CT of the Head, Spine, and Cerebral Vessels

Objectives

- Determine specific imaging plane used to acquire or reformat CT scan, i.e. sagittal, coronal, transverse, and off-axis or oblique.
- Assess and evaluate CT scans for use of contrast media.
- Differentiate between normal anatomy and pathological processes.
- Critique CT scan for proper positioning, acquisition methods, parameter selections, and any protocol modifications.
- Investigate methods to reduce radiation during CT procedures.

TYPE OF STUDY

1. Head, Spine, and Musculoskeletal

A. Head
1. temporal bones/internal auditory canal (IAC)
2. pituitary fossa
3. orbits
4. sinuses
5. maxillofacial and/or mandible
6. temporomandibular joint (TMJ)
7. base of skull
8. brain
9. cranium
10. brain perfusion

B. Spine
1. cervical
2. thoracic
3. lumbar
4. sacrum/coccyx
5. post myelography
6. discography

C. Musculoskeletal
1. upper extremity
2. lower extremity
3. bony pelvis and/or hips
4. shoulder and/or scapula
5. sternum and/or ribs
6. arthrography

FOCUS OF QUESTIONS

Questions about each of the studies listed on the left may focus on any of the following relevant factors:

Anatomy
- imaging planes
- pathological considerations/recognition
- protocol considerations
- patient considerations (e.g., pediatric, geriatric, bariatric)
- post-processing presentations
- landmarks

Contrast Media
- indications
- scan/prep delay
- effect on images

Additional Procedures
- vascular (CTA, CTV) (e.g., PE, dissection, runoff, venogram)
- biopsies
- drainages
- aspirations

(Procedures continue on the following page.)

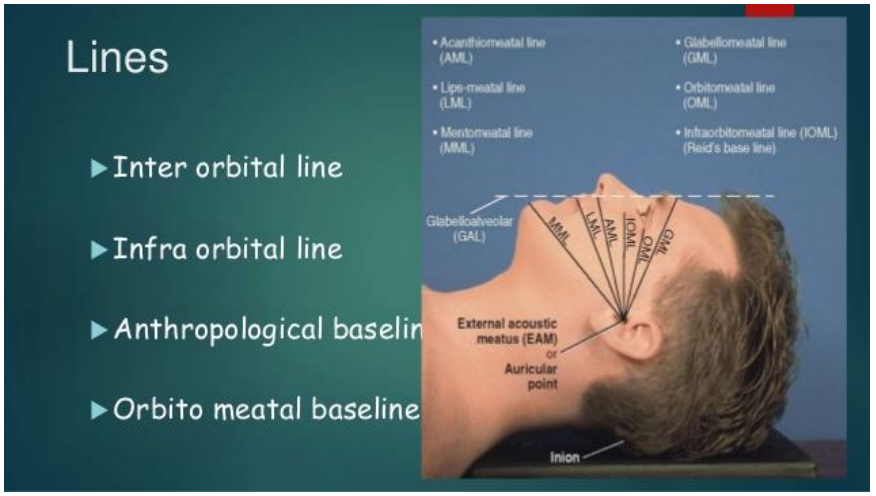
Patient Preparation

- Metallic objects
- Fasting
- Empty bladder
- Patient anxiety
- Contrast injection
- Medications
- Comfort
- Eyes (laser positioning light)

Challenging Patients

- Combative or uncooperative patients
- Body fluid protection

Scanning Protocols - Head



http://www.slideshare.net/sajithroy/positioning-of-skull

- IOML line
- Transverse plane
  - Reformats - thin slices
- Direct coronals
  - Sinuses (air-fluid levels)
  - Temporal petrous bones/IACs/Sella turcica
- Algorithm (kernel)
- Contrast enhancement

Head Positioning

- Center the patients head in the gantry
- Identify patients
- Select protocol
- Scout
- Scan range: Base of skull/C1-vertex

Head Scan

- Axial vs. helical
- SFOV: 25 cm, 50cm (sometimes)
- 120 kVp
- 200-600 mAs
- Slice thickness: 5mm

Head Scan

- Pitch single: 1-1.7
- Pitch: multi-detector: .7-1.0
- Gray/white matter: WL: 35; WW: 80-100
- Bone: WL: 400; WL 3000
- Hemorrhage/Hematoma: WL: 75; WW 150

Head Scan

- Annotate
- Non contrast vs. contrast
- Contrast: 75-150 ml
- Infused with power injector
- Delay

Head and Face

- CT is valuable for assessing intracranial pathological conditions, especially in the acute stage:
  - Cerebral infarction
  - Hemorrhage
  - Aneurysm
  - Hematoma
  - Trauma
  - Infection
  - Tumors
  - Congenital defects

