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Abstract

Vascular radiology includes procedures in which the radiologist or other medical specialist uses the radiological image to diagnose or treat a specific vascular structure. In the published MIRA-2004 report (Milieu- en natuurrapport Vlaanderen) is mentioned that in 2001 the diagnostic vascular procedures comprised only 0.9% and the interventional (cardiology) procedures only 0.4% from the total number of performed radiological medical examinations in Flanders. Notwithstanding the frequency is low, their contribution to radiation exposure in medicine is considerably higher in respect to all X-ray examinations.
Due to the complexity of these procedures, the application of the ALARA-principle, keeping doses as low as reasonably achievable without jeopardizing image quality, is a great challenge. It is obvious that optimization of patient doses necessitates a reliable insight in dose levels associated with the different examinations. However, in Belgium there is a great lack of quantitative data in vascular radiology and no explicit instructions are available on how the work could be done practically. Therefore, the first purpose of the study was to define, to measure and to calculate doses to patients in 7 different hospitals.

In the thesis, patient doses are measured and calculated for 3 specific vascular procedures: angiography of the lower limbs, angiography of the carotid arteries and cerebral embolisations. The doses are evaluated against different technical parameters of the equipment and of the working procedure. In view of optimization purposes, a protocol for performing dose audits in vascular radiology is suggested. From the results and conclusions in this study, some practical guidelines could be given for the radiological protection of the patient.

For 158 patients, relevant parameters as tube voltage (kVp), tube load (mAs), field size, number of frames, fluoroscopy times etc. were recorded. With a flat ionization chamber, positioned in the radiation beam, the product dose*field area (DAP) was measured for every beam projection separately. Skin doses were measured with thermoluminiscent dosimeters (TLDs) attached to the skin of the patient. These measurements confirmed that radiation doses are high and that for every procedure a large dose variability exists between the different hospitals and between the patients within one hospital. The quantification and analysis of patient doses for procedures of this kind was not easy, as the procedures are complex and not performed frequently.
The study also learned us that 'effective dose' is a useful quantity to estimate in view of dose optimization. The effective dose is the weighted sum of organ doses and therefore can not be measured directly. By means of the Monte Carlo computer code, new and appropriate conversion coefficients were determined for the calculation of effective dose for vascular radiology procedures. If every beam projection in the procedure is considered separately, the calculation of effective dose is very complex and only suitable for studies with a small amount of patients involved. For that reason, also a practical method to calculate the effective dose was worked out, for which only one conversion coefficient is used in combination with the total DAP-value of the procedure.
Different national and international organizations have recommended the use of patient dose audits in diagnostic radiology as a means of interinstitutional comparison and the establishment of reference dose levels. Several studies[2,3,4] indicated that the performance of dose audits could reduce the difference between the highest and lowest measured dose with a factor of 2. Because of the high doses associated with vascular radiology, dose surveys could here also be of obvious benefit, but will not be straightforward due to the complexity of the procedures.

The thorough analysis of the patient doses against all possible technical parameters of the equipment and the work procedure, made it possible to set up a protocol for the performance of dose audits in vascular radiology. We propose to register, in addition to the total DAP-values, also parameters as total number of frames, average kVp en possible copper filtration. These data can be used to set diagnostic reference levels (DRLs) or to compare them with existing DRLs per procedure. The information about the energy spectrum of the radiation (kVp and filtration) also makes it possible to estimate the effective dose.
Finally, the extensive dose analysis leads to the proposition of some practical guidelines, in order to restrict patient dose, while maintaining an appropriate image quality. Although the current digital systems for vascular radiology need a lower radiation intensity compared to the conventional film-screen systems, it was found that in practice much more images were taken with the digital systems. If the number of frames is sufficiently reduced and if an appropriate dose level is set at the entrance of the image intensifier, depending on the type and the purpose of the procedure, the dose could already be substantially reduced. Although such guidelines can be raised by medical physicists, it will remain the choice of the radiologist if and how they will be implemented in practice. Keeping the medical staff informed and alert about radiation protection is therefore an important issue in the process of optimization.