ISSN: 0974-5823 Vol. 6 No. 3 December, 2021

International Journal of Mechanical Engineering

A Study on Recognition of Electromagnetic Absorption Rate in Magnetic Resonance Imaging examination

Cheong-Hwan Lim[1], Sung-Hun Jeong[2]*, Myung-Jun Chae[3]
[1]Professor, Dept. of Radiological Science, Hanseo University, Seosan, Korea
[2]Professor, Dept. of Radiological Science, Gimcheon University, Gimcheon, Korea
[3]Master, Dept. of Radiation Management, Howon University, Gunsan, Korea

Abstract
This study intends to suggest the need for guidelines for regulations by examining the awareness level of SAR of radiologists who directly participate in the process of conducting MRI examinations used in the diagnosis and treatment of diseases through questionnaires. A questionnaire was conducted targeting radiologists who are currently working in the MRI laboratory of a medical institution and radiologists who perform MRI with other parts. The structured questionnaire consisted of 10 SAR questions and 6 general questions, showing high reliability with Cronbach α=0.776 for SAR recognition and Cronbach α=0.54 for general questions. Analysis of the submitted 153 cases were conducted with frequency analysis to understand general characteristics and SAR recognition, and cross-analysis to find out the relationship between general characteristics and SAR. Statistical significance was judged to be statistically significant when the p value was 0.05 ($p<0.05$) or less. As a result of the study, it was found that many medical institutions were not equipped with body measurements, and that they were applied higher than the height and weight measured when performing the MRI scan. In the awareness of the safety standards of the absorption rate and the relationship between the absorption rate and the sequence used in the MRI examination, men, and those with more than 7 years of work experience, and the group working exclusively in the MRI room showed a higher level of awareness. Awareness of the correlation between the electromagnetic wave absorption rate and the patient's physical condition was also higher in the group with longer work experience. As the awareness of the patient's electromagnetic wave absorption rate was low among women and the group with short work experience, it is expected that it will be used to provide relevant education, and guidelines for patients.

Keywords: Magnetic Resonance Imaging (MRI), Specific Absorption Rate(SAR), Recognition, Radi-ological Technologist, Radio wave

1. Introduction

Magnetic Resonance Imaging (MRI), used in the diagnosis and treatment of diseases, uses a magnetic field that is harmless to t he human body and radio frequency (RF), which is non-ionizin g radiation for imaging the density and physical properties of atomic nuclei by causing nuclear magnetic resonance in atomic nuclei in the body [1]. However, when the resonance frequency (ω_2) corresponding to the precessional frequency (ω_0) is applied to the used nuclide (mainly ^{1}H), the atomic nucleus in a low en ergy state absorbs the resonance frequency (ω_2) energy and bec omes a high energy state. That is, the precessional frequency (ω_0) for the external magnetic field coincides with the applied res onance frequency (ω_2) to generate a new precessional frequenc y (ω_1) for the X-axis. Transverse magnetization is generated by the resonance frequency (ω_2) having characteristics of electrom agnetic waves, and an image can be acquired using the differe nce in relaxation. At this time, the resonance frequency (ω_2) us ed is 106 to 108 Hz, an electromagnetic wave, which belongs to the radio wave (RF) region [2]. The influence of radio wave, w hich is an electromagnetic wave, on the human body has been s uggested in many studies, but it is indicated by SAR as a bound ary for the risk that appears when electromagnetic waves in the high frequency region are continuously given for a long time d uring the MRI examination process, and it is limited not to exce ed the permitted SAR. SAR indicates the amount of RF energy absorbed by a certain tissue, and the unit of measurement is wa tt/kg. The human basal metabolic rate is 1.0w/kg at rest, and th e metabolic rate increases to 15.0w/kg when exercising [3~4]. I n MRI, SAR is proportional to the square of the external magn etic field, so a high magnetic field and a 180° pulse absorbs 4 ti mes more RF energy than a 90° pulse. In the human body, fat a nd bone with low water content have low electrical conductivit y (δ), and brain, blood, liver, CSF, etc. have high electrical con ductivity (δ), so energy absorption is greater. U.S. Food and D rug Administration (FDA) guidelines require that 0.4w/kg (bod y), 3.2w/kg (head) and other topical areas do not exceed 8.0w/k g [5]. When RF is absorbed during the MRI examination, the tissue exhibits fever, and the patient who radiates excess heat is an important safety issue. Therefore, this study aims to suggest the need for guidelines for guidelines by examining the awareness of SAR among radiologists who directly participate in the MRI examination process.

