



San Gabriel Valley Perinatal Newsletter

October 1, 2003

Vol.1, No. 8

Ionizing Radiation

Pre-conception irradiation of either parent's gonads has not been shown to result in increased cancer or malformations in their children. The noncancer effects of ionizing radiation on the embryo or fetus depend on the radiation dose and the gestational age at the time of exposure. Effects of ionizing radiation on the embryo or fetus include, miscarriage, fetal growth restriction, congenital malformation (e.g. microcephaly), mental retardation, an increased risk for childhood cancer [1].

Noncancer Health Effects

Radiation-induced noncancer health effects are not detectable for fetal doses below about 50 mGy (1 mGy =100 mrad) [2]. Noncancer health effects may be expected after fetal doses ≥ 100 mGy and appear to have the most significant effects between the gestational ages 8-25 weeks. Doses > 100 mGy are not commonly reached with conventional x-ray examinations, but may be reached with fluoroscopic procedures(e.g. barium enema) and with radiotherapy (Table 1). The use of radioactive isotopes of iodine is contraindicated in pregnancy.

Prior to 2 weeks gestation an exposure of 100 mGy (10 rads) may lead to death of the embryo. The dose necessary to kill 100% of human embryos or fetuses before 18 weeks' gestation is about 5000 mGy (500 rads). Radiation-induced noncancer health effects are unlikely at this stage of development no matter what the radiation dose. [2].

For fetuses exposed between 8-15 weeks' gestation atomic bomb survivor data indicate that the decline in IQ score is approximately 25–31 points per 1000 mGy above 100 mGy (40% risk for severe mental retardation) [9].

From 16- to 25 weeks' gestation the average IQ loss is approximately 13–21 points per 1000 mGy (per 100 rads) at doses above 700 mGy (70 rads) [2].

After 26 weeks, doses above 1000 mGy (100 rads) the risks for stillbirth and neonatal death (i.e., infant death within 28 days after birth, including stillbirth) increases [2].

Risk of Childhood Cancer

There appears to be slightly increased risk of childhood cancer with radiation doses to the fetus of ≥ 10 mGy (1000 mrad). There is no evidence that this effect is dependent on gestational age.

Table 1. Maximum Estimated Fetal Dose (mGy) During Some Diagnostic Imaging Studies

Study	View	Mean	Maximum
Dental [3]	-	.001	
Cerebral angiography [5]			<0.1
Chest [4]	AP	<.01	<.01
Chest [4]	PA	<.01	<.01
Upper or lower extremity [7]		.01	
Thoracic spine [4]	PA	<.01	0.01
Thoracic spine [4]	AP	<.01	0.03
Skull [7]		.04	
Chest Helical [6]			0.13
Pulmonary Perfusion (Technetium) 3 mCi (99mTc) MAA [8]		0.18	
Mammogram [5]	CC and Lat (4 films)		0.20
IVP [5]	Lat		0.37
Pulmonary Ventilation (Xenon) 10 mCi (133Xe)6 [5]		0.40	
CT Head* [5]			< 0.50
Pulmonary angiography brachial route [8]			<0.50
Hip [5]	Lat		0.51
Hepatobiliary 5mCi ^{99m} Tc Sulfur colloid [5]			0.55
Upper GI series [5]			0.56
CT Chest * [5]			<1.00
IVP [5]	PA		1.04
Hip [5]	AP		1.40
Hepatobiliary 5mCi ^{99m} Tc HIDA [5]			1.50
Pulmonary Perfusion (Technetium) 5 mCi (99mTc) MAA [5]		1.75	
IVP [5]	AP		2.64
Abdomen [4]	PA	1.30	3.0
Lumbar spine [4]	Lat	.91	3.5
Pulmonary angiography femoral route [8]			3.74
Abdomen [4]	AP	2.90	15.00
Small bowel series with upper GI [5]			21.3
Pelvis [4]	AP	3.40	22.0
CT Abdomen * [5]			26.00
Lumbar spine [4]	AP	7.50	40.00
Barium enema [4]		10.00	130.00

* 10 slices with slice thickness = 10mm

The absolute risk for fatal cancer for ages 0-15 year after prenatal radiation exposure has been estimated to be 0.006% per 1 mGy. For the whole life span this risk is about 0.015% per 1 mGy. In other words there is over a 99% chance that a fetus exposed to less than 100mGy will NOT develop childhood cancer or leukemia

Recommendations International Commission on Radiological Protection (ICRP)

- All medical practices (occupational and patient-related) should be justified (more benefit than risk)
- < A missed period in a regularly menstruating woman should be considered due to pregnancy, until proven otherwise
- Pregnant medical radiation workers may work in a radiation environment as long as there is reasonable assurance that the fetal dose can be kept below 1 mGy during the pregnancy
- The pregnant patient or worker has a right to know the magnitude and type of potential radiation effects that might result from in-utero exposure
- Communication should be related to the level of risk. Communication that risk is negligible is adequate for very low dose procedures (<1 mGy to the fetus)
- If fetal doses are above 1 mGy, a more detailed explanation
- After it is decided to do a medical radiation procedure, the fetal radiation dose should be reduced while still obtaining the required diagnostic information
- Termination of pregnancy at fetal doses of less than 100 mGy (10,000 mrad) is **NOT** justified based upon radiation risk
- At fetal doses between 100 and 500 mGy, decisions should be based upon individual circumstances
- At fetal doses in excess of 500 mGy, there can be significant fetal damage, the magnitude and type of which is a function of dose and stage of pregnancy

There is over a 99% chance that a fetus exposed to less than 100mGy will NOT develop childhood cancer or leukemia

In summary women who have had routine dental x-rays, plain films of the head, extremities, and chest (including mammograms), or computed tomography (CT) of the head or chest may be counseled that there is no increased risk to their fetus of miscarriage, fetal growth restriction, congenital malformation (e.g. microcephaly), or mental retardation. In addition they may be counseled that there is > 99% chance that their child will NOT develop a childhood cancer.

For patients who have had fluoroscopic, studies, studies involving radioactive isotopes, or radiotherapy the fetal radiation dose should be estimated by qualified medical personnel to provide a more detailed approximation of risks to the fetus. Consultation with hospital medical physicists or a health physicist should be considered.

Online Resources:

- Conference of Radiation Control Program Directors
<http://www.crcpd.org/contact.asp>
- Health Physics Society
<http://www.hps.org/publicinformation/ate/cat4.html>
- International Commission on Radiological Protection (ICRP) Educational Modules
http://www.icrp.org/download_educational.asp
- Prenatal Radiation Exposure: Physicians' Fact Sheet
<http://www.bt.cdc.gov/radiation/prenatalphysician.asp>

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