

THE SOLITAIRE DEVICE AND ITS ROLE IN THE MANAGEMENT OF ACUTE ISCHEMIC STROKE

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DEFINING OUR TOPIC

- Stroke can be primarily ischemic or primarily hemorrhagic
- Ischemic strokes can become secondarily hemorrhagic
- Ischemic Stroke
 - Neurologic deficit secondary to reduced blood flow to the brain
 - Average perfusion to brain tissue is 50-54 cc/100g/min
 - Symptomatic Ischemia occurs with CBF < 18-20 cc/100g/min
 - Tissue death (infarction) occurs with CBF < 8-10 cc/100g/min
 - Thromboembolic and hemodynamic etiologies
 - Acute ischemic thromboembolic stroke accounts for 87% of all stroke cases ICA, M1, M2, A1, A2 occlusions account for 33% of all anterior circulation strokes

PATHOGENESIS FOR ISCHEMIC THROMBOEMBOLIC STROKE

- Atherosclerosis with arterial stenosis or occlusion
- Cardiac sourced emboli secondary to valvular, atrial or ventricular abnormalities
- Cardiac sourced paradoxical emboli due to septal defects (PFO)
- Hypercoagulability and subsequent thrombophilia secondary to
 - Inherited thrombophilia
 - Factor V Leiden
 - Prothrombin gene mutation
 - Antithrombin deficiency
 - Protein C deficiency
 - Protein S deficiency
 - Acquired thrombophilia
 - Antiphospholipid syndrome
 - Hyperhomocysteinemia
- Post-surgical
- Trauma
- Fractures
- Cancer
- Pregnancy
- Estrogen use

PATIENT EVALUATION (STEP 1)

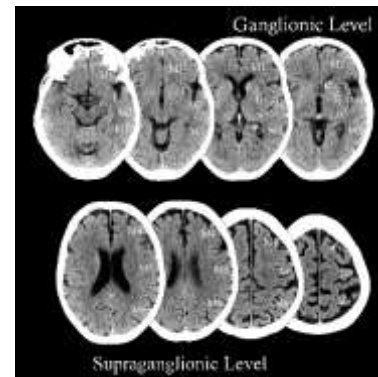
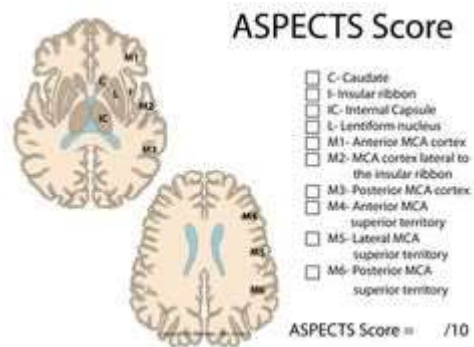
- National Institute of Health Stroke Score (NIHSS)
 - Evaluates motor, sensory, visual, speech comprehension
 - 0 No stroke symptoms
 - 1-4 Minor stroke
 - 5-15 Moderate stroke
 - 16-20 Moderate to severe stroke
 - 21-42 Severe stroke
- Predictor of patient outcome.
 - NIHSS >16 indicates strong possibility of death
 - NIHSS <6 indicates strong possibility of good recovery
 - An increase of 1 point in a patient's NIHSS decreases the likelihood of an excellent outcome by 17%

PATIENT EVALUATION (STEP 2)

- Determine time of stroke onset
 - Defined as when the patient was last observed to be normal
 - $\leq 3 - 4.5$ hours
 - When is 6 hour window
- Current medications
 - Antiplatelet
 - Antithrombotic
- Patient medical history
 - Prior strokes
 - Recent surgical procedures
 - Medications
 - Family history of stroke
 - Pregnancy status
 - Neurologic conditions
 - Cardiac conditions
 - Rhythm disturbances
 - Atrial/ventricular dysfunction
 - Septal abnormalities

PATIENT EVALUATION (STEP 3)

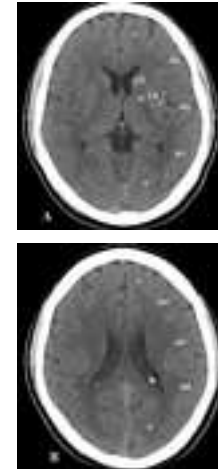
- Emergent Brain Imaging
 - Evaluate patient's brain for:
 - Hematoma (epidural, subdural, subarachnoid, intraparenchymal)
 - Ischemic changes
- Emergent Imaging Modalities
 - CT/CTA with ASPECT Score



- MRI/MRA (usually reserved for patients beyond 6 hour window)
 - Prior to 6 hour window MR generally excessively delays treatment

Alberta Stroke Program Early CT Score (ASPECT Score; ASPECTS)