2. Research subjects and Methods

2.1 Research subject

A questionnaire was conducted targeting radiologists who currently work in radiology departments and MRI labs of medical institutions, and radiologists who perform MRI with other parts. The number of study subjects was analyzed by G-power program. In the F-test, the number of samples required to maintain a medium effect size of 0.25 and a power of 0.8 at a significance level of 0.05, total of 102 cases were needed, but eventually, 160 radiographers were selected by convenience sampling in anticipation of 10% dropouts. The exclusion criteria

were radiation workers who did not undergo MRI examination and when the non-response items in the questionnaire were more than 50%, and they were excluded from this study (Fig. 1).

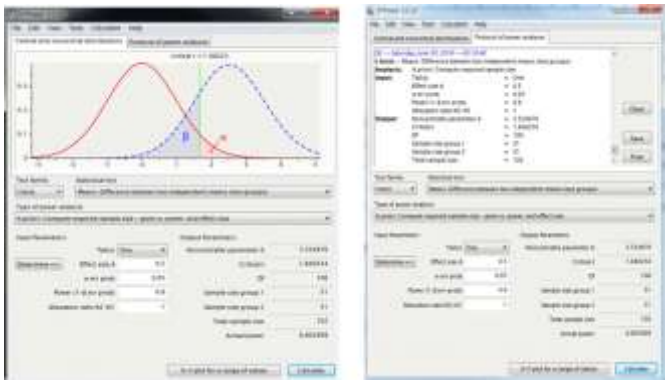

Figure 1. G- power program

2.2 Research Method

The structured questionnaire consisted of 10 SAR-related questions and 6 general questions. Factor reliability analysis was performed to measure the reliability of the questionnaire items. The reliability analysis results of each group showed high reliability with Cronbach α=0.776 for SAR recognition and Cronbach α=0.54 for general. The questionnaire was distributed for 6 months from March 10, 2021. Due to COVID-19, questionnaires were distributed through e-mail and mobile, which are non-face-to-face survey methods. The surveyed questionnaire was analyzed using the statistical package SPSS Ver. 24.0. Of the 160 distributed questionnaires, 153 copies were analyzed, excluding 7 copies with a non-response rate of more than 50% of the questionnaire items. For the analysis items of the questionnaire, reliability analysis to verify the validity of the questionnaire and frequency analysis to understand general characteristics of the questionnaire respondents and SAR awareness were performed. In addition, cross analysis was performed to find out the relationship between general characteristics and SAR. Statistical significance was judged to be statistically significant when the p value was 0.05 ($p<0.05$) or less. This study was conducted after approval of the Bioethics Committee of Howon University as a human research subject. (IRB No: HWU-202001-001-02)

3. Result

3.1 General characteristics

As a result of analyzing the general characteristics of the respondents in this study, 135 men (88.2%) and 18 women (11.8%) were found. In terms of age, those in their 30s accounted for the most at 38.6%, and those in their twenties were the least at 19.6%. Those with more than 7 years of hospital experience were the most at 58.2%, and those with less than 1 year had the lowest at 1.3%. Those with less than 1 year of work experience in the MRI room showed the highest response rate (31.4%), and those with more than 5 years and less than 7 years showed the lowest at 8.5%. Regarding the type of work, 58.2% of the respondents who worked exclusively in the MRI room and 41.8% of the respondents worked in parallel with other part (Table 1).

