Analysis and optimization of an interventional radiology procedure using a Radiation Dose Index Monitoring Software

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Introduction

The optimization principle recommends that all doses due to medical exposure for radiological purposes, as interventional radiology, shall be kept as low as reasonably achievable consistent with obtaining the required medical information.

We identify the prostatic artery embolization (PAE), an interventional radiology exam for the treatment of benign prostatic hyperplasia, as a high dose procedure in our institution. PAE presents a high Kerma Area Product (KAP) compared to other interventional protocols and is associated with high risk of skin lesions.

Methods and Materials

The Radiation Dose Index Monitoring (RDIM) software NEXO[DOSE]® (Bracco, Italy) is a fully-automated vendor-neutral system that collects and analyses dosimetric data to drive the optimization of radiological procedures; at the end of each angiographic procedure it extracts:

- patient details (age, sex, patient ID, etc.),
- geometric informations (primary and secondary angles, table height, field of view, etc.),
- dosimetric parameters (irradiation type, KAP, voltage, filter, etc.)

from the Radiation Dose Structured Report and calculates a skin dose map and the Peak Skin Dose (PSD).

We retrospectively analysed the exposure values of 84 patients, using NEXO[DOSE]®. The results show a median KAP of 731.5 Gy*cm^2 and a median PSD of 3.2 Gy with 65 cases out of 84 with PSD higher than 2 Gy, the threshold for deterministic effects.

The RDIM software separately lists the dose contribution from the acquisition mode and the fluoroscopy. Since the acquisition contribution to the total dose is 70%, the first step was the introduction of a low dose acquisition protocol varying some parameters. The frame rate was reduced from 3 to 2 fps, additional X-ray filtration of 1mmAl+0.1mmCu was added; finally the detector was set to require less dose (**Table 1** and **Figure 1**).

First, the new protocol has been tested on phantom in terms of dose (entrance dose to different PMMA thickness up to 30 cm: this was necessary since the highest dose contributions came from events with oblique angles in PAE procedure) and image quality (low contrast detectability (LCD) in terms of contrast % - detail curve). After this evaluation the dose for 44 patients has been checked in terms of KAP and PSD.

Optimized protocol	
Frame rate	From 3 fps to 2 fps
X-ray filtration	Added 0.1 mm Cu + 1 mm Al
Less entrance dose	Less dose required by the detector

Table 1. Optimized protocol parameters for the PAE angiographic procedure.

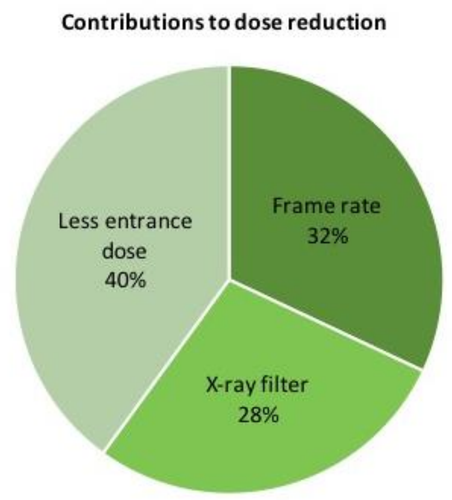

Figure 1. Contribution of different components in the reduction of dose for acquisition mode.

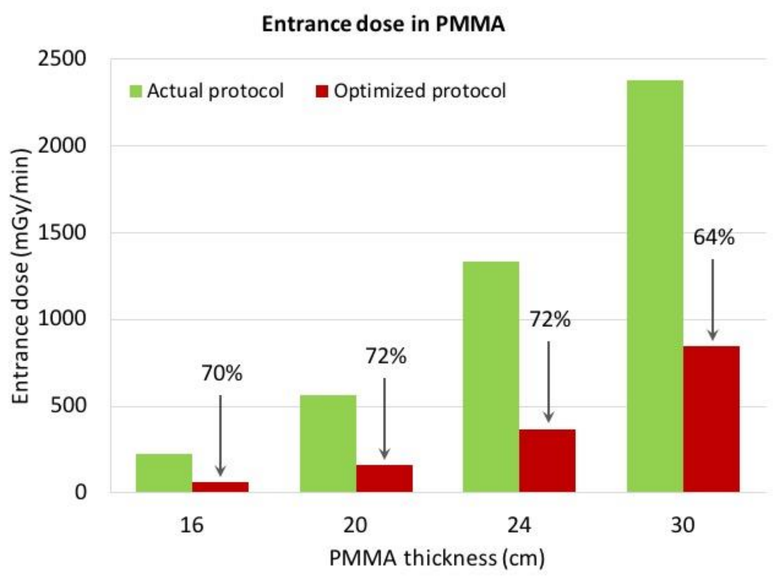

Figure 2. Entrance dose in PMMA with actual and optimized protocol.

