THEN AND NOW: DEVELOPMENT AND STATE OF THE ART OF NEUROENDOVASCULAR THERAPY

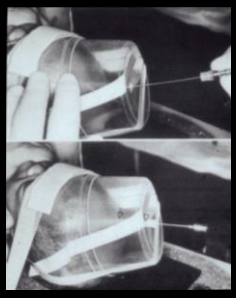
A PERSONAL JOURNEY

Charles M. Strother, MD
University of Wisconsin, Madison

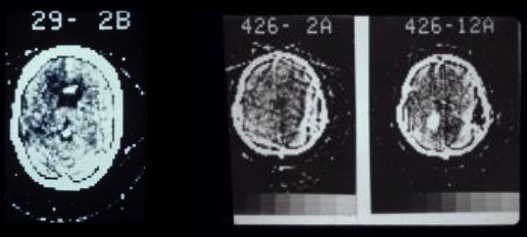
OVERVIEW

- Endovascular Therapy for Cerebrovascular Diseases Prior to DSA (1974-1991)
- Availability of DSA Introduces a New Era For Minimally Invasive Endovascular Procedures
- Full Utilization of Currently Available Imaging Tools Enhances Safety and Efficacy
- A Preview of Current and Soon to be Available Cone Beam C-arm CT Imaging Techniques

BEFORE CT AND DSA



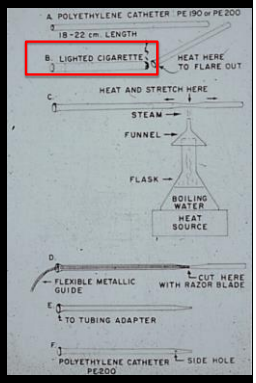
Strother CM, Newton TH. A new method for needle immoblization during Ventriculography. J Neurosurg 44:262-263, 1976.



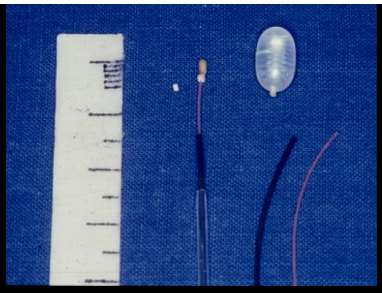
UCSF 1974-75

BEFORE DSA

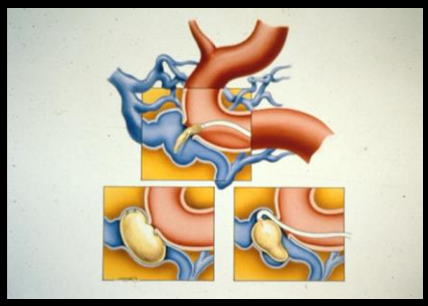
NORWEGIAN AND SWEDISH NEURORADIOLOGIST DEVELOPED TECHNIQUES FOR CATHETER ANGIOGRAPHY. THIS RAPIDLY REPLACED PERFORMANCE OF ANGIOGRAPHY BY DIRECT NEEDLE PUNCTURE

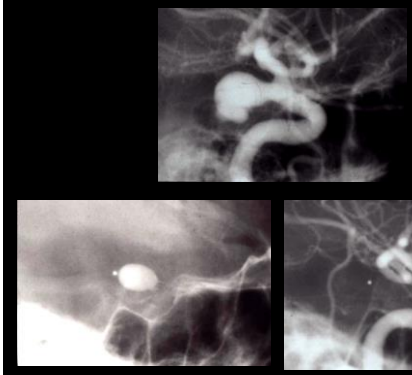


Stanford 1974



IN 1975-76 RUSSIAN NEUROSURGEON SERBINENKO DESCRIBES DETACHABLE BALLOON CATHETER FOR TREATMENT OF CAROTID CAVERNOUS FISTULA.



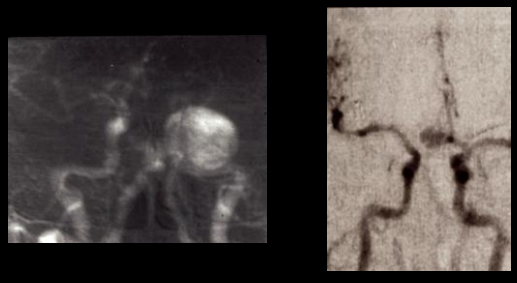


75 year old woman with 3rd nerve palsy

START OF A NEW ERA !