Infarction

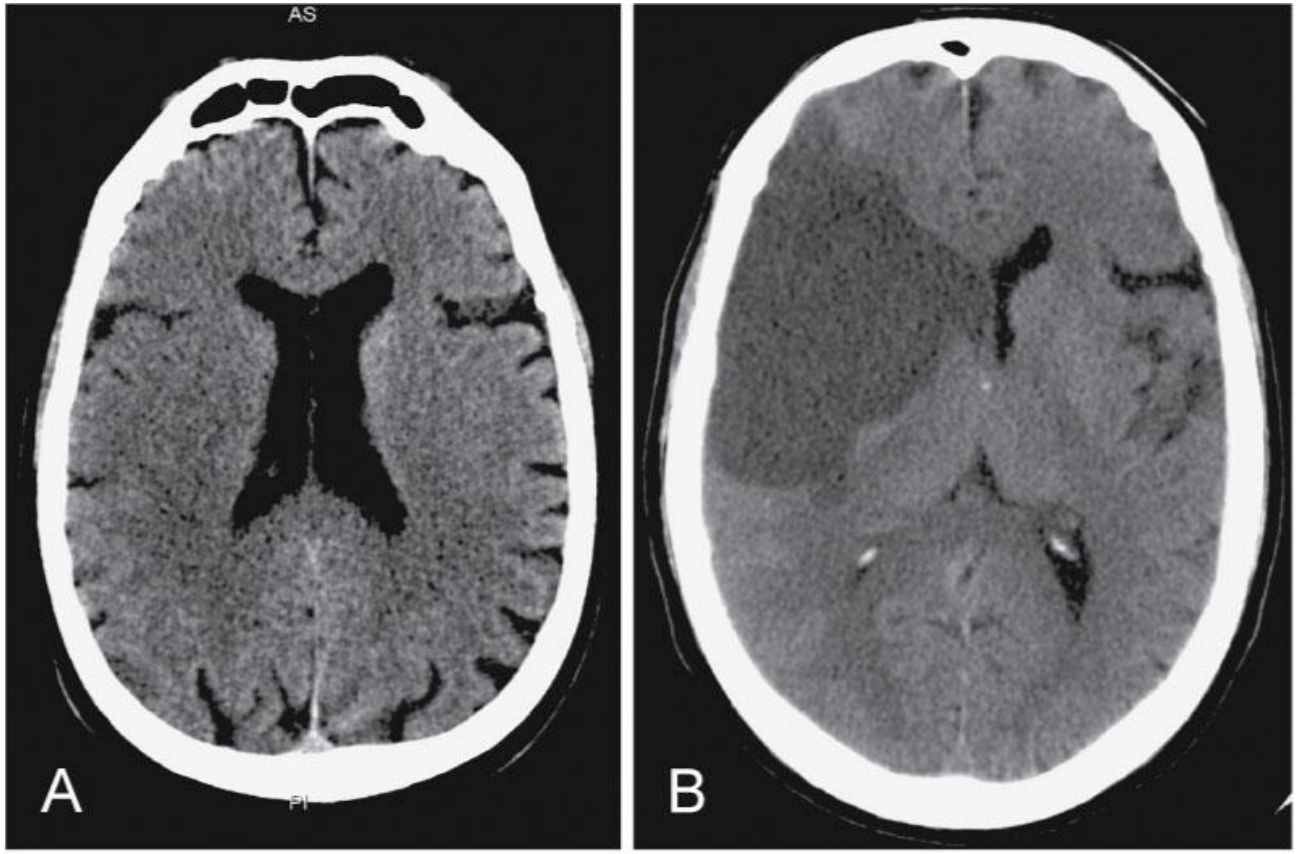


Figure 17-1 **A,** Early subtle infarction. **B,** Late well-defined cerebral infarction. Subtle loss of the distinction between the gray and the white matter is present on the early CT, in the right middle cerebral artery territory, with good delineation of the affected area on the later CT.

Hematoma

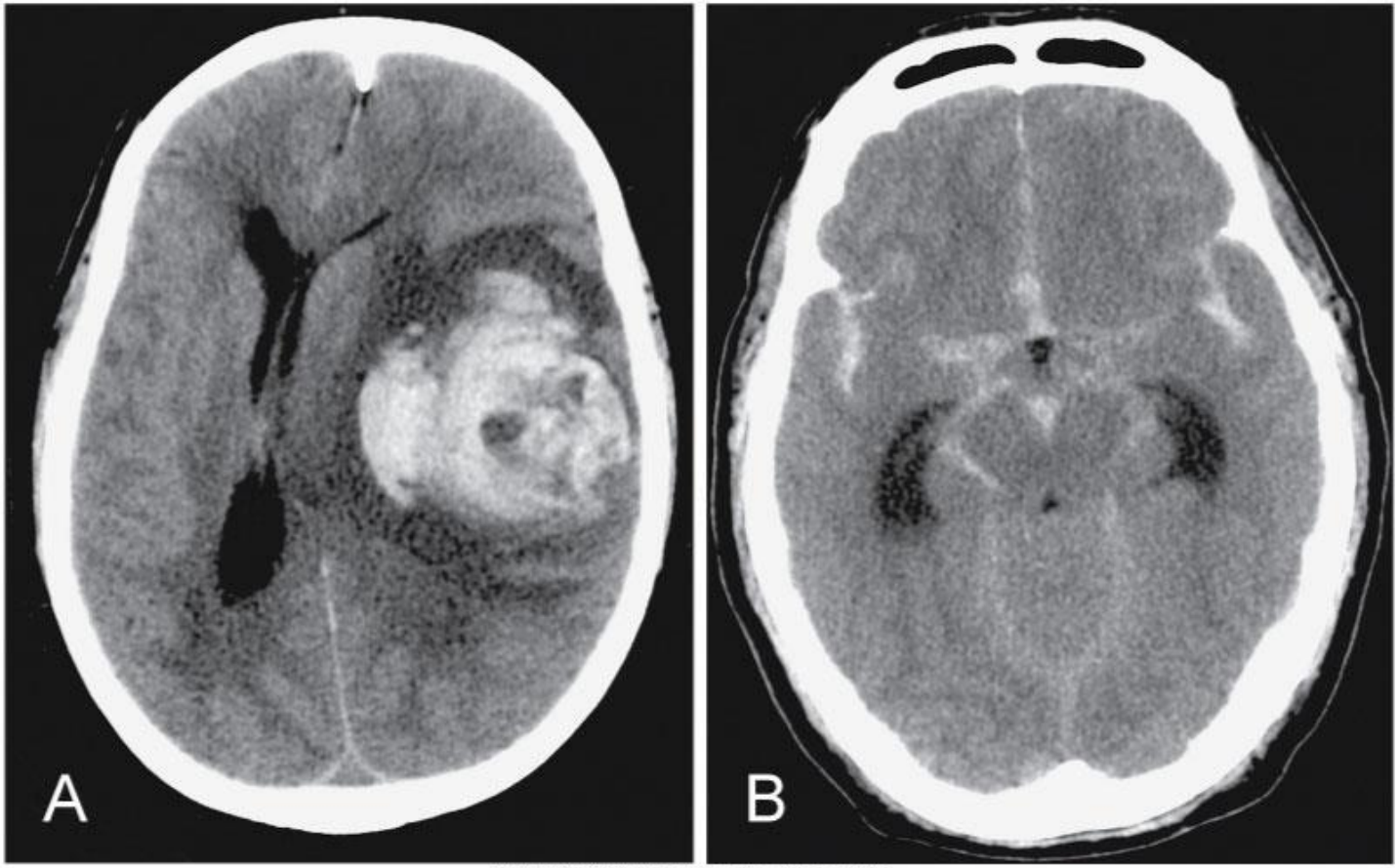


Figure 17-2 **A,** Large left parenchymal hematoma causing a marked midline shift to the right. **B,** Severe subarachnoid hemorrhage outlining all the cisterns of the skull base.