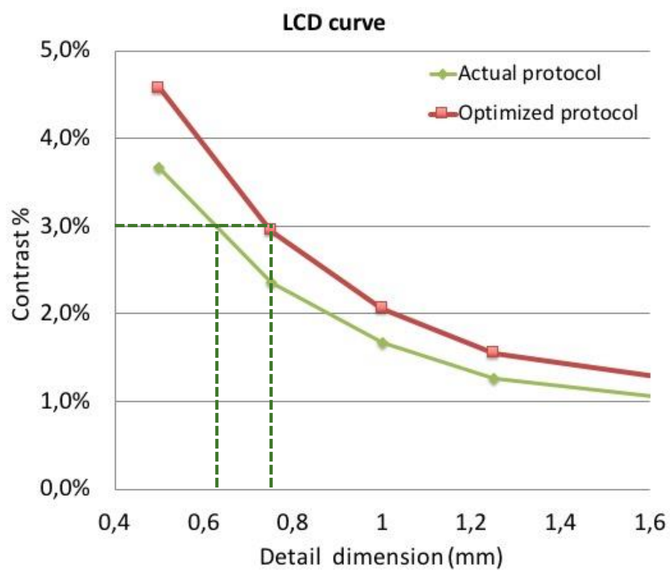

Figure 3. LCD curve with actual and optimized protocol.

Results

For the dose to the phantom, the reduction depends on the thickness of PMMA ranging between 64% and 72% (**Figure 2**).

The contrast-detail curve was assessed through the method of Chao et al.[(1)] adapted for XA from Radice et al.[(2)]. With the new protocol, a contrast of 3% can be obtained with a detail of 0.74 mm instead of the previous dimension of 0.63 mm (**Figure 3**).

After optimization, patient dose was monitored using KAP and PSD. The reduction in KAP is of 47% and the one in PSD of 52% (**Figure 4**). With the new protocol 13 cases out of 44 have a PSD higher than 2 Gy.

Conclusions

The introduction of a low dose acquisition protocol in PAE procedure leads to a significant reduction of patient dose, reducing the number of cases with a PSD higher than the threshold limit for deterministic effects of 2 Gy, and a degradation of image quality that was judged satisfactory from physicians.

NEXO[DOSE]® helps to identify high dose procedures and analyse the dosimetric features.

This was the result of a multidisciplinary team work (physicians, technicians and medical physicists).

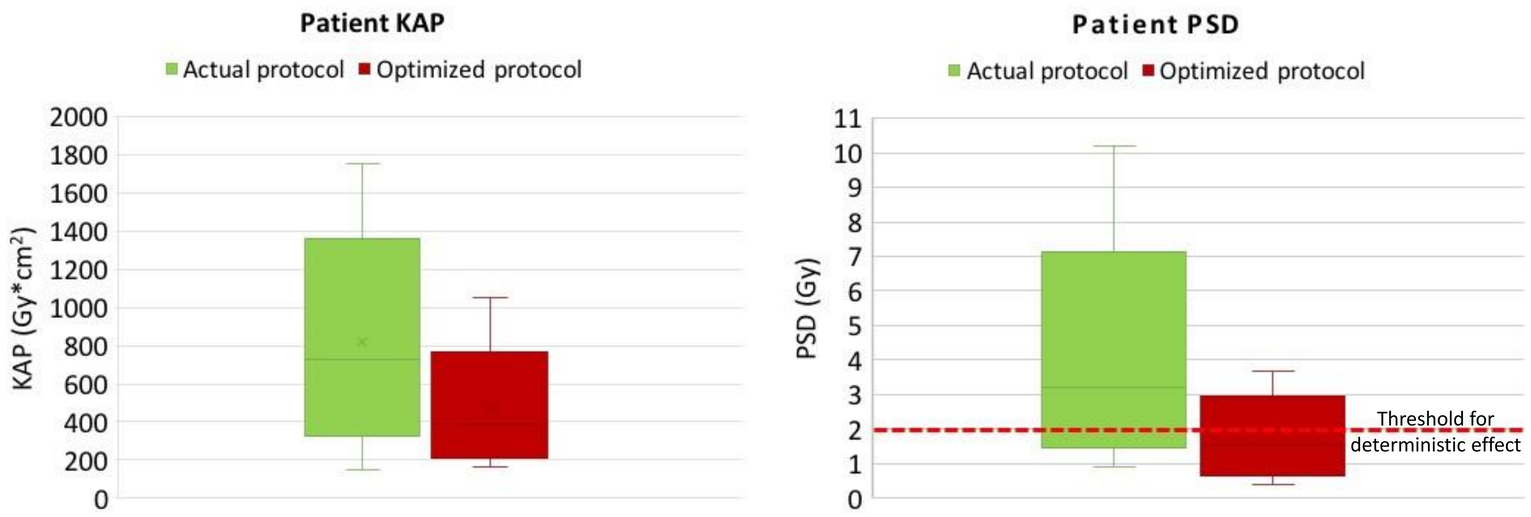

Figure 4. KAP and PSD in patients with actual and optimized dose protocol.

Contact

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References

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