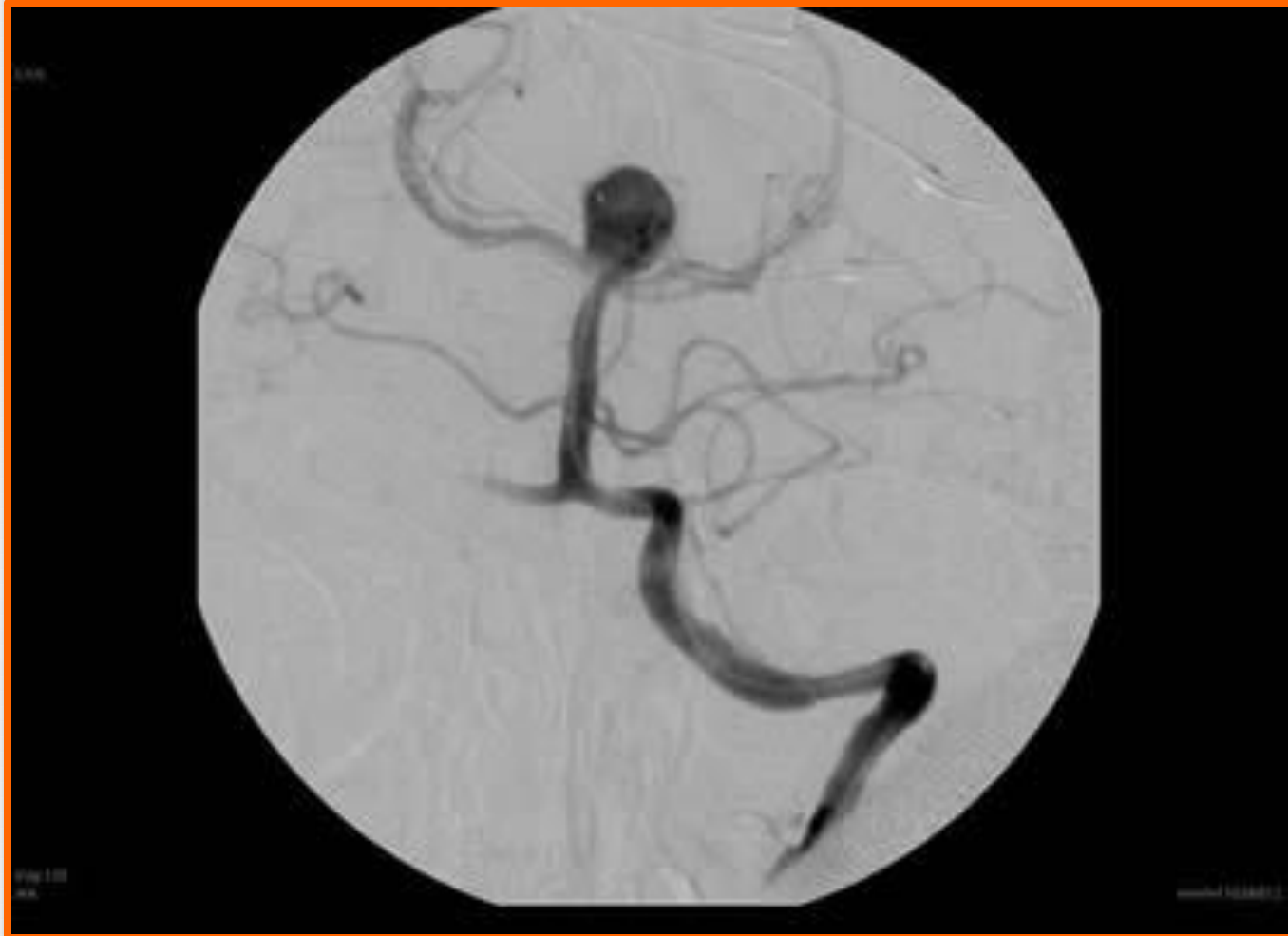
Lateral Wall Aneurysm

(Lateral Wall Aneurysm, 2010)



Basilar Tip Aneurysm

(Basilar Tip Aneurysm, 2010)



2023 Statistic

Prevalence:

- 6.7 million people in the US
- 1 in 50 people

Rupture rate:

- 8-10 per 100,000
- 30,000 will suffer a rupture every year
- One person every 18 minutes
- 50% are fatal
- 15% die before arriving to the hospital
- 66% of survivors have permanent neurological deficit

Death rate:

- 500,000 deaths per year
- 1/2 are younger than 50 years old

Occurrence: 2023

- ||| More common in women (3:2 ratio)
 - After age 55 higher risk of rupture
- ||| Age
 - 35-60 years
 - Most develop after age 40
 - Can occur in children
- ||| Race:
 - African American
 - Hispanic
 - Twice as likely than Caucasian

(Brain Aneurysm Foundation, 2023)

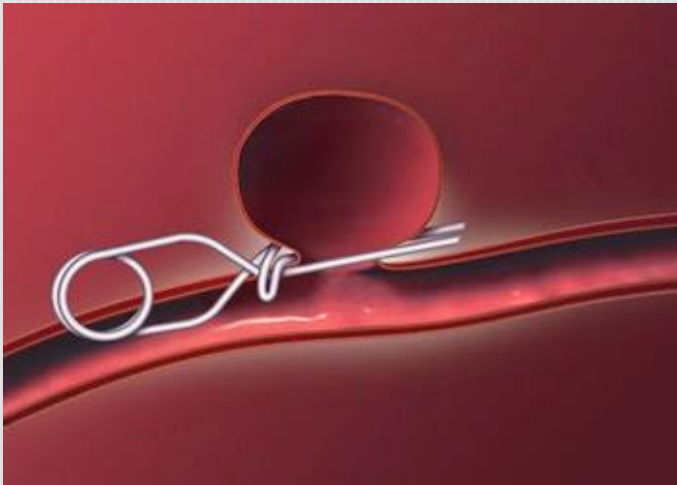
Additional Risk Factors

- “ Diabetes Mellitus
- “ Hyperlipidemia
- “ Excessive Alcohol Consumption
- “ Polycystic Kidney Disease
- “ Connective tissue disorders
- “ Moya Moya
- “ Aortic coarctation
- “ Takayasu’s Arteritis
- “ Neurofibromatosis
- “ Fibromuscular Dysplasia (FMD)
- “ Older patients
- “ Smoking
- “ Hypertension
- “ Traumatic, infections, and neoplastic are rare

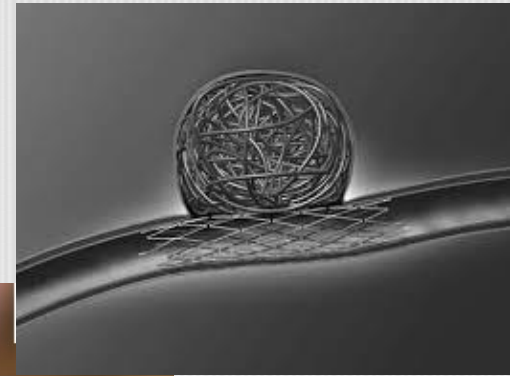
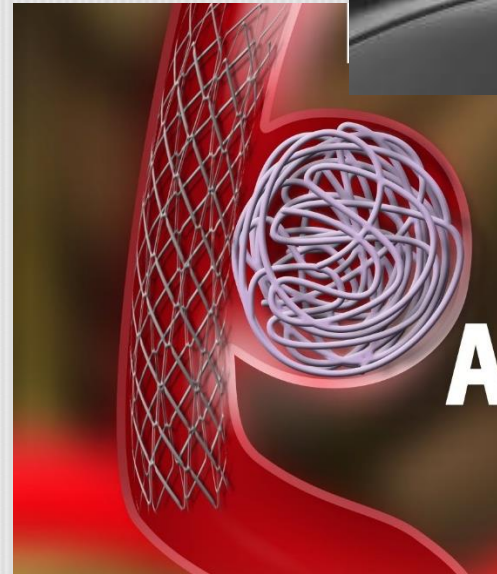
- “ (Bagley, 2009; Thompson et al., 2015; Backes et al., 2017)

