Evaluation of radiation dose during cardiac catheterization using optically simulated luminescent dosimeters

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Introduction

Complex cardiovascular lesion via radial artery puncture (trans-radial approach) has generally been adopted by physicians, which not only helps the patients receiving stenting surgery recovery faster but also greatly reduces their discomfort during the procedure. Heart-related radiation exposure (especially non-invasive cardiac catheter angiography) is thus unavoidable during cardiology to diagnosis and treatment. In this study, the absorbed dose was measured with OSLD to investigate the risk of radiation exposure in patients during coronary angiography.

Material and Methods

The optically stimulate luminescence dosimeters arranged in an anthropomorphic phantom (Pixy-102; with tissue equivalent materials) was used to measure the absorbed dose from six beam directions during coronary angiography. There were 60 seconds for total exposure and 10 seconds for the exposure in each direction. The cardiac fluoroscopy procedure was carried out at 15 frame/s by the Artis Axiom zee coronary angiography system (Siemens AG, Germany). Exposure dose data was readout by the InLight™ reading system (Model MicroStar, Landauer Co., USA). The radiation doses of lens, thyroid and gonad in patients and operators without protection (denoted as Group 1; Fig. 1) were measured with OSLD and compared with those in patients and operators (denoted as Group 2) with lead eyeglasses (Fig. 2), lead collar and lead apron (Fig. 3). Finally, radiation health risks were evaluated according to the risk coefficients from ICRP 103 report.

Fig. 1 The phantom without protection device

Fig. 2 Protection for eyes of the phantom with lead glasses

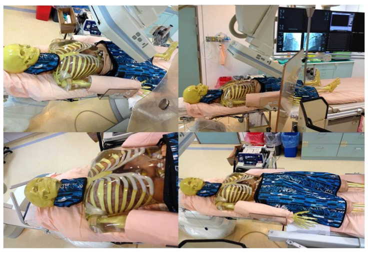

Fig. 3 Protection for neck and gonad of the phantom respectively with lead collar and lead apron

Results and Discussion

Significant difference ($p<0.0001$) was found in the patient absorbed doses of thyroid, lens and gonad between the shielded (respectively 2.64±0.14, 2.32±0.11 and 0.28±0.02 mSv) and the unshielded (respectively 1.021±0.038, 0.668±0.484 and 0.118±0.005 mSv) conditions (Fig. 4). The health risks of thyroid, lens and gonad in unshielded patients were estimated to be 0.15×10^{-5} Sv^{-1}, 0.13×10^{-5} Sv^{-1} and 0.01×10^{-5} Sv^{-1}, and those in the shielded patients were 0.05×10^{-5} Sv^{-1}, 0.03×10^{-5} Sv^{-1} and 0.067×10^{-5} Sv^{-1}, respectively.Significant difference ($p<0.0001$) was found in the operator absorbed doses of thyroid, lens and gonad between the shielded (respectively 0.127±0.035, 0.144±0.002 and 0.125±0.005 mSv) and the unshielded (respectively 0.185±0.03, 0.151±0.001 and 0.114±0.004 mSv) conditions (Fig. 5). The health risks of thyroid, lens and gonad in unshielded operator were estimated to be 0.11×10^{-5} Sv^{-1}, 0.86×10^{-5} Sv^{-1} and 0.71×10^{-5} Sv^{-1}, and those in the shielded operator were 0.07×10^{-5} Sv^{-1}, 0.082×10^{-5} Sv^{-1} and 0.065×10^{-5} Sv^{-1}, respectively.

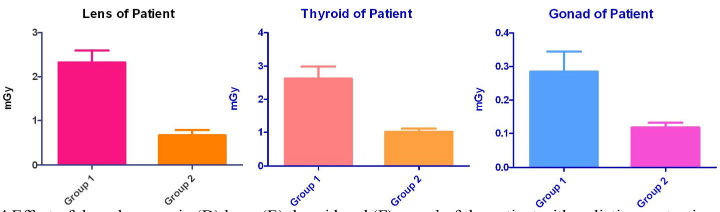

Fig. 4 Effect of dose decrease in (D) lens, (E) thyroid and (F) gonad of the patient with radiation protection devices.

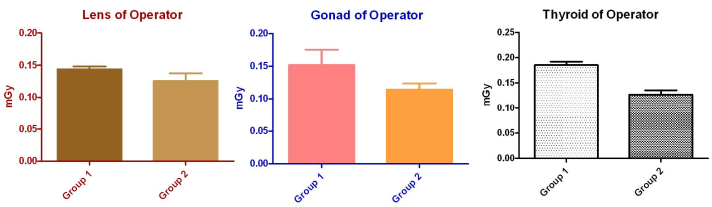

Fig. 5 Effect of dose decrease in (D) lens,(E) thyroid and (F) gonad of the operator with radiation protection devices.

Conclusion

Radiation doses of the thyroid, gonad and lens were significantly less in patients shielded with optimized radiation protection devices. In operators, the doses in thyroid and gonad were also apparently less in shielded condition. Besides, in the shielded condition, the health risks were also decreased. Accordingly, to avoid deterministic effects and minimize stochastic effects for the staff and patients, the radiation protection devices are imperative during coronary angiography.