Summary of Thyroid Cancer Risks Due to Mammography

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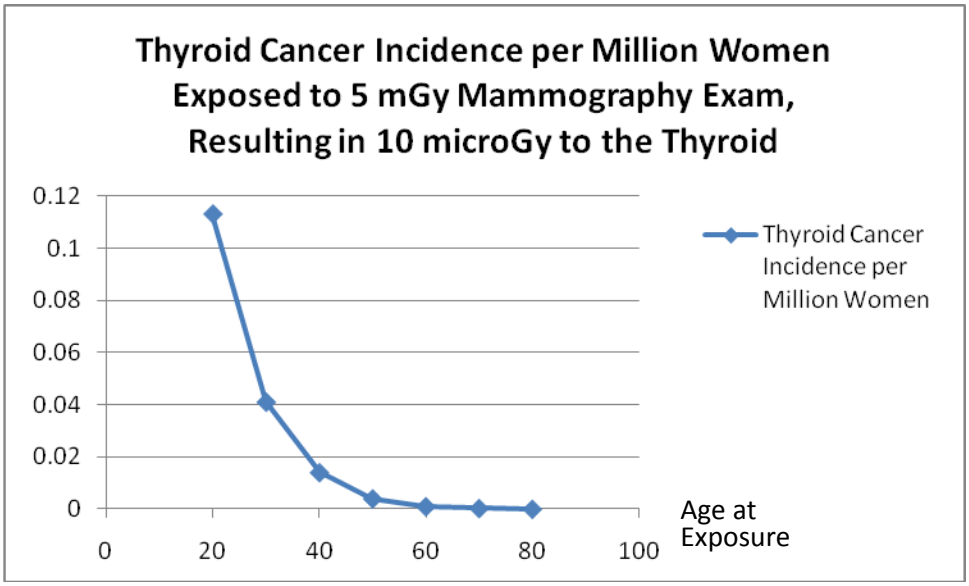
Sechopoulos, et al,[1] studied all body organ doses from mammography and determined that the dose to the thyroid during mammography is less that 0.1% (1/1000th) of the mean glandular dose to the breast. This makes sense, since the thyroid is never in the primary beam and would only receive dose due to secondary radiation backscattered from the breast. Since at the low x-ray beam energies used in mammography the primary attenuation of x-rays in the breast is via photoelectric effect absorption (rather than Compton scattering), there are few backscattered x-rays.

Given that the 2-view breast dose from screen-film mammography is about 4.7 mGy and from digital is about 3.7 mGy,[2] if we assume a typical screening exam breast dose is less than 5 mGy to each breast, then the scattered dose to the thyroid from a 2-view exam of a single breast is less than 5 microGray (< 5 x 10^{-6} Gy) and for a bilateral exam is less than 10 microGy (10^{-5} Gy).

Because the risk of radiation-induced cancer in the thyroid is quite dependent on age at exposure, I have used data from BEIR-VII,[3] which provide age-dependent estimates of radiation-induced cancer incidence rates. They are shown in the graph below for a dose of 10 microGray to the thyroid:



I calculated the cumulative risk from annual mammography from ages 40 to 80 years, and found that the estimate lifetime incidence of radiation-induced thyroid cancer due to annual screening from ages 40-80 at the estimated 5 mGy mammography dose is 1.3 per 10,000,000 women screened, or 1 in 7.7 million women.

Meanwhile, according to BEIR-VII, the number of radiation-induced thyroid cancers occurring in 7.7 million due to 3 mGy of natural background radiation per year over their lifetimes would be 17,300.

Thus, mammography contributes negligibly compared to natural background radiation to the incidence of thyroid cancer is U.S. women.

Further follow-up information from Dr. Sechopoulos determined that if each breast receives a mean glandular dose of 5 mGy from mammography, the total dose to the thyroid from exposing both breasts twice is 5 microGray (half of what was estimated above). Using the weighting factor for the thyroid of 0.04 (from ICRP Report #103, 2007),[3] the effective dose to the thyroid is 0.2 microSv. This should be compared to 3 mSv annual natural background radiation, so the effective dose to the thyroid from a bilateral 2-view mammogram is equivalent in terms of detriment to 35 minutes of natural background radiation (or 1/15,000th of annual natural background radiation). In short, it is a negligible amount of radiation. For annual screening mammography from ages 40-80, the cancer risk from this tiny amount of radiation scattered to the thyroid is less than 1 in 10,000,000.

References:

1. Sechopoulos I, Suryanarayanan S, Vedantham S, et.al. Radiation dose to organs and tissues from mammography: Monte Carlo and phantom study. Radiology 2008; 246: 434-443.

2. Hendrick RE, Pisano ED, Averbukh A, et.al. Comparison of acquisition parameters and breast dose in digital mammography and screen-film mammography in the American College of Radiology Imaging Network Digital Mammographic Screening Trial. Am. J. Roentgenology 2010; 194: 362-369.

3. Health risks from exposure to low levels of ionizing radiation – BEIR VII, Phase 2. Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation, National Research Council of the National Academies, Washington, DC: National Academies Press, 2006.

See also: Hendrick RE. Radiation doses and cancer risks from breast imaging studies. Radiology 2010; 257: 246-253.