Clipping versus Coiling

ANEURYSM CLIPPING



ANEURYSM STENT ASSISTED COILING



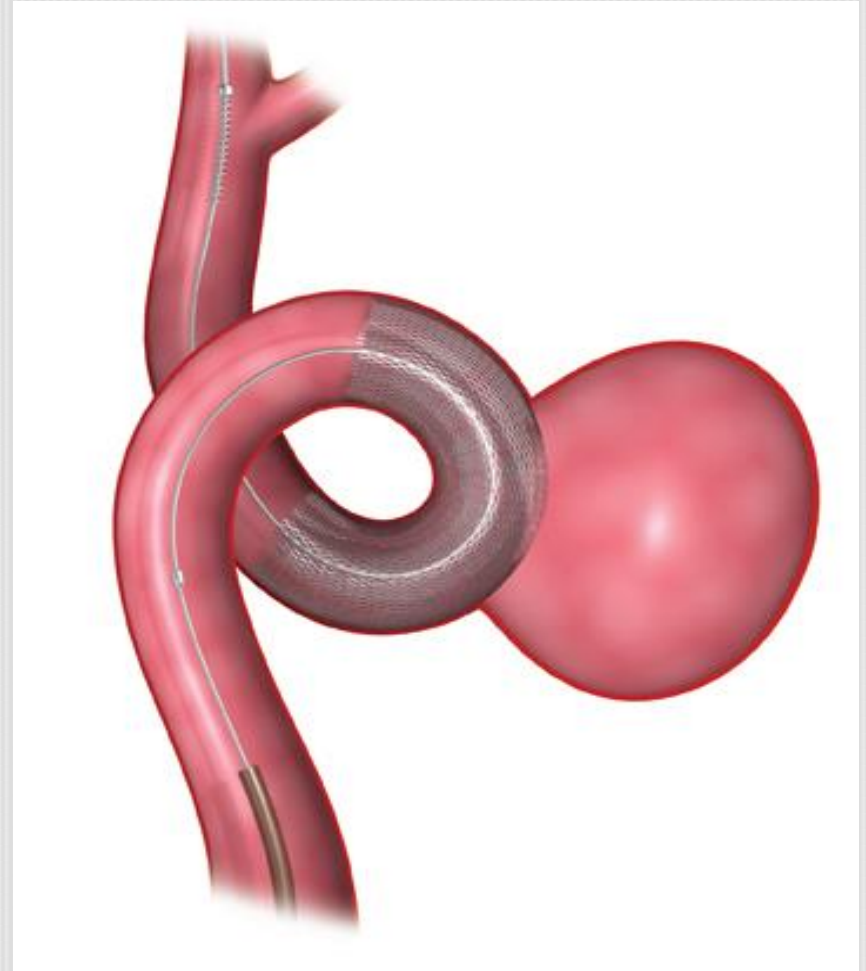
Candidates for Endovascular Treatment

- 1. Location of the lesion
- 2. Narrow neck aneurysm
- 3. Contraindications for aspirin and Plavix™ therapy
- 4. Poor surgical candidates

Flow Diverters

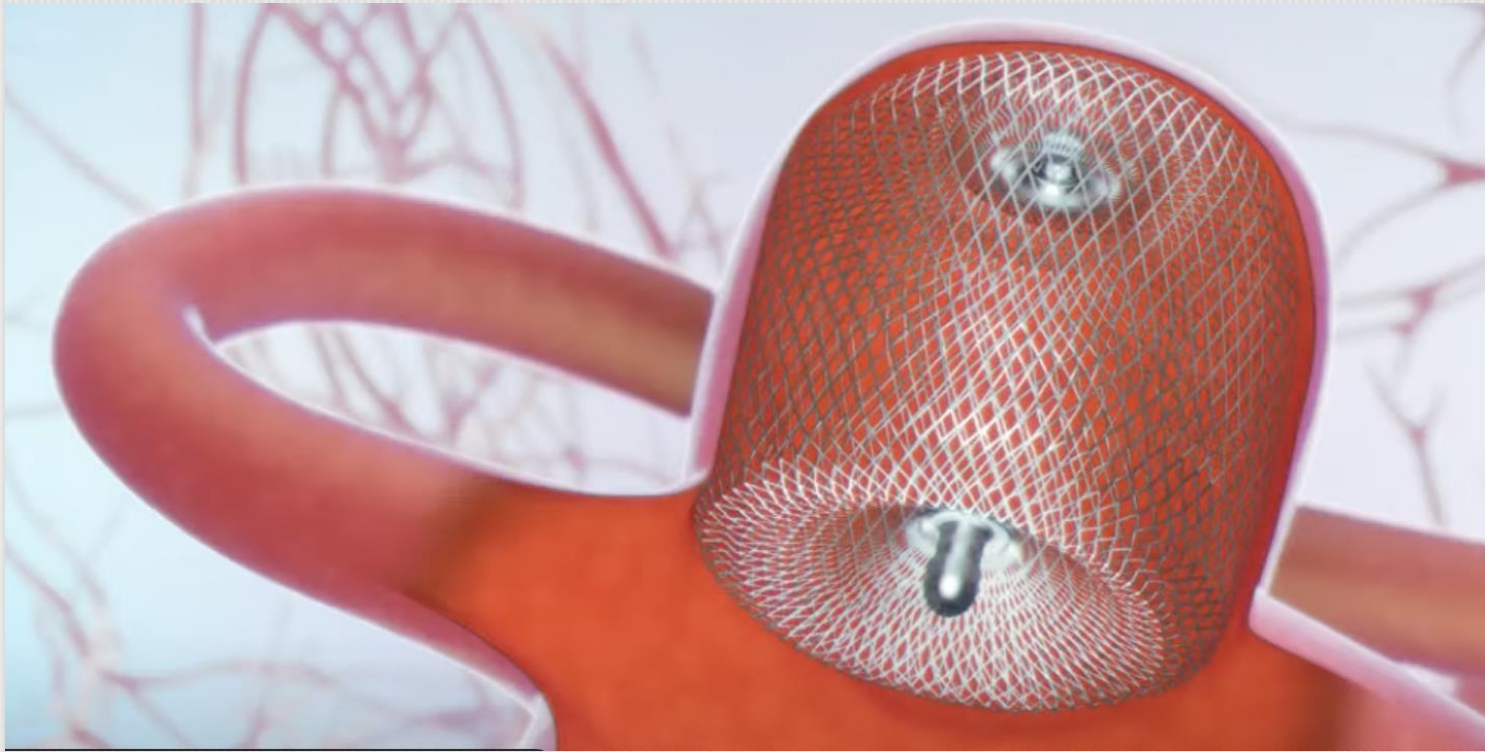


Pipeline Animation



(Covidien, 2016)

Woven EndoBridge (WEB System)