Metastasis

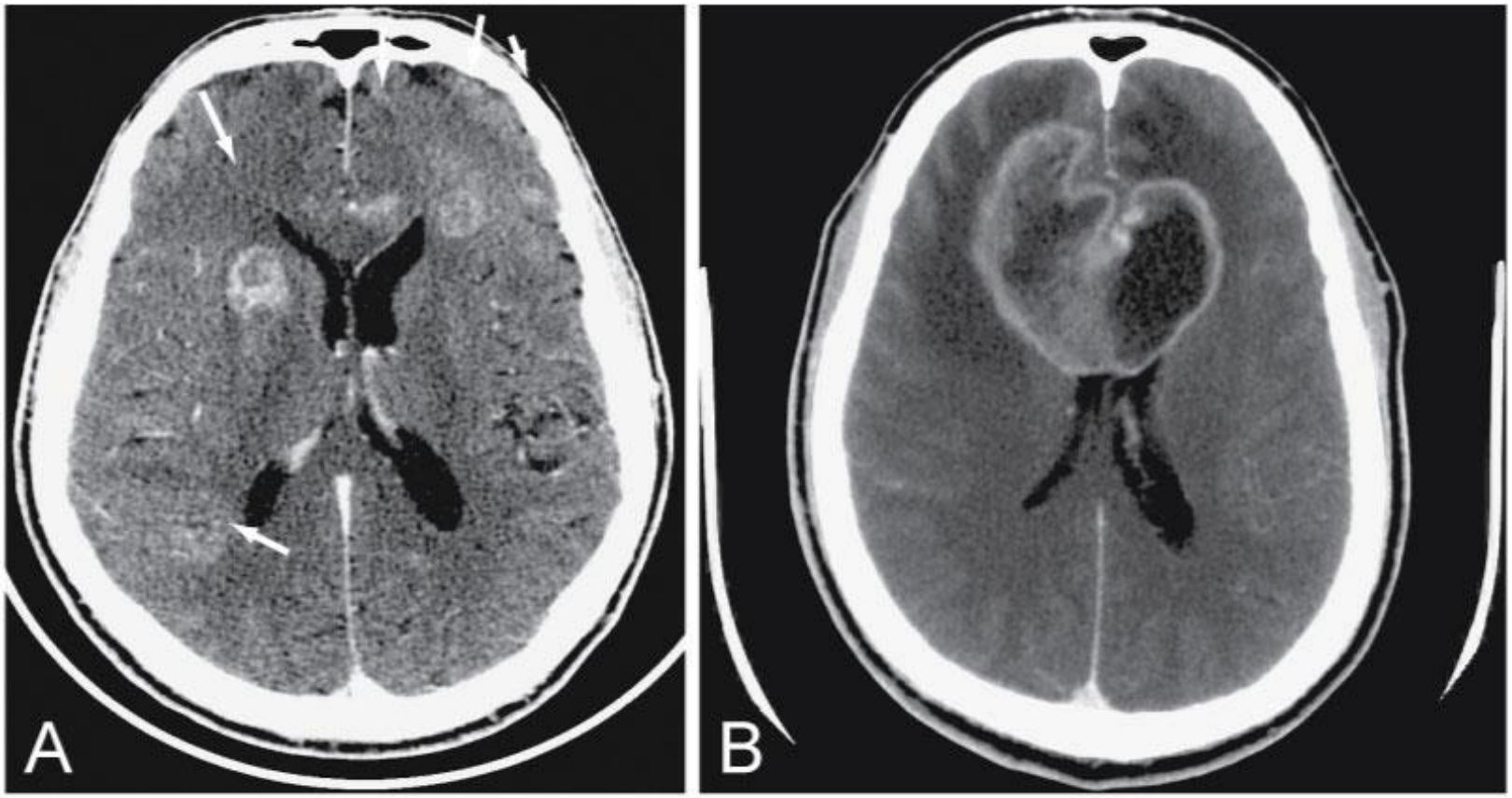


Figure 17-4 **A,** Multiple ring enhancing metastases in both frontal lobes. **B,** Enhancing bifrontal (butterfly) GBM; it is surrounded by edema, causing mass effect on the frontal horns.

Other Conditions in the Head and Face

- Sinus disease
- Mandible
- Orbits
- Trauma
- Pituitary
- IACs

Orbits

- Axial Plane
- Thin 1-3 mm parallel to IOML
- Direct coronals perpendicular to axial plane
- Soft tissue: WL 40; WW 400
- Bone: WL 400; WW 3000
- IV contrast

Sinuses/Facial Bones

- Axial images parallel to hard palate or direct coronal perpendicular to the axial plane
- Include all sinuses; facial bones region of interest
  - TMJ 1-3mm (open and closed mouth)
- Coronal plane best visualizes the osteomeatal complex
- Soft tissue: WL 40; WL 400
- Bone: WL 400; WW 3000
- Contrast