INVENTION OF DSA

Kruger RA, Mistretta CA, Houk TL, et. al. Computerized Fluoroscopy in Real Time for Noninvasive Visualization of The Cardiovascular System. Preliminary Studies. Radiology 1979; 130:49-57



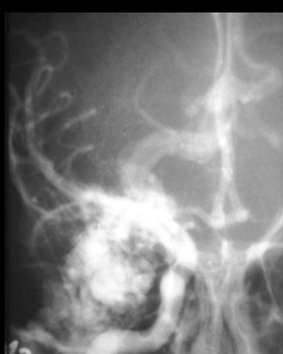
Strother CM, Sackett JF, Crummy AB, Mistretta CA, et al: Intravenous Video Arteriography of the intracranial Vasculature. AJNR 2:215-218, May-Jun 1981

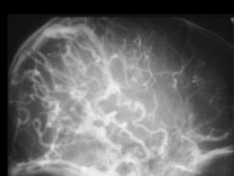
New Catheter for Endovascular Interventional Procedures

Yuichi Kikuchi, MD
Charles M. Strother, MD
Marylin Boyer, RN

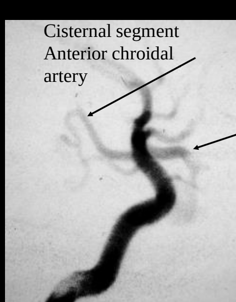
KIKUCHI Y, STROTHER C M, BOYER M
FIRST DESCRIPTION OF OVER THE WIRE VARIABLE STIFFNESS CATHETER

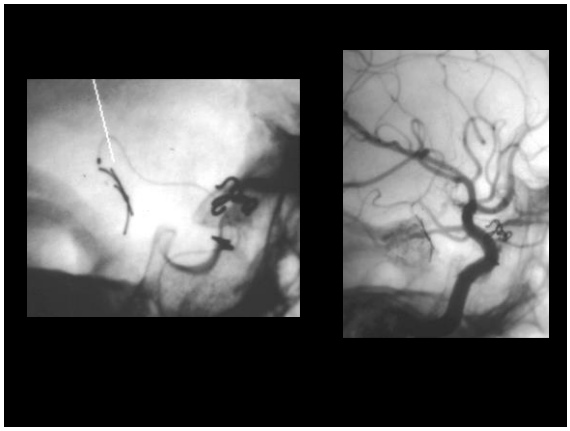
7 Year Old Girl With Seizures



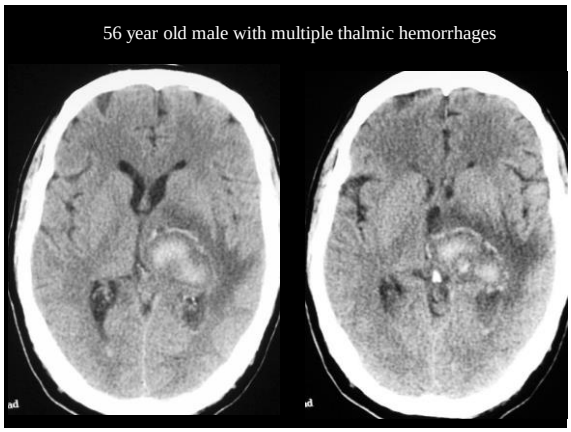


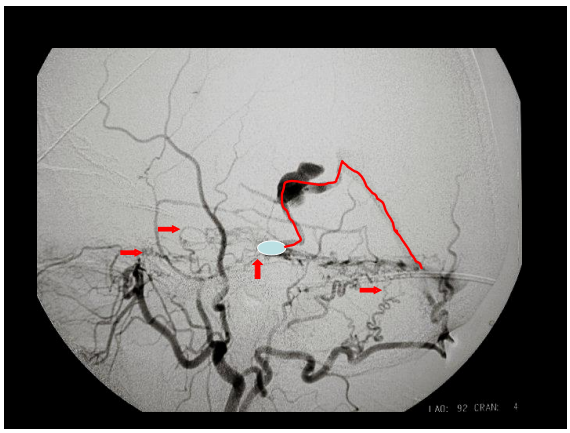
Parents told— “no possibility for treatment of AVM”

