CT Angiography
CTA

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Neuroradiology
- The Fun and Easy Way to use CTA and CTP
- Your First Aid Kit for Reconstructions on Workstation
- Creating Your First Shaded Surface Rendered Image in Plain English
- How to get reimbursement
- How to finance 16 slice CT scanners
Clinical Use of CTA & CTP

- Fast diagnosis of major vessel occlusion in a stroke patient
- Fast diagnosis of the presence of an aneurysm
- Screening of carotid stenosis
CT & CTA

- CT: Most accessible neurological imaging modality

- Fast, efficient and minimally invasive way to look at brain and neck vessels

- Suitable for high volume institutions
CT Angiography

1. Fast, thin section volumetric spiral CT examination

2. Performed with a time-optimized bolus of contrast

3. Reformatting of cross sectional images (raw data → source images)

4. Postprocessing and 3D imaging
CTA

• Can be performed in minutes

• Downside: uses radiation and intravenous contrast
NEW CT TECHNOLOGY

Light Speed
- 16 slice / multislice
- 4,000 programmable protocols
- 3D image processing and display
- Perfusion, advanced vessel anal.
- Dynamic scan: 960 scans/minute
- Image reconstruction time: 6 fps

• Year product introduced: 2002

Light Speed
- 4 slice / multislice
- 4,000 programmable protocols
- 3D Image processing and display
- Perfusion, advanced vessel anal.
- Dynamic scan 240 scans/minute
- Image reconstruction time: 6 fps

• Available since 1998
CT Study for Stroke
16 slice scanner can do it all

- NCCT
- CT PERFUSION
- CT ANGIOGRAPHY
Clinical Aspects

CTA - MRA

CTA
- Fast, needs less sedation
- Less invasive than DSA
- All ERs have CT
- Life support etc
- Less expensive than MRA

MRA
- No radiation
- Information regarding flow direction
- (DWI)

Downsides:
- Radiation
- Uses contrast
- No flow directions

Downsides:
- Difficult if monitors or life support
- Sedation
- Long examination time
CTA study

• The value of CTA and MRA depends significantly on secondary reconstruction possibilities
CTA Postprocessing

- **Image reformatting**, performed by techs at the scanner console is the recomputation of raw CTA image data into source images with varying slice thickness, interslice spacing and display FOV.

- **Reconstructions** refers to the creation of 2D and 3D models from CTA data sets for purposes of diagnosis and communication to referring clinicians.
CTA Postprocessing

2D
- MIP: maximum intensity projection
- Curved reformat
- MPR: Multiplanar reformat

3D
- SSD: Shaded surface display
- VR: Volume rendering
CTA Postprocessing

**MIP** (maximum intensity projection)
- Most commonly used
- Useful for rapid detection of vascular discontinuities
- Part of standard software
- Loss of information; only single layer of the brightest voxels are displayed
- “depth” information is lost

**VR** (volume rend.) - “the best”
- Groups of voxels within defined attenuation thresholds selected
- Transparent images; opacity assigned

**SSD** (shaded surface display)
- First layer of voxels within a defined thresholds used for display
- “depth” information preserved but “attenuation” information lost
Advantage of Multisection CT for vascular imaging of stroke patient

Less than 20 seconds
• Intracranial vessels
• Carotid bifurcations
• Origins from aortic arch

Perfusion CT
• 4 detectors: 2cm slab
• 16 detectors: 3 cm slab
  – Whole brain CTP is not yet possible
Imaging Protocol
for Lightspeed multislice scanner

• 1st group: C-1/2 to vertex
• 2nd group: Arch to C-1/2
• Contrast: IV: 120 cc nonionic contrast, 3 cc/sec, 25 sec delay
• Computer merges both groups
• MIP reformatted images constructed within minutes
CTA -- MRA

MRA
- Flow direction
- Does not visualize collateral flow

CTA
- Shows collateral flow
- Does not show flow direction

CTA and MRA are complementary tests
Neck Vessels

MRA vs CTA

- **PC** (2D/3D)
  - Velocity dependent. Needs specification for VENC (arterial vs venous flow) and flow direction (left-to-right, right-to-left, s/i, a/p)

