Electron Tomography (=Controlled Electron Tomography)

Prof.(Dr.) Bijay Kumar Parida(MBBS,LLB,MS,ICO,FRCSG)[1], Ms. Anannya Anupurva[2]

[1]Associate Professor, Muthusamy Virtual University of Ophthalmology Post Graduation, Bhubaneswar, Odisha, India
[2]2nd year student, MVJ Medical College, Bangalore

Abstract— *Proposed* ***"electron tomography" or electron imaging of human body*** *is most advanced technology to be available to do tomography of human body in comparison to existing CT(Computerised tomography), MRI(magnetic resonance imaging), PET(positron emission tomography), SPECT(single photon emission computed tomography).*

Keywords— electron tomography, electron imaging of human body, Computerised tomography, magnetic resonance imaging, positron emission tomography, single photon emission computed tomography.

I. INTRODUCTION

Nuclei of cells are abundant in body and having highest mass. If emissions from nucleus can be imaged it shall give highest resolution tomogram. To be more precise the hi technology shall tap beta – particles and gamma rays. The method contemplated is to stimulate nucleus of cells of the body to release above mentioned particles and rays.

II. HYPOTHESIS:

Electron having negative charge, if bombarded on human body and made to pass through it, it will hit protons, nucleus and electrons in all the cells of human body (or all the bodies);organic and inorganic, then it will form neutron by combining with protons and heat is generated. Fusion reaction shall be initiated between newly formed neutron and existing one. Neutron itself energized by electrons of hitting and a fission reaction begins. Electrons meet electrons orbiting and get repelled further gaining energy. From higher orbit electrons fall back and release photons.

From fusion and fission reaction of neutrons, beta particles are released. Beta negative particles along with gamma rays emanate together from body, that can be photographed by special camera like camera for photographing beta negative particles(electrons) which can give better image than gamma camera photographing photons because of electrons having mass and better escape than beta + or alpha + particles.

Thus a better image than CT scan, MRI, PET and SPECT can be achieved.

High voltage difference on either sides of the body can push highly energized electrons at faster rate. This shall initiate fusion and fission reaction.

Nucleus is present in every cell. If it can be stimulated and made to release energy, an excellent tomography can be obtained, which shall be far better than CT scan andMRI.

Two types of camera are combined to take better photograph.

The ionization of nucleus by electrons are controlled and limited not to harm the cell.

- Other possible method is specially energized photons, not reaching level of x rays, can also penetrate body and interact with atoms there, initiating ionizing reactions and produce beta negative particles and gamma rays. But these photons are not as competent as electrons.
- Using computer, 3D image can be generated.

III. DISCUSSION:

A **beta particle**, also called **beta ray** (**β**), is a high-energy, high-speed electron or positron emitted in the radioactive decay of an atomic nucleus, such as a potassium-40 nucleus, in the process of beta decay. Two forms of beta decay, β^- and β^+, respectively produce electrons and positrons.[1] Beta particles are a type of ionizing radiation.

Beta minus (β-) particles are the same as electrons .Beta plus (β+) particles are the same a positron. β - are electrons, while β + are positrons (their antiparticles). The approximate radius of an electron is calculated as follows: re = e2/(mec2) = 2.8179402894(58) cm -13 Positron are similar to electron in terms of size and mass.

Beta particles are typically one of the weakest radiation (alpha has the most energy). Ranging from 15 KeV up to 2 MeV. But because it is so small (1/6400 the size of an alpha particle) it can penetrate through the air and the skin. A few layers of aluminum will stop it (while alpha will only go a few inches through air, or just to the first layer of the skin).

The purpose of the machine is to excite nucleus through electrons and released particles can be imaged.

Beta decay involves changing an up quark into a down quark (Beta+) or a down quark into an up quark (Beta-). This causes a neutron to change into a proton (Beta-) and emit a W- boson which decays into a beta particle (electron and electron antineutrino), or, with extra energy, it causes a proton to change into a neutron (Beta+) which emits a beta particle (positron and electron neutrino). Quarks are involved because protons and neutrons are comprised of quarks in sets of three, two up quarks and one down quark to form a proton, and two down quarks and one up quark to form a neutron.

Beta radiation is a negatively charged electron which both penetrates and ionizes fairly well. Alpha is a helium nucleus with 2 protons and 2 neutrons (so a +2 charge) and is **very ionizing but not very penetrating.**

The range of beta particles in the air is up to several hundred feet. Beta particles are emitted by specific types of radioactive nuclei. Potassium-40 is a type of radioactive nuclei that emits beta particles.

