RESEARCH ARTICLE

Assessment of knowledge and perception toward magnetic resonance imaging (MRI) safety among healthcare workers

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Abstract:

The knowledge of healthcare workers about magnetic resonance imaging (MRI) safety is necessary to assure the safety and comfort of patients as well as ensure a smooth workflow. The aim of this study was to assess the knowledge and perception of Magnetic Resonance Imaging (MRI) safety among healthcare workers. A cross-sectional online survey of 132 healthcare workers was conducted between June and August 2022. The survey instrument consisted of demographic characteristics, the basic knowledge of the MRI and the perception of healthcare workers toward MRI safety. Most of the participants were female, aged group of 20 to 29 years old with diploma certificates. Based on the results, most of the healthcare workers have good knowledge with a 24.2% score, 36.4% with moderate knowledge and 39.4% are considered low knowledge regarding MRI safety. In terms of perception of MRI safety, 17.4% of healthcare workers have a high perception, while 47% have a moderate one and 35.6% have a low one. The results show that there is no association between demographic variables with the level of knowledge and perception of MRI safety.

Keywords: healthcare, knowledge, magnetic resonance imaging, perception, safety

1. INTRODUCTION

Magnetic resonance imaging (MRI) is an increasingly preferred diagnostic imaging modality for a wide variety of clinical conditions (Hollingworth et al., 2000). It is a non-invasive imaging technique that generates sectional images with high soft tissue contrast that is obtained at very little risk to the patient undergoing the study (Yang et al., 2021). MRI also provides high-quality images in which it's able to avoid the use of ionizing radiation. In addition, it does not alter the structure, composition and properties of atoms as ionizing radiation-based modalities attempt to do (Hartwig et al., 2009). However, since MR systems use powerful static magnetic fields, fast gradient magnetic fields and strong radiofrequency transmission coils, safety precautions should be always administered due to the association with harmful safety risks.

It was also reported that patient hazards during such examinations could result from MRI's strong static magnetic field, the time-varying dynamic gradient, the radiofrequency field (RF), or the high acoustic noises during MRI scans (Grover et al., 2015; Stecco et al., 2007). The hazards associated with static magnetic fields are interaction with human tissue and equipment. Firstly, it is important to note that the magnet in the MR unit is always on, producing a strong static magnetic field which can torque, attract, and accelerate ferromagnetic objects in direction of the opening of the bore of an MRI scanner and resulting in a serious injury and in some cases, leading to death (Crisp & Dawdy, 2018).

In addition to the static magnetic field, the magnetic gradient coils produce a time-varying magnetic field. It provides spatial encoding of the signal, which makes a loud acoustic noise that will result in a variety of complications, begging with increasing patient anxiety, communication interference, and finally hearing problems in patients varying from temporary to permanent hearing loss in some cases (Westbrook et al., 2011).

The static and time-varying magnetic field within the MR system would then transmit a strong radio frequency (RF) field to the patient. RF pulses are present only during the scanning and the strong RF field can cause heating of the tissue surrounding any metallic medical implant within the patient. This will result in serious tissue damage if they were not MR-safe implants (Winter et al., 2021). In addition to the above tissue heating hazard, induced current burns to the patient skin may occur when the patient is in direct contact with the conducting loops of the RF coils.

Next, the MR personnel is responsible to ensure the safety screening for anyone entering zone 3 and 4, whether they were

working in the MR site, including radiographers, radiologists, physicists, clinical scientists, trainees, or any non-imaging health workers (Kanal et al., 2013). It is reported that a higher perception of safety is related to fewer accidents and maintaining a safe diagnostic environment (Fatahi et al., 2016). Furthermore, during the MR scan, the patient is also required to remove all metallic objects and change into a hospital gown (Shellock & Spinazzi, 2008). It is important to highlight that patients with implants and medical devices are only permitted to undergo an MR scan if the implants are MR-safe or compatible (Shellock & Spinazzi, 2008). Patients with implants should never be considered MR-safe unless the device comes with clear written documentation.

