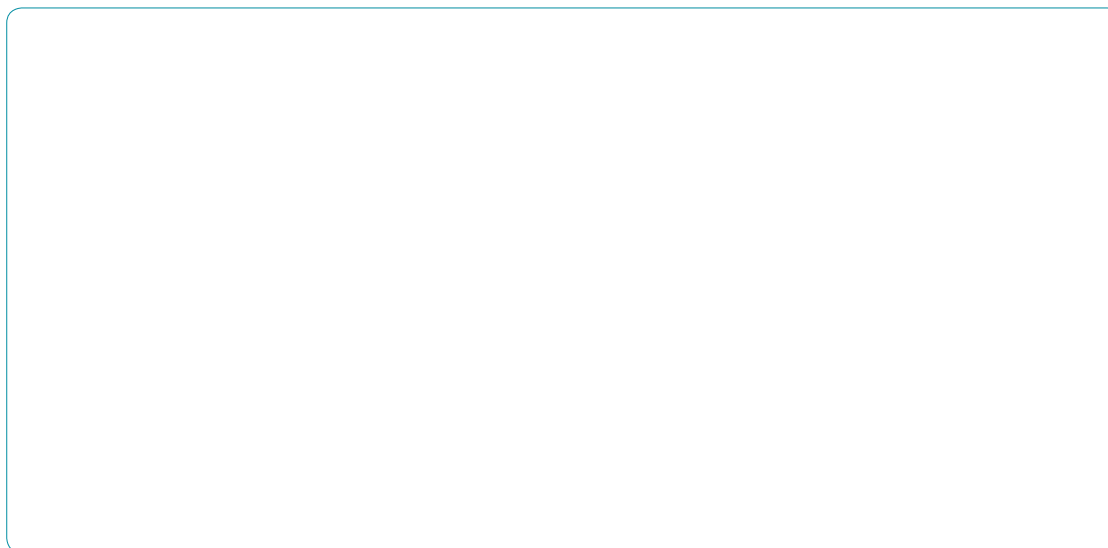


Intraoperative Radiation Exposure of Orthopaedic Surgeons – Mismatch Between Concerns and Protection

Alexander Joeris^{1*}, Sabine Goldhahn¹, Vasiliki Kalampoki¹ and Florian Gebhard²

¹AO Clinical Investigation and Documentation, AO Foundation, Stettbachstrasse 6, 8600, Dübendorf, Switzerland

²Department of Orthopaedic Trauma, Ulm University, Ulm, Germany



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Introduction

Intraoperative imaging using fluoroscopy is increasing in trauma and orthopaedic surgery due to the development of less invasive approaches. This results in an increasing risk for surgeons of being exposed to ionizing radiation, either by scattered radiation or less often in the primary beam [1,2]. Many studies have investigated the radiation doses surgeons are exposed to during different fluoroscopically guided orthopaedic procedures [3-5]. The highest radiation exposures are

the surgeons wear a dosimeter and half of them never use it. Nearly 65% of the surgeons always wear a lead apron, but only 30.8% wear a thyroid protection. Lead gloves and lead glasses were always worn by only 2.5 % (13/531)

Conclusion: Although most operating surgeons worry about their exposure, the knowledge and the practical radiation protection in orthopaedic practice.

***Corresponding author:** Alexander Joeris, AO Clinical Investigation and Documentation, AO Foundation, Stettbachstrasse 6, 8600, Dübendorf, Switzerland, Tel: +41442002463; E-Mail: alexander.joeris@aofoundation.org

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Characteristics	N=531
What Percentage of the Surgeries You Perform Require Radiation, n (%)	525
>75%	159 (30.3)
51%-75%	164 (31.2)
26%-50%	118 (22.5)
	84 (16.0)
Average Time of Radiation Use Intraoperatively, n (%)	518
<30 seconds	77 (14.9)
30-45 seconds	72 (13.9)
46-60 seconds	97 (18.7)
61-180 seconds	201 (38.8)
>180 seconds	71 (13.7)
Main Position of the Radiation Source During Operations, n (%)	515
Always Inferior	70 (13.6)
Mainly Inferior	171 (33.2)
Equally Inferior/Superior	86 (16.7)
Mainly Superior	97 (18.8)
Always Superior	17 (3.3)
Unknown	74 (14.4)
How Often is a Part of Your Body Directly Exposed to the Beam During Surgery, n (%)	521
Never, I Always Keep It Out of the Beam	80 (15.4)
Seldom, Only If Unavoidable	209 (40.1)
Sometimes	124 (23.8)
Often	83 (15.9)
Unknown	25 (4.8)

Table 2: Frequency and practices of occupational radiation usage.