- As per Hacking and Sair in Radiopaedia
 - 10 point quantitative CT scan score used in patients with middle cerebral artery (MCA) stroke
 - Segmental assessment of 10 MCA vascular territories is made with 1 point deducted from the initial score of 10 for every region involved
 - Caudate
 - Putamen
 - Internal capsule (any portion)
 - Insular cortex
 - M1: anterior MCA cortex at level of BG on CT (frontal lobe)
 - M2: MCA cortex lateral to the insular cortex at level of BG on CT (anterior temporal lobe)
 - M3: Posterior MCA cortex at level of BG on CT (posterior temporal lobe)
 - M4: Anterior MCA cortex at level of ventricles immediately above BG on CT
 - M5: Lateral MCA cortex at level of ventricles immediately above BG on CT
 - M6: Posterior MCA cortex at level of ventricles immediately above BG on CT
-
- **ASPECTS < 7 PREDICTS WORSE FUNCTIONAL OUTCOME AT 3 MONTHS AS WELL AS SYMPTOMATIC HEMORRHAGE**
 - **PATIENTS WITH ASPECTS < 8 TREATED WITH THROMBOLYSIS DO NOT GENERALLY HAVE GOOD CLINICAL OUTCOMES**



TREATMENT FOR PATIENTS PRESENTING \leq 4.5 HOURS FROM ONSET OF ISCHEMIC SYMPTOMS

- IV-tPA (recombinant tissue plasminogen activator; Alteplase)
 - tPA is naturally encoded by the PLAT gene on Chromosome 8
 - tPA cleaves plasminogen into the protease plasmin
 - Plasmin degrades Fibrin
 - Polymerized Fibrin normally combines with platelets to form a hemostatic clot
- Tissue Plasminogen Activator for Acute Ischemic Stroke. *New England Journal of Medicine* 1995; 333:1581-1588
 - When compared to patients treated with placebo, those treated with IV-tPA were 30% more likely to have minimal or no disability 3 months following treatment
 - Mortality at 3 months was lower in the tPA treated group (17%) vs the placebo group (21%)
 - Symptomatic intracranial hemorrhage was 6.4% in tPA group vs. 0.6% in placebo group
- In 1996, tPA approved by FDA for treatment of ischemic strokes if administered within 3 hours of symptom onset

iv-tPA INDICATIONS AND CONTRAINDICATIONS

- Inclusion Criteria
 - Time of symptom onset ≤ 3 hours
 - Diagnosis of ischemic stroke causing measurable neurological deficit (NIHSS >4)
 - Age ≥ 18 years
 - Time of symptom onset <4.5 hours
 - Above plus
 - ≤ 80 years old
 - No history of both diabetes and stroke
 - Patient is not taking Coumadin or any other anticoagulant regardless of INR
 - NIHSS ≤ 25
- Exclusion Criteria
 - Significant head trauma or prior stroke in previous 3 months
 - SAH
 - Prior intracranial hemorrhage
 - Intracranial neoplasm, AVM, aneurysm
 - Recent intracranial or intraspinal surgery
 - Arterial puncture at noncompressible site in previous 7 days
 - Elevated blood pressure (S >185 ; D >110)
 - Active internal bleeding
 - Blood glucose <50
 - Acute bleeding diathesis including platelet count less than 100K
 - Heparin received within 48 hours resulting in aPTT greater than normal
 - Current use of anticoagulant with INR >1.7 or PT >15
 - Current use of thrombin inhibitors or Factor Xa inhibitors with elevated aPTT, INR)
 - CT demonstrating multilobar infarction ($>1/3$ cerebral hemisphere; APSECTS <8)

iv-tPA *RELATIVE* CONTRAINDICATIONS

- Minor or rapidly improving stroke symptoms
- Seizure at onset with postictal residual neurological impairments
- Major surgery or serious trauma within previous 14 days
- Recent GI or urinary tract hemorrhage within previous 21 days
- Pregnancy

RESULTS OF iv-TPA PLUS ENDOVASCULAR THERAPY

- **STUDIES**

- **Multicenter Randomized Clinical Trial of Endovascular Treatment for Acute Ischemic Stroke in the Netherlands (MR CLEAN) NEJM 2015;372:11-20**

- 500 patients randomized

- 233 randomized to endovascular therapy with 196 (84%) actually undergoing endovascular treatment. Retrievable stent used in 82% of IA treatments
- Patient receives usual customary care (including iv-tPA when indicated). 90% in each group received iv-tPA
- Age >18
- Distal ICA, MCA (M1,2), ACA (A1,2) occluded
- NIHSS ≥ 2
- IA therapy initiated within 6 hours after stroke onset included thrombolytic therapy and/or mechanical thrombectomy (aspiration, wire disruption, MERCI, retrievable stent)

- **RESULTS**

- No significant difference in adverse events (47% vs 42% control)
- No difference in mortality (21% vs 22% control)
- 71% improvement in good neurological outcomes for patients treated with IA + iv-tPA vs iv-tPA alone
- 33% functional independence in IA group vs 19% in non-IA group (14% absolute difference)
- It was determined pre-study that a 10% absolute reduction in poor outcome (IA vs non-IA) could save approximately 1% of all new stroke cases from death or disability annually (1% x 800,000 = 8,000)
- No residual occlusion in 75% of IA group vs. 33% of non-IA group

- **THE POSITIVE RESULTS OF THIS STUDY LEAD TO THE TERMINATION OF ALL OTHER ONGOING STUDIES LOOKING AT IV tPA PLUS IA THERAPY**

