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Tips & Tricks

IR Working Group

Radiation protection of pregnant patients in interventional radiology

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Health effects of prenatal radiation exposure (ICRP 84, consensus CIRSE-SIR)

Effects depend on the pregnancy stage and dose. Some effects have dose thresholds, others do not.

- Pre-implantation period (up to day 10 post-conception): Embryo death possible with doses from 100 mGy. In this period, risk of malformation or induction of cancer is unlikely.
- Organogenesis (weeks 3-8): Foetus malformations. These effects have a threshold of 100-200 mGy.
- Weeks 8-25: Loss of intelligence quotient, 100 mGy. Mental retardation, from 300 mGy.
- During all trimesters of pregnancy. Leukaemia and childhood cancer: no known threshold. For 10 mGy of foetal dose the relative risk may be as high as 1.4 and absolute risk is about 1/1700.

Health effects of prenatal radiation exposure

Therefore, to protect the unborn child, it is recommendable to:

- Check the pregnancy status of women of child bearing age before imaging.
  - Is it possible to postpone the procedure after delivery?
- Consider the possibility of using non-ionising radiation such as MRI or ultrasound.

If it is necessary to go ahead with the IR procedure, make efforts to anticipate the dose to the unborn child.

How to optimise procedures with pregnant patients

1. Minimise fluoroscopy time and number of images. If available, use a C-arm with dose reduction technology.
2. Reduce the fluoroscopy/DSA frame rate when possible.
3. Try to avoid direct irradiation of the foetus. If not possible, remember: a C-arm angulation with the lower patient thickness will provide a lower radiation dose.
4. Use collimation to minimise foetus exposure. Try to avoid image magnification. Magnification increases radiation dose.
5. Maintain the table as far as possible from X-ray source and image detector as close as possible to patient.
6. Record all information necessary for ulterior accurate estimation of foetal dose by a medical physics expert.

Some published doses in utero for IR patients

Procedure	Fetal dose	Measured/calculated*	Reference
Placement of transurethral stent	44 mGy	Calculated	Metzger. Med.Phys(1999) 26:1714
ERCP	3.3 mGy	Calculated	Metzger. Med.Phys(1999) 26:1714
Uterine artery embolisation	19.1 mGy	Measured in vaginal fornix	Manninen. CVIR(2014) 37:942
Uterine artery embolisation	24-247 mGy	Measured/ Calculated	Glomset. Acta Radiol(2006) 47:179
Hypogastric artery balloon occlusion	0.207 mGy/Gycm^2	Calculated. (PA proj.)	Solomou. Med.Phys(2016) 43: 2990

*Measured in clinical routine / calculated in phantoms.

How to optimise procedures

DO NOT FORGET:

Record all information necessary for an accurate estimation of foetal dose by your medical physics expert: kV, beam filtration, DAP or kerma, beam size, C-arm angles (included in DICOM RDSR) and patient position and dimensions.

The more detailed information, the more accurate the dose estimation, which in turn facilitates better counselling of the patient.

Termination of pregnancy (ICRP 84)

- A foetal dose of 100 mGy has a small individual risk of radiation induced cancer. There is over 99% chance that the exposed foetus will not develop childhood cancer or leukaemia.
- High foetal doses (100-1000 mGy) during late pregnancy are not likely to result in malformation or birth defects since all the organs have been formed.
- Termination of pregnancy in cases of foetal doses of less than 100 mGy is NOT justified based upon radiation risks.
- At foetal doses in excess of 500 mGy, there can be significant foetal damage. The magnitude and type of which is a function of dose and stage of pregnancy.
- At foetal doses between 100 and 500 mGy, decisions should be based upon individual circumstances.

Termination of pregnancy (ICRP 84)

- Probability of bearing healthy children as function of radiation dose:

Absorbed dose to conceptus, mGy above natural background	Probability that child will have NO malformation, %	Probability that child will NOT develop cancer (age 0-19), %
0	97	99,7
0,5	97	99,7
1	97	99,7
2.5	97	99,7
10	97	99,6
50	97	99,4
100	Close to 97*	99,1

*Although the exact risk in humans is uncertain, animal data suggest that malformations due to radiation are not likely at doses less than 100-200 mGy. Above this, malformations would only be observed if exposure were between the 3rd and 25th week of gestation.

References

- ICRP Publication 84. Pregnancy and medical radiation. ICRP 2000.
- ICRP Publication 90. Biological effects after prenatal irradiation. ICRP 2003.
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