Imaging in Pregnancy: should I or should I not?

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Learning objectives

When handling pregnant patients it is not unusual that clinicians present some doubts or concerns about the right imaging study for certain scenario. These uncertainties can sometimes deter or delay the radiologic evaluation needed for the correct assessment of a patient condition. Because pregnant women are a special subset of the population, some particularities should be in mind when planning the diagnostic investigation.

For this exhibit, we set as objectives:

- make a small introductory note about potential radiation effects, common doses of various modalities and ways to reduce radiation dosage.

- discuss the main indications for common pathologies such as pulmonary embolism, abdominal pain and trauma.

- review the safety of contrast agents during pregnancy and lactation.
Background

Fetal radiation induced effects:

**Deterministic effects and stochastic effects:**

- The first relate to damage induced to a group/number of cells and is dose related. The threshold for these is thought to be between 50-100mGy, depending on gestational age. Concern rises from doses higher than 100mGy. Malformations, growth and mental retardation are examples of this group.

- Stochastic effects result from damage to a single cell, causing mutations and eventually leading to carcinogenesis. It is not dose dependent, so there is no direct association between increasing dose and severity of stochastic effects. Doses up to 1mGy are considered safe, and larger doses such as 50mGy double the risk of carcinogenesis, which in turn, remains low in absolute terms.

**Estimated doses from common imaging procedures:**

<table>
<thead>
<tr>
<th>Modality</th>
<th>Fetal dose</th>
<th>(expressed in mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X-Ray</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervical, chest,</td>
<td>up to 0,01</td>
<td></td>
</tr>
<tr>
<td>mammography, extremities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal, lumbar spine,</td>
<td>up to 10</td>
<td></td>
</tr>
<tr>
<td>pyelography</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head/Neck</td>
<td>up to 10</td>
<td></td>
</tr>
<tr>
<td>Thorax/Pulmonary</td>
<td>up to 0,66</td>
<td></td>
</tr>
<tr>
<td>angiography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal</td>
<td>up to 35</td>
<td></td>
</tr>
</tbody>
</table>
• Pelvic up to 50

Table 1 - expected doses for different types of common imaging procedures. Dose varies with gestational age and maternal body index mass. The period more vulnerable to radiation adverse effects is between the 2nd and the 25th weeks of gestation.

Strategies for dose reduction in CT:

• Increase pitch and detector collimation thickness.
• Decrease tube current and kilovoltage. Use automatic tube current modulation.
• Give barium oral contrast (shielding effect).
• Lead shielding of non-examined segments (abdomen and pelvis, in CT pulmonary angiography)
• Fixed injection timing instead of test run (CT angiography)
• Avoid multiple acquisitions

Note: As an example, one study by Litmanovich et al showed that a low-dose protocol CT pulmonary angiography reduced the total effective dose from 10.2 to 2.7 mSv (standard to low-dose protocols).

Managing concrete scenarios:

Pulmonary embolism

Prevalence of venous thromboembolism among pregnant patients is about five times higher than in non-pregnant patients. It is a very important cause of mortality in this group. Increased venous stasis, pregnancy-related hypercoagulability state and prolonged bed rest are some of the factors contributing to this higher prevalence.

The appropriate approach to this scenario is illustrated in figure 1.

Abdominal pain
The list of differential diagnosis of abdominal pain is wide, and as so, clinicians often seek our help confirming/excluding some of its possible causes. We will discuss the management of the most important ones, in the surgical and the medical point of view.

- **Appendicitis**

Appendicitis is the most common nonobstetric cause for abdominal pain requiring prompt surgical attention. It is associated with substantial fetal morbidity and mortality as well as premature labor. Recognizing the appendix is of increased difficulty on pregnant patients since it is usually rotated and displaced superiorly.

- **Urolithiasis**

As a relatively common nonobstetric cause for abdominal pain, it is relevant to know how to manage renal calculi in the pregnant patients. If not diagnosed in time, it can lead to pyelonephritis and premature labor.

The main challenge is to distinguish between normal/physiologic hydronephrosis of 2nd and 3rd trimesters and renal dilatations from obstructive calculi. Some studies point out the absence of ureteral jet on the affected side and the raise in intrarenal resistive index (RI), which is increased >0.7 (or a difference of RI between kidneys >0.04) as indicators of true obstructive hydronephrosis.