Concerned about radiation exposure in your job?



Figure 1: Surgeons' concerns about occupational radiation exposure (n=524).

a certain time period. 64.6% (332/514) of the participants always wear a lead apron, and 30.8% (159/517) always a thyroid collar. Lead gloves and lead glasses were always worn by only 2.5 % (13/517) and 3.1% (16/514) respectively. According to the multivariable logistic regression analysis, region, experience, workplace or concern does not seem to influence the attitude to wear this ionizing radiation measurement device.

Concerns had no influence on the attitude to wear a dosimeter. It is always worn by approximately 23% of the surgeons independent if they

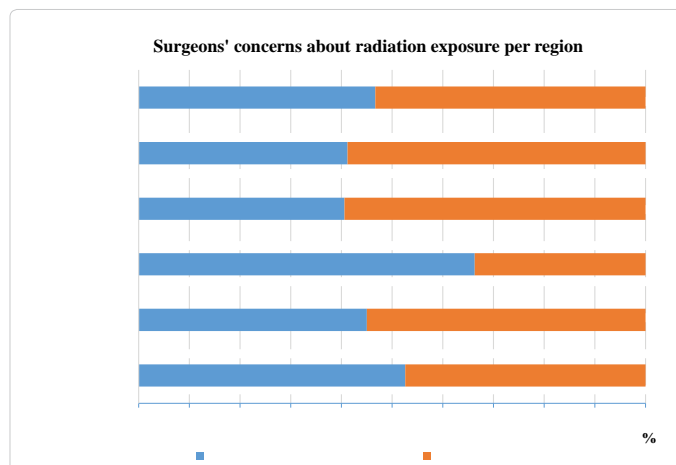


Figure 2: Differences in level of concern about occupational radiation exposure between different global regions presented binary in percentage of total answers (Number of respondents: North America=15, Middle East=52, Latin

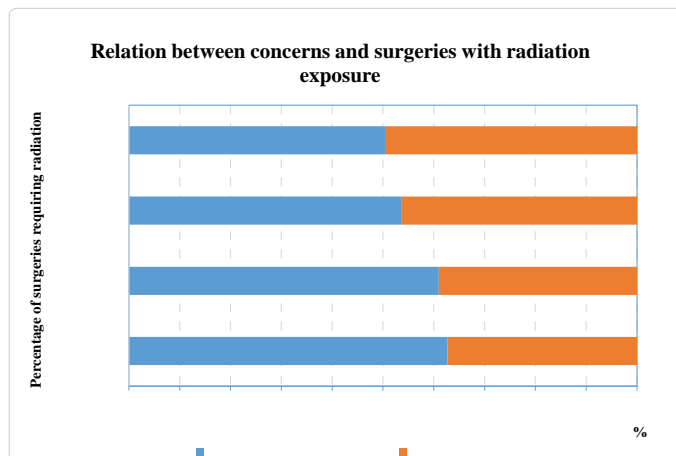


Figure 3: Trend towards more concerns about radiation exposure when more surgeries with radiation are performed (n=186).

rate themselves as being extremely concerned (22.7%; 15/66) or not at all (23.1%; 9/39) (Figure 4a). But if surgeons were extremely concerned, 73.1% (49/67) of them decided to always use an apron compared to 52.6% (20/38) of their colleagues without concerns (Figure 4b). Despite of extreme concerns, the thyroid collar is worn by only 41.8% (28/67) of these surgeons (Figure 4c), and 79.4% and 77.9% of them never wear gloves (54/68) or lead glasses (53/68), respectively. More surgeons with less than 5 years of surgical experience always wear an apron (71.1%; 96/135) and thyroid collar (32.6%; 44/135) compared to surgeons with up to 20 years or more of experience (59.0%; 62/105, and 22.6%; 24/106 respectively).

