

# Grid Recognition among Radiological Technologists in South Korea

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## ABSTRACT

This research was to examine how radiological technologists use and perceive grids. The study entailed a survey of 201 radiological technologists working in Korean medical institutions (general and specialty hospitals and a clinic). Its aim was to improve their use of grids and to provide basic data about grids. A survey was conducted of 201 radiological technologists working in Korean medical institutions regarding the relationships between grid ratio and dose and between grid ratio and video quality as well as differences in video quality and in dose between mobile and fixed grids. There were also five questions on respondents' sociodemographic characteristics. There were significant differences in recognition of adequate grid ratios and of the relationship between grid ratio and dose among radiological technologists working indifferent types of medical institutions ( $p < 0.01$ ) technologists at the clinic level showed the highest recognition that their currently installed grid ratios were adequate. There were also significant differences in recognizing the differences in video image and dose between mobile and fixed grids depending on the different types of medical institutions and differing work durations ( $p < 0.05$ ). To improve image quality and reduce patients' exposure doses, it is desirable that there be proper education on grids.

**Keywords:** Grid, Grid ratio, Adequacy, Recognition, Radiological technologists

**Mathematics Subject Classification:** 92C15, 92C55

**Journal of Economic Literature (JEL) Classification :** I19

## Introduction

Modern medicine has made much progress. Development of diagnostic radiation devices has brought about synergy effects that enable precise diagnosis in the medical field while improving the quality of medical treatments at the same time. In particular, as part of information technology developments, signal systems were developed that receive and develop images from diagnostic radiation devices.<sup>1</sup> As the image receptors of the film in film-screen systems and existing analogy

systems were replaced by computed and digital radiography, image quality improved greatly.<sup>2</sup> Image quality is determined by the software processing in digital radiography systems and by grids and filters that eliminate scattered rays. In particular, grids can improve image contrast by first removing the scattered rays generated when passing through the subject.<sup>3</sup> High grid ratios greatly reduce scattered rays, which improves images but also increases attenuation of the primary rays, which necessarily increases patients' exposure doses.<sup>4</sup> Companies that sell diagnostic radiation devices often use high grid ratios to highlight the superior quality of their images. In the past, the grid ratios of diagnostic radiation devices were 8:1–12:15 but now the ratios are 14:1–16:1 and the devices have set values.<sup>6,7</sup> Despite the importance of selecting and using appropriate grid ratios, there is little research on the subject. The aim of this study, by offering adequate grid ratios and highlighting

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changes in image quality depending on grid changes and evaluation, was to reduce exposure doses in not only patients but also radiological technologists. Toward that end, this research entailed conducting a survey of radiological technologists working in various medical institutions in Korea to analyze current grid usage and recognition. The specific intent was to improve technologists' grid use and provide basic data on grids.

### Research Target and Method

**Research Objects:** The target of this questionnaire survey was Korean radiological technologists working in general, university, or other hospitals or in clinics. The period for data collection was from August 1, 2017, to December 31, 2017, and the surveys were distributed by e-mail and paper mail. Two hundred and one technologists returned their surveys, and all surveys were used for statistical analysis. The average age of the respondents was 33.91 years old, with the majority, 47.5%, in their 30s. Just under half 49.3 were technical college graduates, and another 44.8% were university graduates. Average work experience was 8.30 years, and the majority of technicians, 57.2%, worked in general hospitals. Average age of respondents was 33.91 years old, and, among the respondents, those in their 30s took the largest proportion (47.5%). Technical colleges graduates were 49.3%, and university graduates were 44.8%. Average work years were 8.30 years. The majority of them (57.2%) were in general hospitals (Table 1).

**Table 1: Characteristics of Research Subjects**

Sortation		N	%
Gender	Man	150	74.6
	Woman	51	25.4
Age	20s	65	32.8
	30s	94	47.5
	40s	33	16.7
	50s	6	3.0
Academic background	Associate degree	99	49.3
	Bachelor	90	44.8
	Master	7	3.5
	Doctor	5	2.5

*Conted...*

A hospital career	~3 years	50	24.9
	4 ~ 7 years	60	29.9
	8 ~ 10 years	37	18.4
	11 ~ 15 years	29	14.4
	16 years over	25	12.4
The type of medical institutions	clinic	3	1.5
	general hospital	23	11.4
	university hospital	60	29.9
	hospital	115	57.2
N= Number of persons, %=Percent			

**Measuring Tool:** To assess the radiological technologists' grid recognition, a five item questionnaire was developed to evaluate their knowledge on appropriate grid ratios, the relationships between grid ratio and dose and between grid ratio and image, and the image and dose differences between moving and stationary grids. The face validity of the five items was obtained from a supervising professor and from doctoral students majoring in radiation. The questions were rated on 5-point Likert scales where higher scores indicated better grid knowledge. For the analyses, individual questions were used, but they were not scaled

### Method of Data Analysis

To verify the validity of the questionnaire, data analysis consisted of frequency, mean difference, and crossover analyses using SPSS for Windows ver. 21.0. First, frequency analysis was carried out to identify sociodemographic and career characteristics. Second, t tests and one-way ANOVA were performed to identify the differences in grid recognition based on the participants' sociodemographic and career characteristics.

