

A Comparison of the effectiveness of Mammographic Film-Screen and Standard Film-Screen in the Detection of Small Bone Fractures

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Abstract

The use of mammography film-screen is limited in general radiography. The purpose of this study was to compare the effectiveness of mammographic film-screen and standard film-screen systems in the detection of small bone fractures. Radiographs were taken from patients' extremities and neck areas using mammography film-screen and standard film-screen (n=57 each). Fourteen other radiographs were taken from other views (predominantly oblique views), making a total number of 128 radiographs. Paired radiographs, taken from the same areas, were compared by two radiologists in terms of image visual sharpness, presence of bony fractures, and soft tissue injuries. The surface dose received by patients in the two systems was also compared. The radiographs taken by mammography film-screen had a statistically better visual sharpness compared to those taken by the standard film-screen system. However, there was no statistically significant difference between the diagnostic accuracy of the two systems. Mammography film-screen was able to detect only one out of 57 lesions, whereas standard film-screen system did not detect any lesion. The surface dose received by patients in mammography film-screen was higher than that in standard film-screen system. The findings of the present study suggest that mammography film-screen may be recommended as a diagnostic tool for the detection of small fractures of tiny parts of body such as fingers, hand or foot. They also suggest that mammography film-screen has no advantage over standard film-screen for radiography of thick body parts such as neck and knee.

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Keywords • Bone fracture • mammography • diagnostic techniques • surface dose • X-Ray screen system

Introduction

The value of radiography, as a diagnostic modality, depends on taking qualified images.^{1,2} Images with deficient quality leads to increasing diagnostic error, and subsequently causes poor patient care.³ Nowadays, majority of radiology centers, especially in developing countries, utilize double screen/double emulsion film systems as image receptor. In the mean time, developed countries use digital radiography and computed radiography.^{1,4}

Nowadays, single film-screen systems are employed as image recorder in mammography, and gathered images possess higher contrast and resolution than that of the double film-screen

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systems. However, compared with double film-screen systems, single film-systems increase exposure factors such as the dose received by patients.⁵

There are, however, no adequate studies on the use of single screen/single emulsion film combination in the detection of small bone lesions, and previous studies are controversial. Therefore, the present study was designed to compare the effectiveness of mammography film-screen (MFS) and standard film-screen (SFS) systems in the detection of small bone lesions and fractures.

Materials and Methods

The sample size was calculated using a formula for the calculation of sample size for two independent groups. Using data from the study by Farridah and colleagues,¹ a sample size of 57 radiographs was calculated for each group. The study was approved by Ethics Committee, Hamadan University of Medical Sciences, and informed consent was obtained from all of participants.

This is an experimental study, carried out in three different phases. In the first phase, an in vitro evaluation of the effectiveness of MFS in the detection of bone small fractures was carried out. For this purpose, some pieces of animal (cow) bones were broken to small fragments of different sizes, and the fragments were suspended in a jelly structure to model the small bone fractures and soft tissues (figure 1A). Then, some radiography images were taken from the model in different exposure factors by MFS and SFS, to obtain proper exposure conditions (figure 1B & 1C). Five radiology technicians and two radiologists compared the quality of obtained radiographs in terms of visual sharpness, density and contrast, and determined the optimum exposure factors.

In the second phase of the study, a total of

114 radiography images (57 radiographs by each of the MFS and SFS) were taken from patients, who referred for radiography, with temporary diagnosis of bone small fractures, or soft tissues injuries in lower or upper extremities or neck. In some cases, radiographs in additional views (predominantly oblique views) were taken, making the total number of radiograph to 128 (64 radiographs for each of MFS and SFS). All radiography images were assessed and scored independently by two radiologists according to the method used by Farridah et al.¹ For this purpose, they ranked the image quality as bad, normal, good or excellent.

