Radiation Exposure in Diagnostic Imaging: Better to Err on Safe Side

Ionizing radiation including X-rays and gamma rays are the most common radiations used in medical imaging for diagnosis and management. In last two decades there has been a tremendous rise in utilization of computed tomography (CT) especially after introduction of multislice machines and myocardial perfusion imaging (MPI) in nuclear medicine. Furthermore it is expected to escalate in near future since hybrid imaging using PET/CT has become standard of care in many cancers. According to National Council on Radiation Protection and Measurement (NCRP) report published in 2009, in United States (US) over a period of 10 years (1998 to 2008) CT based procedures had increased from 26 million to 70 million and nuclear medicine procedures from 12 million to 20 million.[1] Importantly these numbers are almost 50% of the CT and NM (primarily MPI) procedures performed globally. In 1980 mean radiation dose to an American was 3.6 mSv (3 mSv from background and 0.6 mSv from medical exposure) but in 2006 medical exposure (primarily CT and MPI studies) contributed 3 mSv.[1] This trend and its aftermath indeed have created anxiety among various statutory and non-statutory bodies and obviously in public regarding stochastic effects of radiation like cancers and congenital abnormalities. In last few years various articles have been published which predicted thousands of radiation induced cancers and cancer deaths in the US. population in future years.[2,3,4,5] These studies have used Biological Effect of Ionizing Radiation-VII (BIER-VII) report[6] which is primarily based on data from Hiroshima and Nagasaki survivors. However, strong proponents of this trend consider this as positive and blame these reports to be sensationalized by media and created anxiety among patients and general public. They argued that risks at low doses delivered by medical imaging has been estimated from data greater than 100 mSv acquired from the Japanese studies, a linear no-threshold(LNT) model of radiation injury was used,even though considerable evidence suggests that it is an inappropriate model for risk estimation.[7] Furthermore, they criticize the methodology as radiation doses to patients were converted to effective doses which is discouraged by International Commission on Radiological Protection (ICRP) for epidemiological studies or for estimation of individual risk.[8] However, IAEA, ICRP, NCRP, American College of Radiology, Society of Nuclear Medicine (SNM), American Society of Nuclear Cardiology (ASNC), European Association of Nuclear Medicine (EANM), and others have taken the issue seriously and released various recommendations to minimize radiation exposure from diagnostic procedures. In this regard every radiation based procedure has to be justified (right procedure, right patient, right time) and optimized by employing As Low As Reasonably Achievable (ALARA) principal. For CT, vendors have produced modification like tube modulation to reduced radiation exposures, use of low KVp and current (120 KVp and 80 mA with automatic exposure control) and use of iterative reconstruction techniques. For MPI (single most dose contributor) use of Technetium-99m based agents, stress first or stress-only protocol, iterative reconstruction with resolution recovery and noise reduction software and use of semiconductor gamma cameras. Furthermore, positron emission (PET) tracer based MPI has also been recommended depending upon its availability. For hybrid imaging like PET/CT, three vendors have marketed PET/MR machines to substantially reduce radiation exposure incurred by CT examination. Although there is no direct evidence of radiation ever causing any harm at the exposure levels encountered with diagnostic radiological examinations, we still believe that every radiation based procedure must be justified and optimized as it is better to err on safe side.

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