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VISUAL AND NUMERICAL METHODS TO MEASURE PATIENT SKIN DOSES IN INTERVENTIONAL PROCEDURES USING RADIOCHROMIC XR-RV3 FILMS

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Introduction and objectives

- Radiochromic films has been established as the best dosimeter to measure skin dose distribution in patients undergone interventional procedures.
- With each batch of radiochromic films Gafchromic® XR-RV3 (International Speciality Products) a calibration strip can be supplied. The vendor provides† this calibration strip to estimate visually the patient dose and it only could be used with films with the same batch number.

†http://online1.ispcorp.com/_layouts/Gafchromic/content/products/xrr/pdf/doseverstripguide.pdf



Introduction and objectives

- The vendor also provides[†] a calibration method based on the controlled irradiation of the films and its digitalization in an RGB scanner. It is necessary to irradiate the films to doses greater to 10 Gy.
- The output in a interventional x-ray unit at tube exit using a high fluoroscopy mode is about 0.25 Gy/min. To deliver 10 Gy it is necessary 40 minutes of x-rays plus some stops to let the x-ray tube rest.
- This calibration method is very time consuming.

[†] http://online1.ispcorp.com/_layouts/Gafchromic/content/products/xrr/pdf/ProdCal.pdf

Introduction and objectives

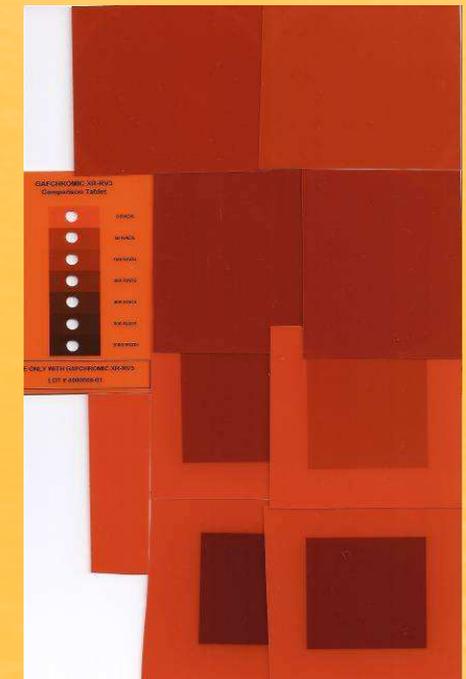
In this work we explore the usefulness of the calibration strip to be used with a scanner to assign doses to films, comparing it with a calibration performed with controlled irradiated films. We also verify the influence of backscatter radiation on film response and the differences in doses when we scan the films splitting RGB channels or when we scan in gray scale merging the three RGB channels.

Materials and methods

- Film irradiation in an Interventional Radiology room Philips Allura Xpert FD10/20 using a high dose rate fluoroscopy mode at 82 kV, HVL of 4.9 mm Al. It was necessary to permit the tube to dissipate heat periodically.
- To save time we located all the film pieces together and we remove them for each dose level from lower to higher.
- In air from 0 to 6 Gy. Films located at tube exit. (3 hours).
- With backscatter conditions it was not possible to locate films pieces at tube exit. From 0 to 2 Gy. (3 hours).