WEB Animation

Risks: Endovascular Treatment-- Aneurysm

- ▮ Morbidity and mortality rates are estimated at 4-10%
 - ▮ Intracranial or subarachnoid hemorrhage
 - ▮ Thrombo-embolic formation
 - ▮ Coil compaction, migration, and revascularization
- ▮ (Bagley, 2009; Santoro et al. 2022)

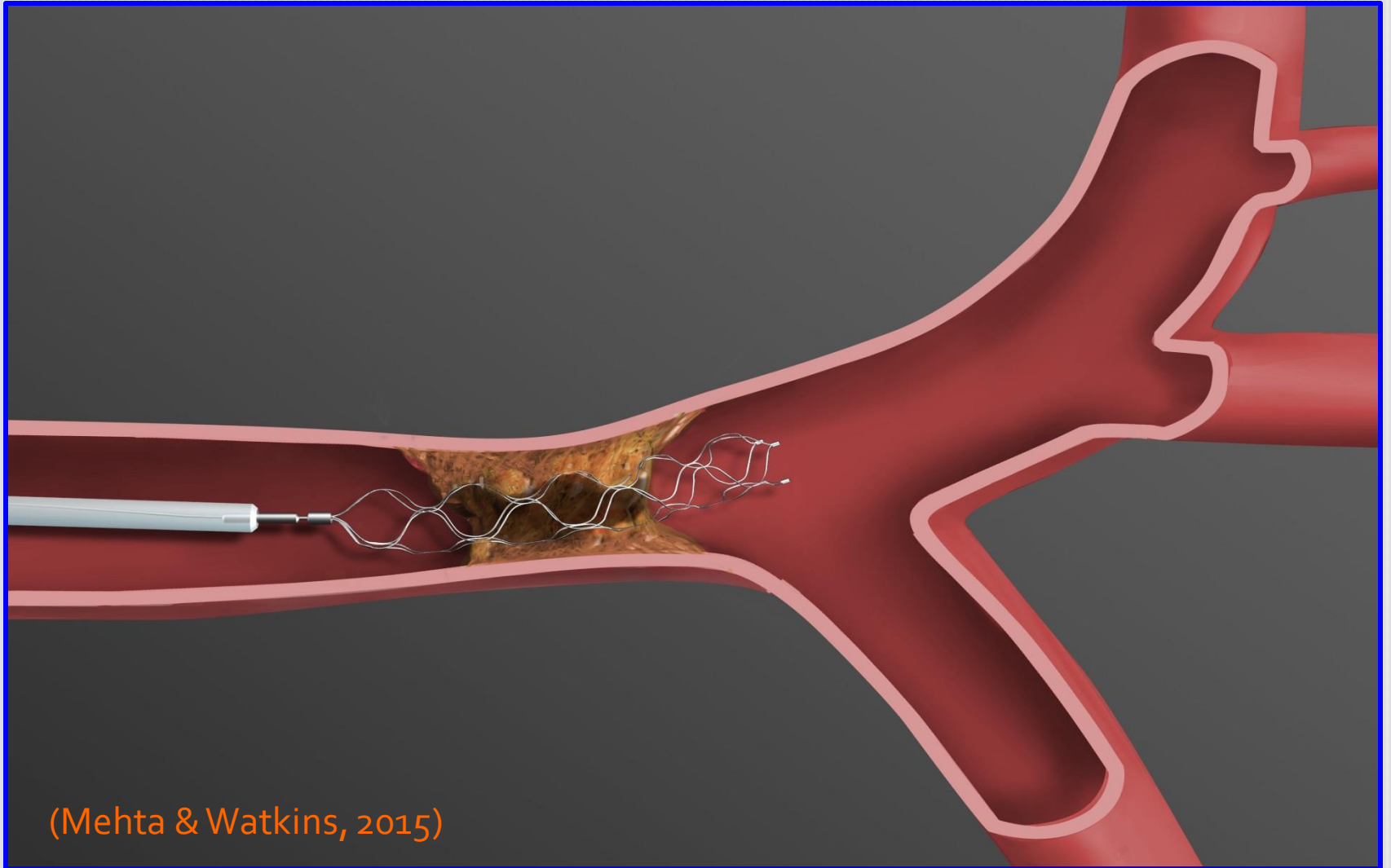
Wait! It is an ischemic stroke (clot)



Embolic?

1. Causes
 - a. Thrombosis (clot)
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2. Treatment
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 - c. Surgery
 - d. ERT
 - i. Mechanical Retrieval
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 - b. Aggrastat

What is a stentriever?



(Mehta & Watkins, 2015)

Mechanical ERT: Trevo

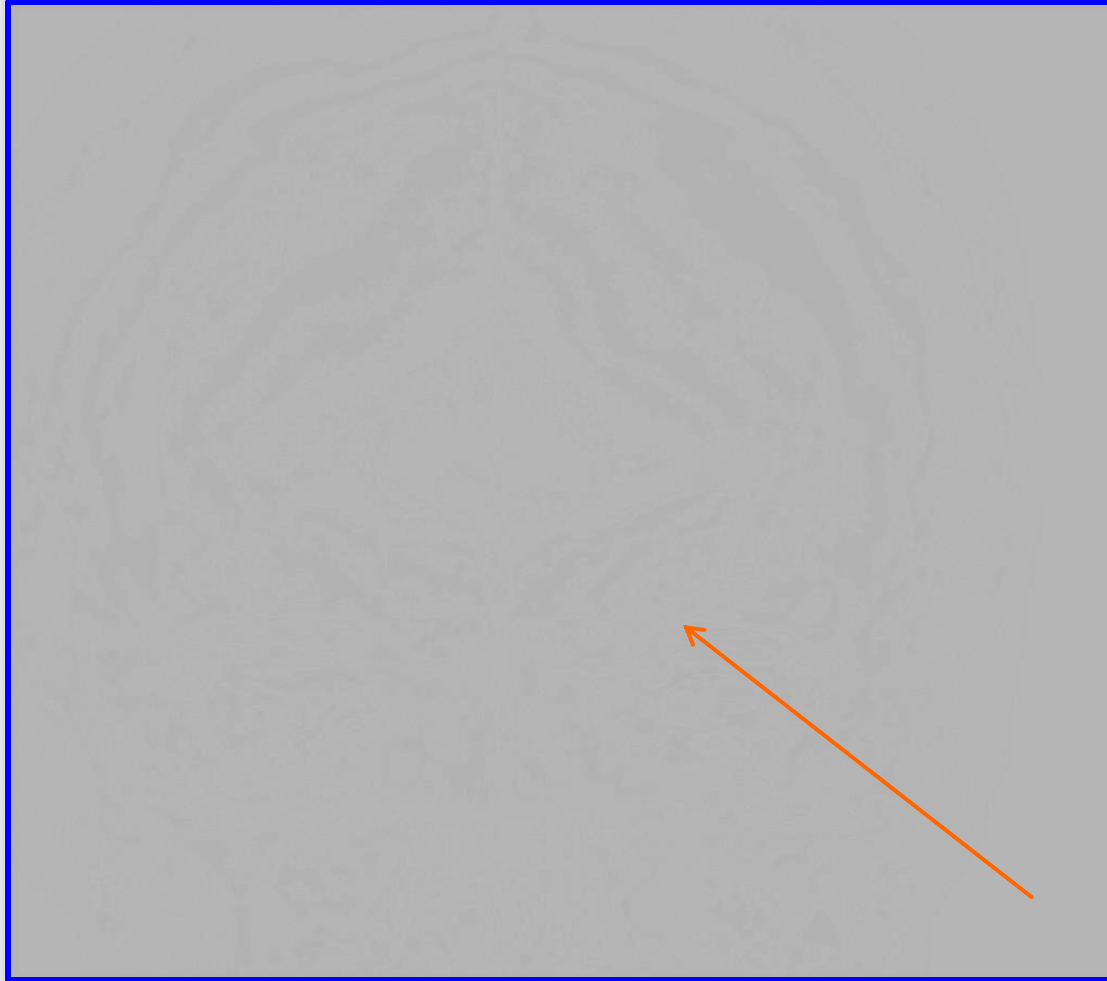
- “Trevo utilizes Stentriever technology for thrombus removal by maximizing clot integration”
- Indications
 - Removing clot
 - Restoring blood flow
 - Within 8 hours onset
 - Ineligible for or failed tPA therapy