### Results

**Recognition of Adequate Grid Ratios:** There were significant differences in recognition of adequate grid ratios in diagnostic radiation depending on the type of medical institution [ $F = 4.837, p < 0.01$ ]. Because the differences between groups were not significant in ex-post analysis, average values were analyzed, and there were differences. The proportion of those who perceived that grid ratios were adequate was the highest among clinic technicians, followed by those working in general and specialty hospitals (Table 2).

**Table 2: Recognition of Adequate Grid Ratios**

Sortation		N	M	S.D	t/F-value	Duncan
Gender	Man	146	2.79	.483	-.370	-
	Woman	51	2.82	.478		
Age	20s	62	2.81	.568	.209	N.S
	30s	93	2.77	.445		
	40s	33	2.85	.442		
	50s	6	2.83	.408		
Academic Background	Associate Degree	98	2.81	.490	.042	N.S
	Bachelor	87	2.79	.486		
	Master	7	2.86	.378		
	Doctor	5	2.80	.447		
A Hospital Career	~3 years	47	2.85	.551	1.115	N.S
	4 ~ 7 years	60	2.70	.497		
	8 ~ 10 years	36	2.89	.398		
	11 ~ 15 years	29	2.83	.468		
	16 years over	25	2.80	.408		
The Type of Medical Institutions	Clinic	3	3.00	.000	4.837**	a
	General Hospital	23	2.96	.367		
	University Hospital	60	2.62	.524		
	Hospital	111	2.86	.457		

\*\*p<0.01 N= Number of persons, M=Mean, SD=Standard Deviation

**Recognition of the Relationship between Grid Ratio and Dose:** The technologists' differences in recognizing that higher grid ratios entailed higher doses differed significantly by type of medical institution (F = 4.073, p < 0.01), (Table 3).

**Table 3: Recognition of the Relationship between Grid Ratio and Dose**

Sortation		N	M	S.D	t/F-value	Duncan
Gender	Man	150	2.28	.625	-.587	-
	Woman	50	2.34	.626		
Age	20s	65	2.31	.610	2.137	N.S
	30s	93	2.32	.628		
	40s	33	2.27	.626		
	50s	6	1.67	.516		
Academic Background	Associate Degree	99	2.28	.686	.454	N.S
	Bachelor	89	2.33	.560		
	Master	7	2.29	.756		
	Doctor	5	2.00	.000		
A hospital Career	~3 years	50	2.36	.631	.932	N.S
	4 ~ 7 years	59	2.32	.628		
	8 ~ 10 years	37	2.22	.672		
	11~ 15 years	29	2.38	.561		
	16 years over	25	2.12	.600		

Conted...

The Type of Medical Institutions	Clinic	3	1.67	.577	4.073**	a
	General Hospital	23	2.17	.778		ab
	University Hospital	60	2.50	.537		b
	Hospital	114	2.23	.610		ab
**p<0.01 N= Number of persons, M=Mean, SD=Standard Deviation						

**Recognition of the Relationship between Grid Ratio and Image Quality:** There were significant differences in recognizing that higher grid ratios resulted in higher image quality, also by type of medical institution (F = 5.304, p < 0.01), (See Table 4).

**Table 4: Recognition of the Relationship between Grid Ratio and Image Quality**

Sortation		N	M	S.D	t/F-value	Duncan
Gender	Man	150	2.23	.699	-1.449	-
	Woman	51	2.39	.603		
Age	20s	65	2.32	.640	.978	N.S
	30s	94	2.27	.691		
	40s	33	2.24	.751		
	50s	6	1.83	.408		
Academic Background	Associate Degree	99	2.19	.724	1.723	N.S
	Bachelor	90	2.39	.612		
	Master	7	2.14	.900		
	Doctor	5	2.00	.000		
A Hospital Career	~3 years	50	2.32	.621	1.005	N.S
	4 ~ 7 years	60	2.27	.686		
	8 ~ 10 years	37	2.19	.776		
	11 ~ 15 years	29	2.45	.572		
	16 years over	25	2.12	.726		
The Type of Medical Institutions	Clinic	3	2.67	1.155	5.304**	a
	General Hospital	23	2.04	.706		
	University Hospital	60	2.53	.596		
	Hospital	115	2.17	.666		
**p<0.01 N= Number of persons, M=Mean, SD=Standard Deviation						

**Recognition of Dose Differences between Mobile and Fixed Grids:** There were significant differences in the radiological technologists' recognition of the dose differences between mobile and fixed grids by type of medical institution (F = 2.770, p < 0.05), (Table 5).

