Hand monitoring in Fluoro-CT guided procedures

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Introduction

Computed Tomography in fluoroscopy mode (Fluoro-CT) is frequently used for the collection of lung biopsies, amongst other tissues. Fluoro-CT allows the display of real time images minimizing the effect of the respiratory movement and at the same time provides a good perception on the direction and depth attained by the biopsy needle, benefitting the access to small target lesions located in the neighborhood of sensitive organs [1,2]. The type of lesion and of procedure dictates the positioning of the interventional radiologist (IR) relative to the patient and the X-ray source and in turn the IR's exposure to a radiation field that is often difficult to describe. Personal protective equipment is recommended and routinely used but individual monitoring data can be of benefit to better understand the dose levels involved, as these might come close to the established annual dose limits. The hands of the IR deserve higher attention as the nature of the procedures may require a proximity of the hand to the X-ray plane [3,4]. The aim of this work is to measure and analyse the dose levels received on the hands of the IR using fluoro-CT guided procedures for the collection of lung biopsies in 45 patients selected at random.

Material and Methods

Hand monitoring was performed using home-developed gloves prepared with casings for the insertion of thermoluminescence dosemeters (TLD) of the extremity type, one for the dominant and another for the non-dominant hand.

In each procedure, LiF:Mg,Cu,P (TLD-100H) extremity detectors were placed at the tip and at the base of each finger, as well as on the wrist, as shown in the figures.

Dominant (left) hand:
11 extremity dosemeters:
- 5 at finger tip
- 5 at finger base
- 1 on the wrist

Non-dominant (right) hand:
6 extremity dosemeters:
- 5 at finger base
- 1 on the wrist

The dosemeters were calibrated in terms of $H_p(0.07)$ using an N120 X-ray beam incident on a ISO rod phantom at the Ionizing Radiation Metrology Laboratory of IST. Readouts were performed on a Harshaw 6600 reader using predefined cycles the day after the irradiations [5,6].

The Fluoro-CT dose assessment was performed at IPOP during a total of 45 lung biopsy cases performed on a Toshiba Asteion CT scanner. The IR wore protective goggles, lead apron and lead gloves over the dosemeter gloves and a third sterilized one was used on top.

Conclusion

- In this work, an assessment of the dose to the hands of the IR was performed based on the analyses of the results obtained in 45 procedures;
- Dose values measured for the dominant hand are much higher than those for the non-dominant hand;
- In the dominant hand, the index, middle and ring finger tips receive the highest dose values;
- The dose measured in the wrist position is negligible compared to other positions in the hand;
- The results obtained in 45 procedures suggest that the annual dose limit to the extremities (500mSv) may easily be exceeded;
- These results highlight the importance of using needle holders to keep the hand as far as possible from the X-ray beam;
- Suggested positions of dosemeters for routine monitoring: tip and base of the ring and/or middle fingers, so that IR work is not impaired.

References

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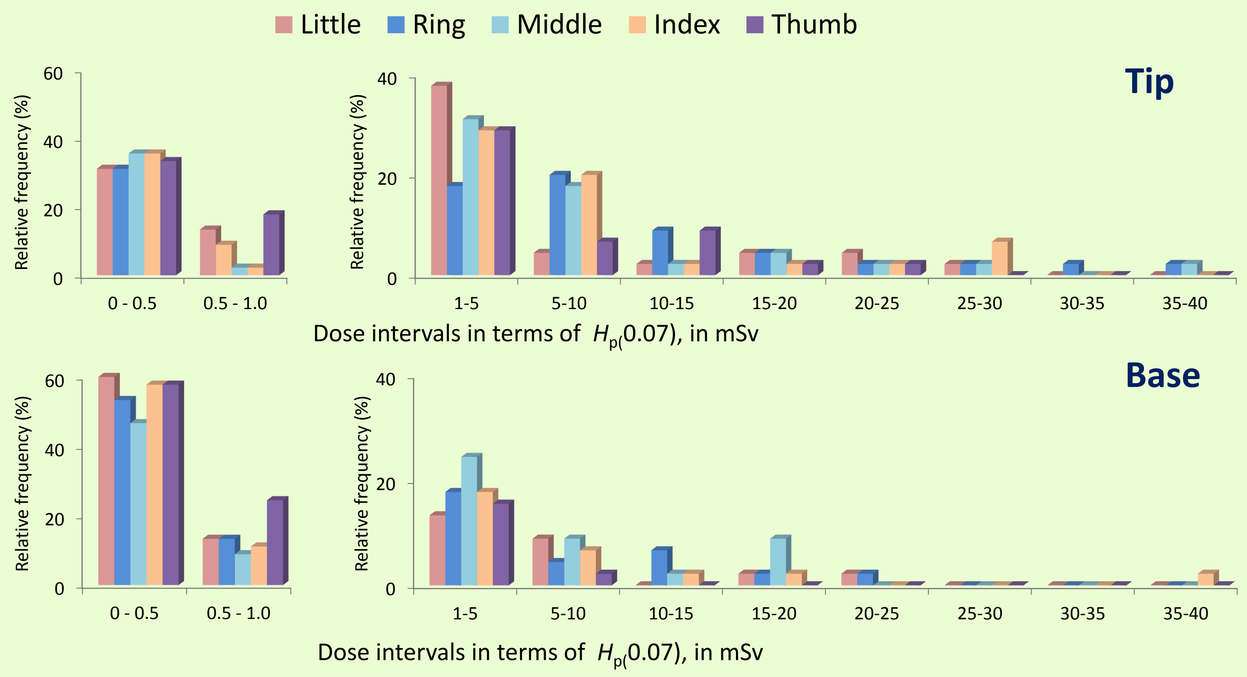
Results and Discussion