Trevo™ Stentriever Technology



Trevo

Pre ERT Treatment



Left
Middle
Cerebral
Artery

Post ERT Treatment



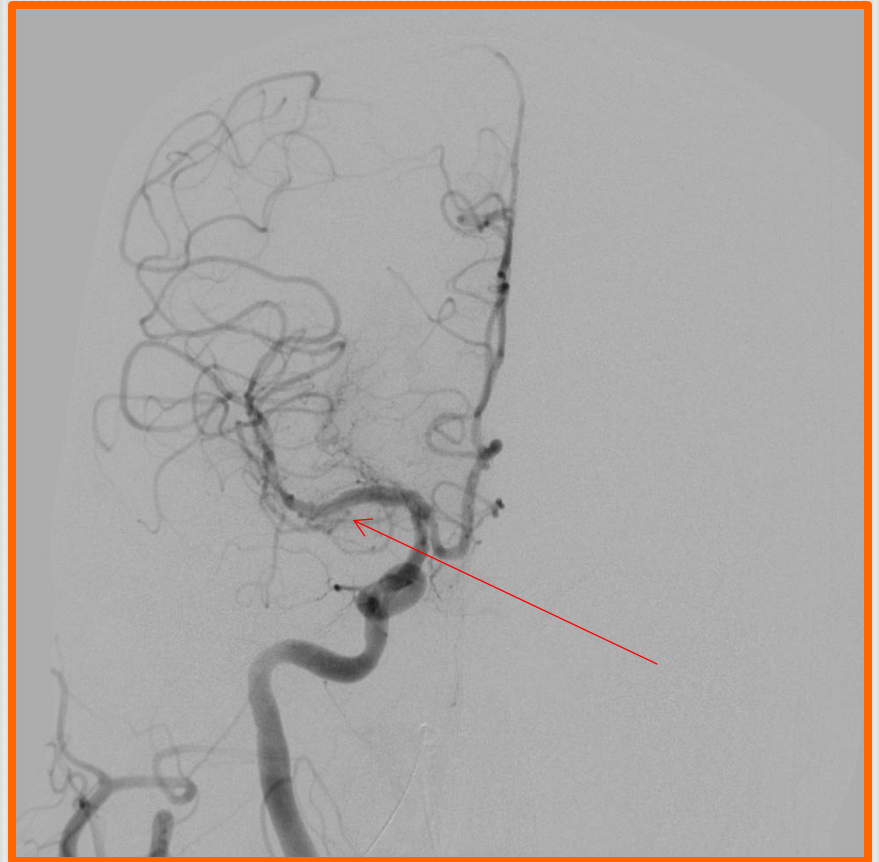
Left
Middle
Cerebral
Artery

Embololic Stroke Imaging

Pre-ERT



Post-ERT

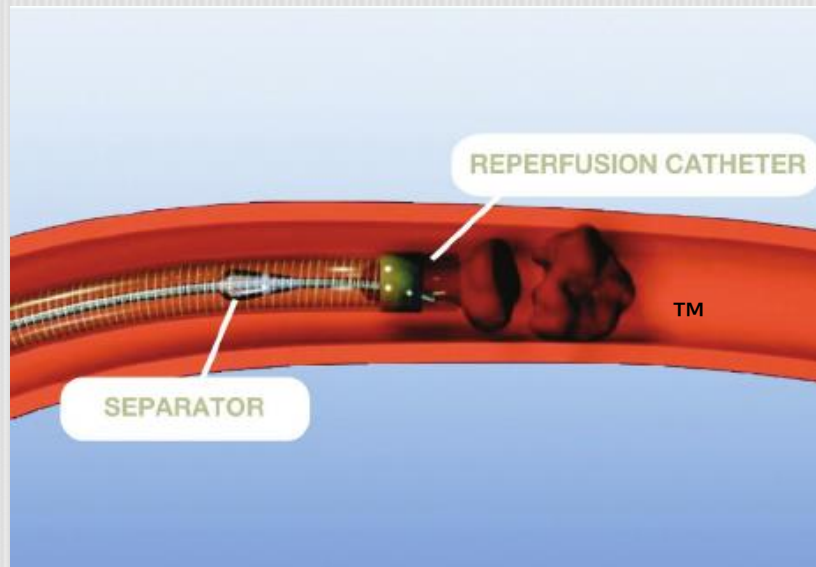


Right Middle Cerebral Artery

Mechanical ERT: Solitaire

- “Overlapping stent based design (technology) to restore flow via clot retrieval, and revive neurological tissue”
- FDA labeling:
 1. Restore Blood Flow
 2. Remove Thrombus
 - a) Large Intracranial Vessel
 - b) Onset of symptoms within 8 hours of ischemic stroke
 3. Patients that are ineligible or failed IV tPA

