IMPLEMENTATION OF SPECT TECHNIQUE IN DETECTION OF CANCER

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***ABSTRACT*-- In the present day scenario complete diagnosis of patient's body condition with in-depth internal details of body structure is very much required for a physician to provide proper medication. Gamma camera is a medical device used in nuclear medicine. It provides high quality images of the distribution of gamma ray emitting radio nuclides.It is the part of Single Photon emission compute tomography (SPECT) System, which allows us to visualize Functional information about a patient specific organ or body system.The use of digital image processing is now widespread in nuclear medicine in that it can be used to rapidly and conveniently control image acquisition and display of images, to store the images for subsequent retrieval and to communicate the image data to other computers over a network. It has been undergoing investigation for several years as a possible complementary tool to x-ray mammography in Breast, Bone, thyroid, brain and kidney cancer detections, to lesion or to eliminate the need for painful biopsy procedure.**

***Keywords* -SPECT,Gamma Camera, Image Processing,Mammography.**

1.INTRODUCTION

Gamma camera is an electronic instrument used in medical diagnostics to image the distribution of radioactive compounds in animal tissue.It produces images of the distribution of gamma ray emitting radio nuclides.Gamma imaging carried out by injecting patient with a tracer that emits gamma ray.

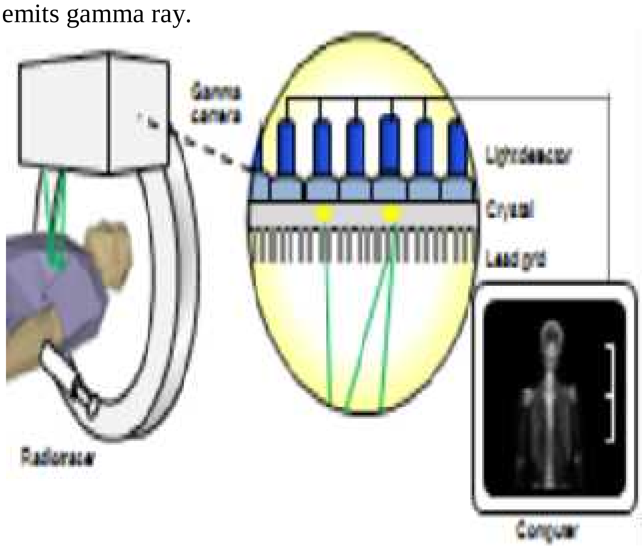
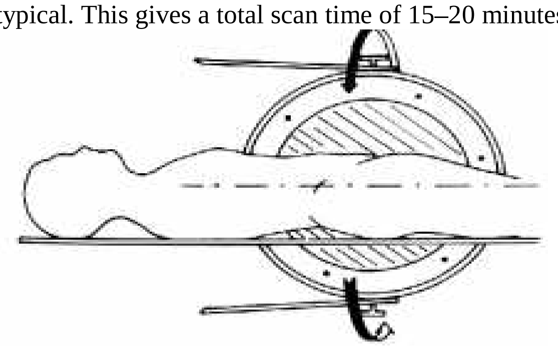


FIG: Gamma Imaging

A gamma camera is a complex device consisting of one or more detectors mounted on a gantry. It is connected to an acquisition system for operating the camera and for storing the images.The system accumulates counts of gamma photons that are absorbed by a crystal in the camera, usually a large flat crystal of sodium iodide with thallium doping in a light-sealed housing.The crystal scintillates in response to incident gamma radiation when the energy of a gamma photon is absorbed, it emits a faint flash of light. Photomultiplier tubes (PMT) behind the crystal detect the fluorescent flashes and a computer sums the fluorescent counts.The computer in turn constructs and displays a 2- D image of the relative spatial count density on a monitor.This image then reflects the distribution and relative concentration of radioactive tracer elements present in the organs and tissues imaged.To obtain static or dynamical 3-D images with a gamma camera SPECT (Single Photon Emission Computed Tomography) technique is used.

2.SPECT TECHNIQUE

The Single Photon Emission Computed Tomography (SPECT) system which is characterized by one or more gamma cameras with collimators, mounted on a gantry, which allows rotation around the long axis of a supine patient. To acquire SPECT images, the gamma camera is rotated around the patient. Projections are acquired at defined points during the rotation, typically every 3–6 degrees. In most cases, a full 360-degree rotation is used to obtain an optimal reconstruction. The time taken to obtain each projection is also variable, but 15–20 seconds is typical. This gives a total scan time of 15–20 minutes.



During the rotation procedure, multiple 2-D projections of the 3-Dradiopharmaceutical distribution can be acquired and stored on the computer. If a large number of linear and angular data samples are taken,it is possible to reconstruct the cross-sectional images that represent the radiopharmaceutical distri-butions in the body.

3.IMAGING SYSTEM

The components making up the gamma camera are the collimator, detector crystal, photomultiplier tube array, position logic circuits, Digital Image Processing and the data analysis computer.

