

# **DIRECT MEASUREMENT OF SKIN DOSE WITH RADIOCHROMIC FILMS IN FLUOROSCOPY GUIDED VESSEL REPAIR**

**J. KALEF-EZRA,\*<sup>1</sup> E. KATSAROU,<sup>1</sup>  
S. KARAVASILIS,<sup>1</sup> M. MATSAGKAS,<sup>2</sup>  
L.K. MICHALIS<sup>3</sup>**

**<sup>1</sup> Medical Physics Department, <sup>2</sup> Vascular  
Surgery Division and <sup>3</sup> Cardiology Department  
University of Ioannina, Ioannina, Greece**

***\* jkalef@cc.uoi.gr***

# INTRODUCTION

- **Real-time monitoring of entrance skin dose during lengthy fluoroscopy guided interventional procedures as well as registration of the irradiation data are recommended because of potential skin injury.**
- **There are severe limitations in the usefulness of the indicated DAP and kerma values (limited accuracy of the DAP meters used, errors due to the varying beam angles and field sizes, field locations and focus to skin distances used,...)**
- **Direct 2D dose skin mapping could be carried out on each patient using appropriate passive detectors. Such procedures are expensive, time consuming and do not provide real-time guidance to the operator to adjust the employed technique during repair.**
- **The aim of this study was the development of a practical method to assess in real-time the peak skin dose in patients undergoing fluoroscopy guided vessel repair with adequate accuracy correlating the indicated DAP values with peak skin doses.**

# MATERIALS AND METHODS

Self-developed GafChromic films (XR RV2 or RV3 type) were used to map the skin dose distribution in twenty patients that underwent angioplasty of the left anterior descending coronary artery (LAD-PTCA) using a stationary Philips Allura 9" angiographic unit and in twenty patients that underwent endovascular abdominal aortic aneurysm repair (EVAR) using a mobile Philips Pulsera 12" unit.

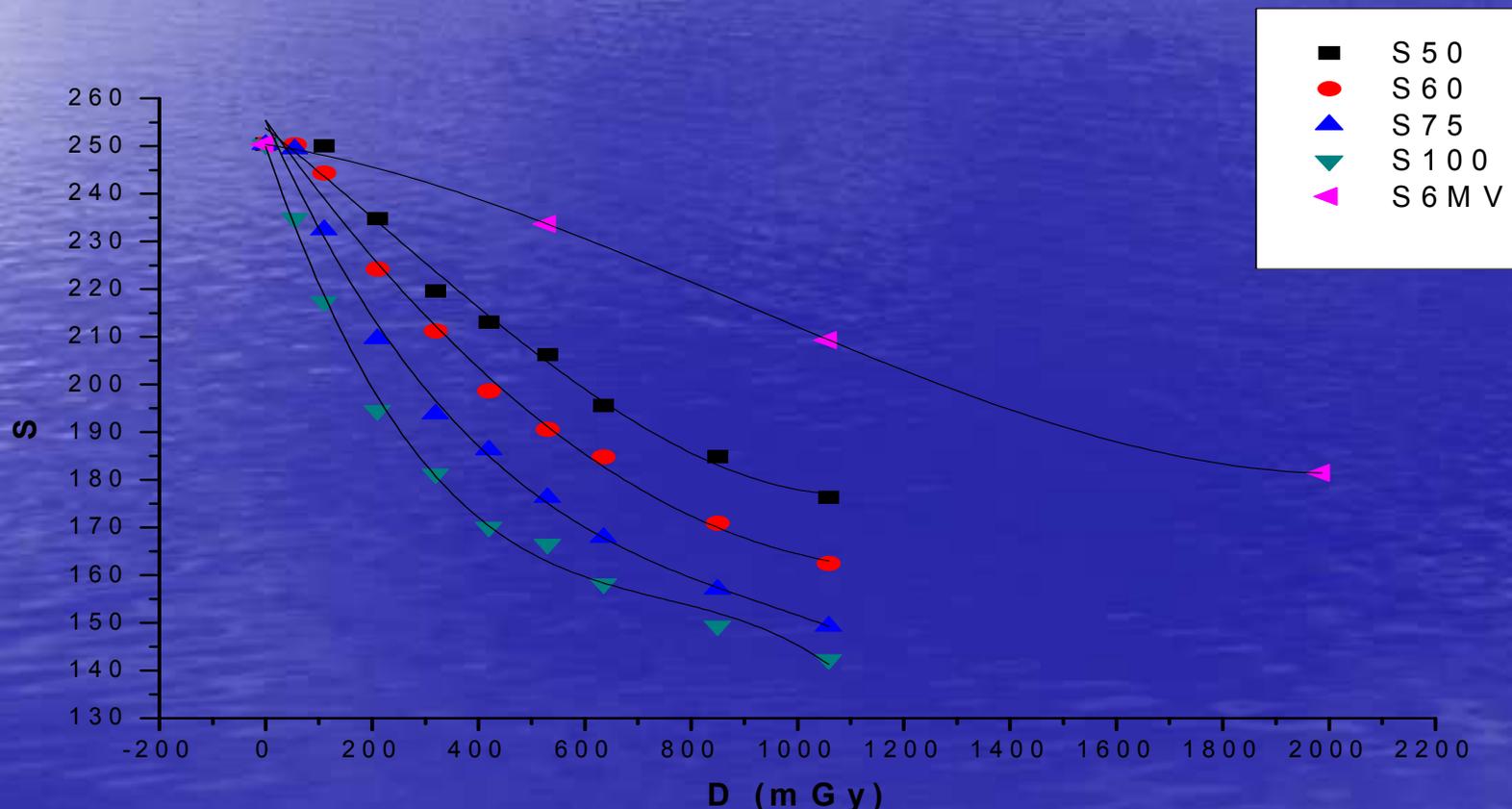
Energy deposition in the color producing microcrystals of the film results in partial polymerization, leading to increased absorption of visible light.

