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Nordic guidelines for dose reduction to radiosensitive organs of the patient in conventional radiography and fluoroscopy

The Nordic Radiation Protection co-operation

These Nordic guidelines are written to emphasize the value of appropriate technique for patient radiation dose reduction in conventional radiology and fluoroscopy.

Given that all examinations have been properly justified, and image receptor exposure is optimized based on evaluation of image quality, the following should be considered in order to reduce radiation doses to radiosensitive organs.

The aim of keeping the radiation doses as low as reasonably achievably (ALARA) is to minimize the risk for stochastic effects and tissue reactions. The general approach is to use appropriate radiographic technique and equipment. However, the ALARA approach has to be customized for the individual patient.

PA projections

PA projections are in most cases the best projection for reducing dose to many of the radiosensitive organs. Since only about 1 % of the incident radiation to the patient will reach the detector, dose will be reduced significantly to organs on the ventral side compared to AP projections. In some cases, the use of PA projections will also compress the body to some degree, thus reducing the dose.

In the latest main publication from the ICRP, some of the tissue weighting factors (W_T) were revised [1]. The W_T for breast glandular tissue increased from 0.05 to 0.12, indicating more than a doubling of the previously assumed radio sensitivity. The W_T is an average over the whole population (both sexes and all ages), and since it is in general females that develop breast cancer, the true W_T will be higher for females and especially for female teenagers.

In 2012, ICRP recommended to decrease the annual dose limit for the lens of the eyes from 150 mSv/year to 20 mSv/year for exposed staff, due to new knowledge about radiation induced cataract [2].

Special attention – In some organs, like breast glandular tissue and eye lens, the dose reduction will be significant in PA projections. Special attention should be taken e.g. for female scoliosis patients in their teens.

Collimation of the radiation field

A strict collimation to the area of interest will reduce the dose to neighboring organs. A smaller radiation field will also generate less scattered radiation, benefitting both the patient and any staff standing close to the patient. A strict collimation will also result in a reduced need for shielding of radiosensitive organs, due to the increased distance to other organs. Another important benefit is the increase in image quality, due to the reduced scattered radiation and hence the enhanced contrast.

In dentistry, a rectangular collimator reduces the dose to patients, since the collimation will be restricted to the area of interest.

Special attention: Appropriate knowledge of age related anatomy is especially important in pediatric imaging.

Scatter radiation grid

The use of a grid increases contrast but also increases the radiation dose to the patient by a factor of approximately 3.

When imaging small children, a grid is usually not needed, because of the relatively small amount of scatter produced in the exposed volume.

Compression

The use of compression is an effective dose reduction technique, routinely used in mammography. The technique was more common for other applications earlier, but new and more effective compression equipment on the market have highlighted the technique again. The compression technique is most usable when imaging pelvis, lumbar spine and non-acute abdomen. The half-value layer (HVL) in human tissue is about 3 cm in diagnostic radiology. Most of the patients can be compressed by 7-8 cm in the abdominal area, without feeling any major discomfort [3]. A compression of 6 cm (2 HVL) will reduce the dose by about 75 %. The compression equipment can also be used for immobilizing the patient, thus avoiding blurry images or poorly centered images due to movement.

Gonad shielding

The main goal of shielding gonads are to reduce the risk of hereditary effects. The recent ICRP publication 103 has however, reduced the risk estimates for hereditary effects by a factor of 6-8 [1]. This reduction in risk is reflected in the significant decreased tissue weighting factor for the gonads, from 0.20 to 0.08.

Males

Shielding of male gonads are easy to perform in many cases, and should be performed if the gonads are in the radiation field or closer than 5 cm. The shielding should be done with dedicated shielding equipment, suited for the actual age and size of the patient. When using properly adjusted capsules, the absorbed dose in the testes can be reduced up to 95 % [4]. Shielding should not be performed if this could compromise visualization of structures of clinical interest or interfere with AEC, thus increasing the risk for re-takes or increased dose.

Females

Shielding of the female gonads are less beneficial, especially for younger females. A dose reduction up to about 50 % may be achieved, if the shielding is applied correctly. However, the location of the female gonads can vary significantly, so the dose reduction in many cases will be much smaller than 50 % [5]. In addition, the risk associated with the potential loss of diagnostic information, resulting in retakes, often outweigh the benefit of gonad shielding. This is more likely for small children and teenagers.

Using the other described dose reduction techniques in an appropriate way, will usually have a larger impact on the gonad dose of the female patient.

Pregnancy

The radiographer shall verify pregnancy status before the examination starts. The verification can be limited to examinations where the pelvic area are exposed, since the fetal exposure will be low for other examinations.

References

1. ICRP 2007. The 2007 recommendations of the International Commission on Radiological Protection. ICRP publication 103. Annals of the ICRP, 2007.
2. ICRP 2012. ICRP statement on tissue reactions/early and late effects of radiation in normal tissues and organs – threshold doses for tissue reactions in a radiation protection context. ICRP publication 118. Annals of the ICRP 41(1/2).
3. Olsson ML, Tingberg A and Mattsson S. A phantom study showing the importance of compression in conventional diagnostic X-ray examinations. Radiation Protection Dosimetry (2010), Vol. 139, No. 1–3, pp. 78–80.
4. ICRP, 2013. Radiological protection in pediatric diagnostic and interventional radiology. ICRP Publication 121. Ann. ICRP 42(2).
5. Fawsett SL, Gomez AC, Barter JS, Ditchfield M, and Set P. More harm than good? The anatomy of misguided shielding of the ovaries. The British Journal of Radiology, 85 (2012), e442–e447.