3.1. CAMERA COLLIMATOR

The first object that an emitted gamma photon encounters after exiting the body is the collimator. The collimator is a pattern of holes through gamma ray absorbing material, usually lead or tungsten, that allows the projection of the gamma ray image onto the detector crystal.The collimator achieves this by only gamma rays traveling along certain directions to reach the detector as ensures that the position on the detector accurately depicts the originating location of the gamma ray.

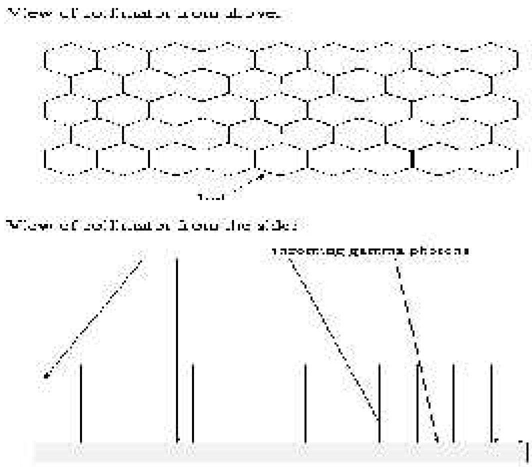


FIG : Collimators

3.2. SCINTILLATION DETECTOR

In order to detect the gamma photon we use scintillation detectors. A Thallium-activated Sodium Iodide [NaI(Tl)] detector crystal is generally used in Gamma cameras.A detector crystal may be circular or rectangular.It is typically 3/8" thick and has dimensions of 30-50 cm .A gamma ray photon interacts with the detector by means of the Photoelectric Effect or Compton Scattering with the iodide ions of the crystal.This interaction causes the release of electrons which in turn interact with the crystal lattice to produce light, in a process known as scintillation.

3.3. PHOTOMULTIPLIER TUBES

Only a very small amount of light is given off from the scintillation detector.Therefore, photomultiplier tubes are attached to the back of the crystal. At the face of a photom-ultipliertube(PMT) is a photocathode which ,when stimulated by light photons ejects electrons.The PMT is an instrument that detects and amplifies the electrons that are produced by the photocathode.This electron from the cathode is focused on a dynode which absorbs this electron and re-emits many more electrons (usually 6 to 10). These new electrons are focused on the next dynode and the process is repeated over and over in an array of dynodes. At the base of the photomultiplier tube is an anode which attracts the final large cluster of electrons and converts them into an electrical pulse.Each gamma camera has several PMT’s arranged in a geometrical array.The typical camera has 37 to 91 PMT's.

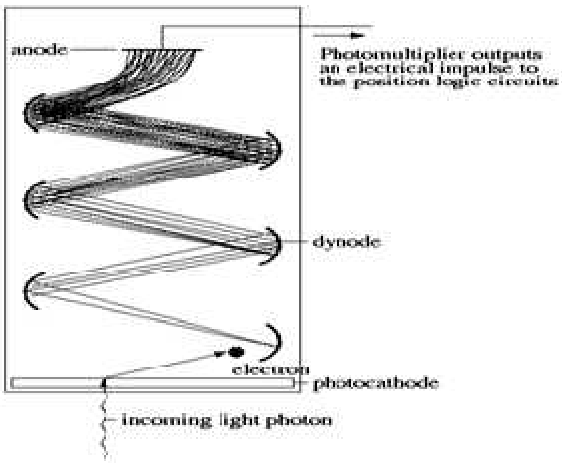


FIG:Photo Multiplier Tube

3.4. POSITION CIRCUITRY

The position logic circuits immediately follow the photomultiplier tube array and they receive the electrical impulses from the tubes in the summing matrix circuit (SMC).This allows the position circuits to determine where each scintillation event occurred in the detector crystal.

4. DIGITAL IMAGE PROCESSING

Today, the applications of computers in radioisotope imaging include data acquisition,data processing,data storage and system control.These applications will briefly be discussed below.\

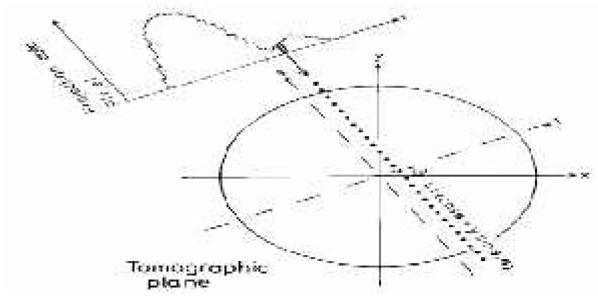
4.1. DATA ACQUISITION

Data from a gamma camera can be acquired and stored in a computer either in list mode or frame mode. In list mode the converted signals are stored as they arrive, as numbers corresponding to the x-y position of the registered photons.In the more commonly used frame mode, the acquired x-y data directly increment a 2-D memory matrix in the computer. The analogue pulses from the gamma camera are digitised in such a way that the storage location for the detected event is determined. If the energy of the pulse fits a preset energy window corresponding to the photo peak, the event is allowed to update the memory matrix.

