Ionizing radiation and contrast agents used for imaging during pregnancy

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Abstract

Maternal medical conditions can appear often during pregnancy and may require radiographic imaging for proper diagnosis and treatment. Many clinicians are still skeptical in using this diagnostic method due to its potential harm to the foetus. This article aims to bring to the attention that radiation exposure through radiography, computed tomography (CT) scans or nuclear medicine imaging techniques in usual settings is at a dose much lower than the exposure associated with fetal harm. The use of gadolinium contrast with magnetic resonance imaging (MRI) should be limited. This may be used as a contrast agent in a pregnant patient only if it significantly improves diagnostic performance and is expected to improve fetal or maternal outcome. Breastfeeding should not be interrupted after gadolinium administration.

Keywords: *ionizing radiation, contrast agents, pregnancy, foetus*

Rezumat

Afecțiunile medicale ale mamei pot apărea adesea în timpul sarcinii și pot necesita investigații radiografice pentru un diagnostic și tratament adecvat. Mulți clinicieni sunt încă sceptici în legătură cu folosirea acestei metode diagnostice, considerând că ar putea avea un potențial efect nociv asupra fătului. Scopul acestui articol este de a informa că expunerea la radiații sub forma tomografiei computerizate sau a rezonanței magnetice în maniera standardizată actuală se face la o doză mult mai mică decât cea care ar putea fi asociată cu leziuni fetale. Folosirea gadoliniului ca substanță de contrast în imagistica prin rezonanță magnetică trebuie limitată. Gadoliniul poate fi folosit ca substanță de contrast la pacienta gravidă numai dacă sporește semnificativ performanța diagnostică, îmbunătățind prognosticul matern sau fetal. Alăptarea nu va fi întreruptă după administrarea de gadolinium.

Cuvinte-cheie: *radiații ionizante, agenți de contrast, sarcină, făt*

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Radiațiile ionizante și substanțele de contrast folosite în investigația imagistică din timpul sarcinii

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Introduction

Radiographic imaging during pregnancy is often avoided due to concerns regarding the safety of using it. Such misconception can lead to excessive and unnecessary anxiety among patients, delays in diagnosis and treatment, or even inappropriate termination of pregnancy[1].

Imaging examinations requiring the administration of contrast agents pose two problems for the pregnant patient: the irradiation or exposure to a magnetic field of the embryo and the foetus, and the possible diffusion of the contrast agent through the placenta. Very few studies are available on this issue, but prudence should prevail[1,2].

In this article we discuss on the ionizing radiation and different types of contrast media that may be used in such patients according to the imaging modality (iodinated contrast media, gadolinium-based), focusing on their adverse effects, potential teratogenic effects, strategies to minimize risks, and current clinical recommendation.

It is very important, when counselling the patient, that every healthy woman begins her pregnancy with a 3% risk for birth defects and 15% risk for miscarriage, which represents the background risk for all healthy pregnant women[1].

Discussion

Ionizing radiation – radiation dose and pregnancy

Computed tomography uses ionizing radiation and it can play an important role in diagnosing pulmonary embolism, appendicitis and small bowel obstruction. The American College of Obstetricians and Gynaecologists (ACOG) recommend pulmonary CT angiography for pregnant patients with suspected pulmonary embolism[2].

When the foetus is not in the field of view, foetal dose is not important. It becomes important when the pelvis is scanned and attempts should be made to adhere to ALARA principle (as low as reasonably achievable). The medical physicist should not use the standard parameters in imaging pregnant patients. Imaging parameters should be adjusted to achieve the lowest possible dose. This includes lowering tube potential (in kilovolts) on the basis of the patient's weight, decreasing tube current time product, limiting image length, increasing pitch, and limiting the number of acquisitions to one. Foetal absorbed dose from a single-phase pelvic CT examination can be decreased from approximately 25 mGy to 13 mGy by using some of these techniques[3].

Diagnostic X-ray is often useful in cases of trauma. When the diagnostic X-ray is of the head, teeth, chest, neck or legs, the radiation exposure is not to the embryo and scatter that might reach the embryo, if any, would be extremely decreased and without risk. X-ray of the back, bladder function, gallbladder, pelvis and hip may expose the embryo to radiation and we have to determine the actual dose received by the embryo. This has to be done by a medical physicist[4].