Table 1. General characteristics (unit: N, %)

Order		N	%
Gender	Male	135	88.2
	Female	18	11.8
Age	20~29 year	30	19.6
	30~39 year	59	38.6
	40~49 year	32	20.9
	50 year	30	19.6
Hospital career	Less than 1year	2	1.3
	1 and Below 3 year Group	16	10.5
	3 and Below 5 year Group	18	11.8
	5 and Below 7 year Group	28	18.3
	more than 7 years	89	58.2
MRI Room career	Less than 1year	48	31.4
	1 and Below 3 year Group	28	18.3
	3 and Below 5 year Group	23	15.0
	5 and Below 7 year Group	13	8.5
	more than 7 years	41	26.8
Working form	MRI room only	89	58.2
	Other part	64	41.8

3.2 Distribution of application of body measurements according to MRI examination

Table 2 shows the results of analyzing the function and usage distribution of body measuring instruments in the MRI examination. As a result of analyzing the function of the measuring instruments used in the MRI room, “there is no body measuring instrument” was the most at 62.1%, “only the weight can be measured” at 15.7%, and “only the height can be measured” with 1.3%. 20.9% answered that “weight and height can be measured”. As for the results of the application of height and weight when performing an MRI scan, 47.7% said “both height and weight are applied”, 36.6% “apply only body weight”, 9.2% “do not apply”, and “apply only one” was 6.5%, respectively. In the range of application of height, “apply accurately” was the highest at 42.5%, “apply 1~9cm higher than

the measured height" at 33.3%, and "apply 30cm or higher than the measured height" was the least answered with 2.6%. In addition, the range of applying the weight was the highest at 36.6% for "apply 10 to 19 kg larger" than the measured body weight, and 34.6% for "apply 1 to 9 kg larger". In MRI scan, SAR occurred in 49.0% of Spine examination, Abdomen was 28.8%, Brain was 14.4%, and Extremity was 7.8% in that order (Table 2).

Table 2. Distribution of application of body measurements according to MRI examination

(unit: N, %)

Order		N	%
The function of the measuring instruments used in the MRI room	weight and height can be measured	32	20.9
	only the weight can be measured	24	15.7
	only the height can be measured	2	1.3
	there is no body measuring instrument	95	62.1
The application of height and weight when performing an MRI scan	both height and weight are applied	73	47.7
	apply only body weight	56	36.6
	apply only one	10	6.5
	do not apply	14	9.2
In the range of application of height	apply accurately	65	42.5
	apply 1~9cm higher than the measured height	51	33.3
	apply 10~19cm higher than the measured height	33	21.6
	apply 30cm or higher than the measured height	4	2.6
In the range of application of weight	apply 1 ~ 9 kg larger	53	34.6
	apply 10 ~19 kg larger	56	36.6
	apply 20 ~ 29 kg larger	38	24.8
	apply 30kg larger	6	3.9
In MRI scan SAR occurred	Brain	22	14.4
	Spine	75	49.0
	Abdomen	44	28.8
	Extremity	12	7.8

3.3 Awareness of safety standards for electromagnetic wave absorption in MRI examination

For men, 30.1% answered "I know well", 27.5% answered "I have heard of it", and 17.6% answered "I know very well". For women, 5.2% said "I have not heard of it", 1.3% said "I know very well", and 2.6% said "I know well" and "I have heard of it", respectively. Men showed higher awareness of the safety standards of SAR than women, and it was statistically significant ($p<0.05$). Awareness by age was high at 17.0% for "I know well" in their 30s, 10.5% in "I know well" in their 40s, and 7.8% in "I know very well" in their 50s. On the contrary, for the ages of in their 20s, the recognition level is relatively low and "I have heard of it" was found to be 11.8%, and it was found to be statistically significant ($p<0.000$). In terms of hospital experience, 22.2% of respondents who had worked at the hospital for more than 7 years answered "I know well" and 15.0% of "I know very well", and those who worked for 5-7 years answered "I don't know" of 7.8%, as well as "I don't know at all" of 1.3% for less than 1 year of low recognition level, which was statistically significant ($p<0.000$). In MRI room experience, 10.5% of "I know well" and 9.8% of "I know very well" for more than 7 years of experience in the MRI room, and 13.1% of "I have heard of" and "I have not heard of it" of 10.5% for less than 1 year with low recognition level, and it was statistically significant ($p<0.000$). In terms of work type, in the group working exclusively in the MRI room, 19.6% of "I have heard of it", 17.6% of "I know very well", and 15.7% of "I know well" showed high recognition level, and the recognition rate was high. In the group working concurrently, 17.0% of "I know well", 10.5% of "I have heard of it", and 11.8% of "I don't know" showed a low level of awareness, which was statistically significant ($p<0.000$), (Table 3).