Material and methods

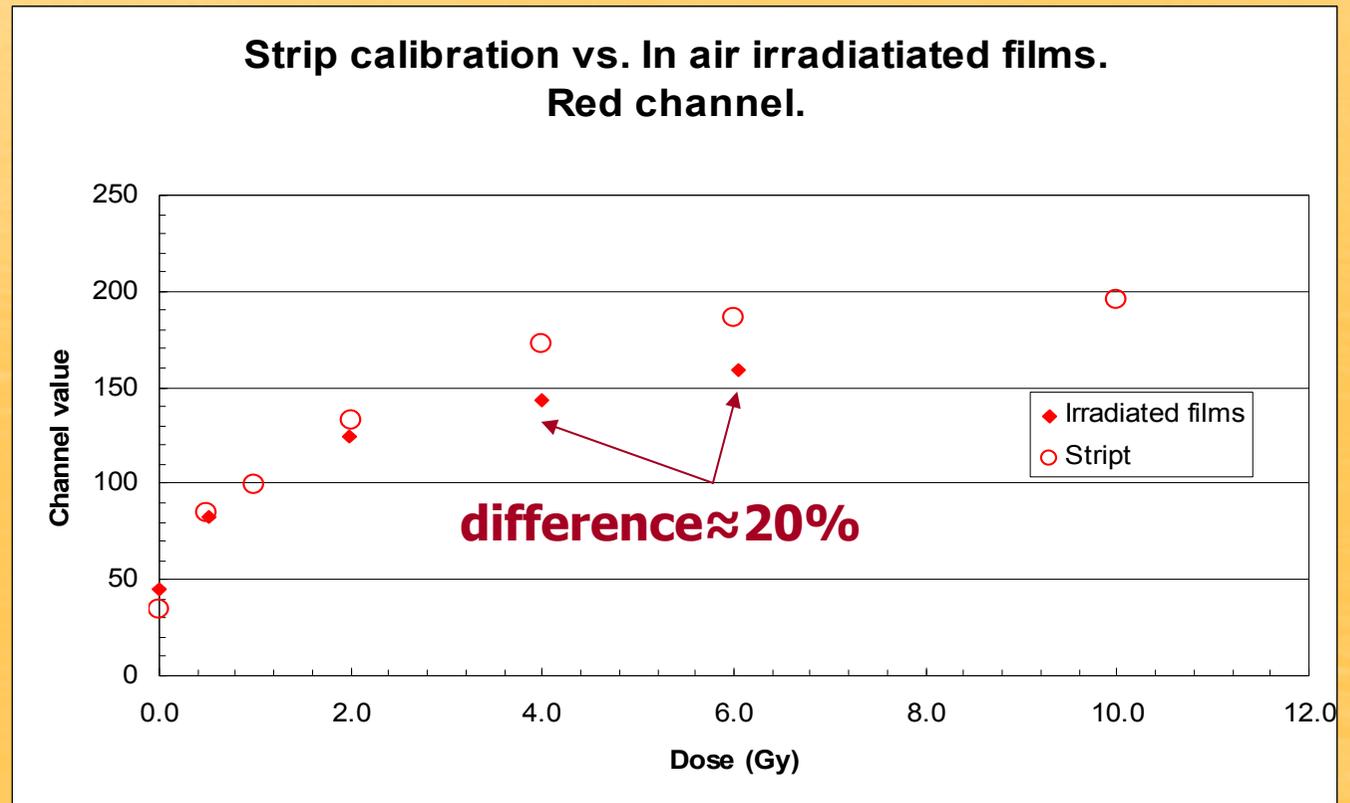
- Film scanning using a scanner EPSON model EU88.
- Colour 24 bits splitting RGB channels and grey 16 bits depth. Median filtering 5x5.
- Irradiated films
- Calibration strip.



Results

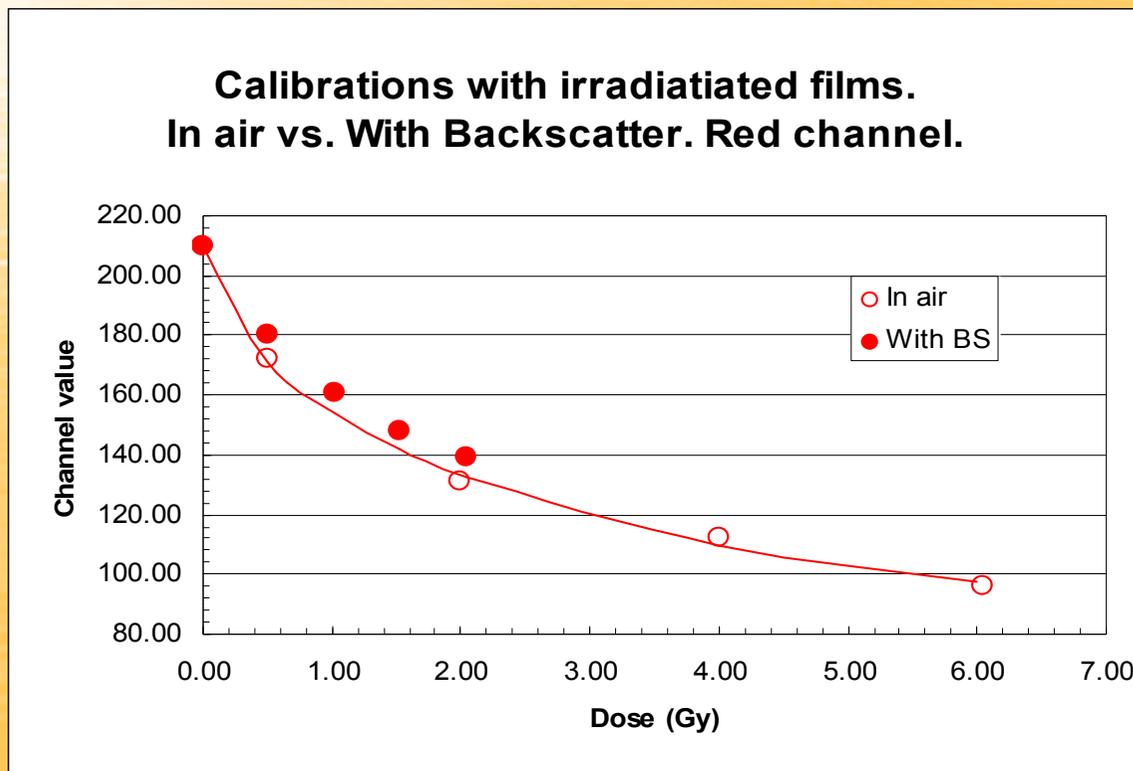
- Calibration strip vs. irradiated films: visual inspection differs in 2 Gy in the region around 4 Gy versus irradiated films.

• When calibration strip is digitized, differences of 20% were detected against irradiated films.