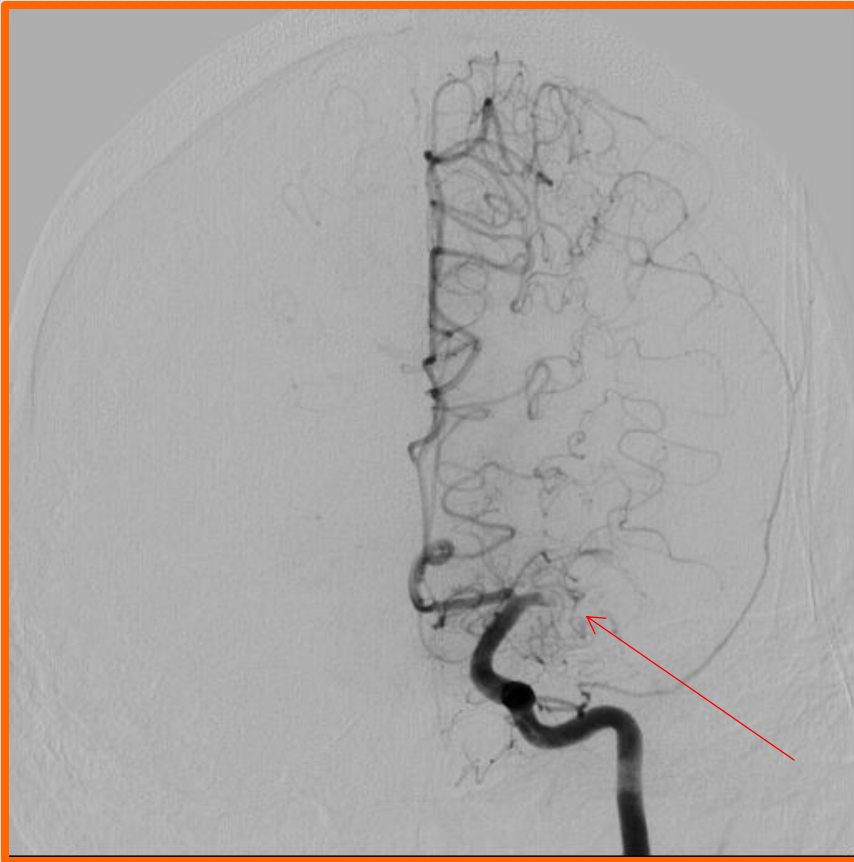
Penumbra™: Clot Aspiration



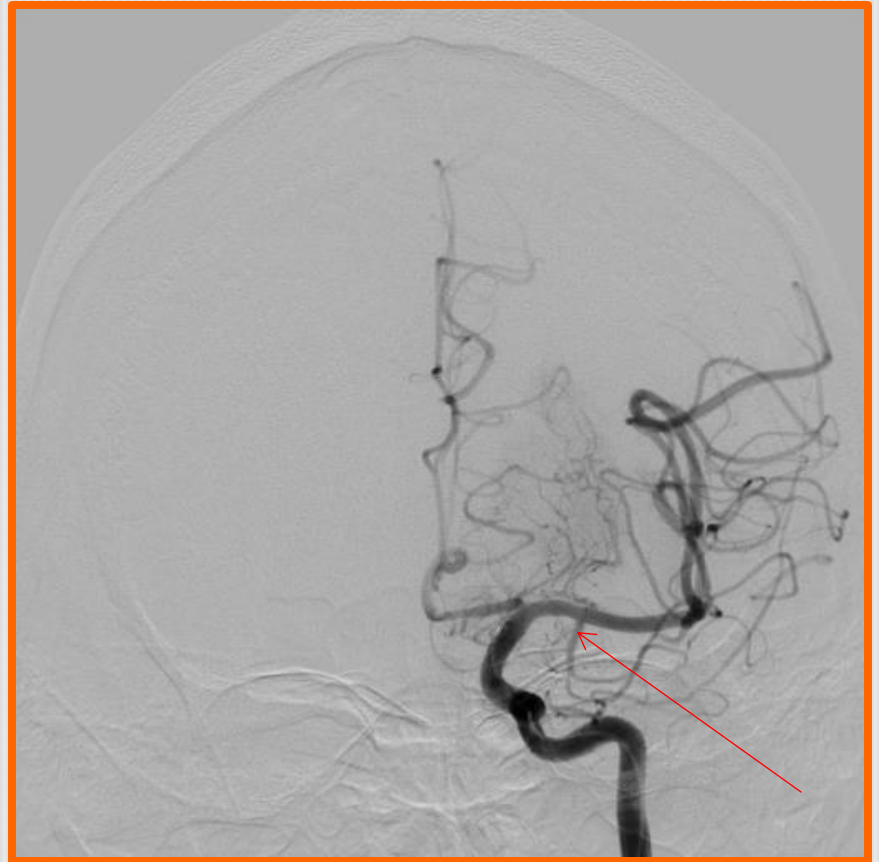
- III Indication is mechanical thrombectomy through aspiration techniques
- III Large vessel occlusions
 - Penumbra Illustration
- III Penumbra Aspiration Device

Embololic Stroke Imaging

Pre-ERT



Post-ERT



Left Middle Cerebral Artery

Criteria for Endovascular Revascularization Therapy (ERT)

INCLUSION CRITERIA

- || Neurologic Deficit
 - Medium Vessel Occlusion
 - Large Vessel Occlusion
- || IA thrombolysis initiated w/in 6 hours
- || Mechanical Thrombectomy
 - Anterior Circulation
 - 8 hours from last known well (LKW)
 - Posterior Circulation
 - 12 hours from LKW
- || Advanced Imaging
- || NIHSS greater than 8
- || Deterioration after IV tPA

EXCLUSION CRITERIA

- || Arterial Stenosis hinders "safe access"
- || Aortic Dissection
- || Uncontrolled hypertension
- || Platelet count less than 30,000
- || Coumadin
 - INR greater than 3
- || Known bleeding
- || Glucose less than 50 mg/dl
- || Seizure onset
- || Image findings

Relative Contraindications for ERT

- ||| Hx within the last 3 months
 - Intracranial Surgery
 - Spinal Surgery
 - Head Trauma
 - Stroke
- ||| Intracranial Hemorrhage
- ||| Terminal Illness
- ||| Known pregnancy
- ||| Subacute Endocarditis
- ||| Known glucose greater than 400 mg/dl
 - ↑ ICH
- ||| Hemo or peritoneal dialysis

Setup and Physicians in Action



Preoperative Nursing Considerations

Preoperative Nursing Considerations

III Comprehensive Assessment

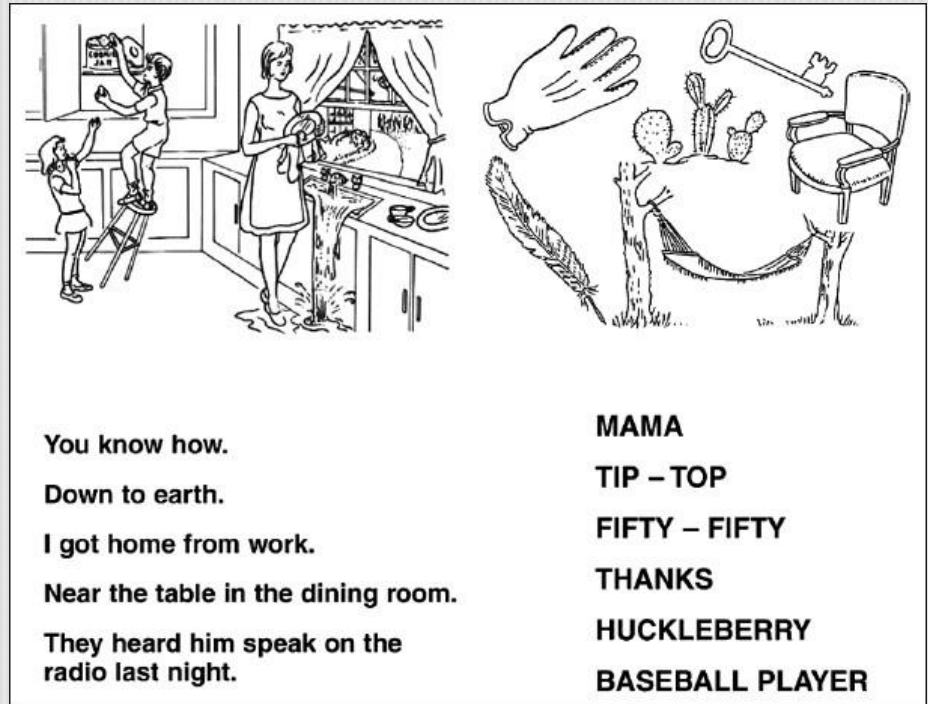
- Preoperative Neuro Exam
 - Alert & Orientated times four
 - Assess cranial nerves II-XII
 - Extra ocular movements intact (EOMs)
 - Visual changes or disturbances
 - Changes in hearing or complaints of dizziness (vertigo)
 - Presence of pronator drift
 - Strength of upper and lower extremities
 - Presence of numbness or tingling
 - NIH Stroke Scale (National Institutes of Health Stroke Scale)
 - (Cox, 2008; Schick & Windle, 2021)

NIHSS

- ||| 1. The National Institute of Health Stroke Scale (NIHSS)
- ||| 2. Stroke Assessment Tool
 - A. Evaluate and document neurological status
 - B. Valid in predicting lesion size and severity
 - C. Predictor of short and long term outcomes
- ||| 3. Common language to exchange information across health care disciplines
- ||| 4. Values are from 0-42
- ||| 5. ERT treatment for NIHSS greater than 8

NIHSS

- 1a. Level of Consciousness
- 1b. Questions
- 1c. Follow commands
- 2. Best Gaze
- 3. Visual Fields
- 4. Facial Palsy
- 5a & b. Arm movement
- 6a & b. Leg movement
- 7. Limb ataxia
- 8. Sensory
- 9. Best Language
- 10. Dysarthria
- 11. Extinction/Inattention



(National Stroke Association, 2012)

Preoperative Nursing Considerations

- Peripheral Vascular Assessment
 - Note bilateral dorsalis pedis pulses
 - Note bilateral posterior tibial pulses
 - Note skin temperature and color
 - Note presence of edema
 - Look for symptoms of vascular insufficiency
 - Document per unit/organizational guidelines
 - For UTSW, document in appropriate flowsheets
 - (Schick & Windle, 2021).