Table 3. Awareness of safety standards for electromagnetic wave absorption in MRI examination

(unit: N(%))

Order		Very well	I know	Heard of it	I don't	know at all	χ^2	P-value
Gender	Male	27(17.6)	46(30.1)	42(27.5)	18(11.8)	2(1.3)	11.07	0.02
	Female	2(1.3)	4(2.6)	4(2.6)	8(5.2)	0(0)		
Age	20~29 year	6(3.9)	2(1.3)	18(11.8)	4(2.6)	0(0)	54.62	0.000
	30~39 year	7(4.6)	26(17.0)	12(7.8)	12(7.8)	2(1.3)		
	40~49 year	2(1.3)	16(10.5)	12(7.8)	2(1.3)	0(0)		
	50 year	12(7.8)	6(3.9)	4(2.6)	8(5.2)	0(0)		
Hospital career	1 year	0(0)	0(0)	2(1.3)	0(0)	2(1.3)	51.24	0.000
	1~3 year	0(0)	2(1.3)	12(7.8)	2(1.3)	0(0)		
	3~5 year	4(2.6)	6(3.9)	6(3.9)	2(1.3)	0(0)		
	5~7 year	2(1.3)	8(5.2)	4(2.6)	12(7.8)	2(1.3)		
	7year	23(15.0)	34(22.2)	22(14.4)	10(6.5)	0(0)		
MRI Room career	1 year	2(1.3)	8(5.2)	20(13.1)	16(10.5)	2(1.3)	54.00	0.000
	1~3 year	0(0)	12(7.8)	12(7.8)	4(2.6)	0(0)		
	3~5 year	9(5.9)	10(6.5)	4(2.6)	0(0)	0(0)		
	5~7 year	3(2.0)	4(2.6)	4(2.6)	2(1.3)	0(0)		
	7year	15(9.8)	16(10.5)	6(3.9)	4(2.6)	0(0)		
Working form	MRI room only	27(17.6)	24(15.7)	30(19.6)	8(5.2)	0(0)	28.41	0.000
	Other part	2(1.3)	26(17.0)	16(10.5)	18(11.8)	2(1.3)		

Very well: I know very well. **I know**: I know well, **heard of it**: I have heard of it, **I don't**: I don't know, **know at all**: I don't know at all, **1year**: Less than 1year, **1~3 year Group**: 1 and Below 3 year Group, **3~5 year Group**: 3 and Below 5 year Group, **5~7 year Group**: 5 and Below 7 year Group

$p<0.05$*, $p<0.01$**, $p<0.001$***

3.4 Recognition of the relationship between electromagnetic wave absorption rate and MRI sequence

Table 4 shows the recognition results for the relationship between the SAR and the sequence used in the MRI scan. For men, 43.1% answered "I know well", 19.0% answered "I know very well", and 15.7% answered "I have heard of it", while women answered "I have heard of it" of 3.9% and "I don't know" of 2.6%. Thus, it was found that males have a higher awareness of the relationship between SAR and MRI sequences than females($p<0.01$). In terms of age, 19.6% of those in their 30s answered "I know well", 13.1% of those in their 40s answered "I know well", 7.8% of those in their 50s answered "I know very well", and 7.8% of those in their 20s answered "I know well", and was statistically significant ($p<0.01$). For those with more than 7 years of hospital experience, 27.5% of "I know well" and 16.3% of "I know very well" were found, and those of less than 1 year, "I have heard of it" of 1.3% showed low awareness, and it was statistically significant ($p<0.001$). In the MRI room experience, 10.5% of "I know well" for 7 years or more, 13.1% of "I know well" for 1 to 3 years, and 10.5% of "I know well" with less than 1 year of experience, and it was statistically significant ($p<0.001$). As for the recognition according to the type of work, in the group working exclusively in the MRI room, 27.5% of "I know well" and 19.0% of "I know very well" were high, and in the group working with other parts, 18.3% for "I know well" and 10.5% for "I have heard of it" showed lower awareness than the group working exclusively in the MRI room, and it is statistically significant ($p<0.001$), (Table).