Of surgeons who are aware of safety guidelines at their hospital, the majority (173/244) always uses a lead apron, but only 35.5% (87/245) and 24.5% (60/245) a respective thyroid collar and dosimeter. Even if surgeons did not know whether safety guidelines exist, 66.7% (84/126) of them always wear an apron. In the multivariable analysis, the only

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Variable	Category	Odds Ratio	95% CI ^a	p value
Region	Europe	1	-	-
	Africa	1.63	(0.60;4.39)	0.335
		2.61	(1.55;4.40)	<.001
	Latin America	2.86	(1.56;5.24)	<.001
	Middle East	2.82	(1.48;5.38)	0.002
	North America	1.59	(0.54;4.74)	0.402
Experience in Practicing Surgery	<5 years	1	-	-
	5-10 years	0.89	(0.50;1.58)	0.695
	11–15 years	0.97	(0.54;1.73)	0.905
	16–20 years	1.22	(0.65;2.29)	0.532
	>20 years	1.9	(1.08;3.34)	0.026
Workplace	University Hospital	1	-	-
	Non-University Hospital	0.67	(0.44;1.01)	0.054
	Private Practice/ Other	0.84	(0.48;1.47)	0.544
What Percentage of the Surgeries You Perform Require Radiation	>75%	1	-	-
	51%-75%	0.95	(0.59;1.52)	0.828
	26%-50%	0.68	(0.40;1.15)	0.15
		0.56	(0.31;1.01)	0.054
Average Time of Radiation Use Intraoperatively	<61 seconds	1	-	-
	61-180 seconds	1.24	(0.83;1.85)	0.3
	>180 seconds	0.69	(0.38;1.25)	0.223
CI ^a				

Table 3: Effect of various factors on the surgeons' concerns about their occupational radiation exposure ("Extremely/Very concerned" versus "Not at all/Slightly/Moderately") using multivariable logistic regression analysis.

factor associated with dosimeter use was the instruction received about safety guidelines in participants' hospital, with those receiving any radiation safety instructions being three times more likely to use dosimeter compared to those with no instruction at all (OR=2.97; 95%CI: 2.00-4.39; p<0.001). Among participants who received adequate radiation safety instructions, an apron and thyroid collar is always used in 76.3% (58/76) and 38.2% (29/76), respectively. If there were none or only limited safety instructions, protective gear was applied less. Being aware of the responsible person for radiation safety leads to an increased use of apron (71.7%; 182/254), thyroid collar (35%; 90/257) and dosimeter (27.7%; 71/256).

D c

Answers of our survey confirm the frequent use of intraoperative imaging in orthopaedic surgery. The survey also reveals varying levels of concerns about radiation. Interestingly, these concerns vary between regions and tend to increase with higher use of intraoperative imaging. However, we could not detect any link between higher levels of concerns about radiation and more active patterns of protection against radiation. In other words: there is a mismatch between concern and action. This is surprising because simple measures of radiation protection like thyroid collar or protective apron are capable to reduce radiation exposure significantly.

Our survey also quantified the low regular use of protective apron (64.6%), thyroid collar (30.8%) or dosimeter (21%) in current clinical orthopaedic practice despite availability. Striking to observe that only less than 5% of the surgeons in our survey reported to always wear lead gloves or lead glasses during surgeries; especially considering that the hands of the surgeons are the part of the body with the highest level of exposure [2,7]. The need to manually position the extremity for imaging may contribute to the increased exposures as well as the type

of fluoroscopy unit, e.g. mini C-arm or standard C-arm. However, the influence of the fluoroscopy unit is controversially discussed [7,23-25].

In agreement with our results, a recently published survey of consultants, medical students and medical staff from two German hospitals also reported that 84% wear a lead apron, but only 33% and 44% use a respective thyroid shield and dosimeter during more than half of their clinical routine with radiation exposure [21]. These results highlight that improper use of safety gear is a problem affecting surgical staff at large and not only orthopaedic surgeons.

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