Imaging Methods: CT Handout

Kinga Karlinger, MD, PhD
Senior Scientific Worker
Semmelweis University, Budapest

Digital picture of CT
- mosaic picture, calculated
- voxel: a volumen element: prism
- pixel is the basis of the prism: 0,5 x 0,5mm
- slice tickness is the height of the prism: 0,6 – 5,0 - ..mm

Fundamental concepts

- gantry (x-ray tube, detectors)
- table-moving
- sequential scanning - one-slice „slices and steps" CT
- continuous scanning – spiral CT and newer generation multidetector/ multislice CT

CT equipment
- gantry and the table
- a generator of high voltage
- computer
- the driving counter
- workstations for postprocessing (measurements, reconstructions)

Sequential or conventional CT: *stepping and shooting one after of each other*
Spiral CT: pushing forward the table continuously while screening continuously

- **One detector row CT** (SDRCT): fan beam, the slab of detectors in one slab (bow -like)
- **Multi detector row CT** (MDRCT): wide fan or cone beam, the detector slab is in two dimension

CT geometry of 3rd generation
X-ray source and the detector are rotating perpetually around the object investigated.
The detector can be:

- One row or line: fan-beam / straight / bended (Single slice CT)
- Multi row:
  - Flat-panel CT
  - Bended (banana)

CT TYPES
- x-ray, digital tomography
- demonstrates of differences in the x-ray attenuation, in one shift
- out of date
  - » one slice :– 2 - 4 sec
  - » whole scanning: 5 - 15 min
- **Spiral CT**
  - » one slice – 1 - 1.5 sec
  - » whole scanning: 30 - 60 sec (+ preparation)
- **Multidetector / multislice spiral CT** (4-64 etc rows of detectors)

- » one slice – 0.4 - 1 sec
- » whole scanning: 5 - 15 sec

→HRCT (high resolution CT)

- data collection is longer
- x-ray load is higher
- thin slices
- high resolution, detailed picture

→Multidetector / multislice CT

- parallel rows of detectors
- during one rotation 4, 16, 32 …. attached slices
- continuous data collection – no information - lost
- quickly a huge amount of data, volumetric data collection
- x-ray load is more favorable
- only during one inspiration a whole body scan is possible
- reconstructions in any preferable plane
- 3D visualization

→Dual Source CT

- 2 x-ray tubes, 2 detectors in the same time
- the 2 tubes are at right angles to each-other, data collection is synchronic
- two working types:
- dual source : both tubes work on the same kV = half time
- rotation is 90
- dual energy: tube one: 80 KV, tube two 140 kV, rotation is 180
- tissue attenuation is different according to the energy of the x-ray,
- the two data collection differ from each other = tissue differentiation

Advantages of Dual Source imaging

- better quality of pictures
- lowers x-ray load
- tissue differentiation
- vessels and bones can be directly subtracted
- oncological staging of tumors
- vessel plaque characterisation
- fluid differentiation in emergency diagnostics

Cardiological imaging with dual source CT

- The optimal phase is the diastolic
- At high frequecies this phase shortens
- With dual source CT each of the two detectors have to turn only 90° degree
- Rotation time 0,33 sec
- Time resolution 0,83 msec - irrespective of cardiac frequency

→PET-CT

- combined (hybrid) diagnostic method, computer tomography (CT) and pozitron emission tomography (PET)
- radioactive izotope (^{18}F) + glucose molecule = (FDG)
- small amount, short half-life time
- PET shows the metabolic processes in the cells
- malignant tumors: early detection, staging, follow up - therapeutic effect

Computerized reconstruction of pictures

➢Density and absorption: Hounsfield-scale
The fixed point of the scale:
water = 0 HU
air = -1000 HU,
bones = 3000 HU
Human eye can differenciate 24-30 shades on the gray scale.

→ Windowing:

➢Window center = put at the same attenuation of the tissue, which is to be demonstrated
➢Window width =
•narrow – small range of attenuation differences „hard"
•wide – broad range of attenuation differences „smooth"

→ How to use the windowing depends on:
which part of body
what is targeted
other influencing circumstances (corpulent patient)
other contrast enhancing factors influencing densities (c.m. i.v. or p.o.)

Important HU values:

-1000 HU	vacuum
-100 HU	fat
0 HU	water
20 HU	dens fluid
20 – 80 HU	soft tissues
70 – 100 HU	fresh bleeding
100 – 1000 HU	contrast mat., Ca

Procedure of CT scanning:
1st scan topogram / scout view
2nd sequence tomogram / slices

Imaging:

Reconstruction:

a) **filtered backprojection**

several variations:

- parallel-beam
- fan-beam (eg.ASSR)
- cone-beam (eg.AMPR)

b) Iterative approach

Imaging
2 dimensions:
a) Transaxial slice-pictures
b) Orthogonal pictures (transaxial, coronal, frontal)
c) Multiplanar reformation images (MPR)
d) Curved planar reformation images (CPR)
e) Slab pictures (sum, MIP, mIP)
3 dimensions :

a) **Surface rendering**
b) **Volume rendering**

- Maximum intensity projection
- Minimum intensity projection
- Volume rendering
    - transparency: opacity and gradient map
    - color: pixel value (color-map)

Contrast materials

- I.v. iodinised
- Contrast materials into the G.I. tract.

Dynamic CT investigations

- iodinised c.m iv.
- seriogram on the same place /slice
- detection of contrast enhancement during the time

Advantages of spiral CT :

- volumetric data collection: small masses, lumps.
- shorter scanning time = shorter investigating time
- more precious measuring of densities
- decreases some artefacts
- economizes the amount of c.m.
- lowers x-ray loading

This document was created with Win2PDF available at http://www.daneprairie.com.
The unregistered version of Win2PDF is for evaluation or non-commercial use only.