A beta particle is an electron, this has a mass much less than a proton or neutron and so was can use zero in most situations. However in some calculations for mass defect of whole atoms and Q-value calculations in nuclear decays it can become important, in these calculations. An electron has a mass of 511 keV/(c^2), and an AMU is 931 MeV/(c^2). So, dividing the electron mass by the AMU mass, we get the mass of the beta in AMU: 511/931000 = 0.00055 AMU.

A beta particle, sometimes called beta ray, denoted by the lower-case Greek letter beta (β), is a high-energy, high-speed electron or positron emitted in the radioactive decay of an atomic nucleus, such as a potassium-40 nucleus, in the process of beta decay. Two forms of beta decay, β^- and β^+, respectively produce electrons and positrons.[1] Beta particles are a type of ionizing radiation**.**

Alpha radiation consists of helium nuclei and is readily stopped by a sheet of paper. Beta radiation, consisting of electrons or positrons, is halted by an aluminum plate. Gamma radiation is dampened by lead.

β− decay (electron emission): Beta decay. A beta particle (in this case a negative electron) is shown being emitted by a nucleus. An antineutrino (not shown) is always emitted along with an electron.In the decay of free neutron, a proton, an electron (negative beta ray), and an electron antineutrino are produced.

An unstable atomic nucleus with an excess of neutrons may undergo β− decay, where a neutron is converted into a proton, an electron, and an electron antineutrino (the antiparticle of the neutrino):

This process is mediated by the weak interaction. The neutron turns into a proton through the emission of a virtual W^- boson. At the quark level, W^- emission turns a down quark into an up quark, turning a neutron (one up quark and two down quarks) into a proton (two up quarks and one down quark). The virtual W^- boson then decays into an electron and an antineutrino.

Beta decay commonly occurs among the neutron-rich fission byproducts produced in nuclear reactors. Free neutrons also decay via this process. Both of these processes contribute to the copious quantities of beta rays and electron antineutrinos produced by fission-reactor fuel rods. These fuel rods also help control the rate of reaction inside of a reactor.

β^+ decay (positron emission: Unstable atomic nuclei with an excess of protons may undergo β^+ decay, also called positron decay, where a proton is converted into a neutron, a positron, and an electron neutrino. Beta-plus decay can only happen inside nuclei when the absolute value of the binding energy of the daughter nucleus is greater than that of the parent nucleus, i.e., the daughter nucleus is a lower-energy state Of the three common types of radiation given off by radioactive materials, alpha, beta and gamma, beta has the medium penetrating power and the medium ionising power. Although the beta particles given off by different radioactive materials vary in energy, most beta particles can be stopped by a few millimeters of aluminium. However, this does not mean that beta-emitting isotopes can be completely shielded by such thin shields: as they decelerate in matter, beta electrons emit secondary gamma rays, which are more penetrating than betas per se. Shielding composed of materials with lower atomic weight generates gammas with lower energy, making such shields somewhat more effective per unit mass than ones made of high-Z materials such as lead.

Being composed of charged particles, beta radiation is more strongly ionizing than gamma radiation. When passing through matter, a beta particle is decelerated by electromagnetic interactions and may give off bremsstrahlung x-rays.

In water, beta radiation from many nuclear fission products typically exceeds the speed of light in that material (which is 75% that of light in vacuum),[2] and thus generates blue Cherenkov radiation when it passes through water. The intense beta radiation from the fuel rods of pool-type reactors can thus be visualized through the transparent water that covers and shields the reactor.

Detection and measurement: Beta radiation detected in an isopropanol cloud chamber (after insertion of an artificial source strontium-90).

The ionizing or excitation effects of beta particles on matter are the fundamental processes by which radiometric detection instruments detect and measure beta radiation. The ionization of gas is used in ion chambers and Geiger-Muller counters, and the excitation of scintillators is used in scintillation counters. Beta particles can be used to treat health conditions such as eye and bone cancer and are also used as tracers. Strontium-90 is the material most commonly used to produce beta particles.

Beta particles are also used in quality control to test the thickness of an item, such as paper, coming through a system of rollers. Some of the beta radiation is absorbed while passing through the product. If the product is made too thick or thin, a correspondingly different amount of radiation will be absorbed. A computer program monitoring the quality of the manufactured paper will then move the rollers to change the thickness of the final product.