**Table 5: Recognition of the Dose Differences between Mobile and Fixed Grids**

Sortation		N	M	S.D	t/F-value	Duncan
Gender	Man	150	2.63	.871	-.237	-
	Woman	50	2.66	.823		
Age	20s	65	2.52	.687	.835	N.S
	30s	94	2.73	.941		
	40s	33	2.58	.902		
	50s	6	2.67	1.033		

Conted...

Academic Background	Associate Degree	99	2.65	.884	1.770	N.S
	Bachelor	89	2.62	.805		
	Master	7	3.14	1.215		
	Doctor	5	2.00	0.000		
A Hospital Career	~3 years	50	2.52	.614	.788	N.S
	4 ~ 7 years	60	2.60	.764		
	8 ~ 10 years	37	2.84	1.214		
	11 ~ 15 years	28	2.61	.832		
	16 years over	25	2.68	.900		
The Type of Medical Institutions	Clinic	3	3.00	1.732	2.770*	b
	General Hospital	23	2.17	.834		a
	University Hospital	60	2.65	.709		ab
	Hospital	114	2.71	.890		ab

\*p<0.05 N= Number of persons, M=Mean, SD=Standard Deviation

**Recognition of the Differences in Image Quality between Mobile and Fixed Grids:** There were significant differences in the technologists' recognition of the differences in image quality between mobile and fixed grids by duration of work experience ( $F = 3.020, p < 0.05$ ) and by type of medical institution ( $F = 3.761, p < 0.05$ ), (Table 6).

**Table 6: Recognition of the Differences in Image Quality between Mobile and Fixed Grids**

Sortation		N	M	S.D.	t/F-value	Duncan
Gender	Man	150	2.59	.876	.047	-
	Woman	50	2.58	.810		
Age	20s	65	2.52	.664	.541	N.S
	30s	94	2.64	.926		
	40s	33	2.48	1.004		
	50s	6	2.83	.983		
Academic Background	Associate Begree	99	2.55	.884	1.419	N.S
	Bachelor	89	2.61	.778		
	Master	7	3.14	1.215		
	Doctor	5	2.20	1.095		
A Hospital Career	~3 years	50	2.58	.702	3.020*	ab
	4 ~ 7 years	60	2.37	.663		a
	8 ~ 10 years	37	2.97	1.166		b
	11 ~ 15 years	28	2.61	.737		ab
	16 years over	25	2.52	1.005		a
The Type of Medical Institutions	Clinic	3	3.67	1.528	3.761*	b
	General Hospital	23	2.17	.717		a
	University Hospital	60	2.68	.725		
	Hospital	114	2.59	.900		

\*p<0.05 N= Number of persons, M=Mean, SD=Standard Deviation

## Discussion and Conclusion

In radiologic imaging, grids improve image contrast primarily by removing the scattered rays generated when X-rays pass through patients during normal scanning. However, high grid ratios lead to greatly reduced scattered rays and increased attenuation of the primary rays, which results in higher patient exposure doses.<sup>8</sup> Specifically, grid functions vary depending on the first ray transmittance, scattered ray transmittance, and total dose transmittance; transmittance can be broader or narrower depending on grid ratio. However, as grid ratio increases, grid function decreases, and exposure rate necessarily increases.<sup>5</sup> The grid ratio is the ratio of the height of the lead foil to the distance between the lead foils.<sup>9</sup> High grid ratios increase the removal rate of the scattered rays, but it also increases the absorption of the primary rays in the grid, which increases the number of shoots. Additionally, the higher the grid ratio, the greater the contrast.<sup>10</sup> However, because the dose increases at low tube voltage, which in turn increases the exposure dose, the grid should be selected based on tube voltage.<sup>4</sup> The current standard is that during high tube voltage shooting, the grid ratio should be 10:1 or 12:1, during low tube voltage shooting, the ratio should be 8:1, and when shooting the head, spine or abdomen, the ratio should be 6:1 or 8:1.<sup>6</sup> Because of the high radiation exposure doses with grids, radiological science departments are currently teaching students to use non-grid devices to examine thin subjects.<sup>11</sup> However, the digital radiography equipment for clinical use does not allow non-grid examination because grids are attached, and thus, patient exposure doses are increasing. Also, despite the fact that the grids are easily attached and detached, technologists do not remove the grids during examinations because they are not aware of non-grid examinations.<sup>12</sup> In this study, the technologists' scores for recognizing the relationship between grid and dose averaged 2 points on a 5-point scale ( $p < 0.05$ ), which was very low. In this study, the Korean radiological technologists averaged a score of 2 on a 5-point scale for grid recognition, which was considered somewhat low. There were significant differences in recognizing grid ratio adequacy as well as recognizing the relationships between grid ratio and dose and between grid ratio and image quality depending on the technologists' personal characteristics and type of medical institution.

Based on the findings of low grid recognition among the Korean radiological technologists in this study, it appears that better education on grids is needed in order to enhance image quality while reducing patients' radiation exposure doses.

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**Conflict of Interest:** Nil

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