CT Procedures and Anatomy

Cross Sectional Anatomy – Overview & CT imaging Procedures - Introduction
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Overview Cross-Sectional Anatomy
- Head & Neck
  - Brain
  - Vasculature
- Spine
  - Cervical
  - Thoracic
  - Lumbar
- Body
  - Chest
  - Abdomen
  - Pelvis
  - Vasculature
  - Musculoskeletal
    - Upper extremities
    - Lower extremities

Head
CT Images
MRI Images

Cranial Bones & Brain Lobes

Brain Anatomy: Mid-Sagittal

What separates the lobes?
Sylvian Fissure or Lateral Fissure,
Separates the Frontal lobe from the parietal lobe
Inside is the 5th lobe of the brain, the "Insula" & the MCA

Midline Sagittal
Axial CT Image
Brain Specimen

Midline Sagittal
CT Image

Midline Sagittal reformat
Para Sagittal reformat

Para Sagittal
Axial
Coronal

Cranial Bones
Frontal Parietal Occipital Temporal
Cerebellum
Midline Sagittal CT Image

Cerebellum
Parietal
Frontal
Occipital

Occipital bone
Frontal bone
Parietal bone

Frontal lobe
Parietal lobe
Occipital lobe
Temporal lobe
Sylvian fissure (insula located within)

Sylvian fissure or Lateral fissure,
Separates the Frontal lobe from the parietal lobe
Inside is the 5th lobe of the brain, the "Insula" & the MCA

Tentorium... separates cerebellum from cerebral

Longitudinal Fissure
Right and Left lobes
(inside is the Falc Cerebri)
Brain Anatomy: Gray & White Matter

- White Matter
- Gray Matter

Brain Anatomy: Corpus Callosum

- Corpus Callosum (genu)
- Corpus Callosum (body)
- Corpus Callosum (splenium)

Fractional Anisotropy

- FA = 0, 0, 1

Brain Anatomy: Brain Stem

- Cerebral peduncles
- Pons
- Medulla Spinalis

Brain Anatomy: Midline Structures

- Anterior horn
- Lateral ventricle
- Thalamus
- Third ventricle
- Pituitary gland
- Olive

- Hint: we know that we are in the midline when we see the spinal cord

- Hint: we know that we are in the midline when we see the pituitary and sella Turcica
**Brain Anatomy: Para-Sagittal**

- Maxillary Sinus
- Teeth
- Parietal lobe
- Occipital lobe
- Sulci
- Gyri
- Maxillary Sinus
- Teeth
- Parietal lobe
- Occipital lobe
- Cortex
- Temporal Lobe
- Cerebellum

**Coronal Plane**

- Coronal slice more anterior
- Coronal slice more posterior
- Coronal slice very posterior

**Coronal Facial Bone Anatomy**

- Ophtalmic canal
- Ethmoid plate
- Orbit roof
- Nasal conchae
- Zygoma
- Maxilla
- Mandible
- Fracture

**High Resolution Brain Protocol**

- Lateral & AP Scout: 120 kv, 80 ma, 50 fov
- Axial: 120 kv, 220 ma, 28cm fov
- 512 x 512 matrix
- 1-3 mm to frontal sinus
- Perpendicular to floor of maxillary sinus
- Perpendicular to table gantry
- Straight
- 9 mm to top of head
- 5mm / 5mm through fossa
- 8-9mm entire head
- 125 W 55 L Head
- Bone windows:
  - Coronal: 120 Kv, 220 ma, 16-20cm fov
  - 3 mm to frontal sinus
  - Angled perpendicular to mandible
  - 250 W 30 L (soft tissue)
  - 2000 W 350 L (bone)

**Coronal Through Pituitary Gland**

- Optic chiasm
- Pituitary gland
- Septum pellucidum
- Temporal lobes

**Brain Anatomy Coronal Posterior**

- Cisterna Amiens
- W/Pineal gland
- Cerebral aqueduct
- 4th ventricle
- Cerebellum
Imaging Planes