Table 4. Recognition of the relationship between electromagnetic wave absorption rate and MRI sequence (unit: N(%))

Order		Very well	I know	Heard of it	I don't	know at all	χ^2	P-value
Gender	Male	29(19.0)	66(43.1)	24(15.7)	14(9.2)	2(1.3)	12.80	0.01
	Female	2(1.3)	4(2.6)	6(3.9)	4(2.6)	2(1.3)		
Age	20~29 year	6(3.9)	12(7.8)	6(3.9)	6(3.9)	0(0)	37.43	0.002
	30~39 year	5(3.3)	30(19.6)	10(6.5)	10(6.5)	4(2.6)		
	40~49 year	6(3.9)	20(13.1)	6(3.9)	0(0)	0(0)		
	50 year	12(7.8)	8(5.2)	8(5.2)	2(1.3)	0(0)		
Hospital career	1 year	0(0)	0(0)	2(1.3)	0(0)	0(0)	57.62	0.000
	1~3 year	0(0)	8(5.2)	4(2.6)	4(2.6)	0(0)		
	3~5 year	4(2.6)	10(6.5)	0(0)	4(2.6)	0(0)		
	5~7 year	2(1.3)	10(6.5)	4(2.6)	8(5.2)	4(2.6)		
	7year	25(16.3)	42(27.5)	20(13.1)	2(1.3)	0(0)		

MRI Room career	1 year	2(1.3)	16(10.5)	10(6.5)	16(10.5)	4(2.6)	69.01	0.000
	1~3 year	0(0)	20(13.1)	6(1.3)	2(1.3)	0(0)		
	3~5 year	9(5.9)	12(7.8)	2(1.3)	0(0)	0(0)		
	5~7 year	5(3.3)	6(3.9)	2(1.3)	0(0)	0(0)		
	7year	15(9.8)	16(10.5)	10(6.5)	0(0)	0(0)		
Working form	MRI room only	29(19.0)	42(27.5)	14(9.2)	4(2.6)	0(0)	32.79	0.000
	Other part	2(1.3)	28(18.3)	16(10.5)	14(9.2)	4(2.6)		

Very well: I know very well. **I know**: I know well, **heard of it**: I have heard of it, **I don't**: I don't know, **know at all**: I don't know at all, **1year**: Less than 1year, **1~3 year Group**: 1 and Below 3 year Group, **3~5 year Group**: 3 and Below 5 year Group, **5~7 year Group**: 5 and Below 7 year Group

p<0.05*, p<0.01**, p<0.001***

3.5 Awareness of the correlation between electromagnetic wave absorption rate and patient physical condition

Table 5 shows the results of examining the perception of the correlation between the absorption rate of electromagnetic waves and the patient's physical condition. In terms of gender, 31.4% of male respondents answered "relevant" and 20.9% answered "not related". For women, 3.9% of "not related" and 2.6% of "related" were found to be statistically insignificant (p>0.05). In terms of age, 11.8% of those in their 40s answered "relevant", 10.5% of those in their 30s answered "relevant" and 10.5% answered "not relevant", and those in their 50s or older answered "relevant" 6.5%, and those in their 20s, "not related" was 6.5%, which was not statistically significant (p>0.05). In terms of hospital work experience, those with more than 7 years of work experience were as high as 23.5% for "relevant" and 12.4% for "very relevant", and less than 1 year as "not related" at 1.3%, and it was found to be statistically significant (p<0.01). In terms of work experience in the MRI room, 9.2% of "relevant" and 7.2% of "very relevant" for 7 years or more, whereas 15.7% of "not related" and 5.2% of "very unrelated" for less than 1 year of work experience. It was statistically significant (p<0.001). In terms of work type, in the group working exclusively in the MRI room, 23.5% of "relevant" and 19% of "absolutely related" responses showed a high level of recognition, and in the group working in parallel with other parts, 17.0% for "not relevant" and 7.2% for "not very relevant", where awareness level was low. It was statistically significant (p<0.001).

