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Perception o Orthopedics Surgeons about the Risks of Radiation Exposure in Fluoroscopy*

Percepção de cirurgiões ortopédicos sobre os riscos da exposição à radiação na fluoroscopia

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Abstract

Objective The present study aims to understand the perceptions of orthopedists and traumatologists regarding the risk of exposure to ionizing radiation in fluoroscopy procedures.

Methods An objective, structured, self-administered questionnaire with sociodemographic, professional, and occupational variables was developed, available through an invitation sent to orthopedist physicians whose contacts were made publicly available.

Results A total of 141 questionnaires were answered and analyzed. Most respondents (99%) use fluoroscopy in their surgeries, and only 34.8% of the participants feel safe with the use of the equipment. It was observed that the knowledge about ionizing radiation is inadequate, because 22.6% of the participants are unaware of the type of radiation emitted in fluoroscopy and its biological effects. In addition, 52% of the participants did not know or do not understand the principles of radiological protection and their relationship with surgical practices.

Conclusion We concluded that the radiological protection of most orthopedists in surgical procedures is inadequate, and initial and continued training programs of professionals are necessary, bringing health benefits to orthopedists and their patients.

Keywords
- radiation, ionizing
- X-rays
- risk assessment
- radiation exposure
- orthopedic
- surveys and questionnaires

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Resumo

Objetivo Este estudo visa compreender as percepções dos médicos ortopedistas e traumatologistas em relação ao risco da exposição à radiação ionizante nos procedimentos de fluoroscopia.

Métodos Desenvolveu-se um questionário objetivo, estruturado, autoaplicável e com variáveis sociodemográficas, profissionais e ocupacionais, disponibilizado através de convite enviado a médicos ortopedistas cujos contatos estavam disponibilizados publicamente.

Resultados Foram respondidos e analisados 141 questionários. A maioria dos respondentes (99%) utilizam a fluoroscopia em suas cirurgias e apenas 34,8% dos participantes se sentem seguros com o uso do equipamento. Observou-se que o conhecimento sobre radiação ionizante é inadequado, pois 22,6% dos respondentes desconhecem o tipo de radiação emitida na fluoroscopia e seus efeitos biológicos. Além disso, 52% dos respondentes não conhecem ou não compreendem os princípios de proteção radiológica e suas relações com as práticas cirúrgicas.

Conclusão Concluímos que a proteção radiológica da maioria dos ortopedistas nos procedimentos cirúrgicos é inadequada e são necessários programas de formação inicial e continuada dos profissionais, trazendo benefícios para a saúde dos ortopedistas e de seus pacientes.

Palavras-chave

- radiação ionizante
- raios X
- medição de risco
- exposição à radiação
- ortopedia
- inquéritos e questionários

Introduction

In interventional radiology, there are specific standards for radiological protection of professionals working in imaging procedures. However, the orthopedist, who acts as an autonomous professional, is not necessarily controlled from the dosimetric point of view by the institution in which he carries out his professional activity. Thus, their exposure to radiation is unknown.

The popularization of fluoroscopy, with minimally invasive techniques for orthopedic and traumatology surgeries, makes orthopedists a group at special risk of excessive radiation exposure.

Knowledge of the principles of radiological protection, such as justification, optimization of protection, and application of the individual dose limit is essential, because, when implanted, the biological effects of ionizing radiation decrease.[1]

In Brazil, there are few studies on the knowledge of radiological protection measures by orthopedists, as well as the use of protective equipment, such as plumbiferous aprons and glasses, as well as thyroid protectors. In addition, the better positioning of the surgical team in relation to the equipment for better radiological protection is usually unknown.

Previous international studies show that orthopedists have a perception of occupational risk, but do not have adequate knowledge of the risks of radiation exposure, nor the notion of radiation dose in their practice.[2–6] It is essential that orthopedists have a perception of the risks of radiation exposure, forms of protection, and control of individual exposure to minimize damage.[7]

This study aims to analyze the perceptions of orthopedic physicians regarding exposure to ionizing radiation in their practice. We expect it to contribute to the understanding of the knowledge of orthopedists and the impacts on their professional practice.

Methods

An online questionnaire, with 34 questions, was sent by e-mail to orthopaedic physicians whose data are publicly available on the websites of the Brazilian Society of Orthopedics and Traumatology (http://sbot.org.br), the Brazilian Society of Pediatric Orthopedics (http://www.sbop.org.br), and the Brazilian Society of Spine (http://portalsbc.org). The questionnaire can be found, in its entirety, in the complementary material (►**Appendix 1, available only online**). This project was approved by the research ethics committee (CAAE 39995920.8.0000.5336, Opinion 4,398,246).

