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Exposure of radioactive emanations, during surgery in orthopedics and traumatology

Exposición de las emanaciones radiactivas, durante la cirugía en ortopedia y traumatología

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Abstract

Introduction: The radiations used during surgery are electromagnetic radiations, similar to visible light, but of shorter wavelength, which penetrates materials that absorb light. The relevant concepts, there are several factors that can affect the absorption, such as thickness, density, atomic number, contrast media, kilovoltage, filtration, the composition of the target and the distance from where the beam emanates. The federal regulation code in the United States establishes a permissible level in the hands of 18,750 mlrem to three months or 70 rems per year, but it should be noted that in the bibliography consulted, it is not necessary to specify what the minimum amount of harmful radiation is. Within these risks, malignancy has been reported at the level of the eye lens, liver, spleen, gonads and skin, and complications at low doses in relation to the risk of thyroid cancer in adults. **Conclusion:** Monitoring of real radiation with evaluations every three months should be considered, since it is cumulative, so it must be taken into account what is not known and not seen, of the likely long-term risks.

Keywords: Radiation incidents, interventional radiology, computed tomography, digital radiography, effective dose, fetal exposure.

Resumen

Introducción: *Las radiaciones que se utilizan durante la cirugía, son radiaciones electromagnéticas, similares a la luz visible, pero de menor longitud de onda, que penetra materiales que absorben luz. Los conceptos relevantes, existen diversos factores que pueden afectar la absorción, como el espesor, la densidad, el número atómico, medios de contraste, kilovoltaje, la filtración, la composición del blanco y la distancia de donde emana el rayo. El código federal de regulación en Estados Unidos, establece un nivel permisible en las manos de 18,750 mlrem a tres meses o 70 rems por año, pero cabe destacar que en la bibliografía consultada, no se precisa ¿cuál es la cantidad de radiación mínima dañina? Dentro de estos riesgos se ha reportado malignidad a nivel de cristalino, hígado, bazo, gónadas y piel, y complicaciones a dosis bajas con relación al riesgo de cáncer de tiroides en adultos.* ***Conclusión:*** *Se debe considerar la monitorización de radiación real con evaluaciones cada tres meses, ya que es acumulable, por lo que debe ser tomado muy en cuenta lo que no se conoce y no se ve, de los probables riesgos a largo plazo.*

Palabras clave: *Incidentes de radiación, radiología intervencionista, tomografía computada, radiografía digital, dosis efectiva, exposición fetal.*

Introduction

There is a great paradigm when talking about radiation during surgery and the discussion is when this binomial «enemy-ally» is established, this is generated by the myths and fallacies, as well as the realities that exist in relation to the exposure to radiations in the operating room.

The development of closed or minimally invasive techniques makes it dependent on equipment such as the fluoroscope, which favors optimal results during surgery, allowing immediate tranquility for the surgeon.[1-3]

Radiation used during surgery is a form of electromagnetic radiation, similar to visible light, but of shorter wavelength, it penetrates materials that absorb

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Table 1: Exposure during surgery. Radiation dose ml/rem 1.

Type of surgery	Total	Type Qx X (min)	X fluors (min)	Total	X/min	X/Qx
Centromedullary tutor	21	107	3.61	590	5.51	128.0
Femur	11	119	4.14	560	4.71	50.9
Proximal block	6	92	2.37	60	0.65	10.0
Distal blocking	5	151	6.26	500	3.31	100.0
Tibia	10	95	3.08	30	0.32	3.0
Proximal block	2	52	1.65	0	0.00	0.0
Distal blocking	8	106	3.44	30	0.28	3.8
Others	44	128	2.10	50	0.39	1.1

light and emit radiation to certain substances, but can also produce biological changes, hence its relevance in terms of its knowledge and importance.

Among the relevant concepts related to the physical characteristics of radioactive emissions, there are several factors that can affect absorption, such as thickness, density, atomic number, contrast media, kilovoltage, filtration, white composition and the distance from where the beam emanates, characteristics that the surgeon must know for his personal protection and that of his surgical team.[4-6]

It is also important to know how to quantify radiation, for example the RAD was previously considered as the unit of measurement of the absorbed dose of ionizing radiation, but currently the REM (Roentgen Equivalent Man) is considered the unit of radiation measurement, by the ionizing effect that it produces and is cataloged as the amount of any ionizing radiation that has the same biological effectiveness of 1 RAD, existing multiples like Gray and Silver.[7-9]

What happens while I am using the rays during surgery in orthopedics and traumatology?

The use of new non-invasive techniques has led to the increasingly frequent use of fluoroscopy, so it is very important to know the amount of mlrems that emanate in some procedures *(Table 1)*.