Table 5. Awareness of the correlation between electromagnetic wave absorption rate and patient physical Condition (unit: N(%))

Order		Very well	I know	Heard of it	I don't	know at all	χ^2	P-value
Gender	Male	27(17.6)	48(31.4)	16(10.5)	32(20.9)	12(7.8)	3.47	0.48
	Female	2(1.3)	4(2.6)	4(2.6)	6(3.9)	2(1.3)		
Age	20~29 year	6(3.9)	8(5.2)	4(2.6)	10(6.5)	2(1.3)	23.96	0.09
	30~39 year	9(5.9)	16(10.5)	12(7.8)	16(10.5)	6(3.9)		
	40~49 year	4(2.6)	18(11.8)	2(1.3)	6(3.9)	2(1.3)		
	50 year	8(5.2)	10(6.5)	2(1.3)	6(3.9)	4(2.6)		
Hospital career	1 year	0(0)	0(0)	0(0)	2(1.3)	0(0)	36.98	0.002
	1~3 year	0(0)	8(5.2)	4(2.6)	4(2.6)	0(0)		
	3~5 year	4(2.6)	6(3.9)	0(0)	6(3.9)	2(1.3)		
	5~7 year	6(3.9)	2(1.3)	2(1.3)	12(7.8)	6(3.9)		
	7year	19(12.4)	36(23.5)	14(9.2)	14(9.2)	6(3.9)		
MRI Room career	1 year	2(1.3)	6(3.9)	8(5.2)	24(15.7)	8(5.2)	80.90	0.000
	1~3 year	0(0)	18(11.8)	0(0)	6(3.9)	4(2.6)		
	3~5 year	9(5.9)	12(7.8)	2(1.3)	0(0)	0(0)		
	5~7 year	7(4.6)	2(1.3)	2(1.3)	0(0)	2(1.3)		
	7year	11(7.2)	14(9.2)	8(5.2)	8(5.2)	0(0)		
Working form	MRI room only	29(19.0)	36(23.5)	12(7.8)	12(7.8)	0(0)	54.00	0.000
	Other part	0(0)	16(10.5)	8(5.2)	26(17.0)	14(9.2)		

Very well: I know very well. **I know**: I know well, **heard of it**: I have heard of it, **I don't**: I don't know, **know at all**: I don't know at all, **1year**: Less than 1year, **1~3 year Group**: 1 and Below 3 year Group, **3~5 year Group**: 3 and Below 5 year Group, **5~7 year Group**: 5 and Below 7 year Group

p<0.05*, p<0.01**, p<0.001***

4. Discussion

Currently, radiology departments of medical institutions use radiation-based general imaging devices, computed tomography imaging devices, mammography devices, and magnetic resonance imaging devices using resonance frequencies. In the case of equipment that uses radiation, a lot of effort and research have been actively made to obtain an optimal medical image