ADDITIONAL RESULTS OF iv-tPA PLUS ENDOVASCULAR THERAPY

- STUDIES
 - SWIFT PRIME (Global)
 - EXTEND IA (Australia, New Zealand)
 - REVASCAT (Spain)
 - ESCAPE (Global)
- Each of the above studies compared iv-tPA alone vs iv-tPA plus the Solitaire device within 6-12 hours of stroke onset

STUDY RESULTS

- SWIFT PRIME
 - Functional independence (Good Outcome) improved with Solitaire at 90 days (60% vs 35%)
 - Reduction in death with Solitaire (12% vs 9%)
- EXTEND-IA
 - Functional independence improved (71% vs 40% control)
 - IA patients 15 days in hospital or rehab vs 73 days
 - Death reduced (9% vs 20% control)
 - Symptomatic ICH (0% vs 6% control)
- ESCAPE
 - Functional independence improved (53% vs 29% control)
 - Death rate reduced (10% vs 19% control)
- REVASCAT
 - Functional independence improved (44% vs 28% control)
 - No difference in death from stroke (18% vs 16% control)

GUIDELINES FOR STROKE TREATMENT AS A RESULT OF MR CLEAN STUDY

- Patients eligible for IV r-tPA should receive tPA even if IA therapy is being considered
- Patient should receive endovascular therapy with a stent retriever device if
 - Pre stroke Modified Rankin Scale (mRS) is 0-1 (no symptoms or no significant disability; able to carry out all usual activities despite some symptoms)
 - Acute ischemic stroke receiving IV-tPA within 4.5 hours of onset
 - Occlusion of ICA or proximal MCA (M1)
 - CTA can be useful to rapidly identify these cases when a hyperdense sign does not appear on plain CT imaging
 - Age ≥ 18
 - NIHSS ≥ 6
 - ASPECTS ≥ 6
 - Groin puncture can occur within 6 hours of symptom onset

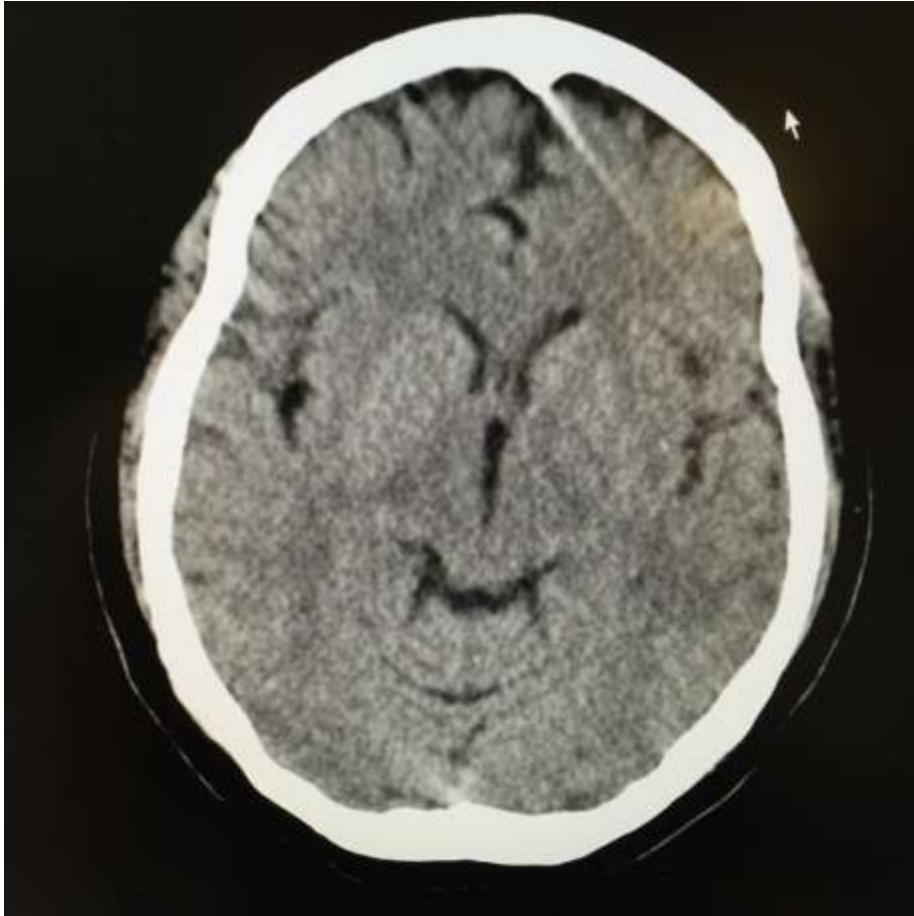
CASE ILLUSTRATION

- 44 year old right handed woman presents to ER AT 0910
- Chief Complaint
 - Difficulty speaking. Right sided weakness
- History
 - Husband found wife in bed with difficulty speaking and right sided weakness. Patient was presumed normal at 0600 when she climbed into bed. At 0700 she fell out of bed and was found to be aphasic and plegic on her right side.
- PMH
 - Sleep apnea
 - Migraines
 - Tobacco use
 - Hyperlipidemia
 - Bipolar disorder
 - GERD
- Medications
 - Atenolol
 - Gabapentin
 - Vistaril
 - Lodine
 - Lipitor
 - Lexapro
 - Amerge
 - Migranal
- Exam
 - BP Systolic <150; BP Diastolic <90
 - BMI 42
 - NIH 22 (>21 considered a severe stroke)