The safety of medical staff and patients is prioritized in any diagnostic procedure involved in ionizing and non-ionizing radiation. The MR staffs play an important role in patient screening and preparation before the execution of the MRI examination. Proper written MR information and clear visual labelling in the MR site should be made available to all individuals who enter the MR area. Therefore, non-imaging health workers (physicians, nurses, and non-imaging technicians) knowledge of MR safety regulations is essential to avoid any MR incidents (Kanal et al., 2013; Tsai et al., 2015). The study by Alelyani et al. (2021) has shown that nurses were more likely to be aware of MRI safety and perception as compared to physicians, laboratory specialists, and others (Alelyani et al., 2021). However, there is a lack of studies that assess the knowledge and perception of MRI among healthcare workers in Malaysia. Therefore, this study aims to assess the knowledge and perception of Magnetic Resonance Imaging (MRI) safety among healthcare workers at one of the hospitals in the northern region of Malaysia.

2. MATERIALS AND METHODS

2.1 Study design

This study is a descriptive cross-sectional survey study which is designed to assess the knowledge and perception of Magnetic Resonance Imaging (MRI) safety among healthcare workers. The questionnaire was adapted from the study by Alelyani et al. (2021) and Alghamdi A. (2021), in which the level of knowledge and perception of MRI safety were assessed.

This study consists of a self-administered questionnaire that involves three different parts. The first one requires the respondents' demographic variables, including gender, age, level of education, current profession, and years of experience. The second part is about MRI safety knowledge and consists of 15 questions about the basic concept of the MRI system in closed-ended questions (Yes or No). The third part of the questionnaire consists of 11 questions on the perception of healthcare workers toward MRI safety. There is only one correct answer option for the questions in this survey. The maximum knowledge score depends on the number of questions. A score of 1 is allocated for each 'Yes' that indicates a correct or 'agree' answer, and as for 'No' a score of 0 is allocated for an incorrect or 'disagree' answer. A higher score indicates a better understanding of the respondents.

2.2 Study population

There are about 132 respondents of non-imaging healthcare workers from a variety of specialises including physicians, nurses, medical assistants, physiotherapists, pharmacists, medical physicists, anaesthesiologists, respiratory specialists and the one who is primarily involved with the patient having MR examination.

2.3 Data collection

The data from the online questionnaire were collected within two months, starting from June to August 2022, using Google Forms for the healthcare workers who agreed to participate in this study, and the analyses were performed using the Statistical Package for the Social Sciences (SPSS) software version 21.0.

2.4 Statistical analysis

For the internal consistency of questions and responses, Cronbach's alpha coefficient was used to determine the reliability of the variables. The questionnaire was tested for reliability on 12 healthcare workers who were excluded from the studied sample and the results showed that Cronbach's alpha for knowledge and perception toward MRI safety (26 items) was 0.817, which indicates high reliability.

The results were presented as the frequency and percentage of participants' answers. The odds ratio (OR) and 95% confidence interval (CI) were used, and the level of significance is set at $p<0.05$ using the chi-square test and binary logistic regression to evaluate the relationship among the variables in the questionnaire. A chi-square test is used to determine the association between the demographic variables with the level of knowledge and perception of healthcare workers toward MRI safety.

2.4 Ethical considerations

Ethical approval for this study was obtained from Universiti Teknologi MARA (UiTM) ethics committee with the reference number: FERC/FSK/MR/2022/0106, and the approval date was received on 18th May 2022. The data from this study was not manipulated for other non-related purposes. The respondents' identities, as well as the information obtained from respondents, were kept safe and confidential.

3. RESULTS AND DISCUSSION

3.1. Response rate

A full response was obtained from this study where the questionnaire was completed by 132 out of 132 healthcare workers who were invited to participate in the study. Table 1 shows the demographic characteristics of the participants. Most of the respondents were female (63.6%) within the age group of 20 to 29 years old (56.8%), and 50.0% were participants with diploma certificates. The participants who had work experience from 1 to 5 years were the most populated group (41.7%).