Preoperative Nursing Considerations

- Comprehensive Preoperative Pain Assessment
 - Presence of pain
 - Rate pain on a universal scale
 - Numeric Scale
 - Wong-Baker Faces Scale
 - Location and characteristics of pain
 - Duration of pain
 - Home remedies that relieve pain

Preoperative Nursing Considerations

- ▮ Accurate weight
- ▮ Laboratory results
 - ▮ Platelet Aggregation Study
 - ▮ Pregnancy Screening
 - ▮ Type and Screen
 - ▮ Creatinine
 - ▮ Consider risk factors for contrast-induced nephropathy (CIN)

Platelet Aggregation Study

- Measures the effectiveness of aspirin and Plavix™
 - “Therapeutic aspirin”
 - “Therapeutic Plavix”

Pregnancy Testing

- III Test or no test?
- III Screening—yes.
- III No national guideline or standard exists
- 1. *Journal of Radiology Nursing* recommends pregnancy testing the day of procedure (Riley & Bosnick, 2016).
- 2. American College of Radiology (2008) recommends screening at age 12 or menarche.
 - 3. -Date of last period
 - 4. -Asked, "is there a risk of pregnancy
- 5. Exclusions—hysterectomy and/or BSO

Pregnancy Testing at UTSW & Campus Partners

Through consensus agreement of the Department of Anesthesia (UT and Parkland):

Women of child bearing potential under the **age of 60** should receive pre-op pregnancy test **within 24 hours of surgery/procedure.**

Exclusions:

- Post menopausal >1yr
- S/p hysterectomy (tubal ligation is NOT an exclusion)
- Women may elect to forego testing (as is their right), however the surgeon and anesthesiologist must be made aware and the patient is to sign a pregnancy test refusal form.

(Maxwell, 2017)

Contrast Allergy

- Shellfish allergy does not equate contrast allergy!
- Symptoms of intravenous contrast allergy
 - Mild and self limiting
 - Itching and / or hives
 - Severe and life threatening
 - Anaphylactic or cardiopulmonary collapse
- Consider a premedication regimen
- Bickham & Golembiewski (2010)

Premedication Regimens

Iodinated Contrast Allergy

▮ Oral

- ▮ Prednisone 50 mgs by mouth 13, 7, & 1 hour prior to injection of contrast **OR**
- ▮ Methylprednisolone 32 mgs by mouth 12 hours and 2 hours prior to injection of contrast
- ▮ **AND** Diphenhydramine 50 mgs by mouth one hour prior to procedure

▮ Intravenous

- ▮ Hydrocortisone 200 mgs IV 13, 7, & 1 hour prior to injection
- ▮ **AND** Diphenhydramine 50 mgs IV or IM 1 hour prior
- ▮ Bickham & Golembiewski (2010), Mervak et al. (2017)

Contrast-Induced Nephropathy (CIN)

Definition: “An increase in serum creatinine of 25% or greater than 0.5mg/dl within 48-72 hours after contrast administration” (Bickham & Golembiewski, 2010).

“CIN is the third leading cause of acute renal failure of hospitalized patients” (Bickham & Golembiewski, 2010).

A baseline creatinine is crucial for post operative comparison.

Risk Factors for CIN

- Decreased kidney function (serum creatinine greater than 1.5)
- Diabetes
- Age greater than 75 years
- Heart failure
- Cirrhosis or nephrosis
- Hypertension
- Paraproteinemias (multiple myeloma)
- Poor hydration status
- High volume contrast and/or contrast within previous 48 hours
- Currently taking NSAIDs, diuretics, amphotericin, aminoglycosides, cyclosporine, tacrolimus, chemotherapy agents
- Hypotension or use of intra-aortic balloon pump during percutaneous coronary interventions
- (Bickham & Golembiewski, 2010)

Management and Prevention of CIN

- ||| Hydration, hydration, hydration
- ||| 0.9% normal saline IV: Infuse at a rate of 1 ml/kg for 12 hours before and after procedure.
- ||| ~~Sodium bicarbonate infusion~~
- ||| Low or iso-osmolar contrast
- ||| Hold NSAIDs and diuretics 24 hours pre and post procedure
- ||| Acetylcysteine 600-1200 mg orally or IV every 12 hours for 4 doses (2 doses preoperatively and 2 doses postoperatively)
(Bickham & Golembiewski, 2010)

Sodium Bicarbonate Infusion

- Dedicated IV
- Sodium bicarbonate drip
 - 150mEq of sodium bicarbonate in D5w 1000 ml or sterile water 1000 ml
 - UTSW's standard is sterile water
- Infusion
 - 3 mls/kg for one hour *THEN DECREASE*
 - 1 ml/kg continuously until six hours after procedure
 - (Bickham & Golembiewski, 2010)

Question and Answers

- The astute nurse can pick up on any of the concepts discussed and alert the physician.
- Failure to do so on the nurse's part can lead to:
 - Canceled or delayed cases
 - Dissatisfaction with nursing by patients, physicians, and the organization
 - Increased healthcare cost
 - For embolic strokes—"time is brain"

Intraoperative Nursing Considerations

Welcome to the Angiography Labs



Intraoperative Complications

Be prepared for the worst!

- ▮ Radiation dosage
- ▮ Embolic event (clot formation)
- ▮ Hemorrhagic event (extravasation)
- ▮ Vasospasm
- ▮ Positioning

Cutaneous Radiation Injury (CRI)

- Defined as “injury to skin and underlying tissues that occurs because of radiation exposure” (Bixby, 2009).
- Injury may not manifest for 6-12 weeks after the exposure (Bixby, 2009).
- Risk factors include
 - Obesity
 - Prolonged procedures
 - Several interventional procedures in a short period of time (UTSW defines within six months)

Monitoring of Fluoroscopy Dosage

- ||| Monitored throughout the procedure
- ||| Benchmarks for reporting to physician
 - 3000 mGys
 - Then every 1000 mGys
 - *AND/OR*
 - First 30 minutes
 - Then every 15 minutes thereafter
- ||| Documentation of total dosage within medical record
 - Nursing documentation
 - Physician procedure note
 - (Stecker et al, 2009; AORN Journal, 2021)

Intraoperative Complications

Embolic formation

- “Thrombo-embolic events are often caused by the mechanical force of the catheter being navigated and the coils being deposited within the aneurysm” (Fox & Choi, 2009).
- Treatment includes:
 - Preoperative aspirin and Plavix®
 - Intra-arterial tPA infusion
 - Combined intra-arterial and IV Aggrastat™ infusion

Aggrastat™ (tirofiban) Infusion

■ Dosage

- IV infusion at
 - 0.4 mcg/kg/min for 30 minutes
 - For pumps with volume to be infused (VTBI) half the hourly rate
- THEN decrease to
 - 0.1 mcg/kg/min

