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 appears 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 deliver 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 chosen to make the dosimetric study of the patient skin dose.

2-Objectives

- Carry out dosimetric measures to better known 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

<table>
<thead>
<tr>
<th>Dose (Gy)</th>
<th>0h</th>
<th>24h</th>
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<tbody>
<tr>
<td>0.05</td>
<td>0.35%</td>
<td>0.35%</td>
</tr>
<tr>
<td>0.1</td>
<td>0.40%</td>
<td>0.35%</td>
</tr>
<tr>
<td>0.5</td>
<td>0.35%</td>
<td>0.31%</td>
</tr>
</tbody>
</table>

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 calibration curve is about 1,44% with a maximum of 3,6%. Films are a bit dependant of energies between 81 and 117kVp.

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.
- Usual parameters (KSP and AK) just allowed to identify 4 patients/58 patients which have received dose > 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.