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Department of Medical Physics
2nd Stage
Medical Imaging

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LECTURE Four
Computed Tomography (CT scan)

4.1 Introduction

Computed tomography (CT) medical-imaging systems generate three-dimensional (3D) images of internal body structures using complex x-ray and computer. i) CT sometimes called "computerized tomography" or "computed axial tomography" (CAT). Clinical Computed Tomography (CT) was introduced in 1971. It developed into a versatile 3D whole body imaging modality for a wide range of applications in for example oncology, vascular radiology, cardiology, traumatology and interventional radiology. This new technique of CT reconstructs a cross-sectional image of the body from a 'virtual pile of X-ray photographs'. A tomographic image is an image of a slice through the body.

The word 'tomography' comes from the Greek: tomos means slice, graphein stands for 'to write'. So, tomography literally means 'writing slices'. Structures and lesions previously impossible to visualise can now be seen with remarkable clarity. The principle behind CT: a thin collimated beam of X-rays passes through the body to a detector that measures the transmitted intensity. The collimator is a set of narrow lead tubes or an array of small holes in a lead plate, resulting in a thin straight beam of X-rays. Measurements are made at a large number of points as the source and

detector are moved past the body together. The x-ray generator is then rotated slightly about the body axis and again scanned. This is repeated at, for example, 1° intervals for 180°. The intensity of the transmitted beam for the many points of each scan, and for each angle, are sent to a computer that reconstructs the image of the slice. The image is presented on a computer monitor.

Note that the imaged slice is vertically to the long axis of the body. For this reason, CT is sometimes called computed axial tomography (CAT), although the abbreviation CAT, as in CAT scan, can also be read as computer-assisted tomography. The added imaging dimension allows the system to generate multiple slices in parallel. Photo-detector arrays used in CT imaging have as many as 1000 detectors in the long dimension along the semi-circular detector arch; 16 or more detectors are positioned in the shorter dimension tangential to the bracket. The number of detectors in the short dimension determines the number of available image slices.

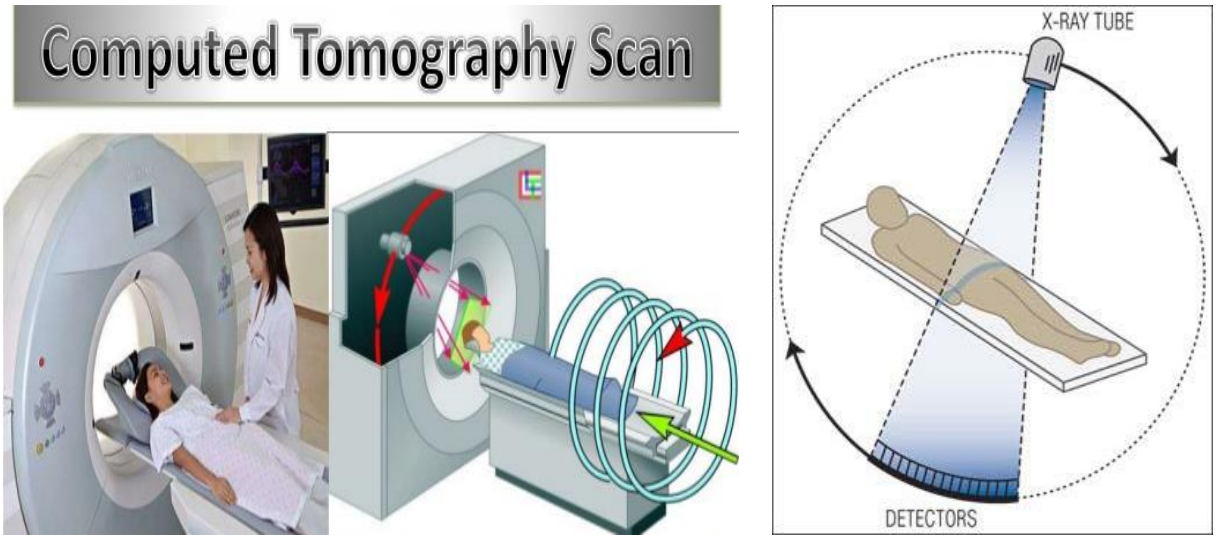

Figure 1: Computed Tomography Scan System

Computed tomography (CT): is a medical imaging system that creates 3D cross-sectional images of the internal body using complex x-ray and computer from a 'virtual pile of X-ray photographs' which used for diagnostic and therapeutic purposes.

4.2 Description of CT scan system

(i) CT images of the body using complex x-ray and computer.