Axial – SLICE # 1

An angled with base of skull

Axial – SLICE # 2

Axial – SLICE # 3

Axial – SLICE # 4

Axial – SLICE # 5

Brain Anatomy: Axial Superior

This red line indicates the location of the axial slice

Brain Anatomy: Axial @ Ventricles

Brain Anatomy: Axial Basil Ganglia

Brain Anatomy: Axial @ Ventricles

White Matter Tracts
Posterior Cerebral Arteries (right & left)

Anterior Cerebral Circulation - Axial (Circle of Willis)

CTA-Rapid Brain Protocol

Circle of Willis - CTA

Head Veins
Overview Cross-Sectional Anatomy

- Head
  - Anterior Circulation
  - Posterior Circulation
  - COW (circle of Willis)
- Neck
  - Carotid Arteries
  - Vertebral Arteries

Carotid Arteries – Sagittal

Vertebral Arteries – Sagittal

Carotid Arteries – Sagittal

Carotid Arteries – Sagittal
Overview Cross-Sectional Anatomy

- Head
  - Anterior Circulation
  - Posterior Circulation
  - COW (circle of Willis)

- Neck
  - Carotid Arteries
  - Vertebral Arteries

Protocol for Neck

- AP & Lat scout
  - 120 kv, 80 ma, 50 cm FOV
- Axial
  - 120 kv 280 ma
  - 512 x 512 matrix
- Scan frontal sinus to carina - include mandible
- Contrast
  - 100 cc’s non-ionic 240-300 mg/ml
  - 2 cc/sec for 20g cath
  - Delay scan 70 second post injection
  - 250 W 30 L (soft tissue)
  - 2000 W 350 L (bone)

Scan Planning

- AP & Lateral Scout
  - 120 kv, 80 ma, 50 cm FOV
- Axial
  - 120 kv, 420 ma
  - 512 x 512 matrix, 24 cm FOV
  - 1 mm from the arch to above the frontal sinuses
- Contrast if 100-120cc’s non-ionic 300-350 mg/ml
- 3 cc/sec for 20g angiocath
- Delay scan 15-20 sec post injection
- Usually reconstructed to a field of 128mm

CTA-Rapid Neck Protocol

- AP & Lateral Scout
  - 120 kv, 80 ma, 50 cm FOV
- Axial
  - 120 kv, 420 ma
  - 512 x 512 matrix, 24 cm FOV
  - 1 mm from the arch to above the frontal sinuses
  - Contrast if 100-120cc’s non-ionic 300-350 mg/ml
  - 3 cc/sec for 20g angiocath
  - Delay scan 15-20 sec post injection
  - Usually reconstructed to a field of 128mm

Image Comparison in the C-spine

- Lateral radiograph
- Sagittal CT
- Sagittal T1 MRI
Overview musculoskeletal Anatomy - TMJ

Localizer for sagittal oblique sections
Localizer for coronal oblique sections

Sagittal Oblique TMJ
Coronal Oblique TMJ

Temporal bone
Fossa
(meniscus within)
Mandibular-condyle
Mandible

Shoulder radiograph
Corocoid vs coronoid...
"There's a sea (C) between two Nations"

Sagittal reformatted CT Lateral radiography (Elbow)
Shoulder radiograph
TMJ 3D CT reformatted image
Shoulder CT
Sagittal MR Elbow

Anatomy Musculoskeletal System

Shoulder
• Shoulder
  – Scapula
  • Spine of the scapula
  • Acromion process
  – Clavicle
  • Head of the humerus
  • Greater tubercle
  • Lesser tubercle

The lumps and bumps of the shoulder

• Shoulder
  – Scapula
  • Spine of the scapula
  • Coracoid process
  – Clavicle
  • Head of the humerus
  • Greater tubercle
  • Lesser tubercle

Reformatted CT Image shoulder

Surgical Fixation

AC Joint
Clavicle
Rib

Surgical Fixation

Overview musculoskeletal Anatomy - Shoulder

Median Line
Midline Sagittal Plane
Parasagittal Planes

Frontal Or Coronal Plane

The sagittal oblique plane is acquired along this dotted red line, parallel to the glenoid fossa

The coronal oblique plane is acquired along this dotted red line on the axial shoulder image. Parallel to the supraspinatus muscle & tendon or perpendicular to the glenoid fossa
Structures of the rotator cuff …(SITS)