Results

- Film response to BS radiation .
- Average difference in scanner signal of 4% measured between 0 and 2 Gy.

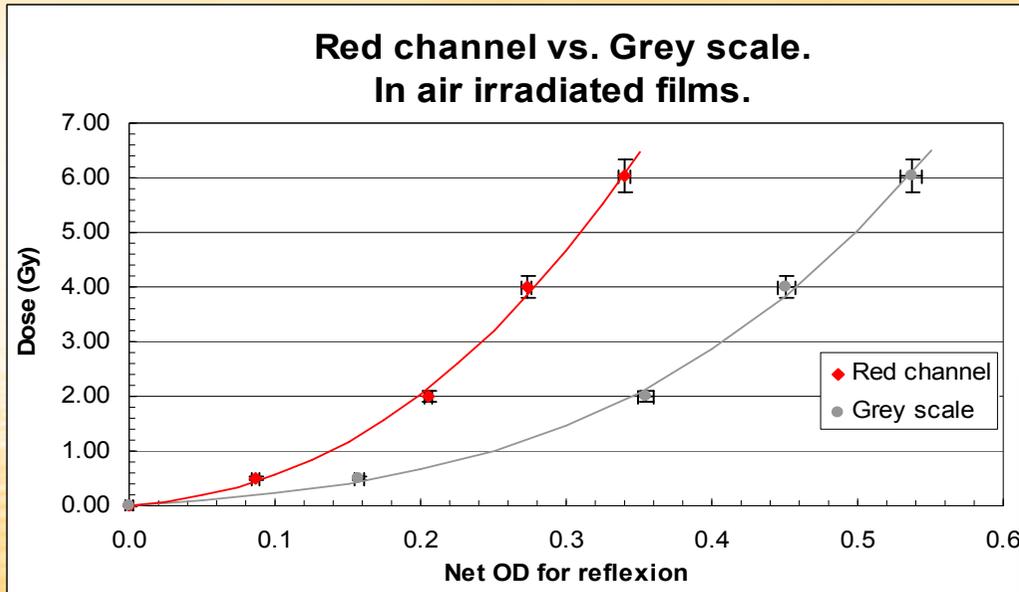


$$Ch\ v = a + bDose + cDose^n$$

- In air: $a=-210,2$; $b=20.81$; $c=76.37$; $n=0.6341$

Results

- Grey scale or Red RGB channel.

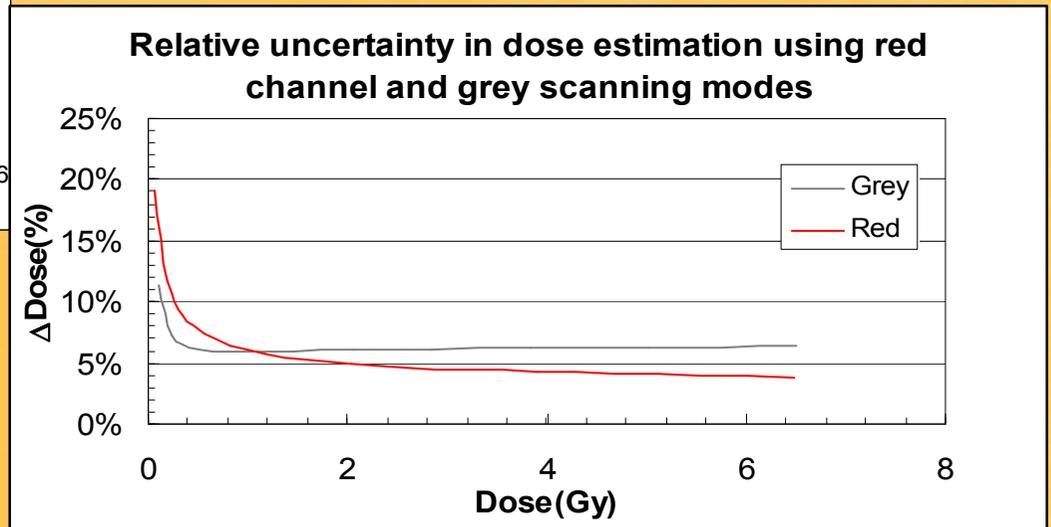


$$D(\text{Gy}) = a \cdot \text{netOD} + c \cdot \text{netOD}^n$$



- Red: $a=2.428$; $b=62.75$; $n=2.297$
- Grey $a=2.043$; $b=33.35$; $n=3.054$

Using red channel the uncertainty is slightly smaller, but to use the grey scale scanning mode is also possible without appreciable lost of performance.



† Devic et al. Precise radiochromic film dosimetry using flat-bed document scanner. Med. Phys. 32 (7), July 2005

Conclusions

- Using the strip to perform visual estimation of the dose could produce discrepancy of 2 Gy in the region of major interest (around 4 Gy).
- Digitizing the strip reduces the previous error to 20%.
- A manual calibration performed in air could be used to measure dose in backscatter conditions.
- If the user software do not permits to separate RGB channel, it is possible to use a grey scale scanning without an important lost of accuracy.