A simple cause of cataracts - irradiating the lens on CT head examinations

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Audit Standard:

The Royal College of Radiologists (RCR) audit standard is 100% lens exclusion on routine CT head examinations.[2]

Introduction

- The lens of the eye is extremely radiosensitive, and therefore highly susceptible to the deterministic effects of irradiation.
- The primary effect of this is the development of lens opacities; these typically occur within the polar region of the posterior cortex, and may therefore lead to the development of posterior subcapsular cataracts (PSCs).
- An exposure of 0.5 Gray (Gy) is sufficient to cause development of detectable opacities, whilst a single exposure of 5Gy can lead directly to cataract development.
- Recent recognition that the radiosensitivity of lens has been historically underestimated has lead to the threshold absorbed dose to the lens of the eye being revised from 5Gy down to 0.5Gy by the International Commission on Radiological Protection (IRCP)[1]
- Importantly, there is a large variation in average dose to the lens delivered per CT head, in the range of 3 -100mGy. In the worst-case scenario, the threshold dose can be reached by 5 CT head examinations.

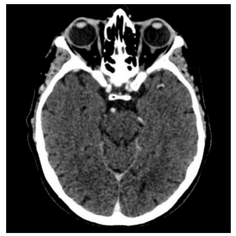


Figure 1. The eye lens are included on CT head examination.

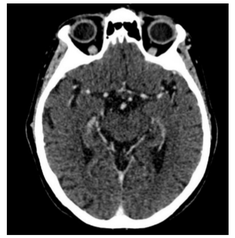


Figure 2. The eye lens are excluded on CT head examination.

Methods and Intervention

- Data was collected retrospectively from CRIS on 100 consecutive patients who underwent CT head examination between 20/11/2018 and 22/11/2018. All CT images were analysed on SYNAPSE PACS by two Radiology Specialty Registrars for inclusion/exclusion of the eye lens (Figure 1 and 2). Patients were excluded if there was a requirement for the orbits to be included in the scan. Data was analysed in Microsoft Excel.
- Following the results of the first round of data collection, the following interventions were introduced: face-face discussion with radiographers and posters in all CT control rooms. Posters emphasised the importance of patient head tilting using the chin-tuck method and where possible effective CT gantry tilting.[3,4]
- Data was collected again between 21/11/2019 and 23/11/2019, for which the methodology was the same as the initial round of data collection.

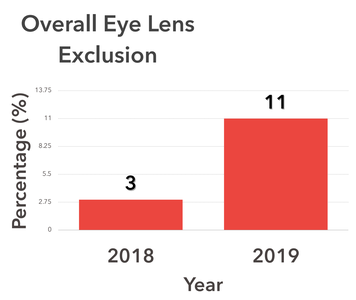


Figure 3.

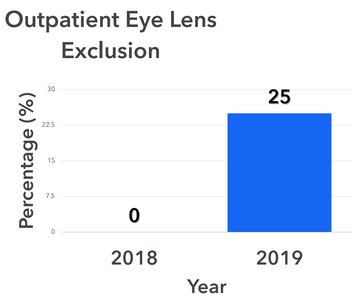


Figure 4.

Results

- Out of a total of 100 patients, 6 were excluded from the study in both 2018 and 2019; in all excluded cases, protocols used required the lens to be in the field of view.
- In 2018, there were 46 male and 48 female patients. Similarly in 2019, there were 47 male and 47 female patients. The average age was 69 in both 2018 and 2019.
- We found an overall lens exclusion rate of 3% in 2018, increasing to 11% in 2019 following intervention (Figure 3).
- 0% of outpatient CT heads successfully excluded the lens when assessed in 2018, improving to 25% in 2019 (Figure 4).
- The equivalent dose to the lens across all patients was 27.2mSv in 2019. One scanner lacking dose modulation had an average equivalent dose 44% higher than the other scanners, further highlighting the importance of lens exclusion.

Discussion

- Following intervention, there has been some improvement in the overall eye lens exclusion on routine CT head examinations from 3% to 11%. A factor to consider is how some patients are too unwell/less mobile for head tilt to be performed, particularly for inpatients.
- Outpatients tend to be well and more mobile compared to inpatients, and there is less time pressure during outpatient CT lists. Therefore, performing head tilt on outpatients should be easier to achieve. Following intervention, there was an improvement in outpatient CT head lens exclusion from 0% to 25%.
- The results are still far from the target of 100% lens exclusion, highlighting the importance of continuing to raise awareness of cataract risk on irradiation of the lens.

Conclusion

Excluding the eye lens from all routine CT head examinations is required to reduce the risk of cataract formation. Raising awareness of this has led to some improvements in practice; further efforts are needed to further highlight this important patient safety issue.

References

1. Boal TJ, Pinak M; Dose limits to the lens of the eye: International Basic Safety Standards and related guidance; 2015. Annals of ICRP
2. Head CT – Lens Exclusion. 7th January 2008. Available at: https://www.rcr.ac.uk/audit/head-ct-lens-exclusion
3. Nikupaavo et al.; Lens Dose in Routine Head CT: Comparison of Different Optimization Methods With Anthropomorphic Phantoms; AJR Jan 2015.
4. Zhang DI et al.; Peak skin and eye lens radiation dose from brain perfusion CT based on Monte Carlo simulation; AJR 2012.

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