■ (Mehta & Johnson, 2006)

Aggrastat™ (tirofiban) Infusion

- Intra-arterial infusion advantages
 - “Direct angiographic identification of the vessel occlusion—confirming diagnosis.”
 - “High local concentration of (drug) with a lower systemic dose—minimizing the risk of systemic complications.”
 - Success or failure of clot “dissolution” through direct visualization by the surgeon which allows for quick determination of mechanical clot retrieval.
 - (Mehta & Johnson, 2006)

Vasospasm:

- ||| Vasospasm window is usually days 4-14
- ||| “Serial clinical assessments and transcranial doppler” are used to monitor for symptoms of vasospasm
- ||| Angiography is done within days 7-10
- ||| Diagnosis is confirmed with direct visualization via angiography

|| (Curran et al, 2006)

Intra-arterial medications: Nicardipine

1. Diagnostic angiography
2. Vasospasm confirmed
3. Microcatheter parked in general region of vasospasm
4. Infusion of nicardipine by physician
 Dosage 0.5-6 mgs (Curran et al, 2006)
5. Nursing considerations: Hypotension intra and post operatively

(Curran et al, 2006)

Intra-arterial medications:

Milrinone

1. Diagnostic angiography
2. Vasospasm confirmed
3. Microcatheter parked in general region of vasospasm
4. Infusion of milrinone by physician
 - a) a. Infuse at a rate of 0.25 mg/min
 - b) b. The recommended therapeutic infusion is a total of 4 mg to a single arterial territory.
 - c) c. Maximum recommended dose is 15 mg during a single intra-arterial treatment.
5. Nursing Considerations: Hypotension and EKG changes

(Shankar, dos Santos, Deus-Silva, & Lum, 2011)

Post-operative Nursing Considerations

Postoperative Nursing Considerations

- ||| Admission to PACU and/or ICU
- ||| Comprehensive Neurological Assessment
- ||| Comprehensive Peripheral Vascular Assessment
 - Assess the femoral puncture site/dressing for bleeding, hematoma, and discomfort
 - Ongoing assessment of pedal pulses with vital sign documentation
- ||| Comprehensive Pain Assessment
 - Remember patient complaints of headache are common and expected postoperatively
 - Note intensity, characteristics, and location and compare to preoperative findings
 - Notify physician if headache is not relieved with pain medication

What is the clinical picture?

- ✓ 1. New and severe onset of back or groin pain
- ✓ 2. Bruising over the abdomen or flank with blood tracking to groin
- ✓ 3. Decreases in blood pressure and increase in heart rate
- ✓ 4. Puncture may/may not be soft (no hematoma)

(Kern, 2013)



Manual Pressure

- || Activated Clotting Time (ACT) should be less than 180-200 seconds
- || Sheath is removed and pressure applied for 20-30 minutes
- || Careful assessment at and around insertion site, abdomen, and inner thigh
- || If sheath is left in place, it should be sutured in place and a sterile dressing placed
- || (Bixby, 2009).

Closure devices

- ▮ Closure devices are utilized to seal or plug the arteriotomy
- ▮ Three main types
 - Collagen
 - Sutures
 - Clips

Closure Devices

Advantages and Disadvantages

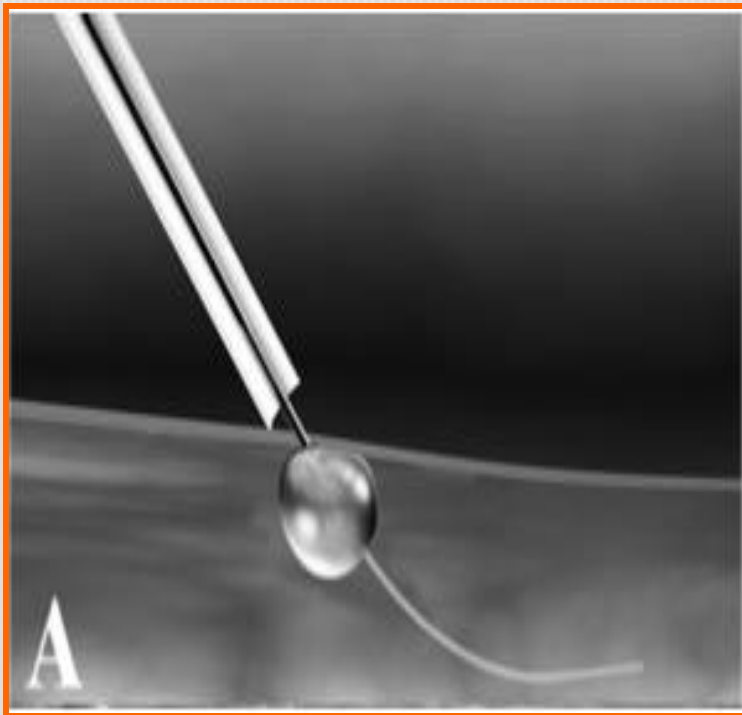
▮ Advantages

- Early ambulation
- Early discharge
- Improved patient comfort

▮ Disadvantages

- Upsizing of sheath
- Failure to deploy
- Infection
- Thrombosis
- (Bixby, 2009)

ExoSeal™ vs Mynx™



Polyglycolic Acid Plug: ExoSeal



Collagen Plug: Mynx™

Complications:

Closure devices or manual pressure

- || Bleeding from arterial site
- || Thrombus formation at the site inhibiting perfusion of distal extremity
- || Hematoma formation
- || Assessment is the key for complications associated with closure devices or manual pressure

Patient Teaching

“ Procedure

- Discuss with patient what to expect pre, intra, and post procedure

“ Medications

- Review medications, indications, regimen, contraindications, and adverse reactions

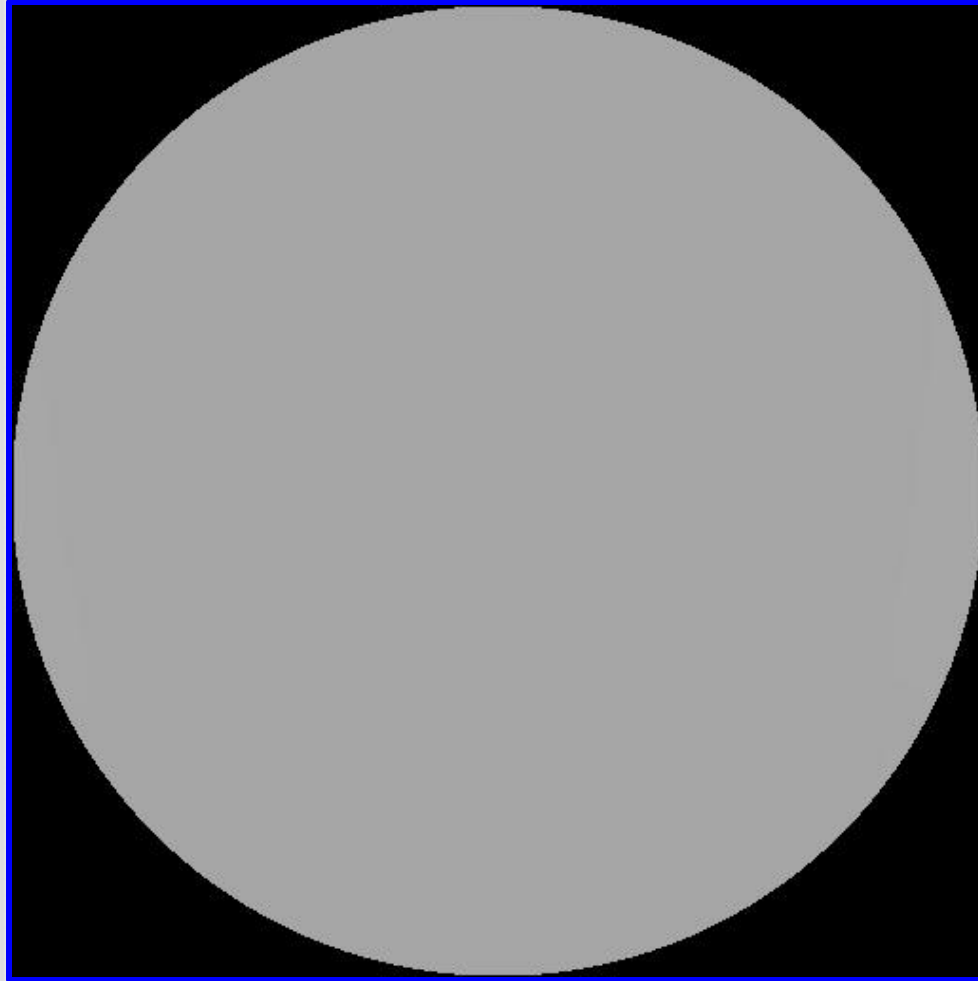
“ Activity/Activities of Daily Living (ADLs)

