

Organ Dose Calculator for Fetus Undergoing Computed Tomography

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Abstract : Pregnant patients may undergo CT in emergencies unrelated with pregnancy, and potential risk to the developing fetus is of concern. It is critical to accurately estimate fetal organ doses in CT scans. We developed a fetal organ dose calculation tool using pregnancy-specific computational phantoms combined with Monte Carlo radiation transport techniques. We adopted a series of pregnancy computational phantoms developed at the University of Florida at the gestational ages of 8, 10, 15, 20, 25, 30, 35, and 38 weeks (Maynard et al. 2011). More than 30 organs and tissues and 20 skeletal sites are defined in each fetus model. We calculated fetal organ dose-normalized by CTDIvol to derive organ dose conversion coefficients (mGy/mGy) for the eight fetuses for consequential slice locations ranging from the top to the bottom of the pregnancy phantoms with 1 cm slice thickness. Organ dose from helical scans was approximated by the summation of doses from multiple axial slices included in the given scan range of interest. We then compared dose conversion coefficients for major fetal organs in the abdominal-pelvis CT scan of pregnancy phantoms with the uterine dose of a non-pregnant adult female computational phantom. A comprehensive library of organ conversion coefficients was established for the eight developing fetuses undergoing CT. They were implemented into an in-house graphical user interface-based computer program for convenient estimation of fetal organ doses by inputting CT technical parameters as well as the age of the fetus. We found that the esophagus received the least dose, whereas the kidneys received the greatest dose in all fetuses in AP scans of the pregnancy phantoms. We also found that when the uterine dose of a non-pregnant adult female phantom is used as a surrogate for fetal organ doses, root-mean-square-error ranged from 0.08 mGy (8 weeks) to 0.38 mGy (38 weeks). The uterine dose was up to 1.7-fold greater than the esophagus dose of the 38-week fetus model. The calculation tool should be useful in cases requiring fetal organ dose in emergency CT scans as well as patient dose monitoring.

Keywords : computed tomography, fetal dose, pregnant women, radiation dose

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