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ORIGINAL ARTICLE

Use of a prototype radioprotection cabin in vascular neuroradiology: Dosimetry and ergonomics

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KEYWORDS
Radioprotection cabin;
Interventional neuroradiology;
Lead vest and skirt;
Thermoluminescent dosimeters

Summary
Objectives: The aim of this work was to compare the performance of a prototype radioprotection cabin in interventional neuroradiology, and to assess its suitability for routine use.
Materials and methods: The radioprotection cabin was a prototype derived from the CATHPAX AF® model. Three operators carried out 21 procedures (19 brain arteriographies and 2 embolizations) using the radioprotection cabin and not wearing the usual lead individual protection equipment (IPE), and 17 procedures (16 brain arteriographies and 1 embolization) wearing the standard lead IPE (vest, skirt, thyroid shield and goggles), and not using the radioprotection cabin. In all cases, thermoluminescent dosimeters (TLDs) were positioned at head, trunk, pelvic region, and upper and lower limbs to measure the dose equivalent for $H_p(0.07)$ or $H_p(3)$ that they received, attenuated by either the cabin or the lead IPE. Parallel to these dosimetric measurements, the ergonomics of the protection cabin were appraised by each radiologist after each procedure.
Results and conclusion: The cabin procured an overall reduction of 74% of the dose received on the whole body with $H_p(0.07) = 0.04$ mSv $\pm$ 0.01 (CL = 95%) against $H_p(0.07) = 0.12$ mSv $\pm$ 0.04 (CL = 95%) for the IPE. Body protection with the cabin was near complete, and close to 100% for the regions not protected by the usual IPE (e.g. the head). We also showed that design weaknesses noted by the operators that hampered procedures (light reflections, reduced hand mobility, awkward access to radioscopy pedal) could be remedied by maker's improvements to the prototype and minor changes in work habits.

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Introduction

The radioprotection of workers and patients has become a priority in interventional radiology. Despite technological improvement in equipment, the exposure of operators, who are necessarily standing very close to patients during procedures, remains a concern.

Indeed, effective dose received in interventional radiology is approximately 2—4 mSv/year [1]. According to the procedure and the location, the doses received by the operator wearing Individual Protection Equipment (IPE) vary for each procedure. For example, at the waist, dose ranges from < 0.1 to 32 μSv; from 48 to 1280 μSv at the hand [2].

Lead individual protection equipment (IPE) (vest, skirt, thyroid shield, goggles) is heavy (≈ 7 kg), displays poor ergonomics [3], and protects the body areas it covers with ranging efficacy. The head is not well protected. New concepts in individual or semi-individual radioprotection are now being marketed, and radioprotection cabins have come into use in cardiology (rhythmology [4]). A first evaluation of equipment of this type was carried out in 2006 in interventional cardiology [5], and showed at least comparable shielding efficacy for the protected parts, and necessarily greater efficacy for the neck and head regions, not covered by the standard IPE.

We set out to study the feasibility of using a radioprotection cabin in vascular neuroradiology. In fact, three percent of population will have an intracranial aneurysm and endovascular treatment is the first line treatment for this pathology [6,7]. To this end we compared the doses received by three operators standing in a radioprotection cabin and wearing no lead IPE, and wearing standard lead IPE.

Materials and methods

Radioprotection cabin

The radioprotection cabin used was a prototype derived from the CATHPAX AF® model (weight 210 kg, width 84 cm, height 196 cm) with 2 mm lead equivalent shielding on its front, left side and upper surfaces, both glazed and panelled. It is designed to be covered inside and out with a disposable sterile drape kit while being used for radiological procedures. Two front openings in the leaded glass pane, one circular on the right and the other indented on the left, are provided for the operator's hands (Fig. 1).

Mobile lead screen

A standard mobile leaded screen (2 mm lead equivalent) was positioned behind the cabin to intercept radiation back-diffused from the wall of the procedure room behind the operator (the ''shield effect'') [8] (Fig. 2). The simultaneous use of the cabin and the mobile screen thus formed a U in which the operator stood, the open side on the operator's right, opposite the X-ray tubes.

Figure 1 Prototype CATHPAX AF cabin. A. Undraped cabin. B. Cabin with sterile drape kit.

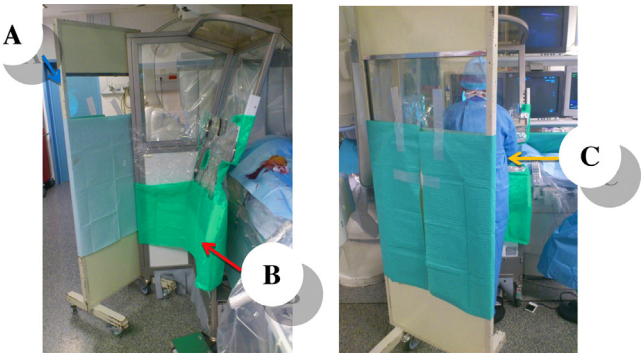

Figure 2 Rear protection for neuroradiologist: side and rear views. A. Mobile screen. B. Prototype cabin. C. Neuroradiologist.

Lead individual protective equipment

When they did not use the radioprotection cabin, the operators wore the usual personal lead IPE provided: vest: 0.5 mm lead equivalent on front, 0.35 mm on rear; skirt: 0.5 mm lead equivalent on front, 0.35 mm on rear; thyroid shield: 0.5 mm lead equivalent; goggles: 0.75 mm lead equivalent for front lenses, 0.25 mm for side shields.

Collective protective equipment

With both the radioprotection cabin and the lead IPE, the operators used collective means of protection: ceiling-suspended lead strip curtains (0.5 mm lead equivalent) hung between the operator and the tube, and a lower table fixed to the examination table rail (0.5 mm lead equivalent).

Usually, they are present in interventional radiology rooms and allow a protection for feet and head for each operator. In our case, there was no ceiling-suspended shield.