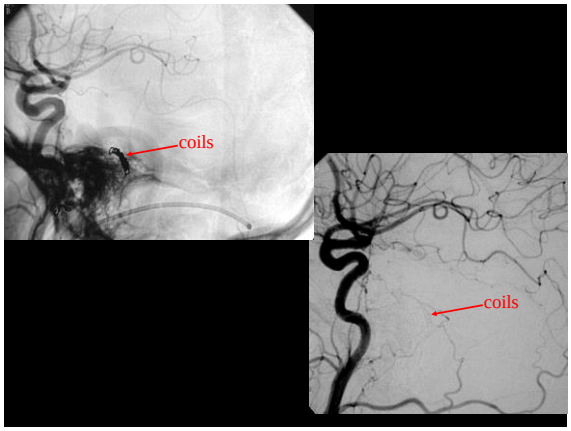


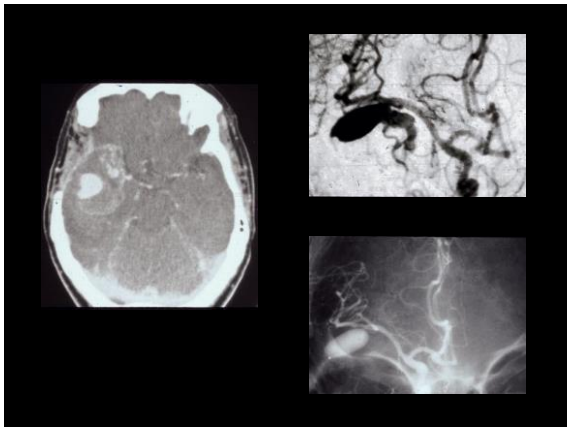


56 year old male with multiple thalmic hemorrhages





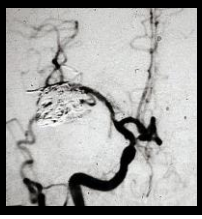

coils
coils



GDC MEETING
MADISON, WISCONSIN
MARCH 7-8,1991

LIST OF ATTENDEES

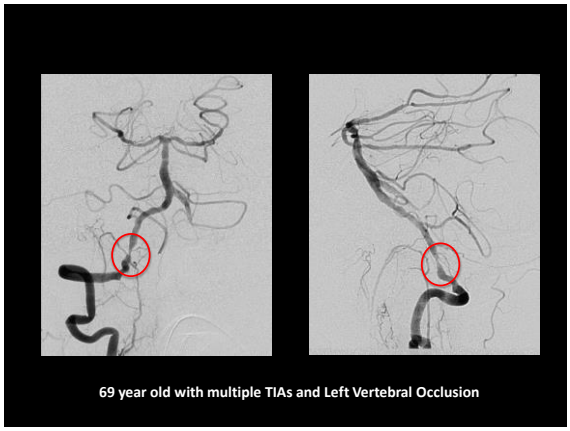
	Institution	March 7	March 8
Charles Strother, MD	Univ. of Wisconsin	X	X
Fernando Vinuela, MD	UCLA	X	X
Guido Guglielmi, MD	UCLA	X	X
Alex Berenstein, MD	NYU	X	X
Mary Madrid, RN	NYU	X	X
Gerard DeBrun, MD	Johns Hopkins	X	X
Van Halbach, MD	UCSF	X	X
Bob Ferguson, MD	Babtist, Memphis	X	X
Lee Gutterman, MD,PHD	Millard Fillmore,Buffalo	X	X
Doug Nichols, MD	Mayo Clinic		X
Daniel Ruefenacht, MD	Mayo Clinic	X	
Erik Engelson	Target Therapeutics	X	X
Charles Maroney	Target Therapeutics	X	X
Ivan Sepetka	Target Therapeutics	X	X
Laurent Schaller	Target Therapeutics	X	X
Terry Nazaroff	Target Therapeutics	X	X



NUMBER 9 IN THE WORLD TREATED

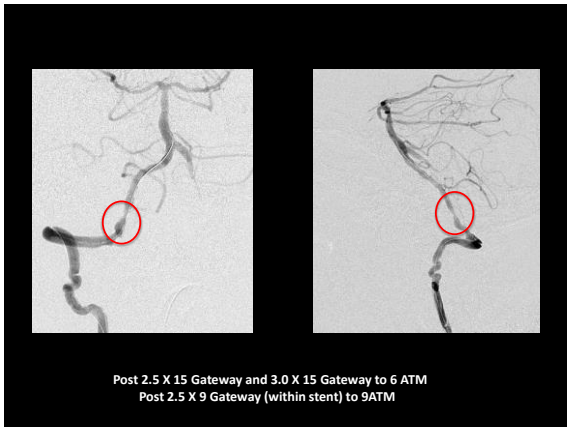
WITH GDC--UCLA

Full Utilization of Currently Available Imaging Tools Enhances Safety and Efficacy