Occupational, professional, and sociodemographic variables were researched. The following questions were asked: age, sex, and years of performance. Professional items such as surgical procedures, area of activity, link with the institution of work, and average duration and frequency of use of the equipment in the procedures were addressed. The use of a dosimeter was also questioned and whether it was proper or provided by the institution. Regarding the occupational variables, we investigated the use of personal protective equipment (PPE), with specification of types, knowledge about the risks of ionizing radiation, prevention of radiation emitted by the fluoroscope, and awareness of the risks of occupational exposure.

The free Google Forms tool was used to create and organize the questionnaire. Anonymous responses automatically returned to the researcher in spreadsheets. In total, 141 orthopedists answered the questionnaire until 11/02/2020, and the answers to all items were optional.

For statistical evaluation, exploratory analyses were performed to verify the integrity and coherence of the data. A

descriptive analysis of the answers was performed using absolute and relative frequencies. The associations between the variables were tested by the Fisher exact test or the Chi-squared test, followed by *posthoc* with Bonferroni correction, in cases in which the test was significant.[8,9] The analyses were performed using the Software SPSS Statistics for Windows, version 17.0 (SPSS Inc., Chicago, IL, USA), with significance level at 5%.

Results

The sample collected from 141 answered questionnaires is composed mostly of male members (84.4%), with more than 10 years of orthopedic practice (70.9%) and in the age group 30 to 50 years (59.6%).

Regarding the workplace, 69% of the participants work in public and private hospitals, most of them being self-employed workers (50%), followed by public servants (20.7%). Most participants work in hospitals that have a medical residency program, of which 56.7% act as preceptors of the service.

Concerning the use of fluoroscopy, 85.8% of the participants used it 1 to 5 times weekly (►**Figure 1**). Regarding the use of PPE, 69 participants (48.9%) used lead apron. The use of thyroid protector associated with the apron was mentioned by 47 participants (33.7%), and only 8 participants (5.7%) wore the set of plumbiferous apron, thyroid protector, and plumbiferous glasses (►**Figure 2a**). Sixteen participants did not use any radiation protection. Regarding frequency, a total of 68.8% used PPE in all or most of the surgeries (►**Figure 2b**).

The main reason (67.8%) claimed for the non-use of PPE was that they hinder the surgical procedure. The second reason (19.29%) was related to the fact that the hospital does not provide PPEs. Only 5% of the participants reported the existence of plumbiferous curtains and 5.7% of plumbiferous displays in hospitals.

Most participants (78.7%) were concerned about ionizing radiation and feared the risk of developing some related complication (►**Figure 3a**). However, it was observed that 82.3% of the participants did not use a dosimeter, not knowing or following their individual doses (►**Figure 3b**).

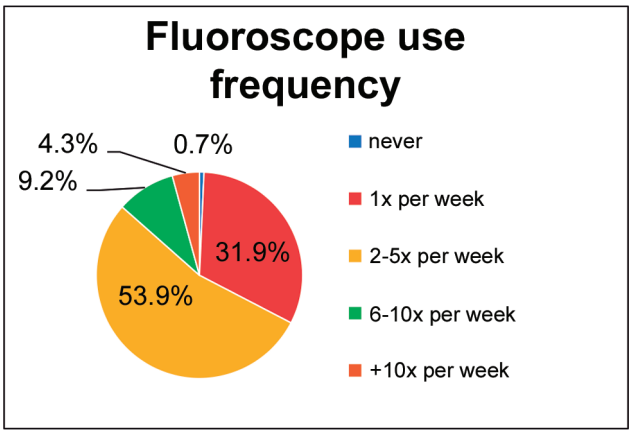

Fig. 1 Frequency of fluoroscopy in surgeries. Source: Author (2020).

Among the participants, 80.9% did not receive any type of radiological protection training regarding the use of fluoroscopy (►**Figure 4**). Regarding the knowledge about radiation, 17.7% mistakenly believed that the radiation from fluoroscopy is gamma ray type, 2.8% beta radiation, and 2.1% were unaware. The radiation emitted in fluoroscopy is formed by X-rays.

Regarding the positioning of the orthopedist in the use of the fluoroscope, 60.3% of the participants moved away from the equipment during use, and 68.8% kept their hand out of the primary beam, except when strictly necessary. However, 30.5% of the participants moved only the hand away from the primary beam, not moving away from the fluoroscopy equipment.

