COMPUTERISED TOMOGRAPHY
&
ITS CLINICAL APPLICATIONS

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Three dimensional (3D) Image Reconstruction

- **The principle**
- Because contemporary CT scanners offer isotropic, or near isotropic resolution, display of images does not need to be restricted to the conventional axial images.
- Instead, it is possible for a software program to build a volume by 'stacking' the individual slices one on top of the other. The program may then display the volume in an alternative manner.

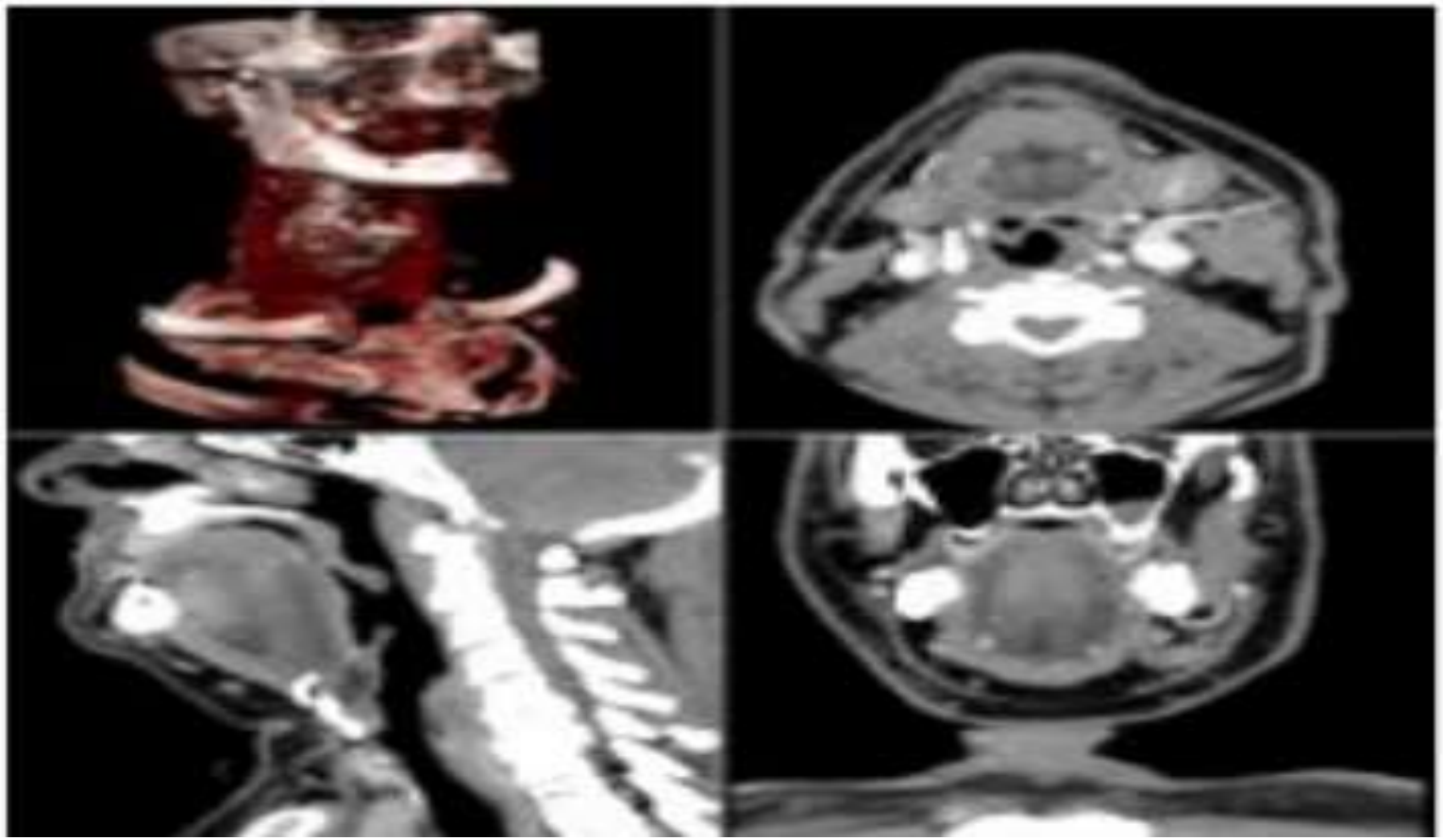
Body CT – 3D images

- 3-D images look like the "real thing."
- They can show details, such as broken bones.
- They are helpful in guiding surgeons before complex operations.

Multiplanar reconstruction

- Multiplanar reconstruction (MPR) is the simplest method of reconstruction.
- A volume is built by stacking the axial slices. The software then cuts slices through the volume in a different plane (usually orthogonal).
- Optionally, a special projection method, such as maximum-intensity projection (MIP) or minimum-intensity projection (mIP), can be used to build the reconstructed slices.

