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Original Article

Radiology Section

Reject Analysis in Digital Radiography: A Prospective Study

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ABSTRACT

Introduction: Rejecting, deleting and repeating of diagnostic radiographs are against the professional and ethical issues of the radiology departments, as it leads to the unnecessary occupation of the staff, additional radiation exposure to patients and increased institutional costs.

Aim: To determine the rate of rejection/repetition in DDR and evaluate its outcomes.

Materials and Methods: A prospective study was conducted in the radiology department of Dokuz Eylül University Hospital and data were collected. A total of 33,001 radiographs were evaluated manually by examining all types of radiological images, the number of exposed images and number of deleted images. The rate of rejection of the different anatomical regions and the reasons for the repeat were calculated by using Microsoft Excel 2010 program.

Results: Out of 33001 radiographic films, 396 of them were retaken (reject/repeat ratio: 1.2%). The causes related to technicians were 88.1%, related to patients were 6.1%, related to doctors 4.8% and other causes were 1%. Most frequent repeats were observed for chest (48.2%) radiographs and least for bone/scoliosis radiographs. Positioning errors constituted the majority of errors leading to repetition.

Conclusion: Our hospital's rejection rate was 1.2% which was within the acceptable range of recommended 5% value by WHO. However, training and supervision of radiology technicians and increasing the guidance and in-service training practices are recommended to reduce the rejection rate.

Keywords: Diagnostic radiographs, Digital waste analysis, Quality control

INTRODUCTION

Reject/repeat radiographs are those radiographs which are not accepted clinically and asked to be retaken. Besides, the images which are irrelevant with the patient and being used for quality control purpose are also considered in the waste category [1]. The deletion, rejection and repetition of radiographs are considered as professional and ethical problems of the radiology departments [2]. Reject/repeat radiographs causes unnecessary patient irradiation, wastage of staff time in shooting, prolongation of patient waiting time, and even extension of the diagnosis/treatment time [3,4]. This is also an unintended and undesired aspect concerning quality assurance programs [5-7]. Reject/repeat rates in conventional screen/film systems are reported to be between 10 and 15% [8]. The primary cause of this is the irradiation parameters (kilovoltage (kV), milliampere-seconds (mAs) that could not be determined correctly due to the limited gray scale range in these systems [9]. Rejection appears to be related with overexposure/underexposure in screen/film systems but with positioning errors in digital systems.

Nowadays, with the help of the technologic improvements, new digital radiography systems are being used for medical imaging. Since digital imaging system is available, reject/repeat analysis programs that were carried out in conventional radiology for performance and quality assessments were under argument as to continue them or not, due to the superiority of this new technology; which gave rise to an expectation that the problems of reject/delete/repeat should not be required any more. In some studies, the reject/delete rate in digital radiology departments were reported to be around 5% [5-11]. Higher reject rates of DDR similar to screen/film systems are considered as an essential problem. An effective quality assurance program should be carried out in Radiology departments to solve this problem and as a consequence of this the patient doses and workload of the technologist will reduce and also both the diagnostic reliability and the cost effectiveness of the Radiology department will be enhanced.

Furthermore, reject analysis results will provide information for the preparation of technician training programs and a possible change in the work flow. For these reasons, the establishment

of a quality assurance program in the radiology departments has great importance [5,10]. There is not much technical literature available which can evaluate reject/repeat rates associated with clinical application of DDR within a quality control program [1]. More studies are required to assess if these high reject/repeat rates of digital radiography are incidental findings or not, and also to meet the expectations regarding digital imaging [8]. Therefore, the present study was conducted with an aim to determine the rate of rejection in Direct Digital Radiography (DDR) and to determine the cause for the same.

