MRAD 251 – Computed Tomography Theory 1

Handout - Radiation Safety & Dosimetry in CT

Purpose

Outcome 5: Summarize radiation safety in computed tomography (CT).

<u>Fundamental Concepts of Radiation Dose in CT</u>

CT produces high exposures, and its clinical use is increasing. Managing dose levels in CT requires knowledge of:

- Radiation quantities (and their units of measurement)
- Factors affecting CT dose
- CT dosimetry
- Radiation protection

CT relevant **radiation quantities:**

1. Exposure
    - The concentration of radiation at a particular point on a patient
    - Measured using an ionization chamber
    - Units of measurement = R (***Roentgen***) or mR (1R = 1,000mR)
2. Absorbed dose
    - The amount of energy absorbed per unit mass of a patient
    - Used to estimate risk
    - Units of measurement = Gy (***gray***) or r (rad) [100r = 1Gy]
3. Effective dose
    - Estimates risk by comparing partial body exposures to a whole body dose
        - Relates exposure to carcinogenic risk and/or genetic effects
    - Attempts to account for the type of radiation a patient was exposed to and the radiosensitivity of the exposed area
        - Tissue-weighting factors
    - Units of measurement = Sv (***Sievert***) or rem (1Sv = 100rem)
        - Dose limits in SC35 are listed in mSv

Factors affecting CT dose and image quality can be categorized as direct or indirect. The effect of these factors correlate to beam geometry. Dose distribution is more uniform in CT due to the 360^0 rotation of the tube during image acquisition.

Scatter radiation contributes to the overall dose measured within a given slice thickness. Ideally, an individual "slice dose distribution" would be rectangular, representing the shape of the image slice. Scatter influences the slice dose distribution, creating a more typical bell-shaped curve.

The method and equipment used to measure patient dose from a CT scanner is known as **CT dosimetry**. Dosimetry enables implementation of radiation safety and QC (quality control) procedures, which assist technologists with patient education. CT doses are measured using:

- Dosimeters
- Phantoms
- Dose descriptors
    - CTDI
        - Measures "average slice dose"
    - DLP
        - Measures "average scan dose"
    - ED (effective dose)
        - Measures risk assessment using *k* values (previously established constants of doses produced using scan protocols)
        - Allows a comparison of the dose received from a CT scan with the dose received from natural background radiation.

Dose measurements are reflective of an attenuation environment somewhat similar to a patient. However, the homogenous nature of the phantoms does not simulate the different tissue types and heterogeneities of a real patient. Therefore, dose measurements <u>do not</u> accurately detect patient dose.

Reference

Seeram, E. (2016). *Computed Tomography: Physical Principles, Clinical Applications, and Quality Control* (4^{th} ed.). Elsevier.