Table 1. Demographic characteristics

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	48	36.4
Female	84	63.6
Age group		
20-29	75	56.8
30-39	44	33.3
40-49	12	9.1
50-59	1	0.8
Level of education		
Diploma	67	50.8
Bachelor's degree	56	42.4
Master's degree	8	6.1
Ph.D.	1	0.8
Current Profession		
Physician	21	15.9
Nurse	61	46.2
Medical Assistant	43	32.6
Other	7	5.3
Work Experiences		
Less than 1 years	11	8.3
1-5 years	55	41.7
5-10 years	51	38.6
More than 10 years	14	10.6

3.2. Level of knowledge of MRI safety

Table 2. Frequency distribution level of knowledge of healthcare workers towards MRI safety

Variables	Agree	Disagree
	n (%)	n (%)
MRI is a non-invasive diagnostic scanning technique in which a patient is placed on a magnetic field.	98 (74.2)	34 (25.8)
A patient with an implanted metal device cannot undergo an MRI.	93 (70.5)	39 (29.5)
If contrast media is injected during the procedure, it is not an iodine contrast.	92 (69.7)	40 (30.3)
An MRI does not involve exposure to ionizing radiation.	92 (69.7)	40 (30.3)
An MRI provides a better contrast between normal and abnormal tissue than a computed tomography (CT) scan.	80 (60.6)	52 (39.4)
All removable metallic objects (rings, watches, cell phones, body jewellery) should be removed before entering the area of the magnet.	106 (80.3)	26 (19.7)
Body jewellery made of titanium, niobium, or surgical stainless steel will not be attracted to a magnet.	74 (56.1)	58 (43.9)
In very rare instances, people with tattoos or permanent cosmetics may experience oedema or burning in the tattoo during an MRI.	88 (66.7)	44 (33.3)
Tattoo pigment can interfere with an MRI image.	49 (37.1)	83 (62.9)
Transdermal patches should be removed before undergoing an MRI.	70 (53)	62 (47)
The procedure involves the patient lying on a platform that moves into either a narrow, closed, high magnet scanner or into an open, low magnet scanner.	100 (75.8)	32 (24.2)
A two-way communication system is used to monitor the patient's response.	102 (77.3)	30 (22.7)
Earplugs are offered to clients to remove discomfort from loud noises during the scanning.	98 (74.2)	34 (25.8)
The MRI procedure lasts between 60 and 90 min.	81 (61.4)	51 (38.6)
The patient needs to remain perfectly still during the time the imaging takes place, but between sequences, some minor movements may be allowed.	91 (68.9)	41 (31.1)

The study discovered that 52 (39.4%) out of 132 respondents rated themselves as having a low knowledge about MRI safety, 48 respondents (36.4%) as having a moderate level of knowledge, and 32 respondents (24.4%) as having a high level of knowledge about MRI safety. Table 2 showed the frequency distribution level of knowledge of healthcare workers towards MRI safety. Q6: "All removable metallic objects (rings, watches, cell phones, body jewellery) should be removed before entering the area of the magnet" received the highest rate of correct answers (80.3%). "The tattoo pigment can interfere with an MRI image" received the lowest rate of correct answers (n=49, 37.1%), followed by Q10: 'Transdermal patches should be removed before undergoing an MRI" (53%).

On further analysis, the Chi-square test revealed that there was no significant between the level of knowledge and demographic variables. The age group and knowledge toward MRI safety (x^2(6, N=7.549), p=0.273), gender and knowledge toward (x^2(2, N=3.386), p=0.184), level of education and knowledge (x^2(6, N=3.506), p=0.743, knowledge and current profession (x^2(6, N=4.654), p=0.589). For knowledge and years of work, it also revealed that it is not statistically significant, x^2(8, N=13.238), p=0.104.

3.3 Level of perception toward MRI safety

Table 3: Frequency distribution level of perception of healthcare workers towards MRI safe

Variables	Yes	No
	n (%)	n (%)
Do you aware about the MRI zones?	64 (48.5)	68 (51.5)
Do you aware about the patient preparation guidelines before MRI procedures?	89 (67.8)	43 (32.6)
Do you aware of the noise produced by MRI scanners?	64 (48.5)	68 (51.5)
Do you know the adverse reactions of MR contrast agents?	112 (84.8)	20 (15.2)
Do you aware why patient undergoing MRI with contrast agent need to be checked for creatinine levels (glomerular filtration rate)?	82 (62.1)	50 (37.8)
Do you know how to handle a patient after having an adverse reaction from an MRI contrast agent?	84 (63.6)	48 (36.4)
Is there a written policy on exposure of pregnant patient to MRI?	117 (88.6)	15 (11.4)
Is there a written policy on the exposure of pregnant health workers to MRI?	75 (56.8)	57 (43.2)
Does pregnant patient can undergo MRI scan at any time?	80 (60.6)	52 (39.4)
Is there a special consent for MRI during pregnancy?	111 (84.1)	21 (15.9)
Is there a regular assessment for babies exposed to MRI in-utero?	48 (36.4)	84 (63.6)

The study had shown that 23 (17.4%) out of 132 respondents rated themselves as having a high level of perception toward MRI safety, 62 respondents (47.0%) as having an average level of perception, and 47 respondents (35.6%) as having a low level of perception about MRI safety. The frequency distributions of individual elements used to assess the level of knowledge are depicted in Table 3.