4.2. DATA PROCESSING

To obtain a 3-D image with the SPECT method one has to apply more or less complex data reconstruction techniques such as back projection.The straightforward back projection technique includes both back projection of the projection data and superposition of all projections at angles 0-π around the object.Mathematically back projection can be expressed as follows:

$$f_{bp}(x, y) = \int_0^{\pi} p(x\cos\theta + y\sin\theta, \theta)\, d\theta$$



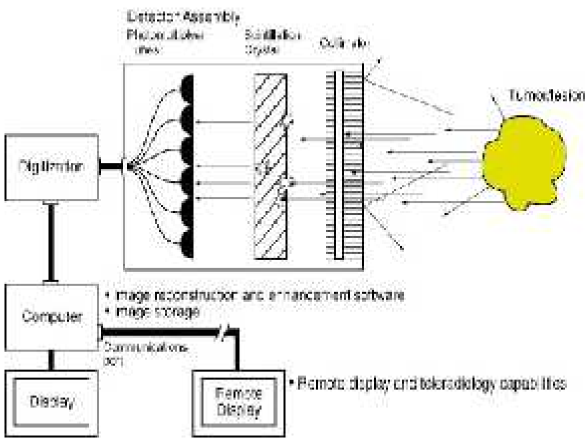
where fbp(x,y) is the picture value obtained after reconstruction at the position (x,y) of the tomographic plane and p(x cos θ + y sin θ, θ) = p(r, θ) is projection data at the point (r,θ) along the projection axis.

4.3. DATA STORAGE

Gamma cameras generate large volumes of data produced during dynamic and tomographic acquisitions. The acquisition requires modest short-term memory and large hard-disc space for semi permanent storage.

5. DATA ANALYSIS COMPUTER

Finally, in order to deal with the incoming projection data and to process it into a readable image of the 3D spatial distribution of activity within the patient, a processing computer is used.The role of computers in different types of system control has also increased since low-cost and powerful microprocessors became available.The control of the gamma camera gantry is necessary for provision of multiview data acquisition.It provides the motion that is needed for a lot of imaging methods,such as rotation in SPECT imaging, transitional in planar scanning and longitudinal tomography. In all cases the computer must store the position information of the gantry. This information is an essential part of the data acquisition and necessary to provide correct spatial and angular information required for data processing.



Low-energy gamma-ray imaging is very awkward and primitive in many respects. Above energy of about 10 keV, it is not possible to make focusing optics based on lenses or mirrors, and direct imaging is not practical.Between about 10 keV and 1-2 MeV, imaging is usually done with any of several possible extensions of the pinhole camera, which are used in medicine and in gamma-ray astronomy. In medicine, such devices are often called gamma cameras, in astronomy, they are usually called coded-aperture instruments.

6.RESULTS

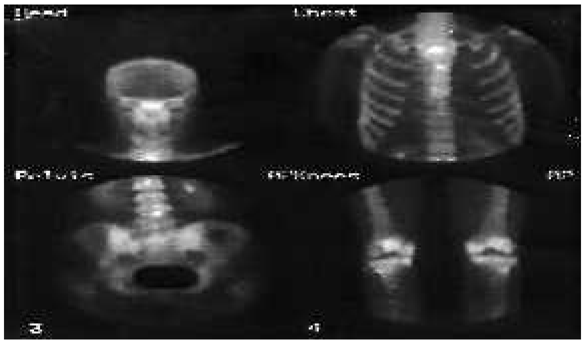


FIG: Gamma Camera Images

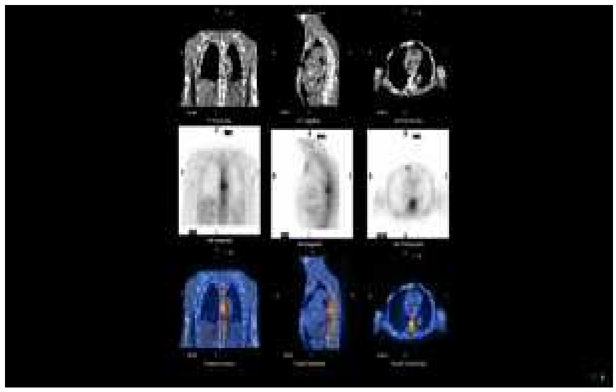


FIG : SPECT Images

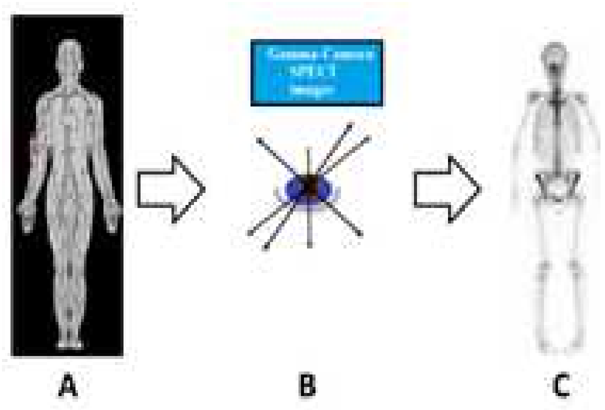


FIG: Gamma-Camera And SPECT Images

7.CONCLUSION

Gamma camera has been undergoing investigation for several years as a possible complementary tool to x-ray mammography in Breast cancer,Bone cancer detection, to lesion or to eliminate the need for painful biopsy procedure.

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