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QUESTION/ANSWER

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When a pregnant woman with suspected appendicitis is referred for a CT scan, what should a radiologist do to minimize potential radiation risks?

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When a pregnant woman with suspected appendicitis is referred for a CT scan, what should a radiologist do to minimize potential radiation risks?

Evaluation of a patient with suspected appendicitis is a classic situation where radiologists must review what the potential benefits will be, evaluate the potential risks, and modify the procedures to reduce the risks. When ultrasound fails, or is not available, CT becomes the modality of choice because it is fast, reliable, and less susceptible to equivocal error. Conceptus dose depends primarily on the following five factors: (1) kV—increasing the X-ray tube voltage from 110 to 140 kV will increase the dose by about 60% (at constant mA); (2) mAs per rotation—the dose is directly proportional to the selected mAs per rotation; (3) patient size—the dose increases as patient size decreases; (4) pitch—doubling the pitch will halve the radiation dose; (5) beam collimation—fine collimation increases the dose owing to oversizing of the beam. For pregnant patients, the radiologist should always limit the scan volume to the necessary anatomy, and dual-pass (with and without contrast) studies should be strictly avoided. Using a step-and-scan protocol and terminating the study when the appendix is scanned might be considered, but requires the radiologist to be present to review images as they are collected.

Standard techniques for appendicitis in an average adult would likely result in a conceptus dose on the order of 30 mGy or less. At doses of < 50 mGy, clinically detectable risks to normal mental and physical development have not been observed [1–3]. For a dose of $\sim$30 mGy, the most seriously suspected risks to the conceptus are stochastic risks of radiation-induced neoplasm and genetically heritable reproductive effects. The cancer risk is considered to be most important, and the numerical risk of inducing a cancer is dependent on the dose and perhaps on the gestational age [4, 5]. The best numerical estimate of risk is about one cancer per 500 fetuses exposed to 30 mGy of radiation [2]. While this numerical risk estimate has considerable uncertainty and might be too high, it can serve as useful guidance in directing medical care. The benefit/risk analysis demands that we ask this question: ''Rather than risk one potential cancer, is it better to forego CT in 500 pregnant patients with suspected appendicitis, or is it better to scan all 500 cases and accept the one potential cancer in order to obtain a more certain diagnosis and to direct medical care more confidently?''

The best way to manage the pregnant patient is to be prepared ahead of time. This includes establishing protocols that appropriately use radiation, performing quality

assurance to determine that protocols are properly used, and having a physicist test the protocols to verify the expected radiation doses. As a matter of routine practice, protocols for CT procedures should use X-ray techniques that balance the conflicting requirements of image quality and dose. Too low a dose degrades image quality, and may compromise the diagnosis, which could result in an inappropriate surgical intervention. We do not recommend arbitrarily lowering the technique because this runs the risk of an inadequate study that might have to be repeated. High doses will increase radiation risk, so patient doses need to be kept as low as reasonably achievable (ALARA), meaning that no more radiation should be used than required to achieve a satisfactory diagnosis. To assure that protocols are followed, a quality-control program is required to verify that any out-of-protocol techniques only occur under the special direction of a physician, and as part of routine testing the physicist must monitor conceptus doses for pelvic protocols to assure that dose levels are within established norms.

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