Sinuses

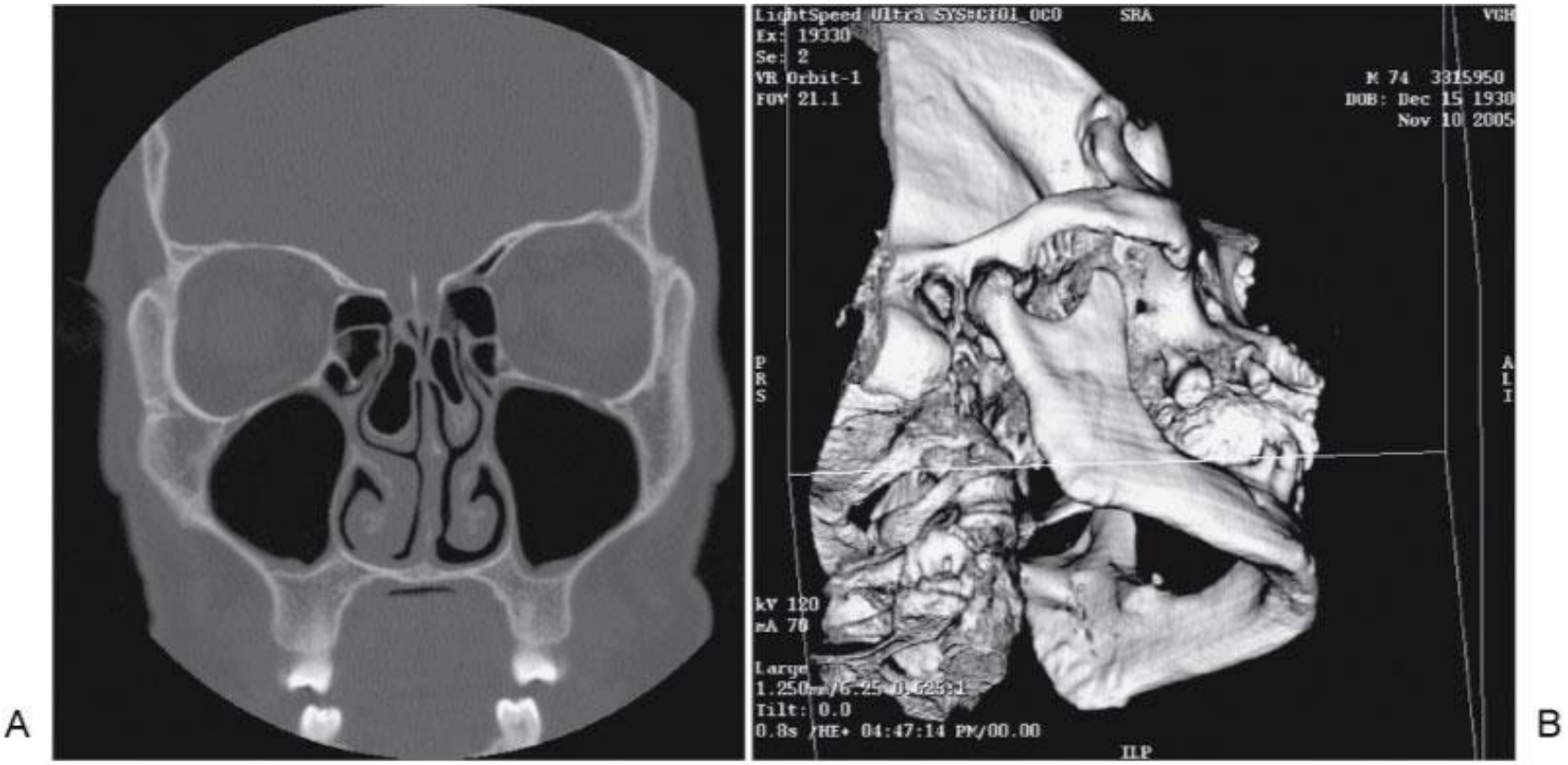


Figure 17-6 **A,** Paranasal sinuses obtained prone to better see the drainage pathways of the maxillary sinuses (known as the ostia). **B,** Reformatted three-dimensional image of the mandible. The image can be rotated on the computer to evaluate all the margins of this curved bone.

Trauma

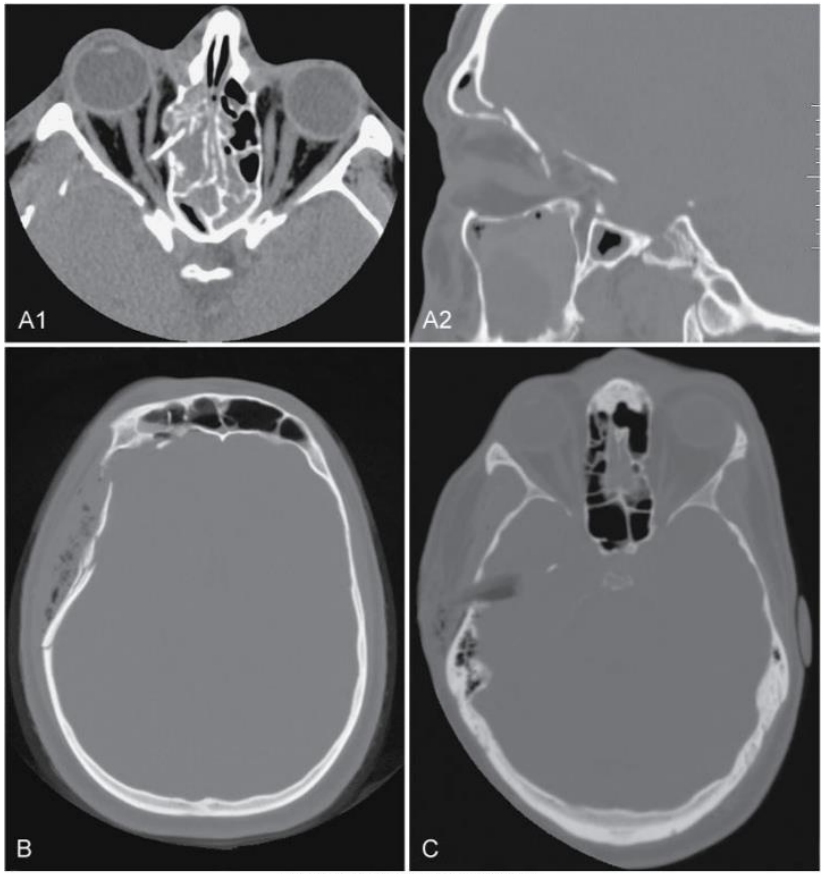


Figure 17-3 **A,** Orbital roof fractures; the transverse image on orbit settings shows the bone fragment spearing the right medial rectus muscle and the sagittal image on bone windows shows the rotation of this fragment. **B,** Comminuted depressed skull fracture with subcutaneous emphysema and fluid in the right frontal sinus. **C,** Wooden stick piercing the right temporal bone and lobe, displacing a fragment of bone into the brain, better appreciated on wide windows (it mimics air on routine brain windows, not shown).