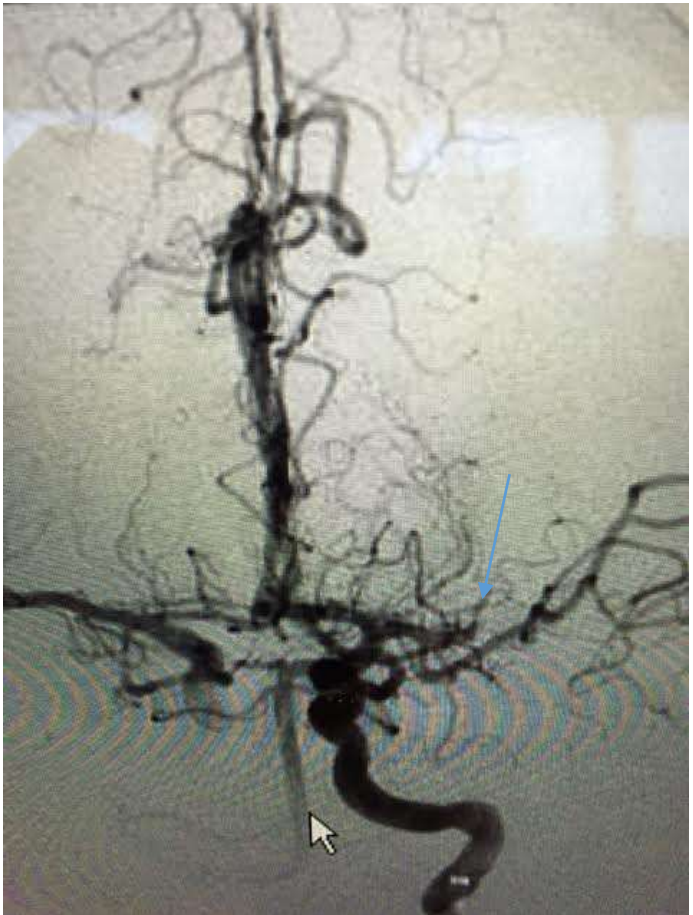
CASE ILLUSTRATION

- CT Head
 - No acute findings. No hemorrhage seen. No stroke seen
- Neurology Consult
 - Not an IV-TPA candidate due to unknown time of stroke onset
- Neurosurgery Consult
 - Patient taken emergently to angiography
 - Left ICA and M1 occlusion (TICI 0)
 - Solitaire and suction thrombectomy performed
 - Post procedure TICI 2b-3