Fig.showing 1 3D and 3 MPR views



- MPR is frequently used for examining the spine. Axial images through the spine will only show one vertebral body at a time and cannot reliably show the intervertebral discs. By reformatting the volume, it becomes much easier to visualise the position of one vertebral body in relation to the others.
- MIP reconstructions enhance areas of high radiodensity, and so are useful for angiographic studies.
- mIP reconstructions tend to enhance air spaces so are useful for assessing lung structure.

3D rendering techniques

- Surface rendering
- A threshold value of radiodensity is chosen by the operator (e.g. a level that corresponds to bone). A threshold level is set, using edge detection image processing algorithms.
- From this, a 3-dimensional model can be constructed and displayed on screen.
- Multiple models can be constructed from various different thresholds, allowing different colors to represent each anatomical component such as bone, muscle, and cartilage.
  - However, the interior structure of each element is not visible in this mode of operation

- Volume rendering
- Surface rendering is limited in that it will only display surfaces which meet a threshold density, and will only display the surface that is closest to the imaginary viewer.
- In volume rendering, transparency and colors are used to allow a better representation of the volume to be shown in a single image - e.g. the bones of the pelvis could be displayed as semi-transparent, so that even at an oblique angle, one part of the image does not conceal another.

What a Body CT can see …

Body CT scans can diagnose a variety of conditions such as:

- Broken bones (skull, spine, ribs, extremities)
- Blood clots in the brain and chest
- Abnormalities of the lungs, such as pneumonia
- Inflammation in the abdomen (such as appendicitis or gallbladder disease)
- Stones (in the gallbladder or kidneys)
- Blocked bowel passage or twisted bowel
- Cancers in various organs and body parts

Some common uses of the procedure

- one of the best and fastest tools for examining the chest, abdomen and pelvis
- it provides detailed, cross-sectional views of all types of tissue.
- used to examine patients with severe injuries from incidents such as a motor vehicle accident.
- performed on patients with acute symptoms such as abdominal pain or difficulty breathing.

- often the best method for detecting many different cancers, including lung, liver, kidney and pancreatic cancer, since the image allows a physician to confirm the presence of a tumor and measure its size, precise location and the extent of the tumor's involvement with other nearby tissue.
- an examination that plays a significant role in the detection, diagnosis and treatment of vascular diseases that can lead to stroke, kidney failure or even death.
- CT is commonly used to assess for pulmonary embolism (a blood clot in the lung vessels) as well as for abdominal aortic aneurysms (AAA).
- invaluable in diagnosing and treating spinal problems and injuries to the hands, feet and other skeletal structures because it can clearly show even very small bones as well as surrounding tissues such as muscle and blood vessels.

For children

CT imaging is more often used to evaluate:

- lymphoma
- neuroblastoma
- kidney tumors
- congenital malformations of the heart, kidneys and blood vessels
- cystic fibrosis
- complications of acute appendicitis
- complications of pneumonia
- inflammatory bowel disease
- severe injuries

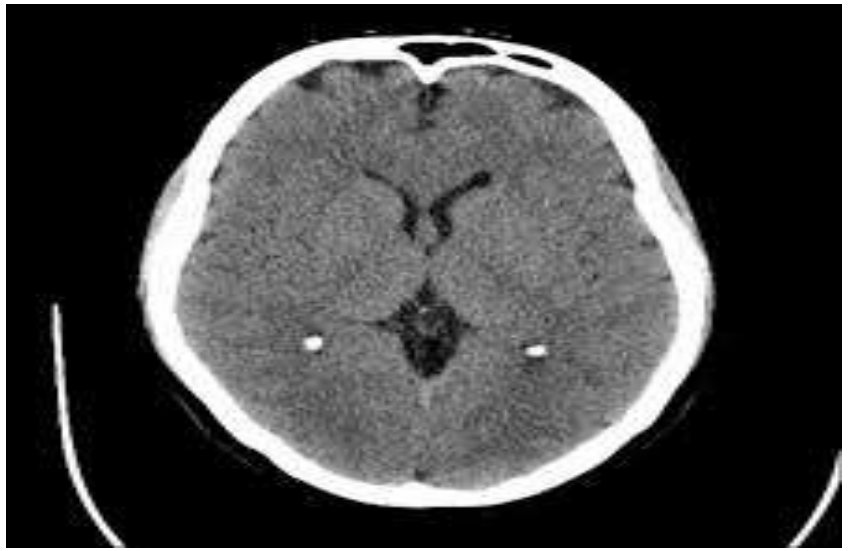
Physicians often use the CT examination to:

- quickly identify injuries to the lungs, heart and vessels, liver, spleen, kidneys, bowel or other internal organs in cases of trauma.
- guide biopsies and other procedures such as abscess drainages and minimally invasive tumor treatments.
- plan for and assess the results of surgery, such as organ transplants or gastric bypass.
- stage, plan and properly administer radiation treatments for tumors as well as monitor response to chemotherapy.
- measure bone mineral density for the detection of osteoporosis.