Pituitary and IACs

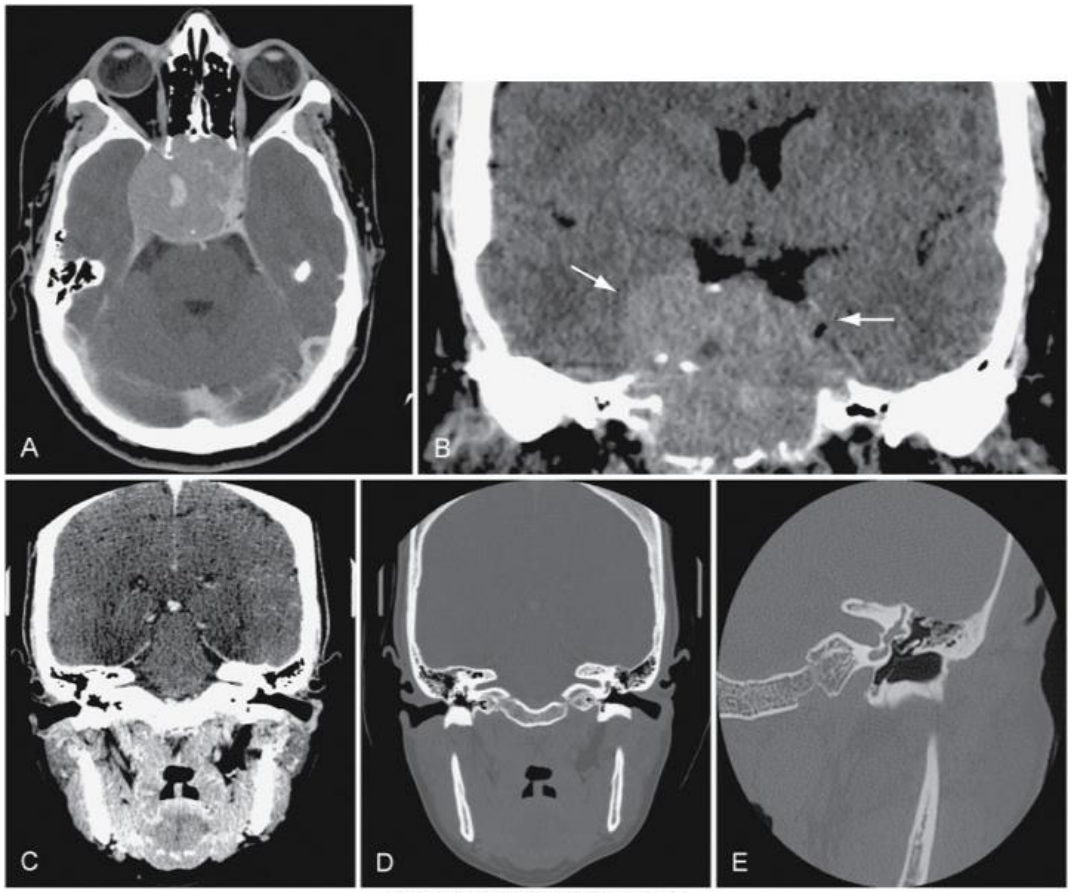


Figure 17-7 **A** and **B,** Very large pituitary adenoma, filling the sphenoid sinus but not abutting on the optic chiasm, imaged in transverse plane and reformatted in coronal plane. **C** and **D,** Direct (i.e., with neck extension) coronal images of the internal auditory canals (IAC), on soft tissue **(C)** and bone **(D)** algorithms. **E,** Left petrous bone, acquired in direct coronal plane, showing the ossicles in the middle ear, surrounded by air.

Spine

- Trauma
- Masses/tumors
- Infections
- Arthritis
- Scoliosis

Spine

- Compliment to radiographs
- Reformats excellent view of alignment and vertebrae
- Trauma vs. routine
- Arms extended down
- Remove metal
- Hold still, no swallowing or breathing.

Spine

- Place patient in the center of table
- Scan Range:
  - C-spine: EAM through T1
  - T-spine: area of interest
  - L-spine: L2-S1
- Lateral laser light mid coronal plane of spine

Spine

- kVp 120-140
- mAs 250-350
- Slice thickness: 2 mm
- Slice interval: 2 mm
- Pitch: .75-1.25

Spine

- Slice thickness: .75-1.25
- Reconstruction: 3-5 mm
- SFOV: 48-50 cm
- DFOV: 10-15 cm
- Pitch: .75-1.25
- Contrast:
  - 100-125 mL; 2-3 mL/sec

Cervical spine

- Matrix 512 x 512
- Standard algorithm:
  - WW 400
  - WL 50
- Bone algorithm
  - WW 2000
  - WL 300