Axial MR Image

Supraspinatus
deltoid
Teres Minor
Subscapularis

Trapezius
Deltoid
RC (S.I.T.S.)
Supraspinatus
Infraspinatus

Axial MR Image

Coronal oblique MR Image

Muscles, Tendons & Ligaments of the Elbow Joint

Humerus
Olecranon process
Joint space
Trochlea
Capitellum
Coronoid process
Ulna

Trapezius
Deltoid
Rotator cuff
Humeral Head
Humeral Head
Glenoid fossa
Glenoid rim
Scapula
Humerus

Axial MR Image

Sagittal Oblique Shoulder

Coronal oblique MR Image

Sagittal Oblique Elbow

Coronal oblique MR Image

Elbow

Humerus
Olecranon fossa
Capitellum
Humero- ulnar joint
Humero-radial joint

"Cap on Head" (Capitellum on the head of the radius)
**Anatomy Musculoskeletal System**

Slide # 97

- Hip
- Acetabulum
- Ilium
- Ischium
- Pubis
- Femoral Head
- Femoral Neck
- Greater Trochanter
- Lesser Trochanter
- Femoral Shaft

**Bony anatomy of the HIP**

Slide # 98

- Acetabulum
- Ilium
- Ischium
- Pubis
- Femoral Head
- Femoral Neck
- Greater Trochanter
- Lesser Trochanter
- Femoral Shaft
- Obturator foramen

**BONE METS**

Slide # 99

- Compressed vertebral body
- Related to the pelvic bone

**Hips & Pelvis**

Slide # 100

- Femoral Head
- Femoral Neck
- Greater Trochanter
- Lesser Trochanter
- Femoral Shaft

**Structures of the HIP**

Slide # 101

- Femoral Head
- Femoral Neck
- Greater Trochanter
- Lesser Trochanter
- Femoral Shaft

**NAVEL**

Slide # 102

- Nerve
- Artery
- Vein
- Empty space
- Lymph nodes
- Quadriceps Muscle
- Iliacus Muscle
- Psoas Muscle
- Rectus Abdominis
- Bladder
Anatomy Musculoskeletal System

Knee Bones of the Knee

Coronal knee MRI

Axial knee

Femur

Patella

Patellar-
femoral joint

Knee Joint

Tibia

Fibula

Bones of the Knee

Femur

Patella

Patello-femoral joint

Knee Joint

Tibia

Fibula

Lower Extremity Anatomy

Mid sagittal slice (MRI)

Para sagittal slice (MRI)

Patellar ligament

Locations of the lateral collateral ligaments

Femoral condyles

Meniscus (posterior horn, lateral meniscus)

Patella

Tibia

Fibula

Muscles of the Knee

Hamstring muscles

Quadriceps Tendon

Attaches the quadriceps muscles

Gastrocnemius muscles

Meniscus and other structures of the knee

Lateral aspect of the patello-femoral joint

Lateral retinaculum

Anterior horn of the meniscus

Posterior horn of the meniscus

Medial collateral ligament

Lower Leg Fracture

Fracture

Fracture

AP Scout

Lat Scout

Lower Leg Fracture
Anatomy Musculoskeletal System

Foot and ankle bones - Come To Cuba Next Christmas

Tibia
Fibula
Come... (calcaneus)
To ... (talus)
Cuba (cuboid)
Next... Navicular
Christmas ... (3 cunei)

Ankle Ligaments and Tendons

Tibia
Fibula
Mortise joint
Medial collateral ligaments
Lateral collateral ligaments

Review, Peripheral Vascular Anatomy

Abdominal Aorta
abdominal aortic aneurysm
Iliac Arteries
Femoral Arteries
Popliteal Arteries
Trifurcation
(anterior tibial)
(posterior Tibial)
(Pernoneus Brevis)

Hand Vasculature

What Do We Do With All The Images?

