Evaluation of patient skin dose in Interventional Radiology with use of radiochromic film

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1-Background

- The risk of deterministic skin effects following procedures using X-rays appeare for absorbed skin-dose about 2-3 Grays at one time (threshold dose of transitional erythema apparition).
- In peripheral interventional vascular radiology, this risk can't be avoided for technically difficult and long procedures, involving profile or oblique incidences with obese patients (abdomino-pelvic region). In neuroradiology, it is not uncommon to déliver doses about 5 Gy for procedures like intracranial aneurysm embolization or arterial-vein deformity.
- The Authority of Safety Nuclear (ASN) demanded a special medical following when patient maximum skin dose exceeded 3Gy (deterministic effects threshold), but facilities just gave airkerma (AK) and kerma surface product (KSP) which are just indicators.
- To detect in advance the risk of having deterministic skin effect, it is necessary to know the absorbed skin dose
- Radiochromic films XR-RV3 have been choosen to make the dosimetric study of the patient skin dose.

2-Objectives

- Carry out dosimetric measures to better know dose delivered to skin patients in interventional radiology.
- We have targeted on these points :
  -films calibration and reading protocols
  -assess the reliability of the measured doses with the films by comparing results obtained with thermoluminescent dosimeters (TLDs)
  -check the possibility to use radiochromic films in routine

3-Method

- We have studied physical characteristics :
  -temporal evolution
  -energy dependance
  -calibration with 2 different voltage : 81 et 117kVp with interventional facility.
- Films have been read with a flatbed scanner Epson 10000XL and analysed with ImageJ.
- We have placed films during several procedures : 37 interventional vascular radiology procedures and 21 neuroradiology procedures.

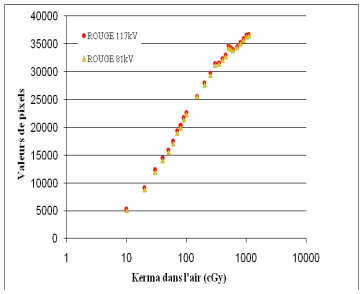
4-Results and discussion

- Darkening film evolution during 24 hours after irradiation

Dose (cGy)	10	100	400	1000
Évolution de 0h à 24h	0.35%	0.40%	0.35%	0.11%

The temporal evolution is negligible, but to be reproducible method we decided to read films 24h after irradiation.

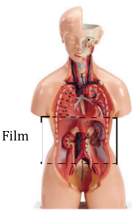
- Comparison of two different energies calibration



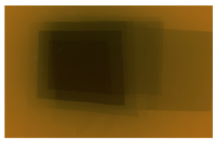
The average space between these two alibration curve is about 1,44% with a maximum of 3,6%.

Films are a bit dependant of energies between 81 and 117kVp.

Example of an interventional radiology procedure :



Film position and orientation (renal dilatation)



Exemple : Darkening obtained on the film to assess the dose distribution to the patient skin and the maximum dose.

Data :
- KSP = 713814 mGy.cm²
- 437 images (graphy)
- 30 minutes of scopy
- AK = 4,445Gy ±0,8Gy

A space of 35% is observed between the data given by the facility and the dose calculated with the radiochromic film. We can explain this difference. In fact, AK does not take into account backscatter from the patient. Moreover, AK of our facility was calculated at 60cm from the source and souce-patient distance vary according to procedures, patient morphology.

The whole study allowed to collect this results :

Patient dose > 3Gy	Dose /facility data (AK / KSP)	Dose / radiochromic films
Interventional Vascular Radiology (31 studied cases)	4 patients	6 patients
Neuroradiology (27 studied cases)	0 patients (*only KSP available on the machine disponible à la console, insufficient to assess the delivered dose*)	6 patients
Total (58 cases)	4 patients	12 patients

Radiochromic films enabled to identify 12 patients/58 studied cases, who have received dose > 3Gy. The only use of AirKerma in air and Surface-Kerma Product given by the facility would have just detect 4 of them.

5-Conclusion

- Data given from the facilities are not reliable enough to know accurately the dose delivered to the patient skin. A simple method to know this dose, to plan appropriate medical follow up, is necessary.

- This study confirm the need of a routine evaluation of patient skin doses during interventional radiology procedures which could generate doses higher than the threshold of 2-3Gy.

- Usuals parameters (KSP and AK) just allowed to identify 4 patients/58 patients which have received doses>3Gy whereas films detected 12 patients (three times more) needed a specific medical follow up.

- Radiochromic films possessed this advantages :
-They allowed the measure of the maximal skin dose taking into account field overlapping
-They gave a picture of the dose distribution
-They enabled to know the dose at the end of the procedure (flatbed scanner and simple analysis)
-Utilization an manipulation were easy in routine (insensitive to visible light during short time)

- Identification of patients who have received high doses would allow radiologist to inform them about potential effects they could have and organized an appropriate medical follow up.

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A publication detailling this study has been submitted to the RADIOPROTECTION review of the French Society of the Radioprotection.

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