An 18×24 cm mammography film-screen combination (Mammoray MRG Agfa film accompanied by a Mammoray Agfa Screen) and an 18×24 standard film-screen combination (Ortho CP-plus Agfa films with two Ortho-fine Agfa screens) were used. All films were developed in a 90 second automatic processor (Konica Minolta, model SRX-201) in 38°C developer temperature by Tetenal processing solutions.

Third phase of study did evaluate the skin entrance dose in two different image receptor systems. The TLD GR-200 chips (LiF, Mg, Ti) were put on a jelly mould, which was exposed at exposure factors used in practice.

Statistical Analysis of findings was done by Statistical Package for Social Sciences (SPSS, version 16) using Chi square, One-way ANOVA and McNemar tests. A P value of <0.05 was chosen as the levels of statistical significance.

Results

The exposure factors, which were utilized for radiography of different parts of the body in both MFS and SFSs, are shown in table 1. Comparison of the image quality scores of MFS and SFS systems, directed by two radiologists, are shown in table 2.

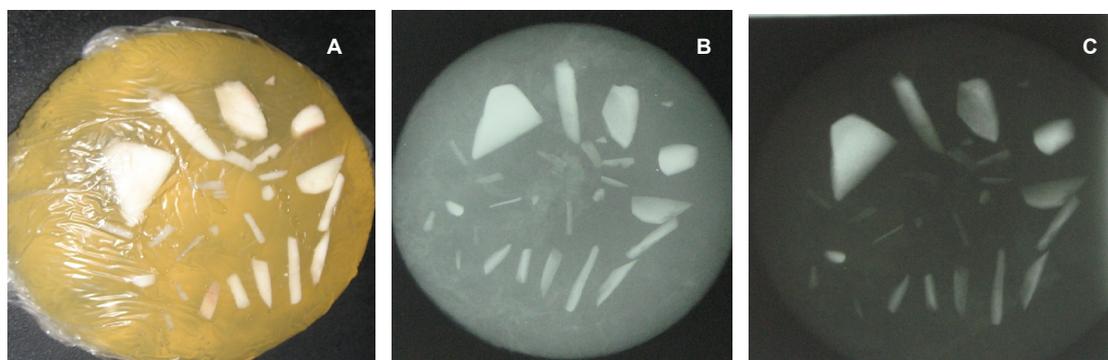


Figure 1: The jelly phantom with pieces of cow bone (A), and its radiograph images taken by mammographic film-screen (B) and standard film-screen (C) systems.

Table 1: The exposure factors utilized for radiography of different parts of the body in mammographic film-screen (MFS) and standard film-screen (SFS) systems

	MFS		SFS	
	Kvp	mAs	Kvp	mAs
Hand Fingers	40	2	48	3.2
Hand	40	2	48	3.2
Wrist	41	2	48	3.2
Forearm	44	2.5	52	4
Arm	44	4	54	6.4
Foot Fingers	41	2	48	3.2
Foot	42	2	50	4
Ankle	44	2	52	4
Leg	44	4	54	6.4
Knee	46	4	56	6.4
Neck (soft tissue)*	55	12.5	66	25
Neck vertebra*	63	12.5	72	25

* These views were obtained with bucky units

Table 2: The frequency of image quality scores taken by mammographic film-screen (MFS) and standard film-screen (SFS) system

	SFS Quality				MFS Quality				P value*
	bad	normal	good	excellent	bad	normal	good	excellent	
Upper Extremities	2	13	44	15	2	6	38	28	0.000
Lower Extremities	2	5	17	6	2	3	13	12	0.202
Neck	4	6	9	5	4	4	16	0	0.001
P value**	0.000				0.001				

* Statistical analysis was performed by McNemar test, ** Comparison between groups in each of two imaging systems was performed by One-way ANOVA followed by Tukey test.

There was only one lesion that was visualized on MFS images, whereas no lesion was obvious on SFS ones. McNemar test did not detect any significant difference between the ability of the two systems in detecting the lesion ($P=1$).

Prototypes of images taken by SFS and MFS systems are presented in figures 2. The surface entrance dose received by patients at different body parts in MFS and SFS systems are shown in figure 3.

