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Tips & Tricks

Paediatric Imaging Working Group

Shielding in pediatric CT

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Introduction

Children are more vulnerable to x-rays than adults due mainly to the increased radio-sensitivity and a longer lifespan after exposure. Several methods exist to reduce radiation dose in paediatric CT examinations. Among of them shielding of radiosensitive organs has received special attention.

In-plane shielding

Breast, lens and thyroid are among the most radiosensitive organs.

During CT, in-plane shielding with bismuth or barium shields placed on these organs have been used to reduce radiation dose.

In-plane shielding

In-plane shielding can provide dose reduction from 20 to 60% to the shielded organ.

However, a few concerns should be considered:

- **Some of the patient's radiation exposure is wasted. When the tube is above the shielded organ, the x-rays are absorbed by the shield reducing dose. When the tube is beneath the patient, the dose is not reduced, but absorbed by the shield thus preventing many photons to reach the CT detectors.**
- **Consequently, image noise is increased in the shielded region, especially when a non foam back shielding is used.**
- **Streak and beam hardening artifacts, and impairment of accuracy and quantifiably of CT numbers are observed in the proximity of the shield.**
- **With automatic exposure controls (AEC), never apply in-plane shielding before the acquisition of localizer CT radiographs, as this could lead to unpredictable and potentially undesirable dose levels.**

In-plane shielding

Alternative methods for reducing dose to peripheral organs:

- Some manufacturers provide **virtual shielding**. The X-ray beam can be switched off when in front of the organ and alternatively increased when the beam is on the opposite side. Consequently organ dose is decreased, with almost no impact to overall dose and image quality.
- Use **dedicated pediatric CT protocols** according to child size.
- Consider **more aggressive AEC parameters** to reduce tube current in region of lower attenuation (e.g. in the thorax).
- Consider **reduction of tube current by the same percentage of reduction offered by bismuth shielding.**
- **Iterative reconstruction** may reduce the radiation dose to the child while maintaining or even improving image quality.
- For **CT head examinations**, in order to reduce radiation dose to the eyes consider **tilting the x-ray tube.**

Out-of-plane shielding

Out-of-plane shielding (e.g. shielding of the abdomen in case of chest CT) **allows significant organ and effective dose reduction due to reduction of external scatter,** with no effect on image quality. The shielding must be positioned out of the acquisition plane, around the child in 360º degrees.

Conclusion

In conclusion, for pediatric CT examinations:

- **In-plane bismuth shielding has been shown to reduce dose to anterior organs in CT scanning, although several disadvantages are well known.**
- **Other techniques can provide the same level of anterior dose reduction with the same or superior image quality. These techniques should be considered and implemented whenever possible.**
- **Use out-of plane shielding whenever is possible, as this significantly reduce dose due to external scatter.**

References

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