

Guidelines for Diagnostic Imaging During Pregnancy and Lactation

- Recommendations
 - Ultrasonography and magnetic resonance imaging (MRI)
 - Risk:
 - are not associated with risk
 - Recommendation:
 - imaging techniques of choice for the pregnant patient
 - Radiography, computed tomography (CT) scan, or nuclear medicine imaging techniques
 - Risk:
 - In most cases at a dose much lower than the exposure associated with fetal harm.
 - Recommendation:
 - If these techniques are necessary in addition to ultrasonography or MRI or are more readily available for the diagnosis in question, they should not be withheld from a pregnant patient.
 - Nuclear medicine:
 - Breast feeding:
 - Some specific nuclear materials excreted into breast milk can have deleterious effects, consultation with experts on breastfeeding and nuclear medicine are recommended when these compounds are used in lactating women.
 - Iodinated contrast with CT:
 - During pregnancy:
 - Risk:
 - lack of known harm (according to available evidence)
 - Recommendation:
 - only be used if absolutely required to obtain additional diagnostic information that will affect the care of the fetus or woman during the pregnancy.
 - During breast feeding:
 - breastfeeding can be continued without interruption after the use of iodinated contrast
 - Gadolinium contrast with MRI should
 - During pregnancy:
 - Should be limited
 - Exceptionally:
 - if it significantly improve diagnostic performance and is expected to improve fetal or maternal outcome.
 - Breastfeeding
 - should not be interrupted after gadolinium administration.

- Ultrasonography:
 - Recommendations:
 - imaging techniques of choice for the pregnant patient
 - Rationale
 - Evidence:
 - no reports of documented adverse fetal effects
 - Theoretically:
 - theoretical increase in temperature
 - elevation for the fetus may be as high as 2°C (35.6°F)
 - risk of temperature elevation
 - lowest with B-mode imaging
 - higher with color Doppler and spectral Doppler applications
- Magnetic Resonance Imaging
 - Advantage over ultrasound:
 - ability to image deep soft tissue structures in a manner that is
 - not operator dependent
 - not use ionizing radiation.
 - no precautions or contraindications specific to the pregnant woman.
 - Disadvantages:
 - theoretical concerns
 - teratogenesis,
 - tissue heating
 - acoustic damage
 - Recommendations:
 - imaging techniques of choice for the pregnant patient
 - Rationale:
 - Animal studies:
 - do not demonstrate risk
 - Human studies:
 - there are no published human studies documenting harm
 - Tissue heating is proportional to the tissue's proximity to the scanner and, therefore, is negligible near the uterus
 - No acoustic injuries to fetuses during prenatal MRI
 - Gadolinium contrast with MRI should
 - During pregnancy:
 - Should be limited
 - Exceptionally:
 - If it significantly improve diagnostic performance and is expected to improve fetal or maternal outcome.
 - Rationale:
 - Human studies:
 - no acoustic injuries to fetuses during prenatal MRI
 - MRI with contrast:

- Unlike CT, MRI adequately images most soft tissue structures without the use of contrast.
- Two types of MRI contrast:
 - 1) gadolinium-based agents
 - 2) superparamagnetic iron oxide particles.

- Gadolinium MRI:
 - Advantages:
 - imaging of the nervous system
 - because they cross the blood–brain barrier when this barrier has been disrupted, such as in the presence of Tumor
 - can define tissue margins and invasion in the setting of placental implantation abnormalities,
 - Disadvantage:
 - Water soluble and can cross the placenta
 - Chelation:
 - Free gadolinium is toxic
 - Only administered in a chelated (bound) form.
 - Rationale
 - Animal studies
 - teratogenic
 - at high and repeated doses
 - Fetal exposure
 - is not known because the contrast present in the amniotic fluid is swallowed by the fetus and reenters the fetal circulation.
 - The longer gadolinium-based products remain in the amniotic fluid, the greater the potential for dissociation from the chelate and, thus, the risk of causing harm to the fetus
 - Large retrospective study
 - gadolinium MRI associated with:
 - rheumatologic, inflammatory, or infiltrative skin condition
 - Stillbirths and neonatal deaths

- Ionizing Radiation
- Measures of Ionizing Radiation

Measure	Definition	Legacy Unit	SI* Unit
---------	------------	-------------	----------

Exposure	<ul style="list-style-type: none"> • Number of ions produced per kilogram of air 	• Roentgen (R)	2.58×10^{-4} C/kg
Dose	<ul style="list-style-type: none"> • Amount of energy per kilogram of tissue 	• Rad (rad)	Gray (Gy) <ul style="list-style-type: none"> • 1 Gy = 100 rad
Relative effective dose	<ul style="list-style-type: none"> • Amount of energy per kilogram of tissue normalized for biological effectiveness 	• Roentgen equivalent man (rem)	sievert (Sv) <ul style="list-style-type: none"> • 1 Sv = 100 rem

- Effects of Gestational Age and Radiation Dose on Radiation-Induced Teratogenesis

Gestational Period	Effects	Estimated Threshold Dose*
Before implantation (0–2 weeks after fertilization)	Death of embryo or no consequence (all or none)	50 mGy (50–100)
Organogenesis (2–8 weeks after fertilization)	Congenital anomalies	200 mGy
	Growth restriction	200 mGy (200–250)
Fetal period	Effects	Estimated Threshold Dose*
8–15 weeks	Severe intellectual disability (high risk)	60 mGy (60–310)
	Microcephaly	200 mGy
	Intellectual deficit	25 IQ-point loss per 1,000 mGy
16–25 weeks	Severe intellectual disability	250 mGy*

	(low risk)	(250–280)
--	------------	-----------

- Risk of carcinogenesis
 - Very small
 - 10–20 mGy fetal exposure
 - ++ risk of leukemia 1.5–2.0x
 - over a background rate of approximately 1 in 3,000
- Contrast with CT:
 - Oral contrast agents:
 - not absorbed by the patient and do not cause real or theoretical harm.
 - intravenous contrast
 - Although iodinated contrast media can cross the placenta and either enter the fetal circulation or pass directly into the amniotic
 - Fluid animal studies have reported no teratogenic or mutagenic effects from its use theoretical concerns about the potential adverse effects of free iodide on the fetal thyroid gland have not been borne out in human studies
 - it generally is recommended that contrast only be used if absolutely required to obtain additional diagnostic information that will affect the care of the fetus or woman during the pregnancy
- Fetal Radiation Doses Associated With Common Radiologic Examinations

Type of Examination	Fetal Dose* (mGy)
Very low-dose examinations (<0.1 mGy)	
● Cervical spine radiography	<0.001
● Head or neck CT	0.001–0.01
● Radiography of any extremity	<0.001
● Mammography	0.001–0.01
● Chest radiography	0.0005–0.01
Low- to moderate-dose examinations (0.1–10 mGy)	

● Radiography	
○ Abdominal radiography	0.1–3.0
○ Lumbar spine radiography	1.0–10
○ Intravenous pyelography	5–10
○ Double-contrast barium enema	1.0–20
● CT	
○ Chest CT or CT pulmonary angiography	0.01–0.66
● Nuclear medicine	
○ Low-dose perfusion scintigraphy	0.1–0.5
○ Technetium-99m bone scintigraphy	4–5
○ Pulmonary digital subtraction angiography	0.5
Higher-dose examinations (10–50 mGy)	
○ Abdominal CT	1.3–35
○ Pelvic CT	10–50
○ F PET/CT whole-body scintigraphy	10–50