Comparison of the quality of images taken by each image system from different parts of the body by One-way ANOVA revealed that there was a significant ($P=0.01$) differences between the quality of images from different parts of the body in MFS system (table 2). Pairwise comparison with Tukey test showed no significant ($P=0.592$) difference between the quality of images from upper and lower extremities, but a significant ($P=0.001$) difference between those of neck and upper or lower extremities was observed. Moreover, one-way ANOVA revealed a significant difference between the quality of images taken by SFS from different parts of the body ($P=0.000$). Post hoc analysis with Tukey test also showed a significant difference between the image quality of upper and lower extremities ($P=0.000$), and also neck and upper extremities ($P=0.009$). But there was not significant ($P=0.761$) difference between the quality of images from neck and lower extremities.

Discussion

The present study revealed that images taken by MFS system had an overall superior quality than those taken by SFS system. Such a finding is in good agreement with those of Faridah et al.¹ Soler et al.² Abdollah et al.⁶ and Hubbard et al.⁷ Such a finding is predictable, since the modulation transfer function and the cross over effect is lower in MFS than in SFS.^{5,7}

The evaluation of image quality is subjective and associated with uncertainties. According to Ciraj-Bjelac et al.⁸ and Oliveira et al.⁹ the quality of radiograph images should be assessed using standardized test objects. Therefore, more supplementary studies using unique test objects are needed for exact decision.

The study also showed that there was no difference between the quality of images taken by MFS and SFS from thick body parts including neck, knee and leg. This finding is similar to that of Soler et al.² but different from those of Faridah et al.¹ and Abdollah et al.⁶ Such a finding might be related to the use of high voltages (usually 50-60 Kvp) for radiography of thick parts of the body. Mammography uses much lower voltages (22-35 Kvp). As the sensitivity and energy absorption of mammography film-screen combination decreases by increasing of tube voltage, the image quality of MFS reduces at high voltage imaging techniques.^{1,5}