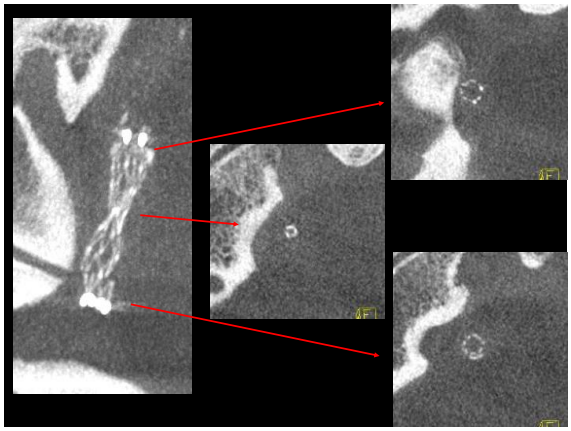


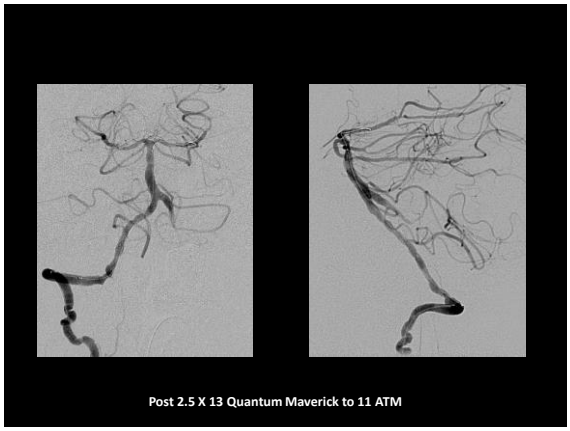
69 year old with multiple TIAs and Left Vertebral Occlusion

IMMEDIATE POST- STENTING

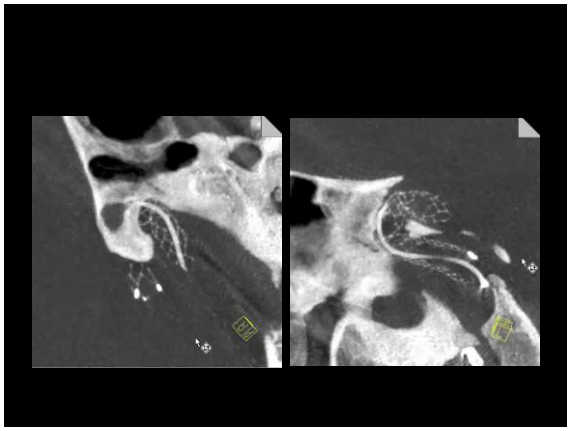


Post 2.5 X 15 Gateway and 3.0 X 15 Gateway to 6 ATM
Post 2.5 X 9 Gateway (within stent) to 9ATM




Post 2.5 X 13 Quantum Maverick to 11 ATM

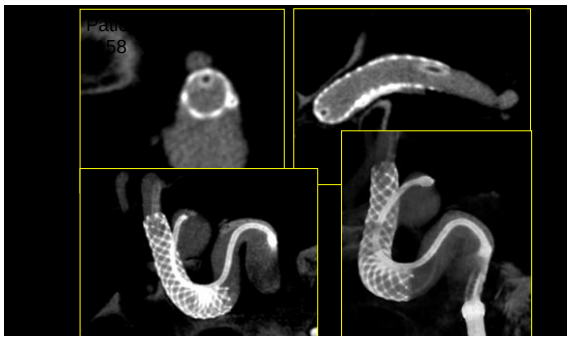

H
R
L
A
F



Low-Dose Volume-of-Interest C-Arm CT Imaging of Intracranial Stents and Flow Diverters

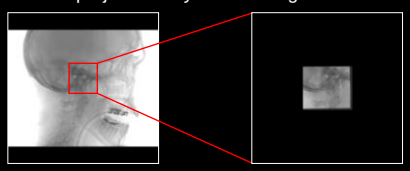
AJNR 2016; 37:648-54

P. Yang, A. Ahmed, S. Schafer, D. Niemann, B. Aagaard-Kienitz, K. Royalty, and C. Strother



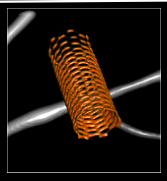
Dose Reduction: VOI Imaging in CBCT

- Tube is collimated to region of interest
- X-ray beam is projected only onto the region of interest