- **2D TOF**
  - Antegrade flow. Saturation pulse to minimize the retrograde flow (including jugular vein)

- **CE MRA**
  - T1 WI, does not take in account the flow direction or velocity. Uses rapid bolus of Gd
    - 3D TOF
      - for circle of Willis

- **CTA-one technique**
New need: 3D Lab Service

- Since late 1990s
- MGH (June 2003)
  - Processed 67 exams/day
    - 47 were neuro CTA/MRA studies and
    - 20 nonvascular 3D CT and MRI exams
3D post-processing
by experiences tech

- It takes 45-60 minutes for head/neck CTA post-processing (source images and MIPs are available “immediately”)

- Full training of a tech took two months
Normal Anatomy
Various ways to look at the Anatomy in CTA

• 2D
• 3D
Normal Anatomy
IC-EC Graft, curved reformatted image
Curved reformatted image
Curvature Reformatted Image
Tracing The Vessel
Vertebrobasilar Analysis

MPR

MIP

SSD
Analysis of Carotid bifurcation
34 year old with headaches
Venous angioma
Saphenous IC-EC Graft
Clinical Use of CTA & CTP

- Fast diagnosis of major vessel occlusion in a stroke patient
- Fast diagnosis of the presence of an aneurysm
- Screening of carotid stenosis
CT Perfusion

• IV bolus of contrast

• Changes of brain tissue attenuation monitored during the 5 second transit time with high-temporal resolution dynamic CT
CT Perfusion

- 40 cc bolus of contrast IV
- Semiautomated postprocessing
- TTP, CBF, CBV in less than a minute
TIA vs Stroke

- NC CT
- CTA with contrast: Perfusion window ("CBV")
TIA vs Stroke

- DWI
- Perfusion MRP: MTT
CTA

- Source image
- MIP
CTA

MIP vs 3D

- **MIP** — Ca++ marked with arrows. Residual lumen not visualized.

- **3D VR** — demonstrates Ca++ and lumen
91 y/o with stroke

- Perfusion window
  (poor man’s perfusion study, CBV)
CTA, MIP

- Patient underwent IA thrombolysis with good initial result
Acute Stroke

- NCCT
- MIP
CTA, Stroke
1 year follow-up

- Initial CTA
- Recanalized vessel
Acute Stroke

- CECT
- Source image
CTA

Curved reformat images
Acute Stroke

• Basilar artery
CTA
75 y/o with stroke
Acute stroke

- NCCT

- CT perfusion window
Acute stroke

- 3/3/03 NCCT
- Follow-up

- 3/2/03 perfusion window
- Initial CTA
CTA Embolus

MIP
CTA

Stroke; 77 y/o Female

- Source

- MIP
Acute Stroke

- DWI
- ADC
Acute Stroke

- MTT
Clinical Use of CTA & CTP

- Fast diagnosis of major vessel occlusion in a stroke patient
- Fast diagnosis of the presence of an aneurysm or other vascular lesion
- Screening of carotid stenosis
Orbital Trauma a Week Ago
Proptosis

• CECT
CTA
video reversal
ICH
CTA
Aneurysm

- Noncontrast CT
- Source image
CTA
Aneurysm

• Coronal MIP

• MIP; magnified
CTA
Surface Rendered Image
3D Image
SAH
CTA
ruptured aneurysm

- Surface rendered
- MIP
CTA
basilar tip aneurysm
CTA
• Aneurysm

• 3D SSD
CTA
Aneurysm
CTA
Aneurysm

- MIP, mag
CTA
Aneurysm

• Source image

• MIP
CTA
Postprocessed images

• Curved reformat

• Surface rendered
CTA
72 y/o with TIA vs stroke
Clinical Use of CTA & CTP

- Fast diagnosis of major vessel occlusion in a stroke patient

- Fast diagnosis of the presence of an aneurysm

- Screening of carotid stenosis or other vascular lesions
Neck Vessel CTA

- Arch

RCCA
CTA

78 y/o with dizziness and abnormal US

- R/O glomus jugulare tumor.
  Abnormal US

- MIP
Carotid Dissection

Curved reformatted image

- Source image
CTV

- Contrast enhanced CT
- CTV
CTV
The End

Thank You