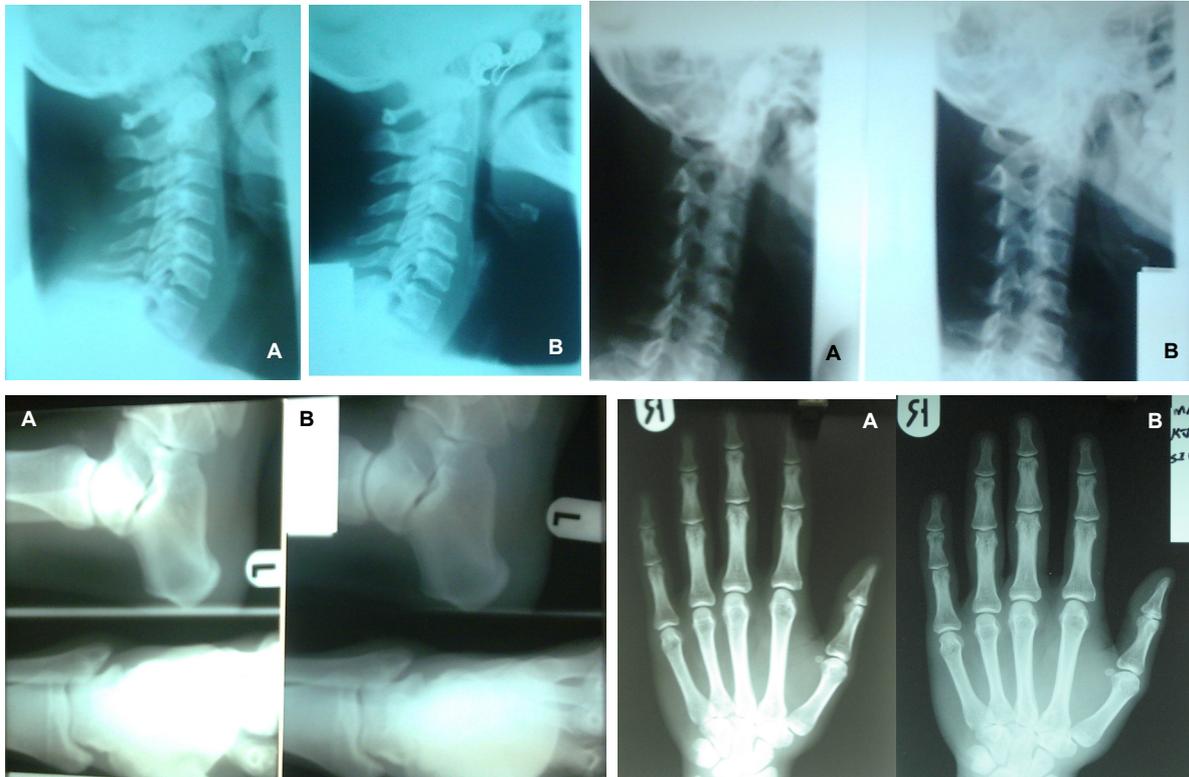


Figure 2: Radiograph images taken by A) mammographic film-screen (MFS) and B) standard film-screen (SFS) systems. Images taken by MFS system from upper and lower extremities, especially those taken from wrist and ankle areas, have a better quality than those taken by SFS system. Images taken by the two systems from neck area have almost the same quality.

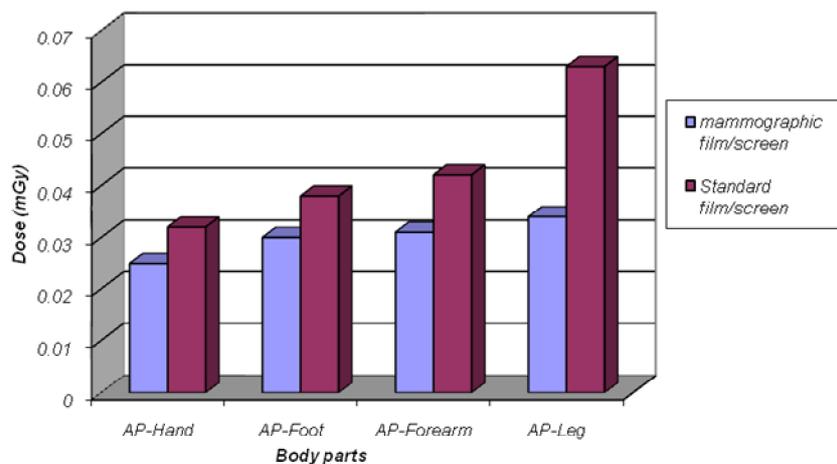


Figure 3: The surface entrances dose received by patients at different body parts in mammographic film-screen and standard film-screen systems (The unit of absorbed dose is milligray).

Nowadays, the analogue systems are being replaced by digital ones. In this study only the analogue film-screen systems were compared. There are many studies on the comparison of digital mammography and radiography systems to examine their abilities to detection small bone lesions and fractures.⁹ Van-ongeval et al.¹⁰ compared the computed radiography and screen-film mammography to detect osse-

ous lesion. They showed that even though images taken by mammography were of higher quality, there was no difference between the two methods for lesion detection. Also, studies by Fischmann et al.¹¹ Yanpeng et al.¹² and others,¹⁰⁻¹³ indicate that even though the quality of images were rated higher in one system, the ability to detect lesion did not differ between the two systems.

The results of dosimetry showed that patients utilizing MFS system received a higher dose of radiation. However, such a finding is not in agreement with those of Abdollah et al.⁶ and Soler et al.² who found no significant difference between the radiations received in MFS and SFS, or that of Faridah et al.¹ who overestimated the difference.

Conclusion

The findings of the present study suggest that MFS system may be recommended as a diagnostic tool for the detection of small fractures of tinny parts of the body such as fingers, hand or foot. They also suggest that MFS system has no advantage over SFS system for radiography of thick parts of the body such as neck and knee.

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Conflict of Interest: None declared

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