with minimal radiation. However, in the case of MRI using resonant frequency, there is still a lack of recognition and research on resonant frequency, which is a kind of electromagnetic wave, because there is no radiation exposure. When performing an MRI scan, the SAR value may be exceeded if a patient with heavy body weight, or tall height, or a sequence using a high-frequency pulse is used. In a previous study by Han et al. (2013), the patient's height and weight were defined as direct factors to the SAR, and reported that the patient's information must be accurately entered before the MRI scan in order not to exceed the allowed SAR [7]. Also, in the research paper of Choi (2019), in order to reflect the exact weight of each patient, there must be a measuring instrument to measure the weight in the MRI room. However, due to the high magnetic field, measuring instruments cannot be installed, and many medical institutions are reporting that they do not have body measuring instruments [8]. As a result of conducting a fact-finding survey on whether or not body measuring instruments are installed in the MRI rooms of medical institutions in this study, 95 out of 153 medical institutions (62.1%) did not have measuring instruments. 15.7% of institutions has weight measuring devices and 1.3% has height measuring devices, and 20.9% has both height and weight measuring devices. When electromagnetic waves are absorbed by the human body, heat action and stimulation action by electric current occur due to the energy of electromagnetic waves, and exothermic effects may also occur due to the cumulative effect when exposed for a long time [9]. In addition, in the case of brain MRI, which is performed most frequently in MRI examinations, in specific tissues such as the brain and eyeball, serious physical and physiological damage to the human body can be induced due to the increase in temperature. In particular, in the case of the brain, it can cause a temperature increase of 3.5°C or more, which can cause serious damage [10]. In the case of the eye, it is reported that an increase in temperature of 3 to 5°C can cause eye diseases such as cataracts [11-12]. In a previous study by Han et al. (2013), it was reported that the average SAR value according to the change of the lean angle with the body weight of the study subjects was 0.14 to 0.29 W/kg under 40 kg, but 0.34 to 0.69 W/Kg for those over 80 kg. In addition, it is reported that in the case of the lean angle change, it is increased by about 1.2 times for every 10° increase [13]. Therefore, in the results of the application of height and weight when performing MRI in this study, the portion of 33.3% said “apply 1 to 9 cm higher” than the measured height, and “apply 10 to 19 kg heavier than the measured weight” was the highest with the portion of 36.6%, and “apply 1 to 9 kg heavier” was found with 34.6%. As a result of analyzing the perception of SAR safety standards in MRI examination, 19.3% of the respondents answered “I don’t know”, which was statistically significant ($p<0.05$). The perception of the relationship between SAR and the sequence used in MRI examination was low in the age group in their 30s, 1 to 3 years of hospital work experience, less than 1 year of work in the MRI room, and the group working in the MRI room in parallel, and was statistically significant ($p<0.01$). As a result of examining the perception of the correlation between the electromagnetic wave absorption rate and the patient's physical condition, 33.9% said "not relevant", while for those less than 3 years of work experience in the MRI room, 27.4% answered "not relevant" and was statistically significant ($p<0.001$). A limitation of this study is that academic background, experience in writing MRI-related research papers, and education experience were not considered

5. Conclusion

As a result of the study, the following conclusions were obtained on the recognition of the electromagnetic wave absorption rate during the MRI examination. First, it was found that many medical institutions were not equipped with body measurements, and higher height and weight numbers applied than measured data when performing the MRI examination. Second, in the awareness level of the safety standards of the electromagnetic wave absorption rate, the recognition level was high among men, those who had more than 7 years of work experience in hospitals and MRI rooms, and those who worked exclusively in the MRI room. Third, in the recognition of the relationship between the electromagnetic wave absorption rate and the sequence used in the MRI examination, men, those with more than 7 years of experience in hospitals and MRI rooms, and the type of work in the group dedicated to MRI showed a high level of recognition. Fourth, the perception of the correlation between the electromagnetic wave absorption rate and the patient's physical condition showed that the more experience they had worked in hospitals and MRI rooms, the higher the level of perception.

Radiologists working in the MRI room should strive to obtain safe and diagnostic images by identifying the factors related to the absorption rate, providing education, and raising awareness. This study intends to use it as a basic data to present patient guidelines for the absorption rate of electromagnetic waves.

Acknowledgments

This paper was funded by 2021 academic research support project of Hanseo university.