Full Head Scan VOI Scan

Collimation Reduces Dose to the Patient



Protocol:
20s DynaCT
496 images
FOV: 30cm x 40cm
~ 2,7 mSv

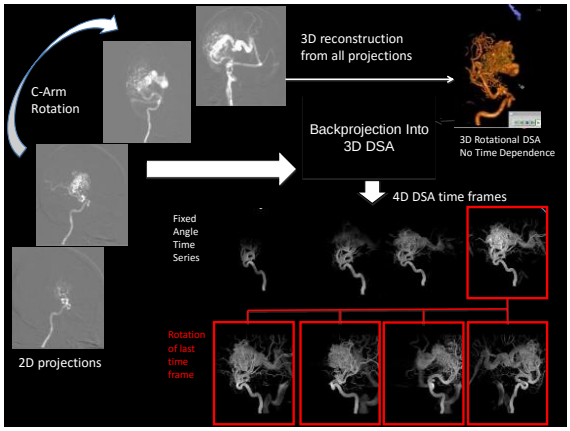
Protocol:
20s DynaCT
496 images
FOV: 22 x 22 cm
~0,9 mSv

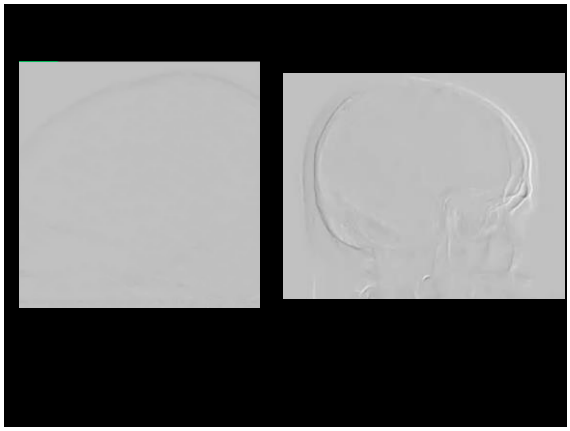
Protocol:
20s DynaCT
496 images
FOV: 5cm x 4 cm
~ 0,1 mSv

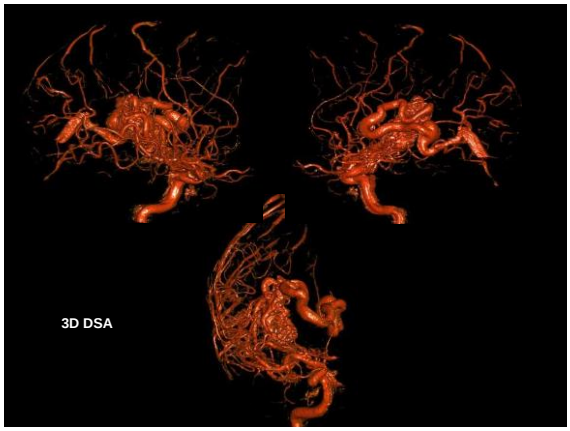
SEQUENT MEDICAL INC WEB EMBOLIZATION DEVICE