Clinical applications of CT

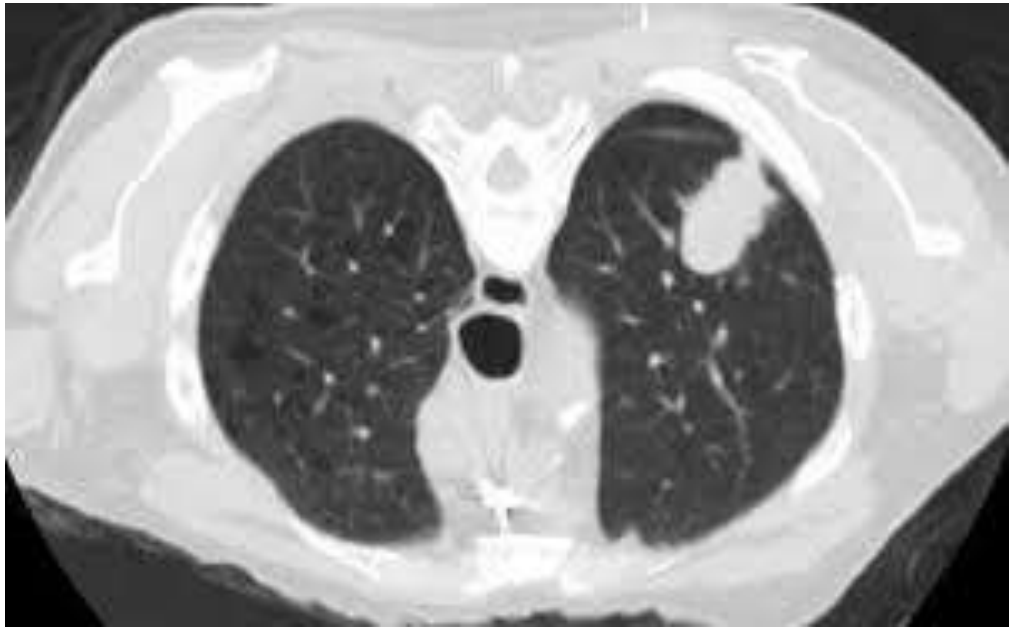
BRAIN & SKULL

- For the detection and diagnosis of brain diseases
- In cases of trauma, fractures of the cranium
- Differentiate between ischemic vs haemorrhagic stroke
- Both primary brain tumors and metastases can be identified.



THORAX

- Detection and description of masses
- For staging of malignancies
- Malformations and fluid collections in the thoracic cavity
- Lung consolidation, pulmonary edema



CT Chest showing a mass in left lung

- ABDOMEN

- Excellent anatomic images of the organs and vessels.
- for early detection of renal carcinomas.
- For differentiating between cysts and solid tumors.
- For staging tumors in pelvic inlet which is difficult to visualise with usg

Spine

- In the investigation of spinal lesions in the event of doubtful radiographic and/or myelographic findings
- The degree of spinal cord compression can accurately be measured using CT
- Gas between vertebrae and in the vertebral canal, which is a sign of disc degeneration, can be identified
- A large amount of epidural fat around the nerve roots in lumbosacral region facilitates visualization of lesions without contrast
- The interpretation of spinal and vertebral CT images is performed in both a bone and soft tissue window

Musculoskeletal

- For diagnosis of orthopedic disorders

- Facilitates the examination of complex joint structures like elbow and tarsals by eliminating superimposed structures