- When to resume a regular diet
- When to shower—avoid community water
- When to lift, exercise, return to work

“ Radiation

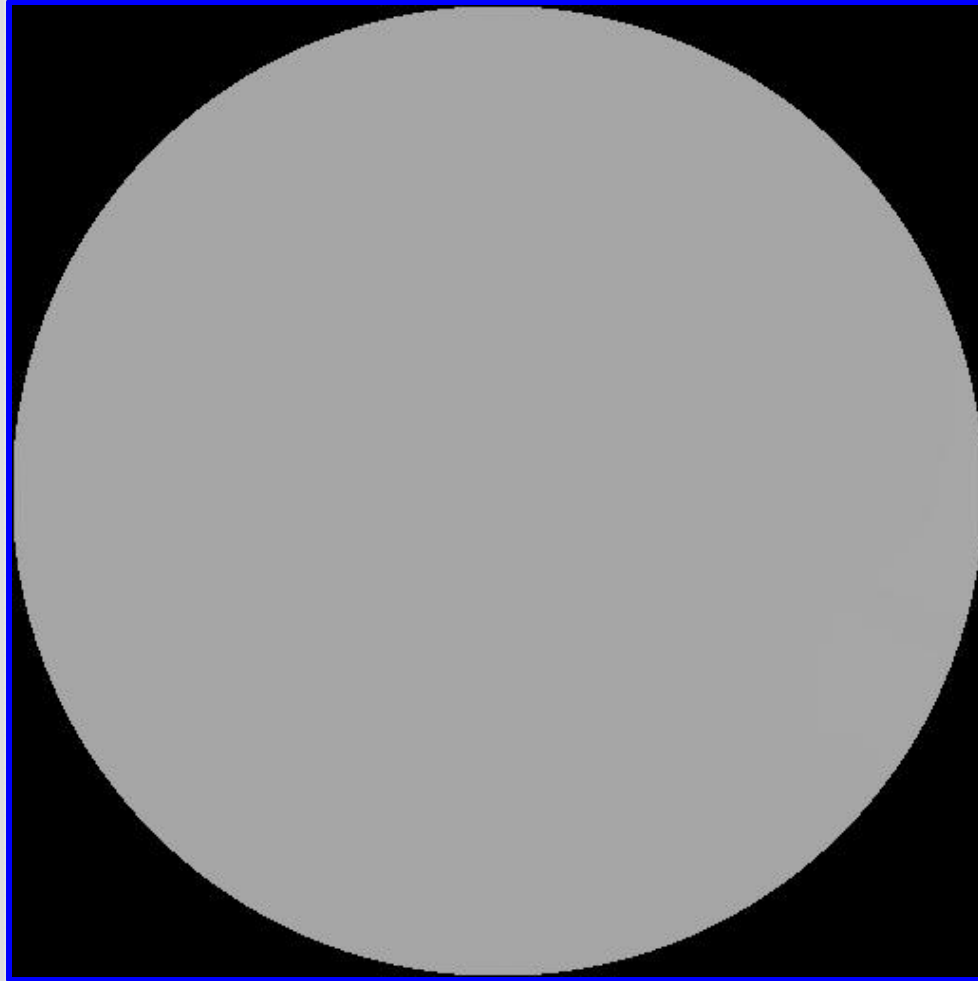
- Changes in skin color or pain
- Loss of hair

AVM: AP View



Distal
Posterior
Cerebral
Artery
(PCA)

AVM: Lateral View



Distal
Posterior
Cerebral
Artery
(PCA)

AVM: Rotational View



Distal
Posterior
Cerebral
Artery
(PCA)

Comprehensive Stroke Center: It is a team approach!

UTSouthwestern
Medical Center

ERT Goals per GWTG, ASA, and UTSW

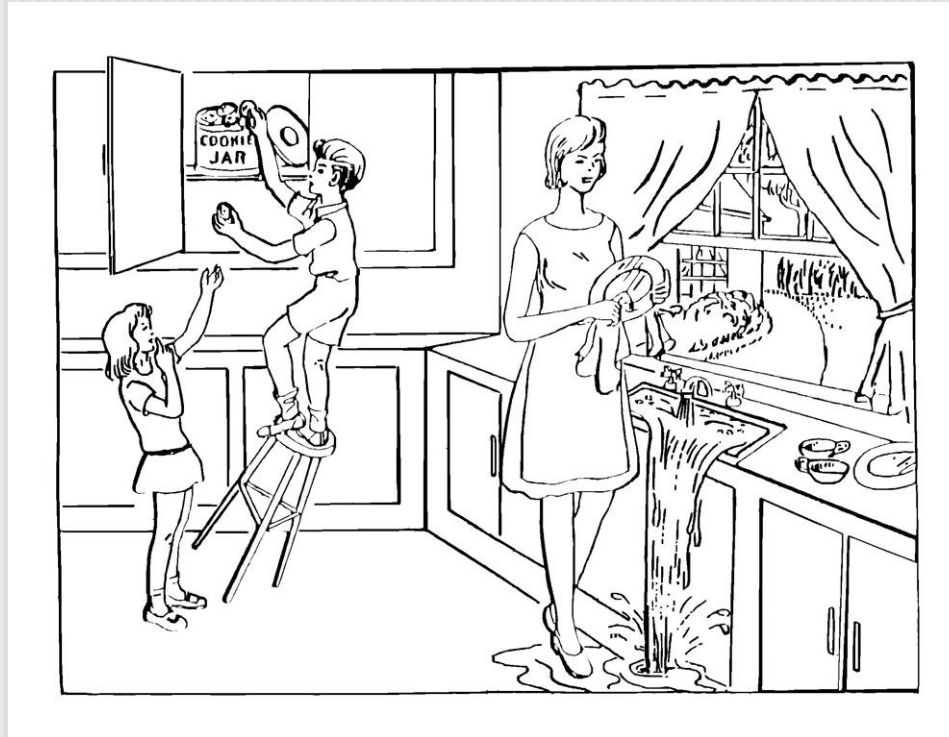
Door to Neuro IR notification 30 min

Door to Groin 90 min

Picture to Puncture 60 min

Door to Start of Revascularization 120 min

Why I do what I do.



Mary Stam

Questions

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