Regarding safety, only 34.8% of respondents felt safe with the use of fluoroscopy. Only 27% of the participants used the principles of radiological protection for their safety, and 52.5% did not even know or understand these principles (►**Figure 5**).

Regarding the concern with radiation exposure, there was a significant difference between those who felt concerned about exposure ($p = 0.038$). In their majority (70.3%), orthopedists did not feel safe when using fluoroscopy. On the other hand, the group that cared less about exposure had a greater sense of security in relation to the use of fluoroscopy (54.5%) ($p = 0.004$).

Another statistically significant difference found was in relation to whether the participant was a preceptor of

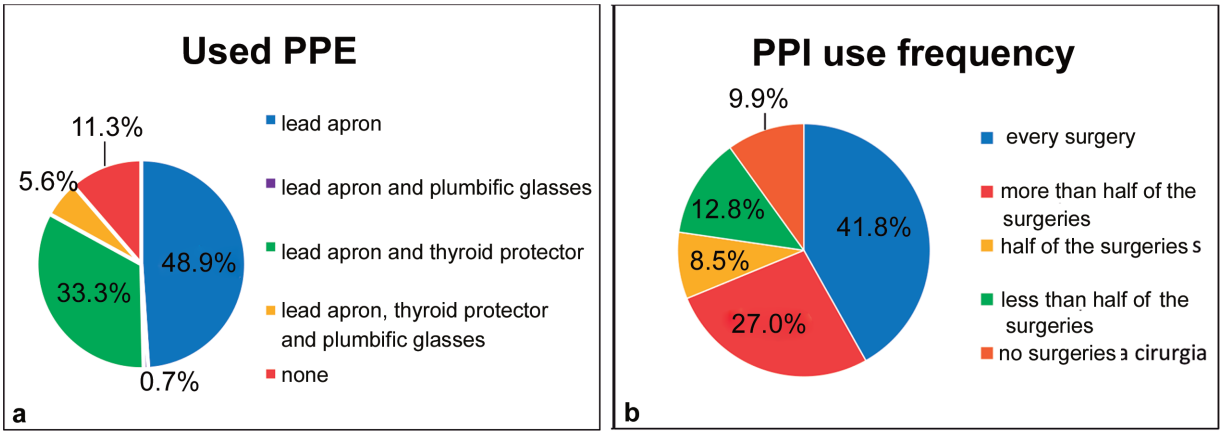

Fig. 2 (**a**) Type of personal protective equipment used; (**b**) Frequency of use of personal protective equipment. Source: Author (2020).

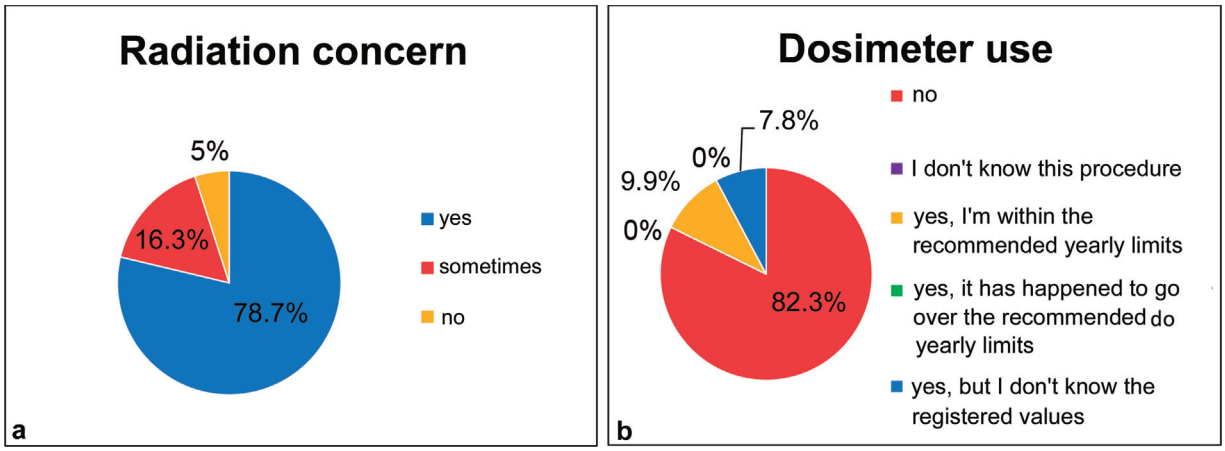

Fig. 3 (a) Concern about radiation exposure; (b) Use of the dosimeter. Source: Author (2020).

