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Pregnant Women Lead Shielding Necessity Undergoing CT Pulmonary Angiography

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ABSTRACT: Pregnancy increases the risk of pulmonary embolism. Computed tomography pulmonary angiography (CTPA) is used for diagnosis. CT generates ionising radiation, and thus, abdominal shielding may be used. Shielding modestly reduces fetal radiation dose but may compromise automatic exposure control, possibly increasing the maternal and fetal radiation dose. Shortening the scan is beneficial, assuming anatomical coverage is secured. Multiple imaging modalities are available for the evaluation of pulmonary embolism, including ultrasound (UL), lung scintigraphy (LS) and computed tomography (CT). Ultrasound does not use ionising radiation, but its findings do not exclude pulmonary embolism, and further diagnostic workup is required. Radiation procedures on pregnant patients are generally avoided because of the risk of genetic damage and teratogenicity in the fetus. However, since pulmonary embolism is a leading cause of maternal mortality during pregnancy, the diagnostic workup justifies radiation exposure to the fetus, but the need for CTPA should be proven by careful consideration of risks and benefits. In clinical practice, it might be common to place protective patient shields around the abdomen of the woman if the shield is not placed in the primary beam field, but this can jeopardise diagnostic performance; as well, the protective effect of shielding has recently been questioned.

I. INTRODUCTION

Patient shielding is a common practice in diagnostic imaging despite growing evidence that shielding might provide only minor radiation protection and may not necessarily be beneficial Shielding may for example introduce a significant risk of increasing patient radiation dose. The work of Kennedy et al.1 suggested a clinical protocol for the use of lead shielding on pregnant patients having chest CT is discussed. Using lead of 0.7 mm thickness as shielding. A thickness of lead greater than 0.7 mm is not recommended as this gives little benefit in terms of dose reduction but increases patient discomfort. If 0.7 mm of lead cannot be tolerated, e.g. in later stage pregnancy, shielding underneath the patient and using a lesser thickness of lead apron over the patient is suitable.Positioning lead around the entire patient and covering up to just below the inferior edge of the scan volume. [1]

When considering the investigation of the patient with possible pulmonary embolism, one needs to balance the likelihood of disease and the diagnostic utility of the test against the risks associated with the investigation. Both computed tomography pulmonary angiography (CTPA) and the ventilation/perfusion (V/Q) scan involve exposure to ionizing radiation. The effect of low-level ionizing radiation remains an issue of some controversy. CTPA delivers a greater effective dose and, in particular, greater doses to breast tissue, than the V/Q scan (typically 10-70 mGy for CTPA vs <1.5 mGy for V/Q to breast). Since breast tissue is particularly radiosensitive in younger women, the V/Q study has an advantage over CTPA in this group. In the pregnant patient, fetal exposure has been raised as a concern. In fact, there is typically only low fetal exposure from either study (<1 mGy). The CTPA does deliver less fetal exposure, particularly in the first trimester, but the difference between CTPA and V/Q scan is small when compared with the difference in dose to maternal breast from the 2 investigations. The "as low as reasonably achievable" (ie, ALARA) principle favors the use of V/Q scans in young women, assuming the diagnostic power of the 2 tests is comparable. CTPA requires a contrast injection that can cause adverse reactions in a small number of patients. No significant risk, however, has been demonstrated with the radiopharmaceuticals involved in V/Q scans.[2,3]

II. DISCUSSION

The use of diagnostic imaging involving ionising radiation may be necessary in pregnancy and requires an assessment of the most appropriate and safest imaging modality which will provide the necessary information balanced with the potential risks to the mother and fetus. In most cases, this will involve a potential fetal radiation dose well below 50 mGy. At these doses, there is no risk of lethality, genetic damage/epigenetic change, teratogenicity, growth impairment or sterility. Older epidemiological data indicating a potential increased cancer risk have been contradicted by newer data and better understanding of the biology of low dose radiation. The linear no-threshold rule has been challenged by

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many and more realistic estimates of oncogenicity risk along with the potential risks of contrast agents are summarised in this review. Imaging in the pregnant population is increasing in both the number of examinations performed and the number of patients being imaged, with the greatest increase being computed tomography scans. Counselling and obtaining informed consent for imaging that involves radiation requires the clinician to communicate with the woman and her family a realistic estimate of the potential radiation dose to herself and her fetus, to describe and quantitate the risks of this estimated dose, to outline the benefits of the imaging procedure and to respond to any questions or concerns. As almost all diagnostic imaging involves doses below the 50 mGy threshold, clinically indicated investigations should not be withheld during pregnancy. All allied staff must also be well informed to ensure the patient receives a consistent message about the risks and benefits of the proposed test.[4.5]

III. RESULTS

Studies have shown an overall higher mortality in patients with central as opposed to peripheral pulmonary embolism. Thus, the CTPA scan may be shortened, since it has been suggested that emboli in the sub-segmental arteries may not contribute significantly to morbidity and mortality(17). Furthermore, it has been demonstrated that the highest fetal dose reduction might be achieved by avoiding scanning the lower parts of the lungs and by reducing the scan length (*z*-axis). Optimising the tube current and voltage of the CTPA scan also might reduce the radiation dose to the pregnant patient and the fetus Amongst pregnant women, there is a high level of anxiety associated with the use of radiation in diagnostic imagingso it is important to address patient concerns prior to the examination and provide evidence-based practice for the most effective procedures in fetal radiation protection.[6,7]

No effect on the automatic exposure control was observed during the short CTPA scans with shielding versus without, and the radiation effective dose to the pregnant woman was 0.9 mSv in both scans . The mean absorbed dose to the fetus was lower (0.02 vs 0.03 mGy) when shielding was used . The mean absorbed dose to the fetus measured with TLD corresponded well with the values that were calculated with VirtualDose CT software.

In the standard CTPA the effective dose was increased by 47% when shielding was applied, with a consequent increased radiation dose to the fetus. The short CTPA resulted in a marginally lower absorbed dose to the fetus when shielding was used, but the shielding did not alter the effective dose to the patient. Although radiation protection shielding appears to modestly reduce the fetal dose, it should be considered in relation to the introduced risk of affecting the dose modulation and increasing the radiation dose. Shortening the CT scan length had the largest effect on decreasing the radiation dose to the fetus, decreasing the mean absorbed dose by 70%.[8]

IV. CONCLUSION

The use of patient shielding in CTPA should be considered in light of both its minor lessening of the radiation dose to the fetus and the risk of its increasing the dose to the patient and consequently to the fetus by affecting the automatic exposure control. Shortening the scan reduces the dose to the pregnant woman and the fetus and reduces the risk of affecting dose modulation. The scan length should be adjusted according to the prerequisites of the diagnostic workup and anatomy of interest. Future research on the development of scanning protocols is needed for evidence-based practice in diagnostic imaging. A better understanding of how to effectively translate research results to the clinic is also important, as habits of patient shielding are difficult to change. Clinical experience suggests that patient knowledge of the effects of radiation protection in CT might be biased. Further research on how to approach patient attitudes toward and expectations of radiation protection is recommended.[9,10]

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