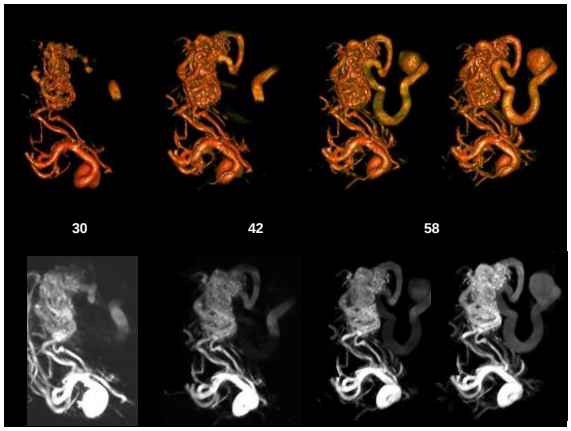

WEB PRIOR TO DETACHMENT
2 MM SLSICE
10 MM SLICE
MPR

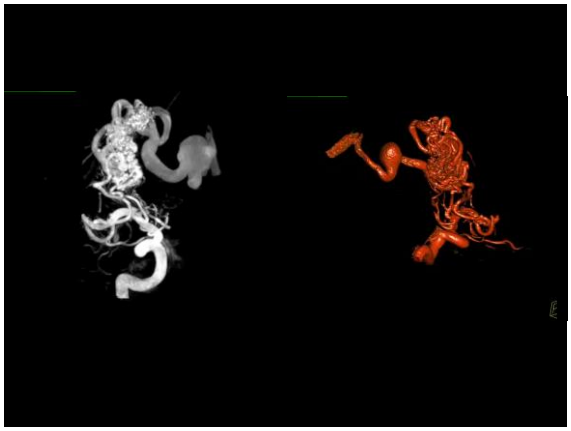
4D DSA


C-Arm Rotation
3D reconstruction from all projections
Backprojection Into 3D DSA
3D Rotational DSA No Time Dependence
4D DSA time frames
Fixed Angle Time Series
Rotation of last time frame
2D projections




3D DSA


30
42
58



A Preview of Current and Soon to be Available Cone Beam C-arm CT Imaging Techniques

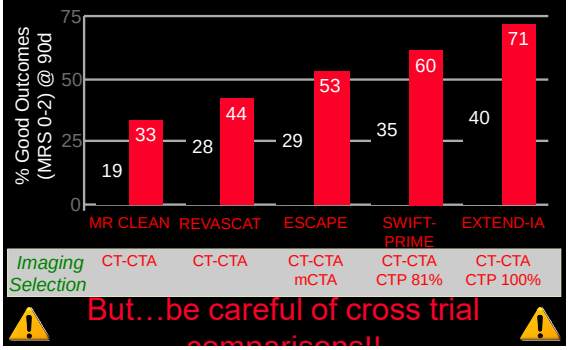
THE NEW ERA IN IMAGING AND TREATMENT OF ACUTE ISCHEMIC STROKE

Positive IV→ IA Stroke Trials in 2015

Trial	Treatment Timeline	Imaging Selection	Outcome IV Only	Outcome IV + IA
MR CLEAN N= 500 Berkhemer NEJM 2015	IV TPA by 4.5 hrs Wait for response Start IA by 6 hrs Puncture @ 260 min	CT - ASPECTS 7-10 CTA - Anterior clot CTP - done in 65% - details not reported	MRS 0-2: 19% Recan: 33%	MRS 0-2: 33% Recan: 75%
ESCAPE N= 316 Goyal NEJM 2015	Symptoms 0-12 hrs IV TPA by 4.5 hrs Puncture @ 185 min CT-reperfusion 84m	CT - ASPECTS 6-10 CTA - Anterior clot mCTA ≥ 50% MCA	MRS 0-2: 29% Recan: 37%	MRS 0-2: 53% Recan: 72%
EXTEND IA N= 70 Campbell NEJM 2015	IV TPA by 4.5 hrs → +/- IA by 6 hours Puncture @ 210 min	CT – IV TPA criteria CTA - Anterior clot CTP - 25% excluded Tmax>6s, rCBF<30%	MRS 0-2: 40% Recan: 34%	MRS 0-2: 71% Recan: 100%
SWIFT-PRIME N= 196 Saver NEJM 2015	IV TPA by 4.5 hrs → +/- IA Solitaire by 6h Puncture @ 224 min	CT – ASPECTS 7-10 CTA - Anterior Clot CTP - Target MM 84% Exclude malignant 13%	MRS 0-2: 35% Recan: N/A	MRS 0-2: 60% Recan: 88%
REVASCAT N= 206 Jovin NEJM 2015	IV TPA by 4.5 hrs → Wait 30 min; CTA/MRA +/- IA Solitaire by 8h Puncture @ 269 min	CT – ASPECTS 7-10 DWI - ASPECTS ≥ 5 CTA/MRA - Anterior Clot	MRS 0-2: 28% Recan: N/A	MRS 0-2: 44% Recan: 66%

Endovascular Trials 2015:

Good Outcomes with Advanced Imaging Selection



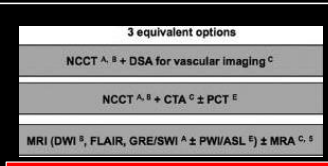
But…be careful of cross trial comparisons!!