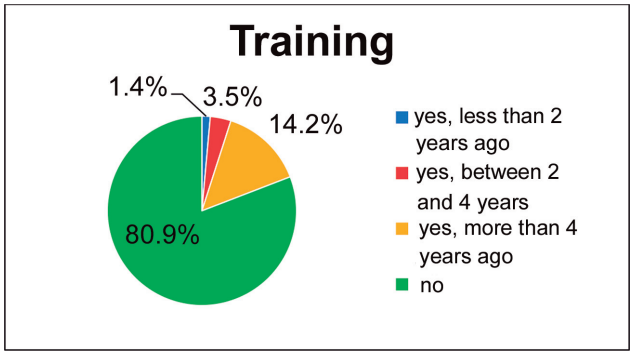

Fig. 4 Training in radiological protection. Source: Author (2020).

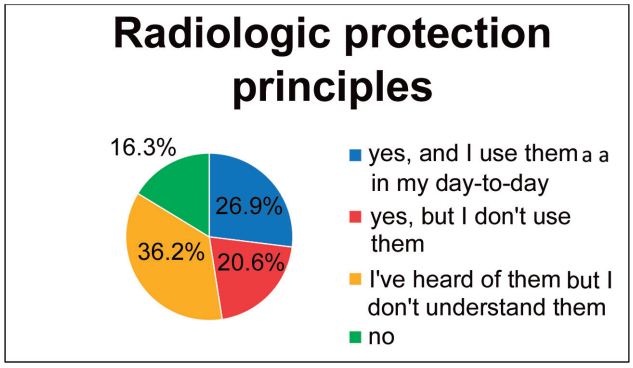

Fig. 5 Principles of radiological protection. Source: Author (2020).

medical residency and the result of hand positioning during fluoroscopy use ($p = 0.029$). Among those who removed the hand from the primary beam every time, 66.7% were preceptors in the medical residence. Those who withdrew the hand except when strictly necessary corresponded to 76.7% of the group that was not a preceptor of residence, compared to 66.2% of the group that were preceptors.

Among the participants aged between 30 and 40 years, 32.7% used PPEs in all surgeries and 48.1% in most procedures. Among the participants aged between 50 and 60 years, 62.5% used PPEs in all procedures and 16.7% in most procedures ($p = 0.009$). In the group aged 40 to 50 years, 43.8% used PPEs in all surgeries and 37.6% in none, or less than half of surgeries.

Of the participants with 5 to 10 years of experience, 82.4% used PPEs in all surgeries or in most procedures. Those with 10 to 20 years of experience, 70.3% also used them in all surgeries, or in most procedures. On the other hand, 52.1% of the participants with 20 to 30 years of experience used PPEs in all surgeries or in most procedures ($p = 0.003$).

Regarding the frequency of fluoroscopy use and the use of PPEs, those who used the fluoroscope between 2 and 5 times per week used PPEs in all surgeries and represent 42.1%. Those who used fluoroscopy in most surgeries represent 31.6%, totaling 73.7%. For those participants who used fluoroscopy less frequently (once a week), 28.3% used PPEs in all surgeries and 23.9% in most of them.

Regarding the knowledge of the principles of radiological protection, 33.8% of the preceptors knew and used them, 21.3% knew but did not use them, 26.3% had heard but did not understand them, and 18.8% answered that they did not know them.

No significant differences were found between the gender of surgeons ($p = 0.925$), years of professional activity ($p = 0.350$), training ($p = 0.473$), and knowledge of the principles of radiological protection ($p = 0.683$) in relation to the concern with exposure to ionizing radiation.

The association between the safety of fluoroscopy use and knowledge of radiological protection principles was not statistically significant ($p = 0.099$).

No associations were found between the preceptors and the procedure in which the patient is more exposed ($p = 0.229$), as well as the positioning in which the patient receives the lowest dose ($p = 0.411$).

The possible relationship between dosimeter use and frequency of fluoroscopy use ($p = 0.060$), regarding exposure to ionizing radiation ($p = 0.590$) and with the participant being a preceptor ($p = 0.363$), was evaluated, but the result was not significant.

Discussion

Currently, orthopedic surgeons have been increasingly exposing themselves to ionizing radiation during procedures.

The effects of exposure to ionizing radiation can be prevented, and some strategies are indicated, including the use of PPEs, shielding, dosimeter, correct team positioning and training.