Beta-plus (or positron) decay of a radioactive tracer isotope is the source of the positrons used in positron emission tomography (PET scan).

History: Henri Becquerel, while experimenting with fluorescence, accidentally found out that uranium exposed a photographic plate, wrapped with black paper, with some unknown radiation that could not be turned off like X-rays.

Ernest Rutherford continued these experiments and discovered two different kinds of radiation:

- alpha particles that did not show up on the Becquerel plates because they were easily absorbed by the black wrapping paper
- **beta particles which are 100 times more penetrating than alpha particles.**

He published his results in 1899.[3]

In 1900, Becquerel measured the mass-to-charge ratio (m/e) for beta particles by the method of J. J. Thomson used to study cathode rays and identify the electron. He found that e/m for a beta particle is the same as for Thomson's electron, and therefore suggested that the beta particle is in fact an electron.

Health: Beta particles are able to penetrate living matter to a certain extent and can change the molecular structure of molecules exposed to this type of radiation

Positron- emission tomography (PET)[4] is a nuclear medicine functional imaging technique that is used to observe metabolic processes in the body as an aid to the diagnosis of disease. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radionuclide (tracer), which is introduced into the body on a biologically active molecule. Three-dimensional images of tracer concentration within the body are then constructed by computer analysis. In modern PET-CT scanners, three-dimensional imaging is often accomplished with the aid of a CT X-ray scan performed on the patient during the same session, in the same machine.

If the biologically active molecule chosen for PET is fludeoxyglucose (FDG), an analogue of glucose, the concentrations of tracer imaged will indicate tissue metabolic activity as it corresponds to the regional glucose uptake. Use of this tracer to explore the possibility of cancer metastasis (i.e., spreading to other sites) is the most common type of PET scan in standard medical care (90% of current scans). One of the disadvantages of PET scanners is their operating cost.[5]

Single-photon emission computed tomography (SPECT, or less commonly, SPET) is a nuclear medicine tomographic imaging technique using gamma rays.[6] It is very similar to conventional nuclear medicine using a gamma camera (that is, scintigraphy).[7] However, it is able to provide true 3D information. This information is typically presented as cross-sectional slices through the patient, but can be freely reformatted or manipulated as required.

The technique requires delivery of a gamma-emitting radioisotope (a radionuclide) into the patient, normally through injection into the bloodstream. On occasion, the radioisotope is a simple soluble dissolved ion, such as an isotope of gallium(III). Most of the time, though, a marker radioisotope is attached to a specific ligand to create a radioligand, whose properties bind it to certain types of tissues.

Up until 2010, 5 billion medical imaging studies had been conducted worldwide.[8] Radiation exposure from medical imaging in 2006 made up about 50% of total ionizing radiation exposure in the United States.[9]

As a discipline and in its widest sense, it is part of biological imaging and incorporates radiology which uses the imaging technologies of X-ray radiography, magnetic resonance imaging, medical ultrasonography or ultrasound, endoscopy, elastography, tactile imaging, thermography, medical photography and nuclear medicine functional imaging techniques as positron emission tomography (PET) and Single-photon emission computed tomography(SPECT).

Creation of three-dimensional images: Volume rendering techniques have been developed to enable CT, MRI and ultrasound scanning software to produce 3D images for the physician.[10] Traditionally CT and MRI scans produced 2D static output on film. To produce 3D images, many scans are made, then combined by computers to produce a 3D model, which can then be manipulated by the physician.. With the ability to visualize important structures in great detail, 3D visualization methods are a valuable resource for the diagnosis and surgical treatment of many pathologies. It was a key resource for the famous, but ultimately unsuccessful attempt by Singaporean surgeons to separate Iranian twins Ladan and Laleh Bijani in 2003. The 3D equipment was used previously for similar operations with great success.

It is clear that beta –rays(electrons) with photons from nuclear decay initiated by electron can produce far superior resolution tomography, slices of much lesser thickness and by use of special camera to photograph electrons and gamma camera to photograph photons. Two types of cameras like camera for electrons and gamma camera are planned.

IV. CONCLUSION

Proposed “electron tomography is a superior technology in comparison to existing CT, MRI, PET, SPECT and shall produce photographs of highest resolution because abundant nuclei and thinnest slice possible. Two types of camera are combined to take better photograph. The ionization of nucleus by electrons are controlled and limited, not to harm the cell.

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