Broad Consensus on Requirements of Imaging

- Must Be Done As Quickly As Possible
- Must Provide Information About Extent of Infarcted and Oligemic Brain
- Must Provide Information About Collaterals

Imaging Recommendations for Acute Stroke and TIA Patients: A Joint Statement by the ASNR, ACR, SNI

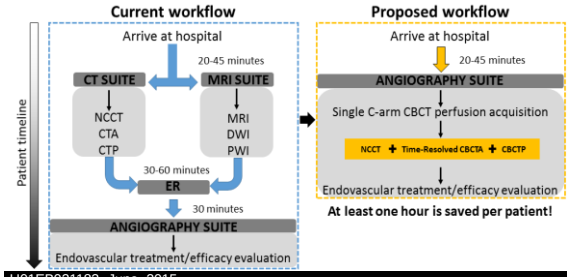
AJNR NOV 2013



Angiographic Suite With C-arm CT

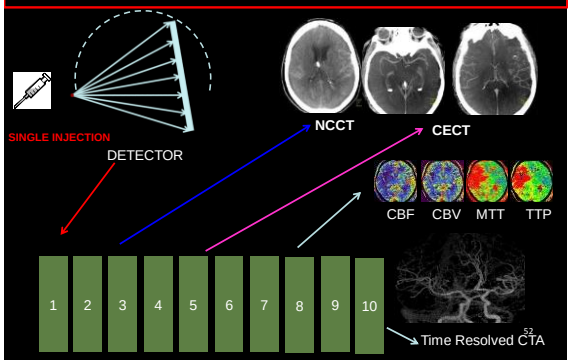
a To assess for intracranial bleeding
b To assess for extent of ischemic core
c To assess location and extent of intravascular clot
d To assess carotid atherosclerotic disease
e To assess the extent of viable tissue

"One-stop-shop" Stroke Imaging: A New Workflow



U01EB021183 June, 2015

WORKFLOW FOR COMPREHENSIVE IMAGING ANGIO SUITE: THE "ONE STOP SHOP"



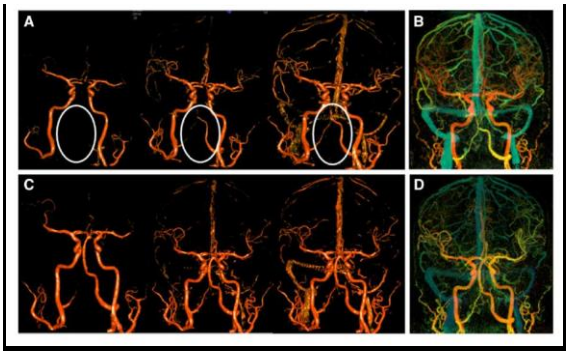
Time-Resolved C-Arm Computed Tomographic Angiography Derived From Computed Tomographic Perfusion Acquisition

New Capability for One-Stop-Shop Acute Ischemic Stroke Treatment in the Angiosuite

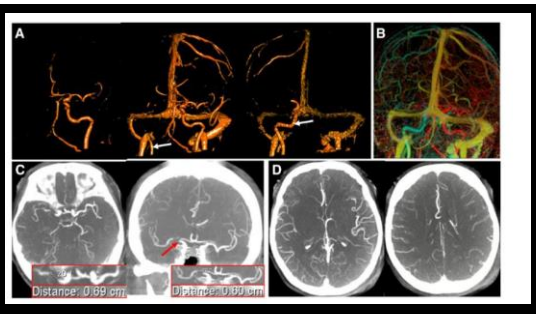
Pengfei Yang, MD; Kai Niu, PhD; Yijing Wu, PhD; Tobias Struffert, MD; Arnd Dorfler, MD; Sebastian Schafer, PhD; Kevin Royalty, PhD; Charles Strother, MD; Guang-Hong Chen, PhD

Stroke. 2015;46:3383-3389

***Conclusions*—Time-resolved CTAs derived from C-arm CT per acquisitions provide high quality images that allowed accurate diagnosis of large vessel occlusions.** Although image quality of arteries in this study was not optimal ongoing modifications of the postprocessing algorithm will likely remove this limitation. **Adding time-resolved C-armCTAs to the capabilities of the angiograph suite further enhances its suitability as a one-stop shop for ca patients with acute ischemic stroke.**



TIME RESOLVED CTAS OF PATIENT WITH MID BASILAR OCCLUSION BEFORE (TOP) AND AFTER (BOTTOM)