Management of these entities is illustrated in figures 2 and 3.

**Trauma:**

It is the leading nonobstetric cause of maternal mortality, and motor vehicle accidents account for about 2/3 of these cases. After patient stabilization it is mandatory to proceed with imaging evaluation to diagnose or discard maternal and fetal injuries.

Assessment of fetal and supportive tissues viability/integrity is made by obstetric ultrasound.

Maternal radiologic evaluation after trauma is displayed in figure 4.

**Contrast agents during pregnancy and lactation:**

Contrast media are used mainly in modalities such as CT and MRI to enhance their diagnostic value. There are few studies evaluating fetal exposure to contrast agents, so
caution is advised using these agents. Their use should always have in consideration the risk/benefit value for each concrete scenario.

Iodine and gadolinium based agents reach the breast milk in a very small percentage of the diagnostic dose, namely 0.01% and 0.5% of the initial dosage, respectively. The maximum concentration of contrast agents in the breast milk is attained 5 hours after injection and 22 hours after injection there is only about one-fifth of this level. Since the current threshold of the dose to reach the infant is considered a maximum of 10% of the therapeutic dosage, these agents are regarded as safe during lactation.

**Current consensus about safety of contrast agents is summarized in Table 2:**

<table>
<thead>
<tr>
<th></th>
<th>Iodine based agents</th>
<th>Gadolinium based agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pregnancy</strong></td>
<td>Probably safe</td>
<td>Uncertain</td>
</tr>
<tr>
<td>(FDA Class B drug)</td>
<td>(FDA Class C drug)</td>
<td></td>
</tr>
<tr>
<td>Neonatal screening for</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypothyroidism is advised</td>
<td></td>
<td>Malformations with supra-diagnostic</td>
</tr>
<tr>
<td>in newborns during the</td>
<td></td>
<td>doses reported in animal studies</td>
</tr>
<tr>
<td>1st week of life</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lactation</strong></td>
<td>Safe</td>
<td>Safe</td>
</tr>
<tr>
<td>(no mandatory resting</td>
<td>(no mandatory resting period)</td>
<td></td>
</tr>
<tr>
<td>period)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Fig. 1:** Management of pulmonary embolism in pregnant women. Positive findings on chest x-ray and in Doppler US require no further imaging. DVT: deep vein thrombosis; V/Q scan: ventilation-perfusion scanning.
Fig. 2: Suspicion of appendicitis relies on ultrasonography as first-line imaging. If negative it can also search for alternate diagnosis such as hydronephrosis, biliary disease, adnexial pathology. If non-diagnostic, further imaging with MRI or CT (if MRI unavailable) is warranted.
Fig. 3: Managing urolithiasis also relies initially on ultrasonography. If suspicion of a distal ureteric calculus is present, transvaginal US is recommended to identify it before proceeding to other modalities. If still non-diagnostic, further imaging with nonenhanced low-dose CT may be required.
Fig. 4: Initial assessment of blunt trauma includes chest x-ray and abdominal/pelvic ultrasound. Negative findings in low-grade trauma with low probability of injury can spare additional imaging. Positive findings on x-ray or US in low-level trauma or in all high probability of injury trauma cases should include contrast enhanced CT in the imagiologic evaluation. CT is the most accurate and cost-efficient tool for evaluating seriously injured blunt trauma pregnant patients.

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Imaging findings OR Procedure details

We have searched indexed publications using scientific repositories such as Medline and Pubmed for current data regarding this particular area of interest. The search was made with keywords like "medical imaging", "pregnancy", "guidelines", "rationale" as well as related articles and its references.
Conclusion

Managing different clinical scenarios in pregnant patients is challenging. Concerns about radiation induced effects in the fetus can sometimes delay adequate radiologic evaluation.

Ultrasonography and magnetic resonance are considered, in general, preferable imaging modalities for assessing pregnant patient pathology. However, radiation dependent modalities, such as CT, can be invaluable in certain circumstances, like blunt trauma. Knowledge of radiation reducing techniques is important in order to reduce potential side effects. Use of contrast agents during pregnancy should be judicious, but their use during lactation is considered safe.
References

1 - Wagner L, Applegate W et al; ACR practice guideline for imaging pregnant or potentially pregnant adolescents and women with ionizing radiation: 2008; ACR practice guideline.


