

Risks of Ionizing Radiation in Pregnancy

Natural background radiation to fetus: 1 mGy

Risk of abnormalities negligible at 5 rad (50 mGy) or less

Risk of malformations significantly increased for doses > 15 rad (150 mGy)

Ionizing Radiation Studies

Mean Fetal Dose by Exam:

- Chest Xray < 0.1 mGy
- Extremity Xray < 0.1 mGy
- CT Head < 0.1 mGy
- CT Chest 2 mGy
- Abdomen AP 3 mGy
- Pelvis AP 4 mGy
- IVU 6 mGy
- Lumbar spine AP 7 mGy
- Barium Enema 10 mGy
- CT Abdomen Pelvis 30 mGy

CT Imaging: Estimated radiation exposure is low for CT when fetus is outside the field of view. CT of the head, c-spine, and extremities can be safely performed in any trimester of pregnancy. Chest CT is also considered low-dose provided the fetus is excluded from the primary beam.

Non-ionizing Radiation Studies

Ultrasound: No documented adverse effects on the fetus. Doppler should be used judiciously and avoided when imaging fetus if possible.

MRI: MRI may be used in pregnant patients if considered necessary by referring physician and attending radiologist irrespective of gestational age. Written informed consent must be obtained. Patient should be told that there are no known risks to the fetus. However, its safety has not been proved and cannot be guaranteed.

Intravenous Contrast

Iodinated Contrast - Iodinated contrast media is FDA Category B: animal reproductive studies have not demonstrated a fetal risk, but there are no controlled studies in pregnant women and they should be used only after assessment of potential risk-benefit ratio. Depression of fetal thyroid function is a potential harmful effect due to exposure of fetal thyroid to free iodide. Thyroid function should be checked in the first week of life (already standard practice in the US).

Paramagnetic Contrast - Animal studies have shown potential lethal toxic effects from IV gadolinium as well as growth retardation and congenital abnormalities. Use would be based only on "overwhelming potential benefit to the patient and fetus outweighing the theoretic but potentially real risks of long-term exposure of the developing fetus to free gadolinium ions."

Protocols for Imaging of Pregnant Patients

Pulmonary Embolism

- Initial study: US of lower extremities. Positive study avoids need for additional imaging.
- CT Angiography - preferred over V/Q Scan because of decreased dose (0.013 vs 0.11-0.20) and ability to detect other causes for patient's symptoms. Suggested modifications:
 - Scan to inferior limit of xiphoid process.
 - Increase the pitch and thicken detector collimation
 - Eliminate lateral scout view
 - Reduce the field of view and decrease the peak values for kVp and mAs (but still maintain image quality)
 - Use lead shielding (does not reduce internal scatter but can decrease patient anxiety)

Acute Appendicitis

- Initial test: Ultrasound - variable sensitivity and specificity. May be improved in third trimester by imaging in left lateral decubitus position. Also should survey for alternative diagnosis, such as ovarian torsion.
- Preferred test: MRI - MR imaging should be used to exclude appendicitis in pregnant women suspected to have acute appendicitis but with inconclusive US results.
- Second-line test: CT of Abdomen Pelvis - If MR imaging cannot be performed, the risk of delaying the diagnosis of appendicitis with possible perforation should be weighed against the risk of developing radiation-induced childhood cancer (estimated risk of 1 cancer per 500 fetuses exposed to average dose of 30 mGy). Use same techniques as above to decrease radiation exposure when possible.

Urolithiasis

- Initial Test: *Ultrasound*. Limited sensitivity for detection of stones. For distinguishing physiologic dilatation of the collecting system vs. obstructive hydronephrosis, RI of intrarenal vessels has been used. RI of abnormal kidney ≥ 0.70 has accuracy of 87%. RI difference of ≥ 0.04 between normal and abnormal kidneys has reported accuracy of 99%.
- Second-line test: *MR Urography* - May be used to evaluate site of obstruction, perinephric fluid and stranding, and possible large obstructing stones. Disadvantages: cannot visualize small stones and high cost.
- Alternative test: *Low-dose CT* of abdomen/pelvis - reported $>95\%$ sensitivity and $>98\%$ specificity. Parameters: 160 mA and 140 kVp. Doses of approx 4 to 7.2 mGy at 0 months, 8.5 to 11.7 mGy at 3 months using these parameters. Conventional parameters may have exposures up to 49 mGy for abdomen and 70 mGy for pelvis components.

Biliary Disease

- Initial Test: Ultrasound.
- Secondary Test: MRCP. MRCP is preferred because it is non-invasive and not associated with complications of ERCP such as pancreatitis.

Trauma

- Due to high risks associated with maternal trauma, there is a need for rapid and accurate imaging. Concerns about fetal radiation exposure should not deter nor delay radiologic evaluation.
- Studies that do not involve direct fetal radiation exposure (CT Head, CT C-spine, CT Chest) should be performed without concerns.
- Ultrasound - Evaluate for free intraperitoneal fluid or solid organ injury. Evaluate fetus.
- CT - CT Abdominal/Pelvis use in blunt abdominal trauma in the setting of negative ultrasound is controversial. Risks/benefits must be weighed. IF CT is used; attempts should be made, as above, to reduce radiation exposure.