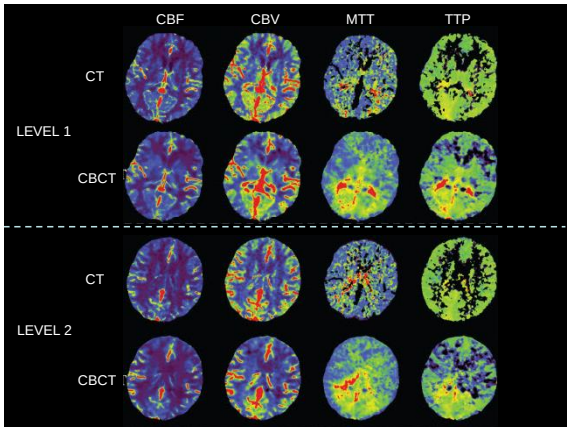
RIGHT ICA OCCLUSION. TEMPORAL MIP IMAGES SHOW ABILITY TO MEASURE CLOT BURDEN AND DIRECTION OF FLOW IN COLLATERALS.

C-Arm Conebeam CT Perfusion Imaging in the Angiographic Suite: A Comparison with Multidetector CT Perfusion Imaging

K. Niu, P. Yang, Y. Wu, T. Struffert, A. Doerfler, S. Schafer, K. Royalty, C. Strother, and G.-H. Chen

AJNR 2016; 37:1301-1309

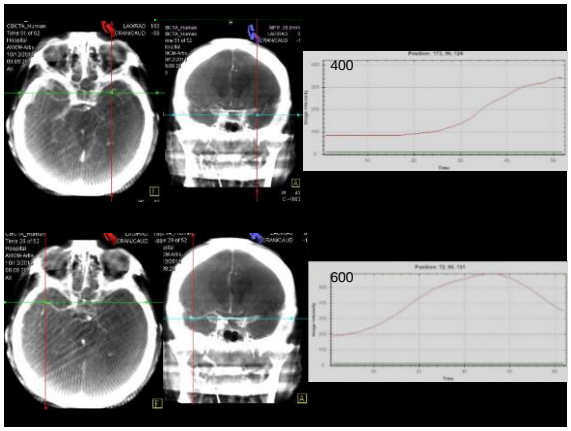
CONCLUSIONS: After postprocessing methods were applied to enhance image quality for conebeam CT perfusion maps, the conebeam CT perfusion maps were not inferior to those generated from multidetector CT perfusion.

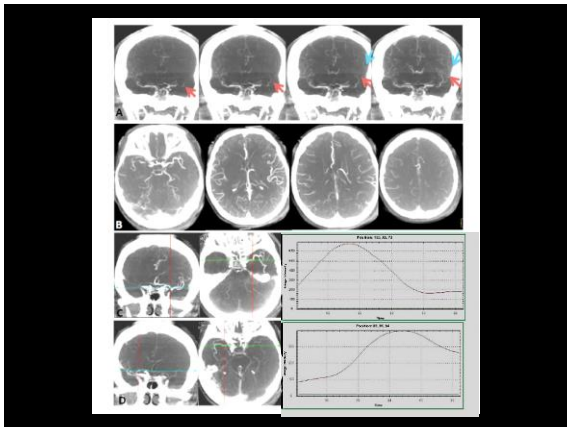


Evaluation of collaterals and clot burden using time-resolved C-arm Cone beam CT angiography I the Angio-suite: a feasibility Study.

Yang P, Niu K, Yijing W, Struffert T, Doerfler A, Holter P, Aagaard-Kinitz, Strother, C, Chen G-H. AJNR In Review

Conclusions: Comprehensive evaluations of clot burden and collateral flow are feasible using time-resolved C-arm CBCTA data acquired in the angiosuite. This technique further enriches the imaging tools in angiography suite to enable a "One Stop Shop" imaging workflow for patients with AIS.





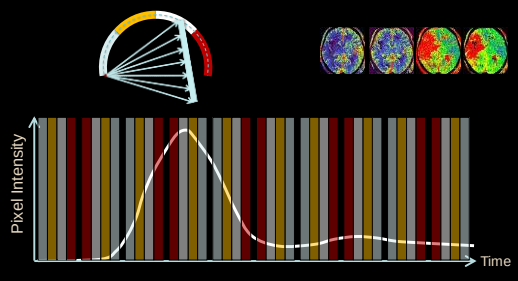
Major Challenges in the "One-stop shop" Workflow

Limitted low contrast resolution as compared to MDCT

Limitted temporal resolution as compared to MDCT

61

SMART-RECON in CBCT Perfusion



THANK YOU