Most of the respondents (88.6%) agreed that there is a written policy on the exposure of the pregnant patient to MRI. However, only 15 (11.4%) respondents of the total sample thought incorrectly that there is no written policy on the exposure of pregnant patients provided to MRI procedures. 64 out of 132 respondents were aware of the MRI zones, while the remaining 68 did not aware of the MRI zones. Furthermore, 67.8% of respondents showed that they were aware of the patient preparation guidelines before the MRI procedures. In addition, only about two-thirds (48.5%) of participants were aware of the noise produced by MR scanners, while another 51.5% were aware of the noise from the MR scanners. Of all respondents, only 36.4% reported that they agreed there is a regular assessment for babies exposed to MRI in-utero (n=48) and 84 (63.6%) disagreed.

The Chi-square test reveals no statistically significant relationship between perception and gender, x^2(2, N=4.482), p=0.106, age group x^2(6, N=5.603), p=0.251, level of education x^2 (6, N=8.119), p=0.229, current profession x^2(6, N=9.197), p=0.163 and years of working x^2(8, N=13.375), p=0.100

4. DISCUSSION

4.1 Evaluation of descriptive analysis

This study aims to investigate the knowledge and perception of Magnetic Resonance Imaging (MRI) safety among healthcare workers. This study also determines the association of the demographic variables with the level of knowledge and perception of healthcare workers toward MRI safety. The study findings reveal that the respondents had limited knowledge about MRI safety, which could be attributed to limited academic and professional practice. This outcome is similar to the previous studies where healthcare workers reported having limited knowledge about MRI (Alelyani et al., 2021; Alghamdi et al., 2021, Lima et al., 2012). The findings reveal that most of the healthcare workers who participated were between the ages of 20 to 29. A similar study by Alelyani (2021) also indicated that most respondents were aged from 20 to 29 years old.

4.2 Knowledge towards MRI safety

Findings from this study depicted that healthcare workers had low knowledge about MRI safety. These findings alongside the previous studies explained that nurses had limited knowledge about MRI (Alghamdi et al., 2021). The average number of correct responses differs between groups, as shown in Table 4.4 where 'Agree' or 'Disagree' questions were asked. The level of knowledge was grouped as "high", "moderate" and "low". This study found that the female respondents (59.4%) have a higher level of knowledge than the male

(40.6%). It showed that there was no significant difference between men and women regarding knowledge. On the other hand, healthcare workers aged 20 to 29 years were 5 times more likely to be aware of the basic knowledge of MRI safety. This finding was consistent with a study from Alelyani et al. (2021), however, it differs in terms of age group. The present study showed that the educational level and knowledge found were not statistically significant. Healthcare workers with diploma certificates were more likely to have a higher understanding of basic knowledge of MRI safety than those having bachelor's degrees. In contrast with the previous study by Shrestha and Khadka (2003), they highlighted that educational status was significantly associated (Shiralkar et al., 2003).

In this study, most of the respondents (106) knew that all metallic objects need to be taken away from the scanning area. This is because of the warning signs around the MRI areas that are continuously displayed on the door or outside the MR scan room. The level of knowledge on the implanted metal device is considered good as 70.5% of the participants agreed that the metal cannot be under an MRI. Other than that, about 69.7% of respondents answered correctly that the contrast media injected is not an iodine contrast. This is because the iodine contrast agent could provide an adverse reaction (Maeda et al., 2020). Moreover, the respondents have a good understanding that MRI does not involve any ionizing radiation which 92 out of 132 answered correctly. However, in one study conducted by Günalp et al. (2014) reveals that medical staff failed to recognize that MRI emits ionizing radiation. Also, the same findings of Zhou et al. (2010), about 25.5% of participants among medical students at Western University and interns at teaching hospitals in Perth answered incorrectly that MRI used ionizing radiation (Zhou et al., 2010).

