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Fluoroscopy-guided intervention for a splenic artery aneurysm during pregnancy: Evaluation and optimization of fetal radiation exposure

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Purpose
A splenic artery aneurysm during pregnancy poses a possibly life-threatening risk to the patient and is challenging to treat. One treatment option is fluoroscopy-guided embolization, which is however often met with apprehensiveness by the medical team due to potential prenatal radiation exposure. Therefore, knowledge of the expected uterus dose and effective radiation protection measures is critical for an informed decision on the course of the treatment. This work evaluates fetal radiation exposure during a clinical case of a splenic artery aneurysm successfully treated by fluoroscopy-guided coil embolization, i.e. simulation and validation thereof, and identifies key factors determining the uterus dose. The results inform best practice radiation protection measures and procedures for planning similar fluoroscopic interventions on pregnant patients.

Methods
The expected uterus dose from the clinical case is simulated with the Monte-Carlo-based software PCXMC and different scenarios are considered to identify key drivers of fetal radiation exposure for similar interventions. To validate the simulation results, TLD measurements within an Alderson phantom are performed.

Results
The fetal dose from the intervention was simulated to be below 0.5 mGy. At this dose level, no adverse deterministic effects or significant increase in the likelihood of childhood cancer are expected. However, the dose can increase significantly if the x-ray fields are uncollimated, the distance between the inferior field edge to the uterus is small, or if the uterus is in the primary beam during femoral access. Uncertainty in the uterus position during the intervention is a non-negligible source of error in the simulation. The simulation findings were confirmed by TLD measurements within the phantom.

Conclusion
The simulation and measurements demonstrate similar fluoroscopy-guided interventions on a pregnant patient are possible with minimal fetal exposure. Simulation of the x-ray fields allows reliable retrospective estimation of the dose to the unborn and to prospectively advise the medical team on radiation protection measures or whether techniques without ionizing radiation should be considered.

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