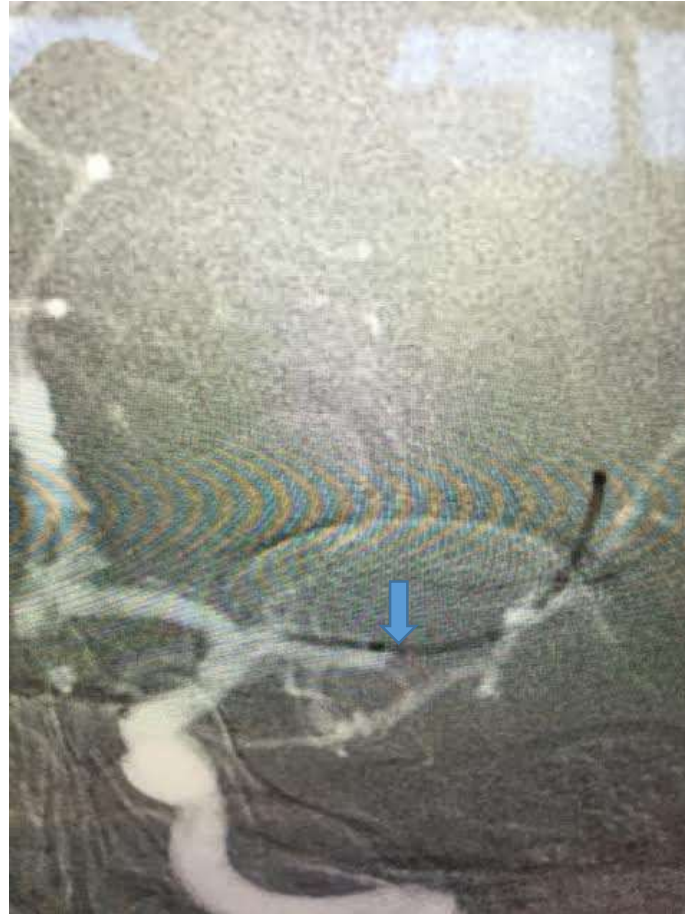
CT BRAIN IN ER



ANGIOGRAPHY PRE TREATMENT

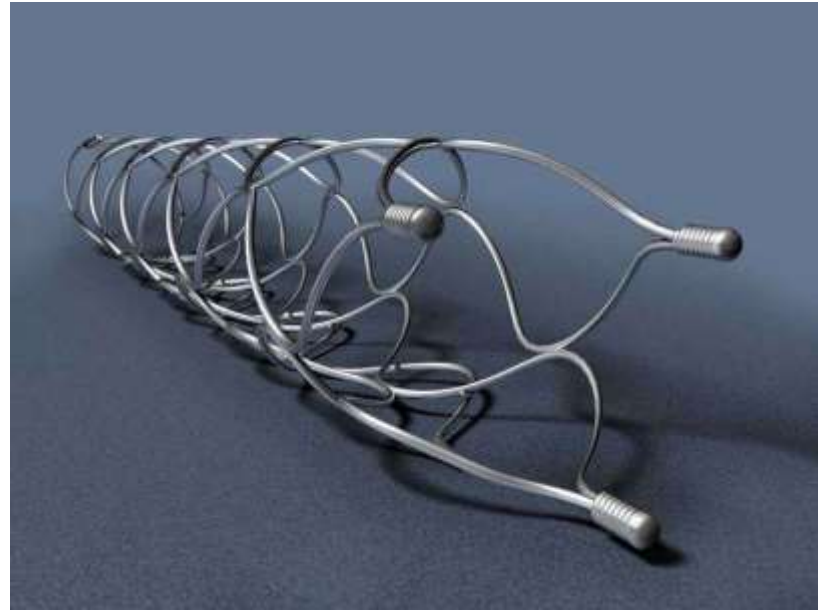
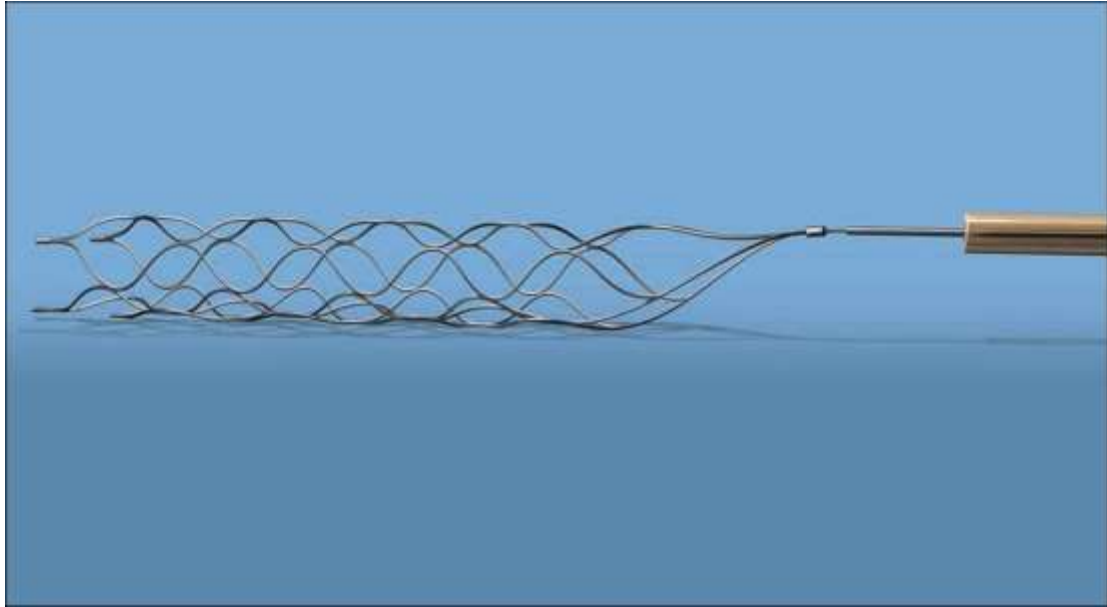