Fractures

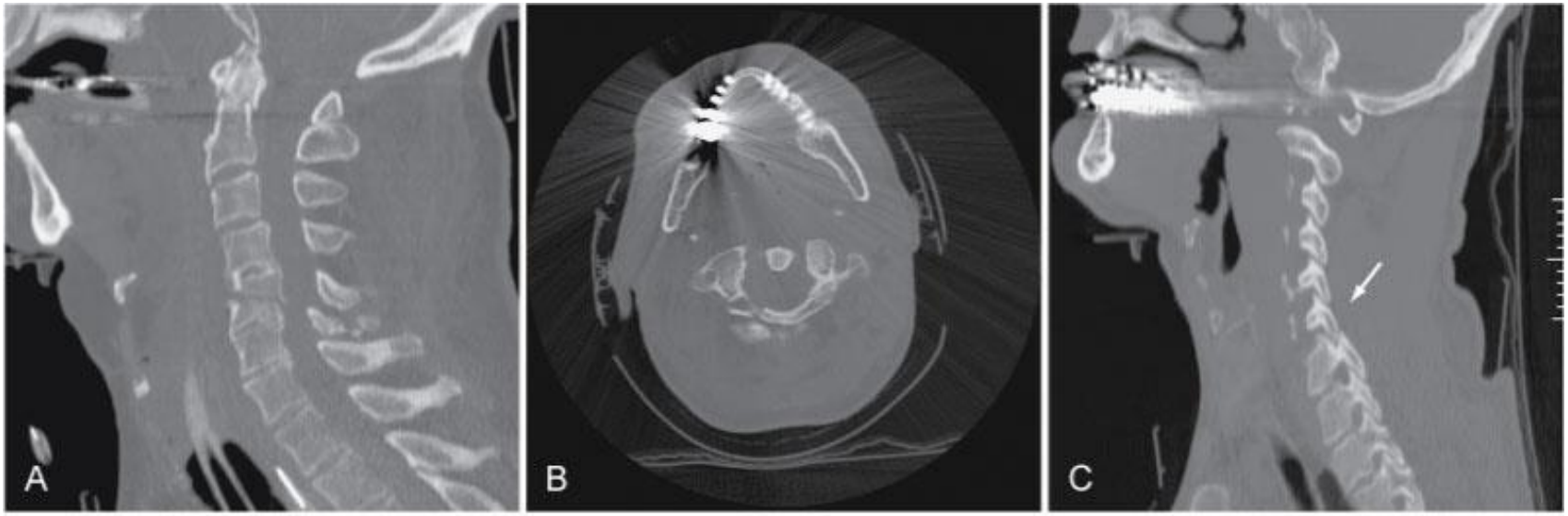


Figure 17-10 **A,** Reformatted image of the cervical spine showing fractures of C2 and C5. Multiple spinal fractures are not uncommon. **B,** Metal causes streak artifacts but still demonstrates the C1 fracture. **C,** Alignment is a critical component of spinal assessment. A facet lock is present.

Myelogram

- Intrathecal administration-subarachnoid space

- Spinal cord, nerves, soft tissue structures

Cerebral Blood Vessels

- CT Angiography
  - Stenosis
  - Thrombosis
  - Cerebral infarction
    - CT perfusion

CT Angiography (CTA)

- Technical requirements
  - Patient preparation
  - Acquisition parameters
  - Contrast medium administration

  - Image postprocessing techniques
    - Mulitplanar reconstruction
    - Maximum intensity projection
    - Volume rendering
    - Interactive cine

Brain Angiography

- Cranial blood vessels (Circle of Willis)
- Contrast: 75-100 mL; 3-4 mL/sec.
  - Delay: 12-20 seconds
- Thin sections: .5-1.5 mm; helical
  - Thin sections reconstructed with minimum of 50% overlap
- Reconstructions:
  - MIP
  - MPR
  - 3-D

Radiographic Technique

- mA, kV, helical pitch, rotation time
- Slice thickness
- Matrix size
- Reconstruction algorithms

Brain Perfusion

- Level of blood flow within the brain, evaluates the perfusion of contrast through vessels of the brain
  - Cerebral blood volume (CVB)
  - Cerebral blood flow (CBF)
  - Mean transit time (MTT)
  - Central Volume Principle
- Contrast:
  - Precontrast scan
  - CTA brain and carotids
    - 50 mL at 4-7 mL/sec.

Carotid CTA

- Used to evaluate carotid arteries
- Slice Thickness: .5-1.5 mm; helical
- Aortic arch-base of skull
- mA minimal: 300-400
- kVp: 80-100
- Contrast: 50-75 mL; 3-4 mL/sec; delay 15-18 seconds
- Thin sections: 50% overlap