References

1. J.W Min, H.W Jeong, J.H Han, S.N Lee, S.Y Han, et al, Study on the Resolution Characteristics by Using Magnetic Resonance Imaging 3.0T, Journal of Radiological Science and Technology, 43(4), August 2020, pp.255~256.
2. https://scienceon.kisti.re.kr/commons/util/originalView.do?cn=JAKO202025551106014&oCn=JAKO202025551106014&dbt=JAKO&journal=NJOU00303477
3. S.J Bae, C.H Lim, 3T MR Spin Echo T1 Weighted Image at Optimization of Flip Angle, Journal of Radiological Science and Technology, 32(2), May, 2009, pp.178~180.
4. https://scienceon.kisti.re.kr/commons/util/originalView.do?cn=JAKO200921140052385&oCn=JAKO200921140052385&dbt=JAKO&journal=NJOU00303477
5. J.H Kim, Y.N Kim, Complex Permittivity Measurement of Simulated Brain Tissue for the Evaluation of Specific Absorption Rate(SAR), The Institute of Electronics and Information Engineers,26(1), July, 2003, pp.310~3.
6. https://scienceon.kisti.re.kr/commons/util/originalView.do?cn=CFKO200311922211661&oCn=NPAP08012785&dbt=CFKO&journal=NPRO00288325
7. K.S Kim, K.G Lee, J.S Bae, Validity Verification for Specific Absorption Rate (SAR)Measurement System, Proceedings of Symposium of the Korean Institute of communications and Information Sciences , July, 2003, pp.1203~06
8. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE02156842

9. M.S Kim, J.W Lee, J.J Eun , Effective of Body Temperature Increasing during Brain MRI scan, The Korean society Radiology,11(1), February,2017, pp.49~54.
10. https://www.kci.go.kr/kciportal/ci/sereArticleSearch/ciSereArtiView.kci?sereArticleSearchBean.artiId=ART002204285
11. S.H Kim, The Assessment of the Breath Hold and the Free Breath Methods about the Blood Flow Evaluation by Using Phase Contrast MRI, Journal of Radiological Science and Technology,39(2), May, 2016, pp.149~153.
12. http://www.riss.kr/search/detail/DetailView.do?p_mat_type=1a0202e37d52c72d&control_no=d9318dd12f2551a3c85d2949c297615a&keyword=%EC%9C%84%EC%83%81%EB%8C%80%EC%A1%B0%EB%8F%84%20%EC%9E%90%EA%B8%B0%EA%B3%B5%EB%AA%85%EC%98%81%EC%83%81%EC%9D%84
13. J.B Han, A Study on Protocol of SAR Reduction by the Variation of Parameter in Brain MRI, Department of Electronics and Computer Engineering Graduate School Chonnam National University, August 2013, pp,28~38.
14. http://www.riss.kr/search/detail/DetailView.do?p_mat_type=be54d9b8bc7cdb09&control_no=a30e1995bedeeee7ffe0bdc3ef48d419&outLink=K
15. Kwan-Woo Choi, “Alternative Input Lower Weight Information Method Error to Reduce Specific Absorption Rate in MRI”, Journal of the Korean contents Association, 20(2), November, 2019, pp. 472~3.
16. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE09308747
17. American National Standard-Safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz, ANSI/IEEE C95.1-1992.
18. https://standards.ieee.org/standard/C95_1-2019.html
A. C Guyton, J. E. Hall, Textbook of Medical Physiology, Philadelphia, PA: Saunders, 2015, pp.215~20
19. http://www.kyobobook.co.kr/product/detailViewEng.laf?ejkGb=ENG&mallGb=ENG&barcode=9781455770168
20. I.K Hong,M.J Park,S.H Kang,Y.J Lee, Noise Level Evaluation According to Slice Thickness Change in Magnetic Resonance T2 Weighted Image of Multiple Sclerosis Disease, Journal of Radiological Science and Technology, 44(4), August ,2021, pp.327~33.
21. https://scienceon.kisti.re.kr/commons/util/originalView.do?cn=JAKO202126051369228&oCn=JAKO202126051369228&dbt=JAKO&journal=NJOU00303477
22. W.T Kim, J.G Yook, Thermal Steady State in an Anatomical Model of the Human Head under High-Power EM Exposure, The Journal of Korean Institute of Electromagnetic Engineering and Science, 21(10), October, 2010, pp.1073~84.
23. http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE01542192
24. J.B Han, S.H Hong, N.G Choi, H.J Seong, Analysis of Specific Absorption Rate in Magnetic Resonance Imaging, Journal of the Korean contents Association, 13(2), February 2013, pp.308~13.
25. http://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE02098050