MICROCATHETER PLACED THROUGH OCCLUSION

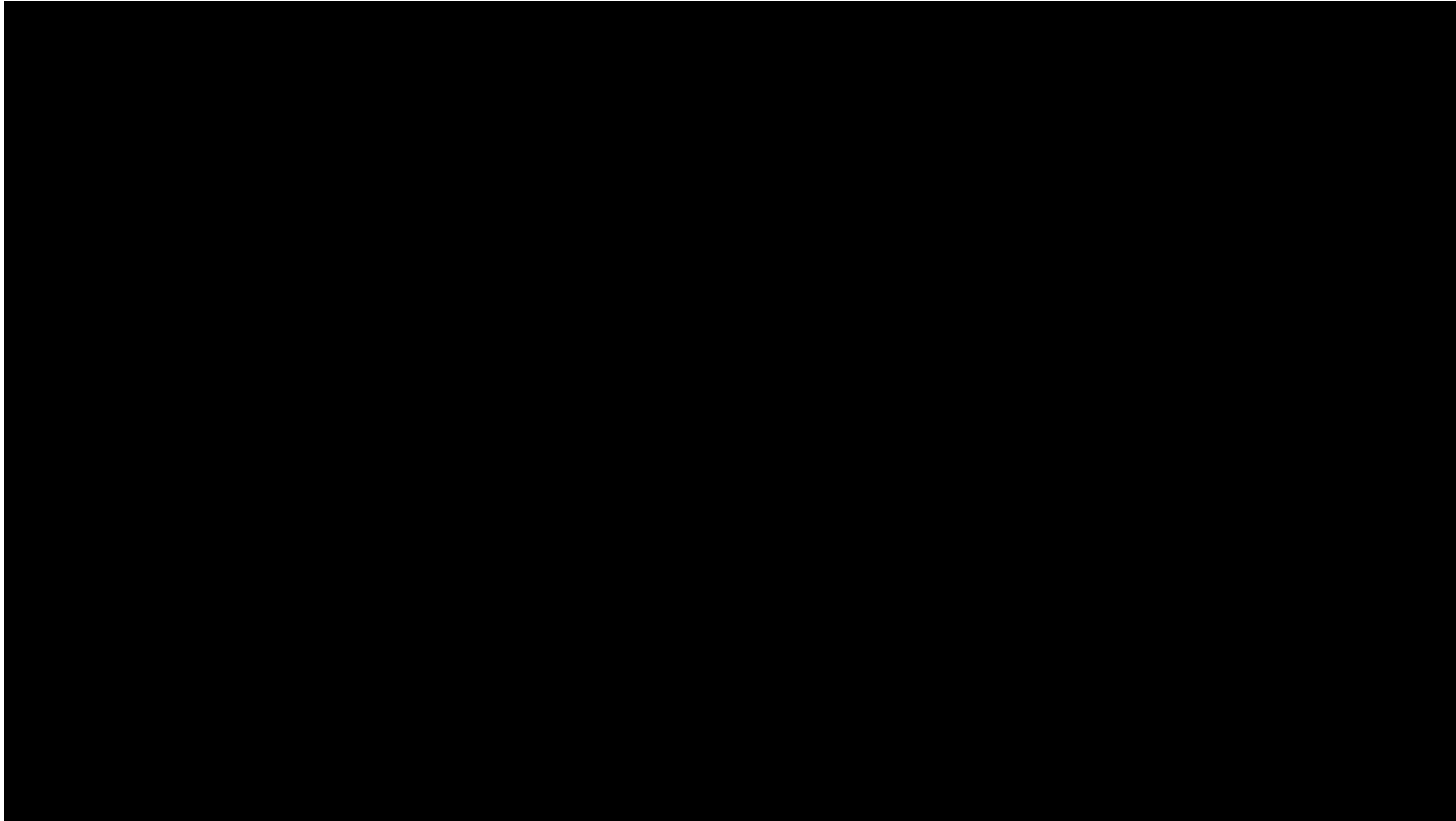


SOLITIARE STENT RETRIEVER

Medtronic
Approved 2012



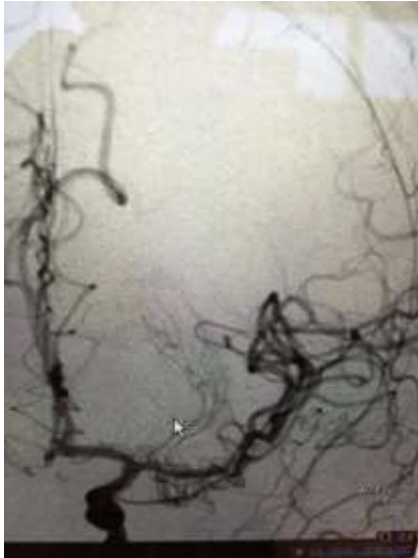
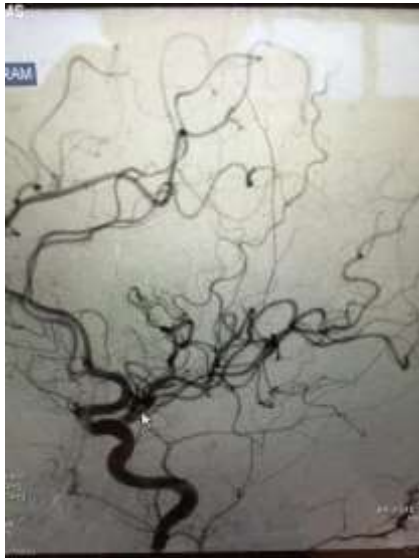
SOLITARE STENT RETRIEVAL THROMBECTOMY DEVICE ANIMATED VIDEO