- View Images
- Scroll Through
- Window / Level
- Magnification
- Post Processing

Basic Tasks
**Imaging Planes**

**CT Images**
- Median Line
- Mid-sagittal Plane
- Parasagittal Planes
- Transverse or Axial Plane

**MRI Images**
- Sagittal Reformat
- Axial

**Chest Coronal, Heart & Lungs**

**CTA**
- CTA
- Heart
- Lungs

**Enhanced Coronal CT**
- Enhanced Coronal CT
- Sagittal Coronal Reformat

**MRI**
- Sagittal
- Axial
- Coronal

**Chest Coronal, Vasculature**

**CTA**
- Pulmonary Arteries
- Pulmonary Veins

**Enhanced Coronal CT**
- Pulmonary Arteries
- Pulmonary Veins

**Coronal MRI**
- Pulmonary Arteries
- Pulmonary Veins

**Chest Coronal, Lungs & Airway**

**CTA**
- Upper lobe of the right lung
- Upper lobe of the left lung
- Lower lobe of the right lung
- Lower lobe of the left lung
- Bronchi - corona

**Coronal CT**
- Middle lobe of the right lung
- Reminder there is no middle lobe because of the heart!

**Coronal MRI**
- Middle lobe of the right lung
- Reminder there is no middle lobe because of the heart!

**Chest Coronal Muscles of the Chest**

**Axial CT**
- Pectoralis muscles
- Heart Muscle

**Coronal CT**
- Latissimus
- Intercostal Muscles
- Diaphragm

**Coronal MRI**
- Diaphragm
- Heart

**Sagittal Chest – “Candy Cane Shot”**

**Aortic Arch**
- Aortic Arch

**Ascending & Descending**
- Ascending & Descending

**Heart**
- Heart

**Sagittal MRI**
- Sagittal MRI
Axial chest

Axial slice #1
- Pectoralis Muscle
- Aortic Arch
- Latissimus Muscle
- Spine (vertebral body)
- Pulmonary arteries
- Pulmonary veins
- Descending Aorta
- Heart

Axial slice #2

Axial slice #3

Basic “Vanilla”
Thorax Protocol

- AP Scout
  120 kv, 60 ma, 50 cm FOV
- Axial
  120 kv, 180 ma,
  36 cm FOV (fit anatomy)
  512 x 512 matrix
generally 5mm
1500 W & 500 L (lung windows)
450 W & 30 L (mediastinal windows)
30 sec (or less) breath-hold
can be modified

Lung Nodule - MDCT

Evaluation of Stent Placement

3D rendering of normal lung
MDCT evaluation of airway stent after chemical injury

Heart anatomy

Heart flow
Pulmonary veins & SVC (Superior vena cava)
RA (right atrium)
Tr
Rv
P valve
Pa
Lang
Lp
Lt
Ao
Aortic valve
Ao – coronary arch
Aortic Arch – the “A, B, C’s”

Ascending aorta
Coronaries
Brachiocephalic (aka innominate)
right common carotid
right subclavian
right vertebral
Left common carotid
Left subclavian
Left vertebral

Coronary Calcifications

- Calcium is an indicator for a disease artery (CAD)
- Calcification in the coronary artery reveals the condition of coronary arteriosclerosis
- Leads to heart attacks

Grossly calcified left coronary artery

Situs Inversus

Cross Sectional Abdomen

Abdomen Images

Imaging Planes
Axial Abdomen

Approximate Slice location
- Liver
- Spleen
- Pancreas
- Kidneys

Axial CT image
Axial MR image

Sagittal Abdomen

Approximate Slice location
- Thoracic Spine
- Liver
- Pancreas
- Lumbar Spine
- Aorta
- Bowel
- Sacrum
- Coccyx
- Bladder

Sagittal CT image
Sagittal MR image

Basic “Vanilla” Abdomen & Pelvis Protocol

- AP Scout
  80 kv 120 ma
  50 cm FOV
- Axial
  120 kv, 220 ma,
  36 fov (fit anatomy)
  512 x 512
  5mm – 8 mm
  500 W & 50 L
  30 sec breath-hold
  can be modified

Renal Calculus (Stones)

- No oral contrast
- No IV contrast
- Run to the bladder For ureters
Non-Contrast Pathology

Trauma

Basic “Vanilla” Abdomen & Pelvis Protocol with sprinkles

- AP Scout
- Axial
  120 kv, 220 ma,
  36 fov (fit anatomy)
  512 x 512
  generally 5mm
  500 W & 50 L
  30 sec breath-hold
  can be modified
- Post contrast
  IV Contrast if 100 cc’s
  non-ionic 300 mg/ml
  2 cc/sec for 20g angiocath
delay scan 60-70 seconds
- Oral –
  gastrografin 30 per 1 liter water
  Barium (dilute for CT) 32 oz

“See Spot Run In..”