(ii) The intensity of the transmitted beam for the many points of each scan, and for each angle, are sent to a computer that reconstructs the image of the slice.

(iii) CT imaging systems create cross-sectional image of internal body (image of a slice through the body) from a virtual images.

(iv) CT scans can be performed on every region of the body for a different of reasons (e.g., diagnostic, treatment planning, interventional, or screening).

(v) Each cross-sectional image represents a slice (section) of the body being imaged, like the slices in a loaf of bread.

(vi) The image is presented on a computer monitor.

4.3 How a CT scan system works

- CT images are generated first by exposing the patient to a fan-shaped x-ray beam and then detecting the projected image on a semi-circular by digital x-ray detector. The x-ray beam and detector rotate as a fan-shaped on a semi-circular

- The x-ray beam and detector rotate at the same time in opposite directions within a semi-circular, to collect the multitude of x-ray projections (dropping).
- The x-ray generator is rotated slightly within 1° to 180°.
- The patient is placed between the source and detector.
- Each image in CT represent one of the x-ray projections (dropping) for slice of the body.
- In finally, images are collected and stored.

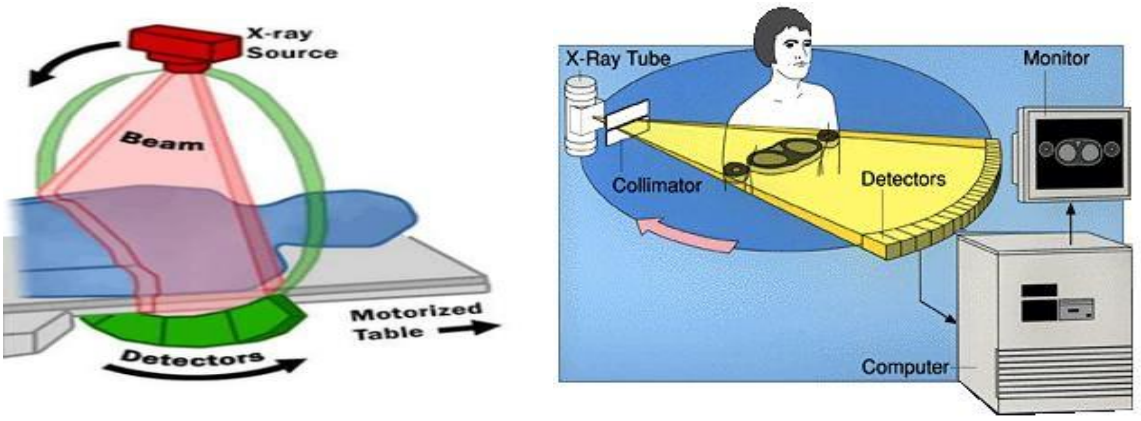

Figure 2: Schematic of Computed Tomography Scan System

Why used CT scan instead the plain X-ray imaging?

One of the problems is the loss of information about depth. For example, a small lung cancer can be seen at a front-to-back chest photograph (Figure 3).

But where is it? The radiologist cannot determine the exact location of this cancer in the forward backward direction. One could make a side photograph (a side view), but the cancer might disappear behind a rib. What is needed in such a case is a cross-sectional image (Figure 4).

Figure 3: Typical AP (anterior-posterior or front-to-back) chest X-ray photograph.

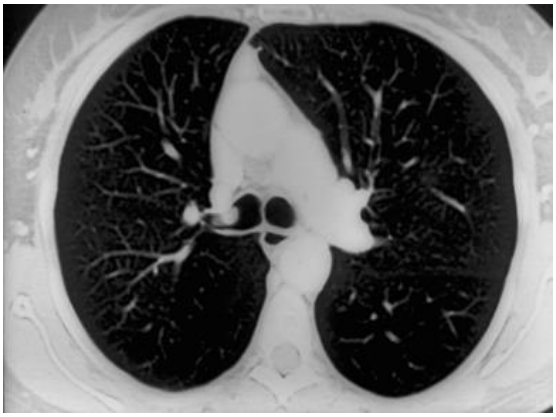

Figure 4: Transversal CT slice of the chest.

4.4 Benefits/Risks

The benefits of a CT scan exceed the risks.

Benefits of a CT scan:

1) CT scans can provide detailed information to diagnose, plan treatment for, and evaluate many conditions in human body.

2) The detailed images provided by CT scans may eliminate (cancel) the need for surgeries.

Risks of a CT scan:

Concerns (worry) about CT scans include the risks from (i) exposure to ionizing radiation and(ii) possible reactions to the contrast agent (dye), which may be used to improve resolution of images.