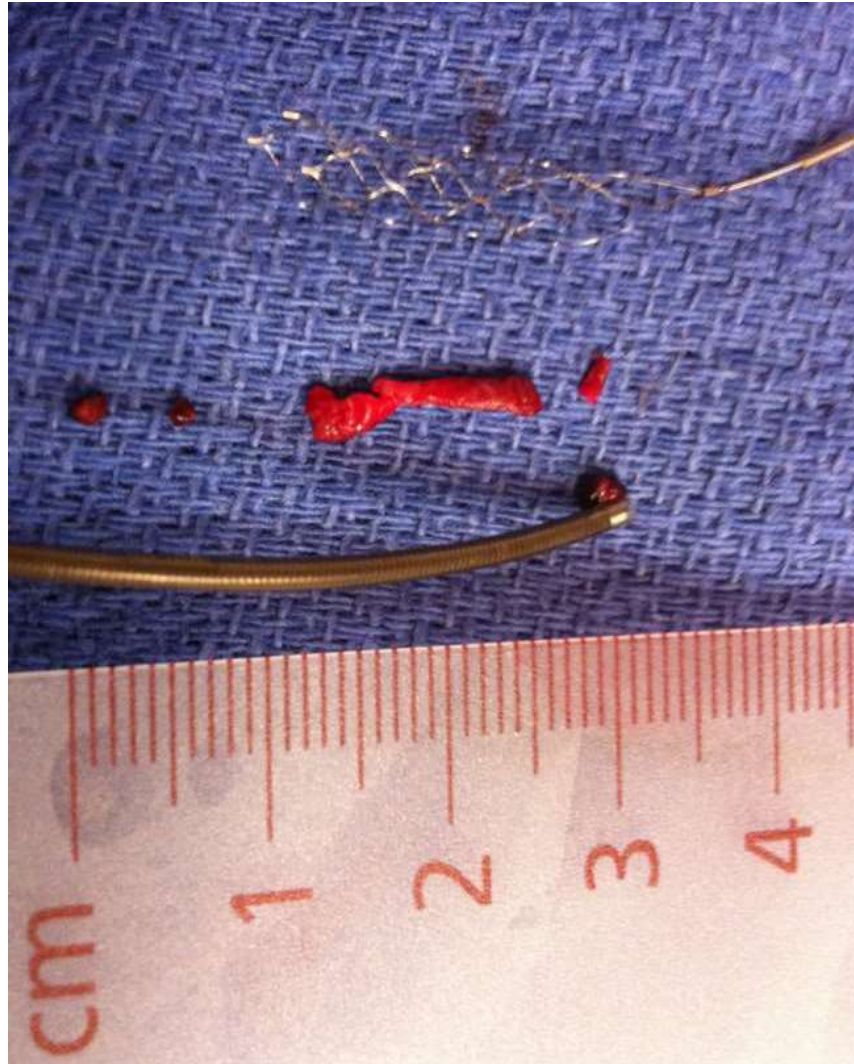
PRE TREATMENT



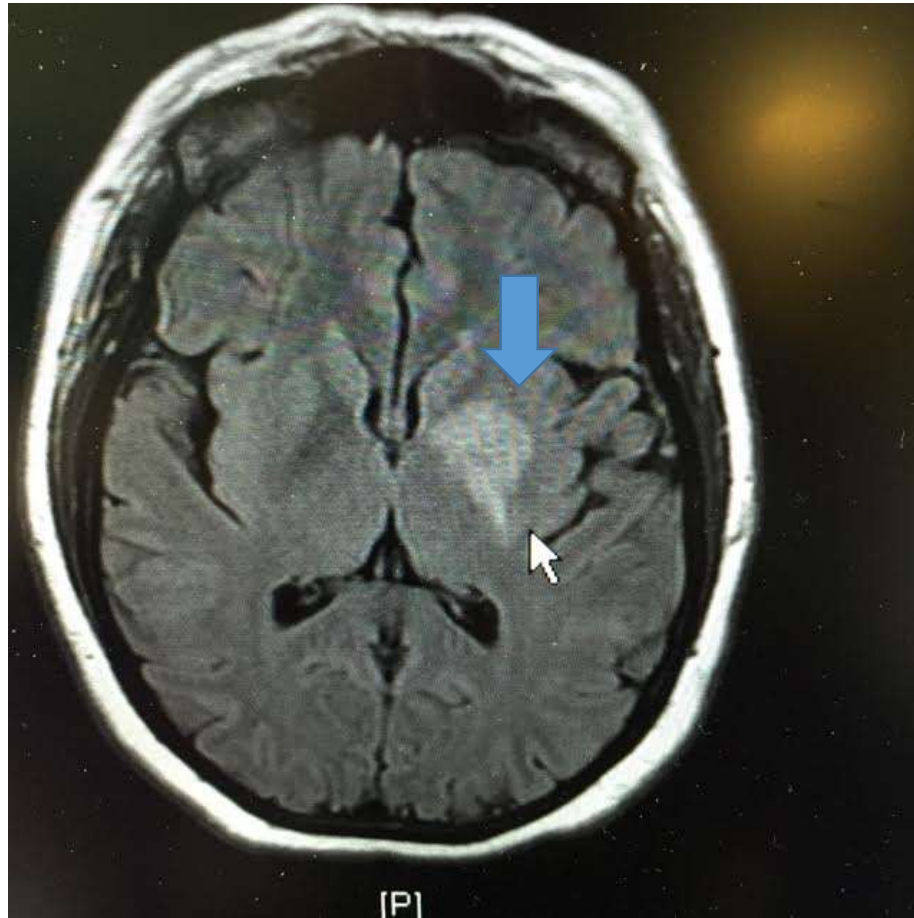
POST TREATMENT



RETRIEVED THROMBUS



MRI BRAIN 24 HOURS POST TREATMENT



WHAT DOES THIS MRI TELL US?