4.3 Perception towards MRI safety

This study reveals that 23 (17.4%) out of 132 respondents rated themselves as having a high level of perception toward MRI safety, 62 respondents (47.0%) as having an average level of perception, and 47 respondents (35.6%) as having a low level of perception about MRI safety. The current study presented that there was no significant difference between gender and perception of MRI safety, while 48.5% of respondents were more likely to be aware of the noise produced by the MRI scanner. In contrast to the previous study from Alelyani (2021), the respondents were more likely to have good exposure to the MRI room surrounding. This study reveals that 23 (17.4%) out of 132 respondents rated themselves as having a high level of perception toward MRI safety, 62 respondents (47.0%) as having an average level of perception, and 47 respondents (35.6%) as having a low level of perception about MRI safety. The current study presented that there was no significant difference between gender and perception of MRI safety, while 48.5% of respondents were more likely to be aware of the noise produced by the MRI scanner. In contrast to the previous study from Alelyani (2021), the respondents were more likely to have good exposure to the MRI room surrounding. Participants within the age group of 22 to 29 years old were more likely to be aware than those aged 30 to 39 years old. In terms of working experience, healthcare workers with 5 to 10 years of working experience were more likely to have a higher score of perception toward MRI safety as compared to others.

4.4 Limitations and recommendations

The main limitation of the study is that it was conducted in a single hospital. Future studies should include a wider population and perhaps the inclusion of healthcare workers in Malaysia too. Besides that, the time length spent on this study was also insufficient as the respondents were occupied with their daily schedules, hence a longer time is required to complete this study. Another limitation of the study would be the researcher was not able to ensure that the respondents were following the inclusion and exclusion criteria accordingly. As for the above matters, future researchers may be conducting a physical survey, like providing a hard copy for the respondent to fill up.

5. CONCLUSION

The study's findings concluded that overall knowledge and perception of MRI safety were generally acceptable. Most of the respondents showed a moderate knowledge and perception of MRI safety, and the nurses significantly showed a higher level of MRI knowledge and perception.

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REFERENCES

Ahmed, S., & Ramzan, R. (2021.). To Assess the Knowledge of MRI Safety, Among Staff Nurses and Ward Boys in Different Hospitals of Delhi/NCR.

Alelyani, M., Alqahtani, M., Alamri, S., Alghamdi, A., Alghamdi, A. J., Asiri, A. A., Alshehri, N., Shafei, A., & Assiri, A. (2021). Saudi Arabian Health Workers' Perception and Attitudes Toward Magnetic Resonance Imaging Safety. Journal of Radiology Nursing, 40(3), 279–285.

Alghmdi, A., Alghamdi, M., Alamri, S., Alshehri, M., Alatawi, I., Alzahrani, S., Aldarbi, M., & Alali, N. (2021). Assessment of Saudi Arabian Nurses' Knowledge and Attitudes Toward

Magnetic Resonance Imaging Safety. Journal of Radiology Nursing, 40(2), 187–193.

Crisp, S., & Dawdy, K. (2018). Building a Magnetic Resonance Imaging Safety Culture from the Ground Up. Journal of Medical Imaging and Radiation Sciences, 49(1), 18–22.

Cross, N. M., Hoff, M. N., & Kanal, K. M. (2018). Avoiding MRI-Related Accidents: A Practical Approach to Implementing MR Safety. Journal of the American College of Radiology, 15(12), 1738–1744.

Dayor Piersson, A., Gorleku, P. N., Gh (, A. D., & Piersson,). (2017). A national survey of MRI safety practices in Ghana. Heliyon, 3, 480.

Demir, M. C., & Akkas, M. (2019). Awareness of Risks Associated with the Use of Plain X-Ray, Computed Tomography, and Magnetic Resonance Imaging Among Emergency Physicians and Comparison with that of Other Physicians: A Survey from Turkey. Medical Science Monitor, 25, 6587–6597.