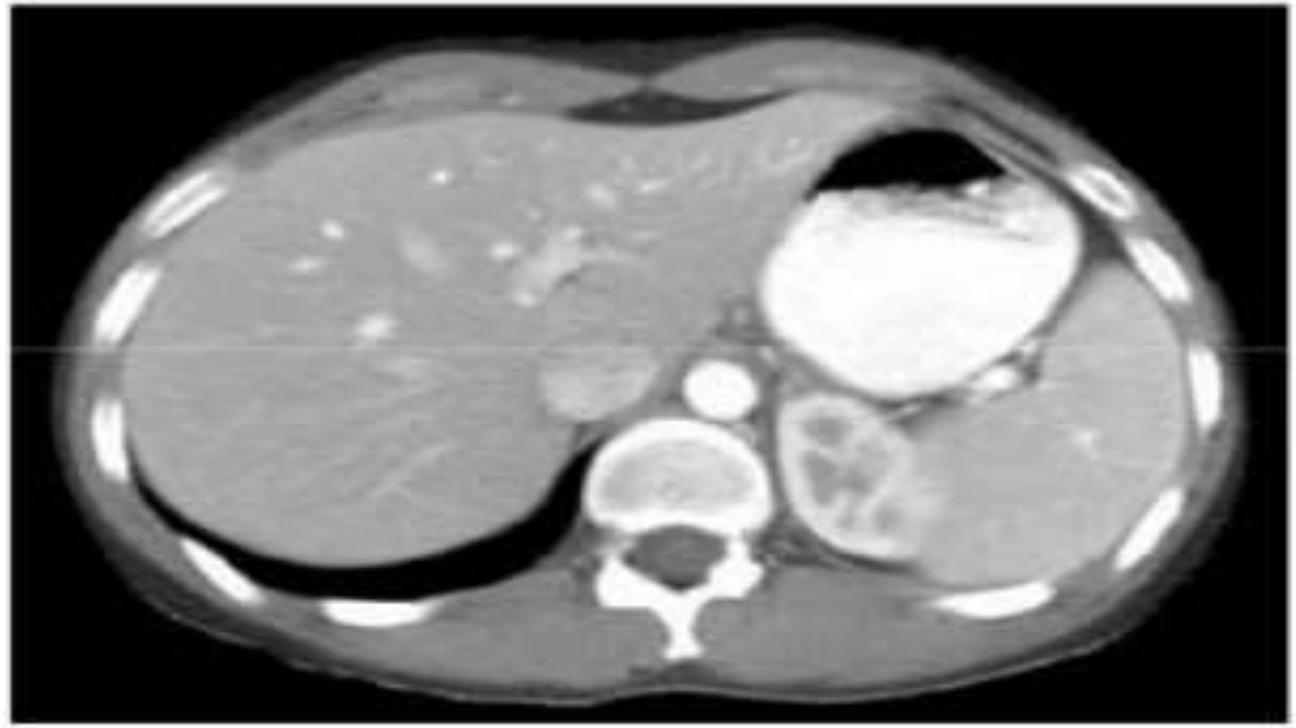
- Ability to view images in several image planes may help to better delineate fracture orientation and to plan the repair process.

Here is what a CT scanner looks like

Equipment

- The CT scanner is typically a large, box-like machine with a hole, or short tunnel, in the center.
- The Patient will lie on a narrow examination table that slides into and out of this tunnel.
- Rotating around patient, the x-ray tube and electronic x-ray detectors are located opposite each other in a ring, called a gantry.
- The computer workstation that processes the imaging information is located in a separate control room, where the technologist operates the scanner and monitors your examination.

CT scan showing the liver



CT slice through the mid-abdomen showing multiple normal-appearing organs

Benefits vs. Risks

Benefits:

- CT scanning is painless, noninvasive and accurate.
- A major advantage of CT is its ability to image bone, soft tissue and blood vessels all at the same time.
- Unlike conventional x-rays, CT scanning provides very detailed images of many types of tissue as well as the lungs, bones, and blood vessels.
- CT examinations are fast and simple; in emergency cases, they can reveal internal injuries and bleeding quickly enough to help save lives.
- CT has been shown to be a cost-effective imaging tool for a wide range of clinical problems.
- CT is less sensitive to patient movement than MRI.

Benefits:

- CT can be performed if you have an implanted medical device of any kind, unlike MRI.
- CT imaging provides real-time imaging, making it a good tool for guiding minimally invasive procedures such as needle biopsies and needle aspirations of many areas of the body, particularly the lungs, abdomen, pelvis and bones.
- A diagnosis determined by CT scanning may eliminate the need for exploratory surgery and surgical biopsy.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in CT scans usually have no immediate side effects.

Risks

- There is no conclusive evidence that radiation at amounts delivered by a CT scan causes cancer.
- Large population studies have shown a slight increase in cancer from larger amounts of radiation, such as from radiation therapy.
- Thus, there is always concern that this risk may also apply to the lower amounts of radiation delivered by a CT exam.

Risks

- The effective radiation dose for this procedure varies.
- CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the baby.
- Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48 hours after contrast medium is given.
- The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and radiology departments are well-equipped to deal with them.

Limitations of CT Scanning of the Body

- Soft-tissue details in areas such as the brain, internal pelvic organs, and joints (such as knees and shoulders) can often be better evaluated with magnetic resonance imaging (MRI).
- In pregnant women, while CT can be performed safely, other imaging exams not involving radiation, such as ultrasound or MRI, is preferred if they are likely to be as good as CT in diagnosing your condition.
- A person who is very large may not fit into the opening of a conventional CT scanner or may be over the weight limit—usually 450 pounds—for the moving table.