Although most studies show that the limits established by the guides and local legislation are not disrespected, there is a concern with high doses in surgeons, especially in the hands and eyes.[2,10,11] Our study showed that, among participants in the age group between 30 and 40 years, almost half use PPE in more than half of the surgeries. In the age group between 40 and 50 years, the percentage of those who use them in all surgeries is similar to those who answered in no surgery or in less than half of surgeries.

Most of the participants in our study claimed that the reason for not using PPE in the procedures is the fact that they hinder the performance of the surgery, reporting that they are heavy, uncomfortable, and hot. In the literature, the authors report that the weight of PPE in surgeries triggers back pain.[7,12] Perhaps for this reason, our study observed that, at the beginning of the career, the use of PPEs is higher in all surgeries or in more than half of them. In addition, our study showed that orthopedists report the lack of supply of PPEs in hospitals (16%), questioning their quality. It should be noted that Brazilian legislation requires quality control and integrity analysis of PE regularly.[13]

Regarding the use of plumbiferous glasses, our study showed that the vast majority of participants did not use them but recognized cataract as an adverse effect of ionizing radiation exposure. Chow et al.[2] reported that the most cited reasons for the lack of use of plumbiferous glasses is that the hospital does not provide them, or orthopedists do not know where to buy them, or do not know cataract as an adverse effect.

Reviewing Resolution of the Collegiate Board No. 330 of ANVISA, which establishes the sanitary requirements for the organization and operation of diagnostic or interventional radiology services, normative instruction No. 53, dated December 20, 2019, section I art. No. 2, &VII and &XIII, the existence of plumbiferous displays and plumbiferous curtains is mandatory in the rooms where fluoroscopy is used.[14] It is noteworthy that the vast majority of participants report that there are no curtains or plumbiferous bulkscales in their workplace. The lack of these items is another aggravating factor for the reduction of radiological protection, along with the complaints of scrapping the equipment and the non-use of plumbiferous glasses.

Regarding the use of dosimeter for dosimeter control, although most participants work in teaching hospitals in the role of preceptors, only 1 in 10 surgeons use it. Our result is compatible with other studies that demonstrate a low compliance with the use of dosimeters.[3,7] It is interesting to note that no participant is unaware of the mandatory use of a dosimeter in the case of exposures to ionizing radiation.

We found that most participants did not receive radiological protection training in relation to the use of fluoroscopy. According to the literature, training is of paramount importance to decrease exposure to ionizing radiation.[15] The lack of training reflects the lack of knowledge of fundamental concepts about radiation. Among the participants, one in five surgeons mistakenly believed that the radiation emitted by the fluoroscope is not formed by X-rays.[2,7,15]

Of the participants in our research, only one in five reported knowing the existence and values of dose limits for occupationally exposed individuals. More than half know the existence of limits but are unaware of the values of these limits. In our study, most surgeons know the dose limits, unlike those presented by Chow et al.,[2] who reported, in addition to the ignorance about dose limits, that among the participants who use dosimeter, almost half do not know their own dose values recorded monthly.

Although the vast majority of participants reported concern about their exposure to ionizing radiation, they did not know or did not understand the principles of radiological protection. This lack of knowledge associated with concern generates anxiety and emotional changes in professionals, as described by Fidan et al.[5]

Finally, it was observed that the participants were concerned with radiation exposure and did not feel safe using fluoroscopy equipment. The importance of ionizing radiation for medicine is indisputable, and it is necessary to develop training and training actions that fill the perceived gap in this research, between the use and knowledge of ionizing radiation.

Despite the importance of the results of this exploratory research and the enthusiasm of respondents in the comments sent to the authors, this study presents as main limitation the low adherence of respondents among orthopedic surgeons. A more comprehensive picture of the perceptions about the use of fluoroscopy in the activity of the orthopedic surgeon will require a more active involvement of medical societies, to expand the distribution of questionnaires and increase the statistical strength of the conclusions.

However, the results show that it is urgent to act in the education and training of orthopedic physicians on the effects of radiation exposure on fluoroscopy and on the application of the principles of radiological protection in their activities. This study allows us to draw an initial overview of the perceptions about radiation of medical professionals who use fluoroscopy in Brazil and to indicate corrective actions in training.

Conclusion

It is concluded that the radiological protection of most orthopedists in surgical procedures is inadequate, and initial and continued training programs are needed by professionals, which will bring benefits not only to the health of orthopedists but to that of their patients as well.

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Conflict of Interests

The authors declare that there is no conflict of interests.

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