CTA of Carotid Bifurcation

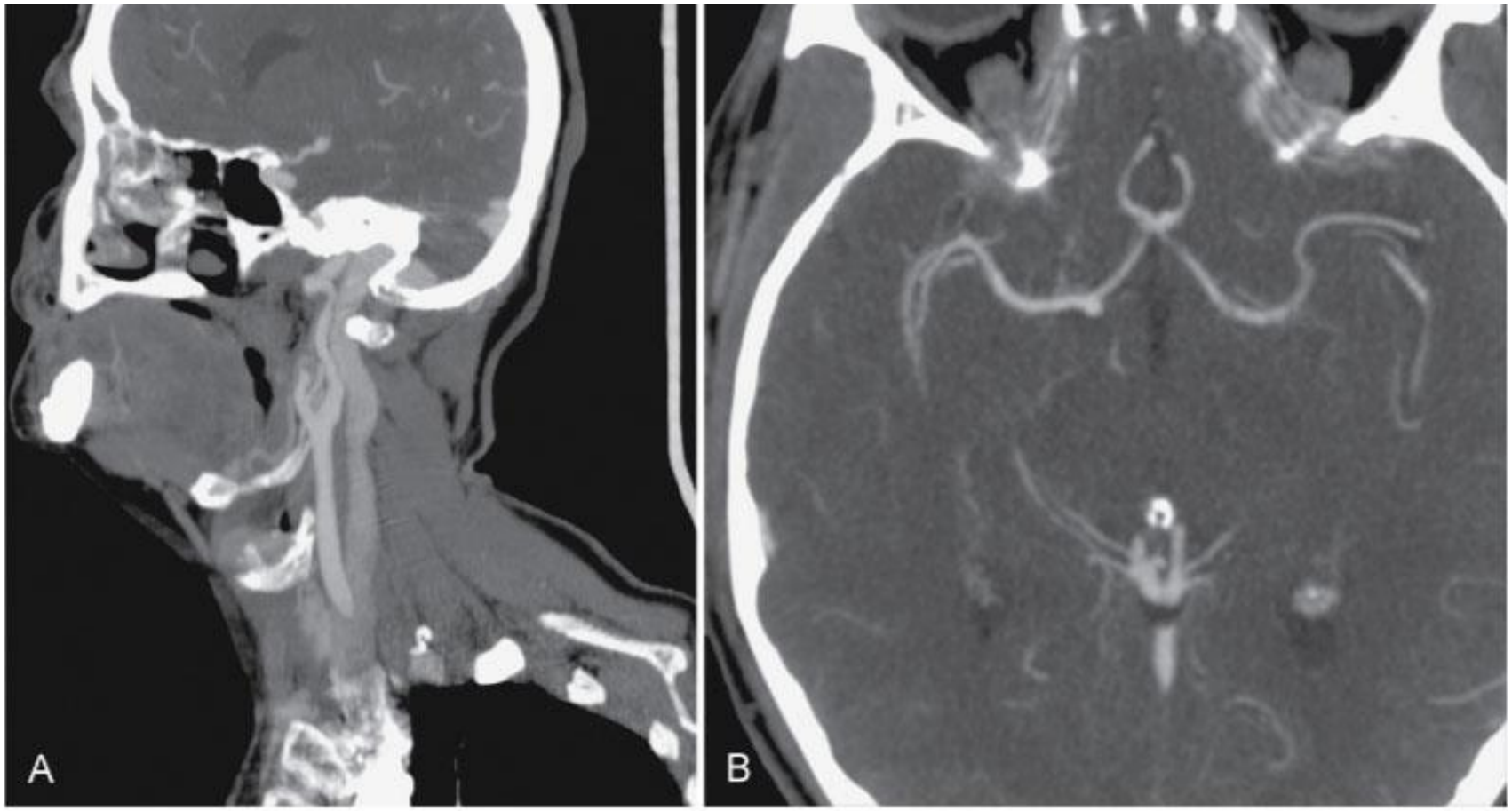


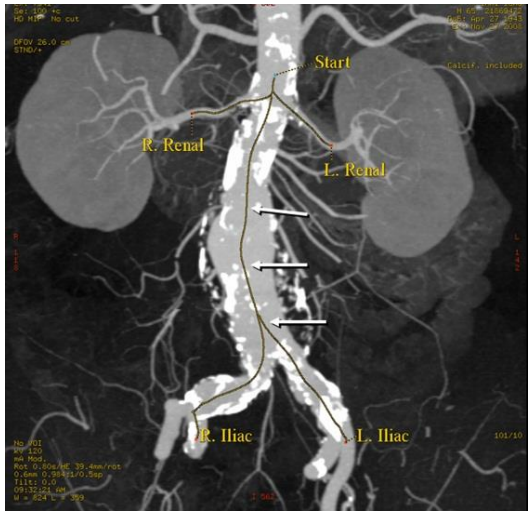
Figure 17-8 **A,** Normal CTA of the common carotid bifurcation, showing the Y-shaped arteries and the large jugular vein posterior to it. **B,** Normal CTA of the circle of Willis, showing the anterior communicating artery and both middle cerebral arteries.

Angiography

- Replacing conventional angiography
- Reconstruction in multiplanar sections
- Imaging of hepatic, renal, messentric, iliac, and femoral arties
- Contrast and timing
- Positioning

Angiography

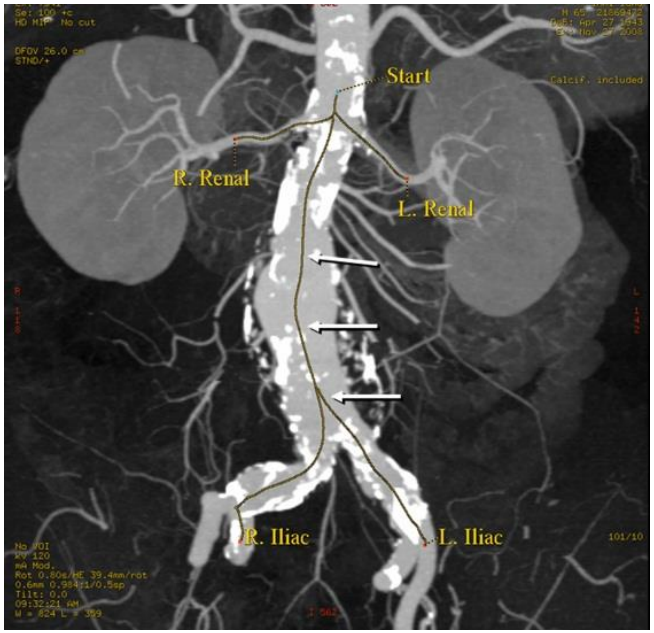
- Mid chest through symphysis
- Spiral: .625 mm; 50% overlap
- SFOV
- DFOV



https://www.intechopen.com/books/aneurysm/abdominal-aortic-aneurysm-in-different-races-epidemiologic-features-and-morphologic-clinical-implica