Films were read using a document scanner.

LAD-PTCA  
(XR RV3)

EVAR  
(XR RV2)

**Relationships between coloration and absorbed dose obtained at various kV were determined experimentally for both types of films. The term "peak skin dose" was used as the maximal mean dose in 1.0 cm x 1.0 cm areas covering the entire film area.**



## **MATERIALS AND METHODS**

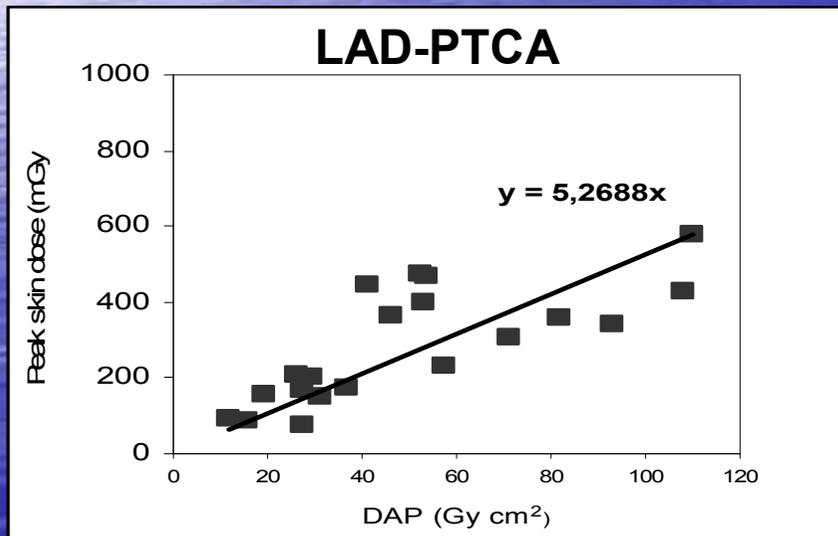
**Fluoroscopy contributed on the average 39% and 80% of the total DAP in LAD-PTCA and EVAR procedures, respectively.**

**Taking into account the substantial difference in the kV used during fluoroscopy and registration in LAD-PTCA (93 and 80 kV on the average, respectively), film coloration was correlated with skin dose to each patient using the DAP-weighted average kV during fluoroscopy and image registration.**