Fatahi, M., Demenescu, L. R., & Speck, O. (2016). Subjective perception of safety in healthy individuals working with 7 T MRI scanners: a retrospective multicenter survey. Magnetic Resonance Materials in Physics, Biology and Medicine 2016 29:3, 29(3), 379–387

Ferris, N. J., Kavnoudias, H., Thiel, C., & Stuckey, S. (2007). The 2005 Australian MRI Safety Survey. Http://Dx.Doi.Org/10.2214/AJR.06.0911, 188(5), 1388–1394.

Grover, V. P. B., Tognarelli, J. M., Crossey, M. M. E., Cox, I. J., Taylor-Robinson, S. D., & McPhail, M. J. W. (2015). Magnetic Resonance Imaging: Principles and Techniques: Lessons for Clinicians. Journal of Clinical and Experimental Hepatology, 5(3), 246.

Günalp, M., Gülünay, B., Polat, O., Demirkan, A., Gürler, S., Akkaş, M., & Aksu, N. M. (2013). Ionising radiation awareness among resident doctors, interns, and radiographers in a university hospital emergency department. La Radiologia Medica 2013 119:6, 119(6), 440–447.

Hartwig, V., Giovannetti, G., Vanello, N., Lombardi, M., Landini, L., & Simi, S. (2009). Biological Effects and Safety in Magnetic Resonance Imaging: A Review. International Journal of Environmental Research and Public Health, 6(6), 1778.

Hollingworth, W., Todd, C. J., Bell, M. I., Arafat, Q., Girling, S., Karia, K. R., & Dixon, A. K. (2000). The Diagnostic and Therapeutic Impact of MRI: an Observational Multi-centre Study. Clinical Radiology, 55(11), 825–831.

Maeda, T., Oda, M., Kito, S., Tanaka, T., Wakasugi-Sato, N., Matsumoto-Takeda, S., Joujima, T., Miyamura, Y., Kiyota, K., Tsutsumi, K., & Morimoto, Y. (2020). Can the lower rate of CT- or MRI-related adverse drug reactions to contrast media be due to stricter limitations on patients undergoing contrast-enhanced CT or MRI? Dentomaxillofacial Radiology, 49(2), 49.

Mozammel Hossen. (2020). Evaluation of Knowledge, Awareness, And Attitude of MRI Technologists Towards MRI Safety In Dhaka City Of Bangladesh. International Journal of Pure Medical Research, 5(5).

Ng, K.-H., Ahmad, A. C., Nizam, M., & Abdullah, B. (2003). Magnetic Resonance Imaging: Health Effects and Safety.

Shellock, F. G., & Spinazzi, A. (2008). MRI safety update 2008: part 2, screening patients for MRI. AJR. American Journal of Roentgenology, 191(4), 1140–1149.

Shiralkar, S., Rennie, A., Snow, M., Galland, R. B., Lewis, M. H., & Gower-Thomas, K. (n.d.). Doctors' knowledge of radiation exposure: a questionnaire study. https://doi.org/10.1136/bmj.327.7411.371

Steco, A., Saponaro, A., & Carriero, A. (2007). Patient safety issues in magnetic resonance imaging: state of the art. La Radiologia Medica 2007 112:4, 112(4), 491–508. https://doi.org/10.1007/S11547-007-0154-4

Tsai, L. L., Grant, A. K., Mortele, K. J., Kung, J. W., & Smith, M. P. (2015). A practical guide to MR imaging safety: What radiologists need to know. Radiographics, 35(6), 1722–1737.

Westbrook, C., Roth, C. K., & Talbot, J. (2011). MRI in Practice Fourth Edition RT (R) (MR) (CT) (M) (CV), FSMRT CEO, Imaging Education Associates Pennsylvania USA.

Winter, L., Seifert, F., Zilberti, L., Murbach, M., & Ittermann, B. (2021). MRI-Related Heating of Implants and Devices: A Review. Journal of Magnetic Resonance Imaging, 53(6), 1646–1665.

Yang, E., Suzuki, M., Nazarian, S., & Halperin, H. R. (2021). Magnetic resonance imaging safety in patients with cardiac implantable electronic devices. Trends in Cardiovascular Medicine.

Zhou, G. Z., Wong, D. D., Nguyen, L. K., & Mendelson, R. M. (2010). Student and intern awareness of ionising radiation exposure from common diagnostic imaging procedures. Journal of Medical Imaging and Radiation Oncology, 54(1), 17–23.