Although it is also worth having an estimate of the amount of mlrems/minute, since it allows to quantitatively evaluate the amount of emanations per session, at present the fluoroscopy equipment quantifies the sum per shot during the use of the equipment, if it stays lit continuously *(Table 2)*.

All this information is useful, but the only way to know the real radiation is by accounting for the accumulated radiation.[10]

The federal regulation code in the United States establishes a permissible level in the hands of 18,750 mlrem to three months or 70 rems per year, but it should be noted that in the bibliographic review carried out, none of the authors specified, what the amount of minimal harmful radiation is, which means that this topic has great relevance.

The high doses of radiation, can produce tissue reactions in the skin, being the main factor to reduce tissue risks, ensuring that the personnel operating the intervention team, has received training on the use of the equipment and know the facilities through which the doses can be reduced.

Likewise, the use of terminology that provides the approximate indication of the risk of any effect not determined for adults, children or fetuses of any exposure is recommended, however, when the exposure represents dozens of effective doses of mSv (millisievert, dose effective), an assessment involving dose estimation for individual organs and tissues is appropriate and then using the coefficients related to age and sex to obtain an estimate of the stochastic risk.[11-13]

Of the risks reported in the literature, the probability of malignancy at the level of eyes (crystalline), neck (thyroid), liver, spleen, gonads and skin, has reported probable complications at low doses in relation to the risk of thyroid cancer in adults. With an incidence of 4.2 cases/1'000,000 per year and Merrian reports problems in the eye lens (cataracts) in doses of 200 rads/session or 550 rads for three months.

Chou et al., reported a 2.9-fold increase in the prevalence of breast cancer in a population of 505 women orthopedic surgeons exposed to trans-surgical radiation, compared to women of similar age and race.[14-16]

It is enough that the figures report damages, however minimal they are to inform and protect.

What does the regulation establish in the different areas?

Political Constitution of the Mexican United States. Employers are responsible for accidents at work and occupational diseases of workers, suffered in practice or because of the work they perform and therefore, employers must pay the corresponding compensation, as it has resulted in temporary or permanent disability to work or the death of the worker, also points out that in order to provide the greatest guarantee for the health and life of workers, the employer is obliged to observe the legal provisions on hygiene and safety in the facilities of their establishment and to adopt the appropriate measures to prevent work risks.[17]

Federal Labor Law. It obliges the employer to comply with the safety and hygiene provisions established by laws and regulations to prevent occupational hazards.[18]

Mexican Social Security Institute. Stresses the adoption of precautionary measures, including providing workers with personal protective equipment to prevent damage.[19]

NOM-012. Safety and hygiene conditions in work centers where sources generating or emitting ionizing radiation capable of producing pollution in the workplace are handled, stored or transported.

In accordance with the norms NOM-146-SSA 1-1996, NORMA SSA 1-1996 on Protection and Safety as Sanitary Responsibility and NOM 157-SSA-SSA 1-1996, Art 5.2.11: For personnel occupationally exposed and for patients, the installation must have protection devices such as screens, collars, aprons, thyroid protectors, gonadal protectors and all that necessary equipment.[20]

Conclusions

The only evidence of malignancy, should be a factor to be taken into account and assess if that exposure can be reduced with situations such as the distance of the radiation source and exposure time, taking extreme care in parts of the body such as the head, neck and hands, with the use of apron, collar, gloves and special glasses.

In the operating rooms there should be shielding and electrical safety switches that evaluate permissible exposure levels with permanent evaluations *(Figure 1)*.

Check the equipment and protection systems, as they can deteriorate with daily use, have a control of the doses received by monthly reading of the individual dosimeter, which allows to know the risk exposed by the measurement of the radiation received. (The dosimeter carriers must undergo an annual medical review).

Finally, note that it is the obligation of the institution to prevent occupational hazards in each hospital, by complying with the regulations for the protection of their workers through these measures, so it must be required that these systems of protection and liability are available to the professional to adopt them.

Therefore, it is necessary to consider real radiation monitoring with evaluations every three months, due to the fact that it is cumulative, so it must be taken into account what is not known and not seen, of the probable long-term risks.

Figure 1: Isolation wall in x-ray room.

Table 2: Exposure during surgery per mlrems/min.

Fluor time	Mean ± SD	Minimum-maximum
0-0.99	0.0 ± 0.0	0 - 0
1-1.99	1.5 ± 6.7	0 - 30
2-2.99	3.8 ± 15.0	0 - 60
3-3.99	3.3 ± 8.2	0 - 70
4-4.99	4.3 ± 11.3	0 - 90
≥ 5	71.4 ± 137.9	0 - 380

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Conflict of interests

The authors declare no conflict of interests with respect to this article.