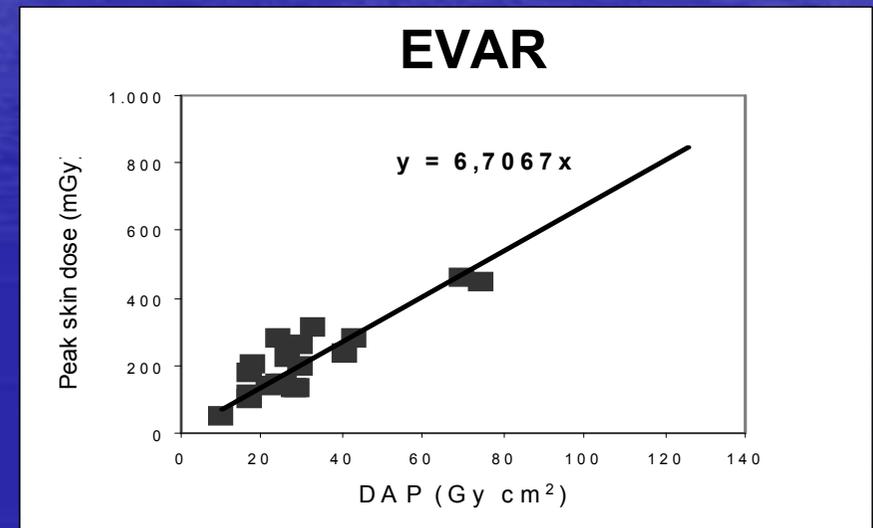
# RESULTS: PEAK DOSES

The mean registered peak skin doses in the skin of the patients that underwent PTCA and EVAR were  $(261 \pm 137)$  mGy and  $(248 \pm 185)$  mGy.

Peak skin dose,  $D$  (in mGy), increased linearly with DAP (in Gy cm<sup>2</sup>), thus allowing the indirect estimation of the peak skin dose in all patients.



**$D = 5.27$  DAP**  
 **$r=0.67$ , SEE=113 mGy**



**$D = 6.71$  DAP**  
 **$r=0.87$ , SEE=56 mGy**

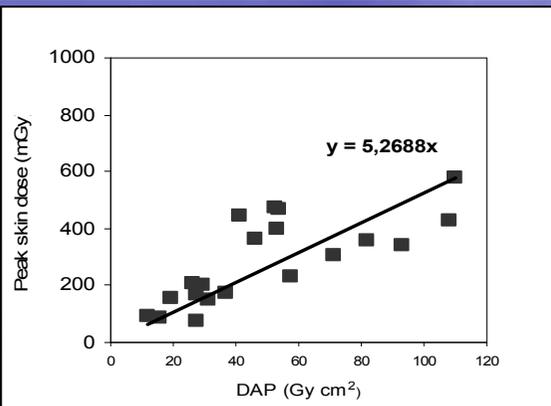
# **RESULTS: MAXIMAL PEAK DOSES**

**Using the DAP data on the 53 EVAR procedures carried out at Ioannina University Hospital (IUH) during 2009 with the Pulsera unit, it was found that the maximum peak skin dose among these patients was 0.80 Gy.**

**Similarly, the maximum peak skin dose related to the 144 LAD-PTCA procedures carried out at IUH during 2009 (median DAP 59 Gy cm<sup>2</sup>) was 1.6 Gy.**

# DISCUSSION

- The restriction of the peak skin dose in the human trunk below 2 Gy over a short time period, precludes the induction of any severe deterministic effect in both male and non-pregnant female patients.
- Based on the findings of the present study:
  - a) interventionalists are informed during the procedure when the anticipated peak dose reaches 1.6 Gy (a triggering level of  $\sim 300$  and  $240 \text{ Gy cm}^2$  in PTCA and EVAR procedures is used), b) a skin assessment follow-up is prescribed.
- Under the assumption, that the relationship found holds for angioplasties carried out at IUH in any coronary vessel (about 500 procedures annually), the maximum peak dose exceeds the 2.0 Gy limit in 0.6% of the repairs in IUH (all carried out at the right circumflex artery, RCA-PTCA).



# CONCLUSION

**Peak skin dose in individual patients treated in a facility can be assessed using empirically determined relationships between the indicated DAP values and peak skin dose, obtained by direct measurements in subgroups of patients using radiochromic films.**