Angiography

- kVp: 80-120
- Auto mA; .5-.8 seconds
- MPR, MIP, and VR



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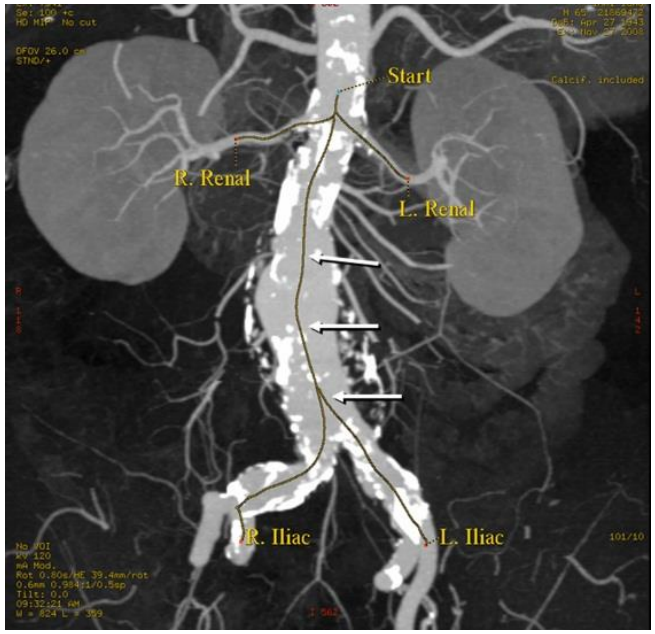
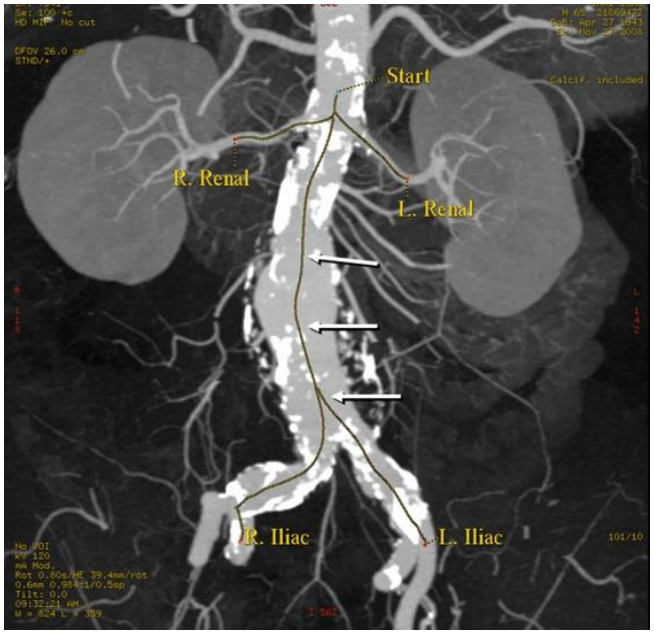
Angiography

- Post processing
- Reformations



Run-off Angiography

- Diaphragm-below ankles
- kVp: 100
- Auto mA; .5-.8 seconds
- MPR, MIP, and VR



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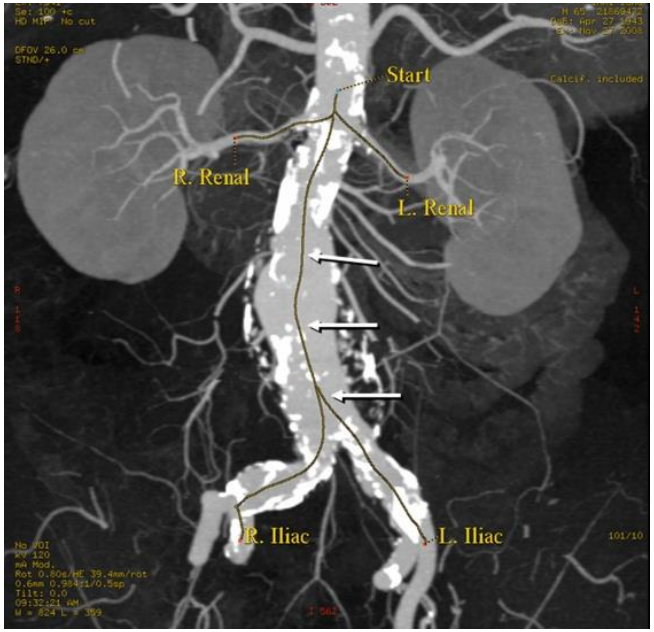
Angiography

- CTA timing
- Trigger: 125-150 HU
- Injection rate: 4-5 mL/second
  - 12-40 second delay
- Amount: 125-175 mL



- https://www.intechopen.com/books/aneurysm/abdominal-aortic-aneurysm-in-different-races-epidemiologic-features-and-morphologic-clinical-implica

CT Runoff Angiogram

(Images courtesy Dr. Mike Martin, Vancouver Hospital.)

Figure 18-23 CT runoff angiogram demonstrating the entire vascular tree from the aorta to the lower calves. 3D reconstruction of the aorta and iliac arteries **(A).** Maximum intensity projection image of the thighs **(B)** demonstrating a femoral graft on the right (arrow) replacing the occluded superficial femoral artery. Maximum intensity projection image of the calves **(C)** demonstrating that the graft *(arrow)* has been anastomosed to one of the runoff branches. Most of the bony structures have been segmented and removed. (Images courtesy Dr. Mike Martin, Vancouver Hospital.)

Musculoskeletal System

- Protocols tailored to each of the different anatomical regions of the musculoskeletal system
- Tailor to the problem
- CT used to visualize bony abnormalities in correlation with plain radiographs
- Precise positioning is important
- When possible both unaffected and affected sides structures assessed for comparison
- Indications: masses/tumors, trauma, osteomyelitis

Musculoskeletal System

- Supine/prone/oblique
- Feet or head first
- Extremity centered

Examination Preparation

- Spiral
- SFOV 25 cm
- DFOV 12 cm or smaller
- Departmental protocols

Examination

- Matrix 512 x 512
- kVp 120-140
- mAs 180-220
- Slice thickness
- Reconstruction 1.25 mm and interval of 0.6
- Departmental protocols

http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-36162016000500489&lng=es&tlng=en

Examination

- Pitch .5-1.0
- Bone algorithm
  - WL 300; WW 2000
- Soft Tissue
  - WL 50; WW 400
- Reconstruction

http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-36162016000500489&lng=es&tlng=en

Examination

- Direct axial
- Oblique axial
- Sagittal
- Coronal

http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-36162016000500489&lng=es&tlng=en

Arthrography

- Evaluation of joint after an injection of contrast into the intra-articular joint space
- Detail of soft tissue structures
- Contrast: administration into joint space
  - .5-10.0 mL
  - Double contrast

References

- Seeram, Euclid, 2016. Computed Tomography Physical Principles, Clinical Applications, and Quality Control. Elsevier, 4th Ed.
- Demaio, D. MEd. RT (R), CT 2018. Mosby's Exam Review for Computed Tomography. Elsevier. 3rd ed.