The major concerns are for growth restriction, microcephaly, intellectual disability and spontaneous abortion.

The risk is dependent on the gestational age at the time of exposure, and the risks for central nervous system effects are maximized with exposure at 8-15 weeks of gestation.

A consensus has emerged that when the foetal radiation dose is less than 50 mGy, the risk is negligible and by using typical imaging parameters it is unlikely to reach this dose level. The lowest clinically documented dose to produce severe intellectual disability is 610 mGy.

A foetal radiation dose of 100 mGy should not be a reason to terminate pregnancy regardless of foetal gestational age. The ACR (American College of Radiology) describes it as too subtle to be clinically detectable. Some authors recommend termination of pregnancy above 200 mGy, others for greater than 500 mGy[2,4].

Before two weeks of pregnancy, dose estimation is not necessary because of the "all-or-none" law. After this age, if the estimated dose is expected to be greater than 50 mGy, a consultation with a medical physicist is necessary. Most diagnostic procedures expose the embryo to less than 50 mGy[3].

Pregnancy termination should not be recommended on the basis of exposure to diagnostic radiation.

There is no risk regarding lactation from diagnostic X-ray, and breastfeeding should not be interrupted[2].

Contrast agent administration in pregnant and lactating patients

Iodinated and gadolinium-based contrast media are used in most radiology practices. These agents are essential for providing accurate diagnosis. Therefore, it is critical for obstetricians to know how these can be used in practice. Half of CT and MRI imaging examinations performed each year include the use of intravenous contrast agents[5].

MRI images, most of soft tissue structures, are without the use of contrast, but there are cases in which the use of contrast agents is of benefit.

There are two types of MRI contrast: gadolinium-based agents, and superparamagnetic iron oxide particles[6].

Gadolinium is water soluble and can cross the placenta into amniotic fluid and foetal circulation[6].

Undergoing a gadolinium MRI at any point during pregnancy was associated with an increased risk for a broad range of medical conditions in young children, including rheumatologic, inflammatory, or infiltrative skin conditions. Gadolinium MRI was also associated with an increased risk for stillbirth and neonatal mortality[2,5].

In animal studies, gadolinium agents have been found to be teratogenic at high and repeated doses. There is a single prospective study which reported no adverse perinatal or neonatal outcomes among 26 patients[3].

Gadolinium use should be limited to situations in which the benefits clearly outweigh the possible risks.

There is no information about the superparamagnetic iron oxide contrast. Therefore, if contrast is to be used, gadolinium is recommended[2,3].

Gadolinium-based agents should be administered at the lowest possible dose.

An old Food and Drugs (FDA) classification mentioned gadolinium-based agents as category C drugs, being recommended if the administration is essential for diagnosis and would alter the management of the case, when delaying after delivery would be impossible and there are no other alternative diagnostic methods available[3].

Breastfeeding is safe after gadolinium administration, because the systemic dose absorbed by the infant from breast milk is under 0.0004% of the dose given to the mother[2].

Iodinated contrast agents are considered FDA category B drugs. There is no reported teratogenic or mutagenic risk from iodinated contrast agent. The major concern is that excess iodine exposure may induce hypothyroidism for the foetus. In the last three decades there have been no documented cases of hypothyroidism from intravenous contrast agent administration. Newborns should be tested for hypothyroidism during the first week of life. For both contrast agents, informed consent is recommended[3,7].

Conclusions

Ultrasonography is the standard method for diagnosis and monitoring the fetal wellbeing, but sometimes ionizing examinations and contrast agents may change patient's care. That may provide essential clinical information and should not be withheld on the basis of radiation concerns. The benefits include gaining information which cannot be acquired by means of an alternate, non-ionizing imaging modality, and the detection of information which affects care of the patient or fetus during the pregnancy, without the possibility of waiting until after the delivery to obtain that information. ■

Conflict of interests: The authors declare no conflict of interests.

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