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Radiological Techniques Department

Fetal radiation risk

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Fetal radiation risk

There are radiation-related risks throughout pregnancy that are related to the stage of pregnancy and absorbed dose. radiation risks are most significant during organogenesis and in the early fetal period, somewhat less in the 2nd trimester, and least in the 3rd trimester

- 0 – 2 Weeks: The embryo is sensitive to the lethal effects of x rays although doses much higher than 50 mSv, that is to cause a miscarriage.
- 3– 8 Weeks: The embryo is in the period of early embryonic development but is not affected with either birth defects, pregnancy loss, or growth retardation unless the exposure is substantially above 200 mSv exposure.
- 8 — 15 weeks: The embryo or fetus is sensitive to the effects of radiation on

the central nervous system. But here again, the exposure has to be very high. Fetal doses in excess of 10 Rem can potentially result in some reduction of IQ (intelligence quotient) while fetal doses in the range of 100 Rem can result in severe mental retardation and microcephaly, (and to a lesser extent at 16-25 weeks). Malformations have a threshold of about 20 Rem or higher and are typically associated with central nervous system problems 16 weeks on: The fetus is completely developed; it has become more resistant to the developmental effects of radiation. In fact, the fetus is probably no more vulnerable to many of the effects of radiation than the mother in the latter part of pregnancy.

Protecting the Embryo/Fetus

- The only way to protect the embryo/fetus from excess radiation is to protect the mother. When a mother "DECLARES" her pregnancy:
- A "Belly" badge for the baby is issued
- Bioassay for radioactive material intake may be initiated and repeated monthly
- The pregnant woman will be administratively limited to work with less than 10% of the all activity to ensure an intake dose of less than 500 mrem.
- Additional information is available through the Radiation Control Office.
- If you are uncomfortable discussing this with the Radiation Safety Officer,

arrangements may be made to discuss your concerns with female radiation health professional.

Medical Radiation effects on Embryo and Fetus

1. Less severe abnormalities in human embryo exposed before 2-3 weeks of gestation was observed, although an increase abortion was reported.

2. Severe abnormalities observed between 4 and 11 weeks of gestation.

3. Abnormalities involving eye, skeleton, genital organs and stunted growth, microcephaly and mental retardation was observed between 11 and 16 weeks of gestation.

4. Weeks 16-20 showed mild stunted growth, microcephaly and mental retardation.

5. Irradiation after 30 weeks caused functional disabilities.

6. Childhood Development

Effects of Radiation on the Embryo and Fetus

Fetal Stages and Radiation Sensitivity

There are three important stages of conception development:

1. Pre-implantation

2. Organogenesis

3. Fetal development

Preimplantation (days 0 to ~14): The number of cells in the embryo is relatively small. The pre-implantation phase of the embryo has the greatest sensitivity to the lethal effects of ionizing radiation.

Radiation can either be lethal or have no apparent effect (“all or none” response).

As a result, Fetuses are more sensitive to radiation than adults. Radiation exposure, thus, affects some risk to the fetus that include:

1- Lethal effects

2- prenatal or neonatal death, congenital anomalies and malformations,

3- severe mental retardation,

4- temporary or permanent growth retardation,

5- carcinogenesis,

6- increased occurrence of seizures,

7- neurological effects, sterility and germ cell mutations.

Other abnormalities include:

- small birth weight,
- microcephaly,
- microphthalmus,
- pigmentary degeneration of the retina,
- genital and skeletal malformation,
- cataracts and heredity effects,

- Intelligence quotient
- Central Nervous System Effects
- Cancer–childhood, adulthood
- Teratogen**:** agent that can disturb the development of the embryo or fetus. Teratogens can halt pregnancy or produce a congenital malfunction.
- Mutagen**:** can cause genetic mutation.

Lethal effects

The effects on the embryo/fetus depend on the time of exposure relative to conception. Exposure of the embryo in the first three weeks following conception is not likely to result in deterministic or stochastic effects in the live-born child. It is thought that any cellular damage at this stage is much more likely to cause the death of the embryo/fetus (Lethal effects) than to result in stochastic effects expressed in the liveborn.

Malformation

Malformations have a threshold of 100-200 mGy or higher and are typically associated with central nervous system problems. During the period of major organogenesis, conventionally from the start of the third week after conception, malformations may be caused in the organ under development at time of exposure. These effects are deterministic in character with a threshold in man.

Mental retardation

Mental retardation was not observed to be induced by radiation prior to 8 weeks from conception, or after 25 weeks. The period 8-15 weeks are more sensitive than the period 16-25 weeks. During the most sensitive period, the fraction of those exposed which became severely mentally retarded increased by approximately 0.4 per Sv.

Intelligence quotient

Observed a general downward shift in the IQ with increasing dose. The shift is proportional to dose. At doses of the order of 0.1 Sv, no effect would be detectable in the general distribution of IQ, but at somewhat large doses the effect might be sufficient to show an increase in the number of children classified as severely retarded. All the observations on IQ and severe mental retardation relate to high dose.

Central Nervous System Effects

During 8-25 weeks' post-conception, the CNS is particularly sensitive to radiation.

Fetal doses in excess of 100 mGy can result in some reduction of IQ (intelligence quotient).

Fetal doses in the range of 1000 mGy can result in severe mental retardation, particularly during 8-15 weeks and to a lesser extent at 16-25 weeks.

Most risk