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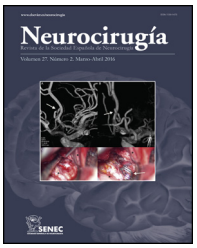

Clinical research

# Radiation protection measures: Implications on the design of neurosurgery operating rooms☆

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ABSTRACT

*Objective:* To describe pros and cons of some radiation protection measures and the implications on the design of a neurosurgery operating room.
*Material and methods:* Concurring with the acquisition and use of an O-arm device, a structural remodelling of our neurosurgery operating room was carried out. The theatre was enlarged, the shielding was reinforced and a foldable leaded screen was installed inside the operating room. Radiation doses were measured in front of and behind the screen.
*Results:* The screen provides whole-body radiation protection for all the personnel inside the theatre (effective dose <5 μSv at 2.5 m from the gantry per O-arm exploration; 0.0 μSv received behind the screen per O-arm exploration; and undetectable cumulative annual radiation dose behind the screen), obviates the need for leaded aprons and personal dosimeters, and minimises the circulation of personnel. Enlarging the size of the operating room allows storing the equipment inside and minimises the risk of collision and contamination. Rectangular rooms provide greater distance from the source of radiation.
*Conclusion:* Floor, ceiling and walls shielding, a rectangular-shaped and large enough theatre, the presence of a foldable leaded screen, and the security systems precluding an unexpected irruption into the operating room during irradiation are relevant issues to consider when designing a neurosurgery operating theatre.



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## Medidas de protección radiológica: implicaciones en el diseño de quirófanos de neurocirugía

*Palabras clave:*
Radioprotección
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Sievert
Oarm

RESUMEN

*Objetivo:* Describir pros y contras de diversas medidas de protección radiológica y sus implicaciones en el diseño de un quirófano de neurocirugía.

*Material y métodos:* Se realizó una reforma estructural del quirófano de neurocirugía a propósito de la adquisición y uso de un O-arm. Se ampliaron las medidas y blindajes del quirófano, y se instaló una mampara blindada y abatible en su interior. Se midieron dosis de radiación delante y detrás de la mampara.

*Resultados:* La mampara proporciona una radioprotección integral para todo el personal de quirófano (dosis < 5 μSv a 2,5 m del *gantry* por cada exploración con O-arm; 0,0 μSv tras la mampara por cada exploración de O-arm; dosis acumulada anual tras la mampara, indetectable), obvia la necesidad de delantales plomados y dosímetros personales y minimiza la circulación de personal. El aumento del tamaño del quirófano permite almacenar los equipos dentro y minimiza el riesgo de colisión o contaminación. Los quirófanos rectangulares permiten aumentar la distancia al foco emisor de radiación.

*Conclusiones:* El blindaje de paredes, techos y suelos, la forma rectangular y la superficie lo más amplia posible, la presencia de una mampara plomada y abatible, y los sistemas de seguridad que impiden una irrupción inesperada en el quirófano mientras se está irradiando son cuestiones relevantes a tener en cuenta en el diseño del quirófano de neurocirugía.



## Introduction

In current neurosurgical practice, procedures requiring the use of intraoperative radiological imaging are increasingly common, especially in spinal surgery.[1,2] The imaging equipment emits ionising radiation with undesirable biological effects that are potentially harmful for patients, surgeons and all other operating theatre staff.[3–6] Therefore, radiation protection measures are a basic need within the framework of a culture of safety and quality of clinical performance.[7–9]

Radiation protection in this context essentially depends on 2 factors: the use of individual radiation protection measures and the design of the facility. The latter is very important, as it will affect the entire useful life of the operating theatre and reduce or altogether prevent the need for other radiation protection measures which may be bothersome or even restrictive. The dimensions of the operating theatre, the thickness of the shielding and the location of the radiation sources are among the factors that influence the amount of radiation absorbed by patients and staff.[2,8]

As operating theatres must be increasingly multi-purpose and virtually all surgical specialisations use ionising radiation intraoperatively,[10] the structural design of the operating theatre is a key element and an ideal opportunity for providing passive radiation protection measures built into the very architecture of the room.[11]

The layout of the radiation protection elements in the operating theatre is a topic that has seldom been studied in the literature, yet is very important.[2,12–14] The operating theatre assigned to our department features an O-arm (Medtronic, Fridley, Minnesota, United States), a 3-dimensional imaging system which combines tomography definition and navigator precision. With a view to structural remodelling, the design, spatial layout and shielding of the operating theatre were modified, and useful, novel radiation protection features were added.

This study reports the various radiation protection measures available in our operating theatre, with a collapsible shielding screen being a key element. We provide dosimetric confirmation of said measures, discuss the advantages and disadvantages of the spatial layout of the operating theatre in relation to versatility and protection against radiation, and propose a number of solutions with implications for the design of multi-purpose neurosurgery operating theatres.

## Material and methods

The acquisition and use of an O-arm navigated 3D imaging device was the motivation behind a structural remodelling of the neurosurgery operating theatre, including a number of radiation protection measures. The details of the remodelling are shown in the sketches in Figs. 1 and 2, which provide specific information about the architecture, dimensions and shielding of the remodelled operating theatre. Placing a collapsible shielding screen on one end of the operating theatre represented a structural novelty with significant repercussions for day-to-day clinical practice. Fig. 3 shows its location and measurements as well as the positioning of the elements, equipment and staff of the operating theatre under normal conditions.