(Abdominal Vasculature)

(Celiac, SMA, Renals (right & Left), IMA)

Coronal CTA Image

Coronal MRA Image

Coronal CTA Image

Coronal MRA Image

Coronal CTA Image

Coronal MRA Image

Coronal CTA Image

Coronal MRA Image
Abdominal Vasculature

“See Spot Run In...”

[“C” not see] Celiac, SMA, Renals (right & Left), IMA

Abdominal Aortic Aneurysm

Peripheral Vasculature “Run-off’s”

Abdominal Aorta
Ilac arteries (at the level of the Ileum)
Iliac Arteries
Superficial Femoral & common Femoral
(Femoral Arteries at the level of the Knee)
Popliteal Arteries (at the level of the Knee)
Tributary (Lower Leg)
Anterior Tibial
Posterior Tibial
Peroneal Brachial
At the level of the Foot
Dorsalis Pedis
Medial Malleolar

Abdominal Veins

Review Vasculature...

Almost ALL Arteries:
- Carry oxygenated blood away from the heart
- Carry oxyhemaglobin blood to organs

Almost ALL Veins:
- Carry deoxygenated blood to the heart
- Carry deoxhemaglobin away from organs

Exceptions:
- Portal vein - Carries deoxhemaglobin to the liver
- Pulmonary veins - Carries deoxhemaglobin to the lungs
- Pulmonary arteries - Carries oxyhemaglobin to the heart

Abdominal Veins

Biliary System

Hepatic ducts
Cystic duct
Pancreatic duct
Common bile duct
Gall bladder

Biliary ducts

MRCP
MR cholangiopancreatography
Coronal
APPENDICITIS

- INFLAMATION OF THE APPENDIX
- TYPICALLY APPEARS PUS/AIR FILLED

CROHNS DISEASE

- REGIONAL ILEITIS
- ETIOLOGY

DIVERTICULITIS

- INFLAMED DIVERTICULUM
- CT PRESENTATION

Female Pelvis Anatomy

Approximate Slice Locations

- Uterus
- Junctional Zone
- Endometrium
- Ovary
- Fallopian tube
- Bladder
- Muscles
- Gastrocnemius
- Vessels
- Nephrotome
- Ureter
- Rectum
- Obturator internus muscles
- Rectus abdominus muscles

Female Pelvis Anatomy

Approximate Slice Locations

- Uterus
- Rectum
- Endometrium
- Ovary
- Fallopian tube
- Bladder
- Muscles
- Gastrocnemius
- Vessels
- Nephrotome
- Ureter
- Rectum
- Obturator internus muscles
- Rectus abdominus muscles
Male Pelvis Anatomy

Approximate Slice Locations

- Psoas Muscles
- Bladder
- Prostate
- Seminal Vessicles
- Vas Deferens
- Urethra
- Apex of the Prostate
- Pubic bone

Symphysis Pubis

NAVEL

Axial CT

Gleuteal Muscles

Rectus abdominus Muscles

Male Pelvis Anatomy

Approximate Slice Locations

- Symphysis Pubis
- Prostate
- Central gland
- Peripheral zone (normal)
- Peripheral zone (cancer)
- Neurovascular bundle
- Rectum

Male Pelvis Anatomy

Approximate Slice Locations

- Prostate
- Base
- Peripheral zone
- Apex
- Rectum
- Rectus abdominus Muscles
- Symphysis Pubis

Basic Pelvis Protocol

- AP Scout
  80 kv 120 ma
- Axial
  -120 kv, 220 ma,
  -36 fov (fit anatomy)
  -512 x 512
  -generally 5mm
  -500 W & 50 L
  -30 sec breath-hold
- If contrast
  -Post contrast
  -Contrast if 100 cc's
  -non-ionic 300 mg/ml
  -3 cc/sec for 20g
  -delay scan 25-30
  -sec injection to peak enhancement

Male Pelvis

Male and Female Pelvis