- Caudate and globus pallidus and putamen (basal ganglia) are infarcted
- The vessels that supply these structures (medial and lateral lenticulostriate arteries) are primarily end arteries originating from the A1 segment of the ACA and the M1 segment of the MCA without good sources of collateral blood flow
- Due to lack of collaterals this tissue cannot tolerate arterial occlusion and tissue death develops over a short time period
- The internal capsule appears to be spared (remarkably)
- The remainder of the MCA territory is free of irreversible ischemic changes

HOSPITAL COURSE

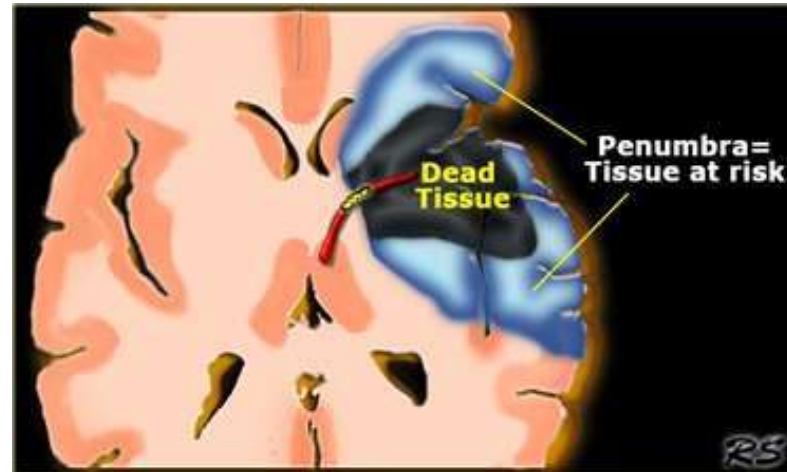
- 7 day hospitalization
- Transesophageal Echocardiogram
 - Normal
- Hypercoagulability evaluation
 - Heterozygous prothrombin gene variant mutation.
 - Placed on ASA
- Discharged from rehabilitation with discharge note stating
 - “She had resolution of her speech deficits and resolution of her right sided weakness. She met all rehabilitation goals and was independent with transfers and ambulation for long distances without device. She is independent with ADLs. She is able to ascend and descend 12 stairs. The patient was discharged home

6 HOURS AND BEYOND

- How do we manage the adult patient who presents with:
 - Ischemic stroke symptoms
 - CT ASPECT ≥ 6
 - In the time window that would not permit groin puncture by hour 6 from stroke onset
- MRI with DWI imaging and perfusion imaging may hold the key to determining which of these patients might **STILL** benefit from endovascular revascularization using mechanical thrombectomy

PHYSIOLOGIC TIME VS CHRONOLOGIC TIME

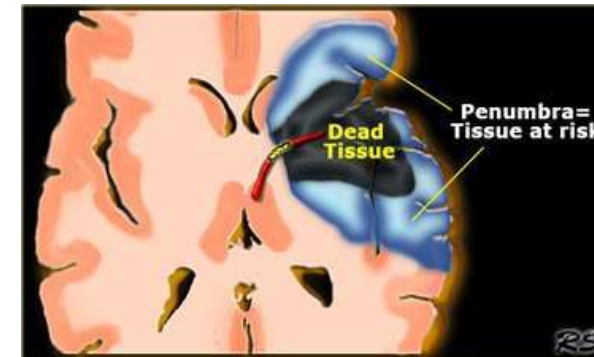
- DEFUSE 2 Study
 - Focused on the issue of physiologic time
 - Core
 - Tissue that will inevitably die and is beyond salvage
 - Penumbra
 - Tissue that is hypoperfused but is not beyond salvage and can survive if normal blood flow is reestablished before the tissue dies.
- GOAL: PRESERVE THE PENUMBRA



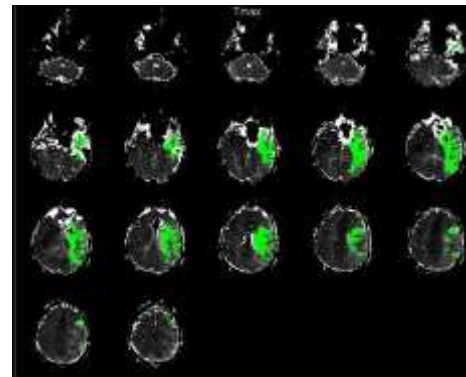
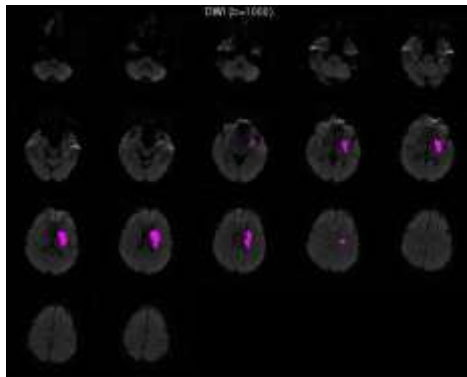
DEFUSE 2

- The ideal candidate for IA therapy despite chronological time from onset of symptoms is the individual with

- Infarct volume less than 50 cc
- Perfusion : Diffusion ratio of ≥ 1.8
 - Perfusion = Blood flow
 - Diffusion = Irreversibly damaged brain



- Patients with P:D ratio ≥ 1.8 and M1 or ICA occlusion likely has good collateral blood flow to involved brain tissue



THANK YOU