❖ Per procedure results

Per procedure results show that the dose levels may present a very large variation. The histograms below were obtained in 45 lung biopsy cases.

• Dominant hand



In general:

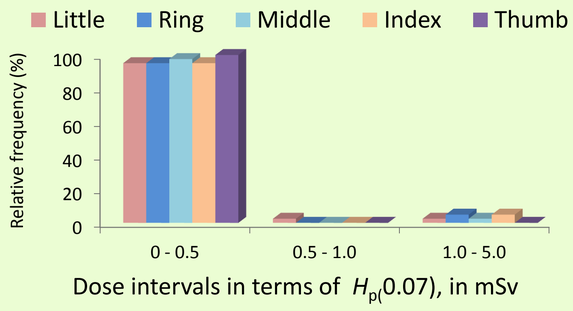
- Dose to the tip higher than dose to the base;
- Dose to the tip broadens to higher dose values;
- Dose base < 1.0 mSv in 55% procedures;
- Dose tip < 1.0 mSv in 35% procedures;
- Ring, middle and index fingers are the most exposed.

Finger	Max value on Tip (mSv)	Max value on Base (mSv)
Little	26.52	8.97
Ring	36.29	38.98 (16.18)*
Middle	37.80	17.58
Index	29.58	21.24
Thumb	22.14	21.20

(*) If 38.98 eliminated.

• Non-dominant hand

- The maximum dose value is 10 times lower than maximum dose values on dominant hand in the same position.
- Most if not all below 0.5 mSv.



• Wrist

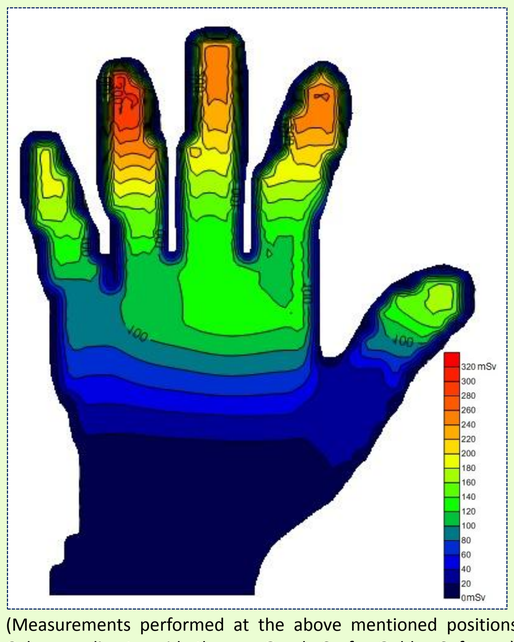
- The dose to the wrist is negligible when compared with the dose to the fingers.
- Dominant hand: dose ranged from 0.04 to 0.70 mSv.

❖ Total dose in 45 procedures

Total accumulated dose for the dominant hand:

Finger	Total dose Tip (mSv)	Total dose Base (mSv)
Little	176.26	93.40
Ring	286.06	115.59
Middle	236.73	133.43
Index	246.12	117.82
Thumb	156.80	34.34

There seems to be a similar distribution of the dose in the ring, middle and index fingers.



(Measurements performed at the above mentioned positions. Colour grading to guide the eye. Graph: Surfer, Golden Software)