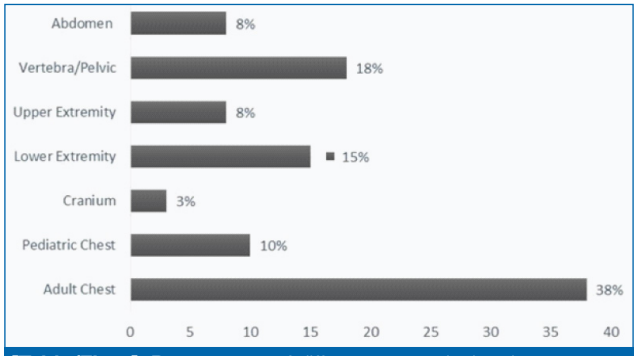
MATERIALS AND METHODS

A prospective study was conducted in the radiology department of Dokuz Eylül University Hospital and data were collected. Radiographs that have been taken in a five-month period from March 2015 to July 2015 were examined by a medical physicist and a technician to determine the rejection rates within the framework of quality control studies of three different DDR equipments which were located in the Radiology department. Philips OPTIMUS DDR devices were used. DDR 1 is used only for musculoskeletal radiographies, while DDR 2 for only chest and DDR 3 for abdomen/pelvis radiographies. After all the radiographies of the patient were completed, all the images taken were sent to PACS (Picture and Archiving Communication System, PHILIPS iSite Radiology, version 4.1.110).

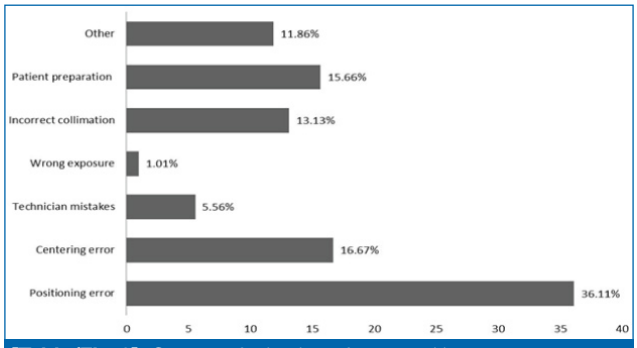
The anatomical regions studied were abdomen, vertebra/pelvis, upper extremity, lower extremity, cranium, paediatric chest and adult chest. Although we know that the positioning errors cover the centering errors too, a distinction was made between centering errors and positioning errors in order to determine the topics while making a detailed training plan. In the present study, the films with poor image quality containing no diagnostic information and which do not support clinical indications are defined as waste radiographies. The images having poor diagnostic information were deleted in the PACS by a quality control technician and good images were sent to the radiologist for evaluation. All the images on the PACS were taken into evaluation and a medical physicist worked together with the quality control technician in determining reasons for rejection but the radiographs of conscious or unconscious moving patients were not included in the statistical evaluation. For this reason, the number of monthly shots by means of PACS and the reasons for the repetitions were easily determined with respect to anatomical regions. Microsoft Excel 2010 program was used to calculate the repeat rates for each anatomical region, the distribution of repeat images with respect to rejection reasons and the total repeat/reject rate.

RESULTS

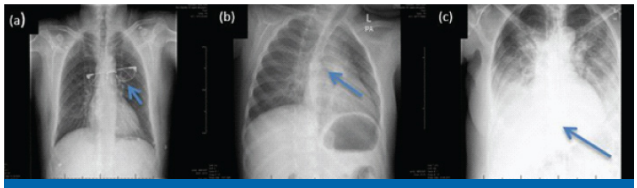
A total of 33001 radiographic examinations were performed in the radiology department and 396 were retaken. In the repeat radiographs, chest (adult and child), cranium, lower extremity, upper extremity, vertebra/pelvis and abdomen were the regions that were re-examined. Repeat rate was the highest for chest (48%) radiographs whereas it was lowest for cranial (3%) radiograph [Table/Fig-1]. Improper patient positioning (36.11%) and centering (16.67%) were the significant causes of rejection errors caused by a technician. Preparation of the patient was another cause with a rate of 15.66% indicating a significant result. Other causes of repetitions (11.86%) were caused by the doctor and DDR device [Table/Fig-2].



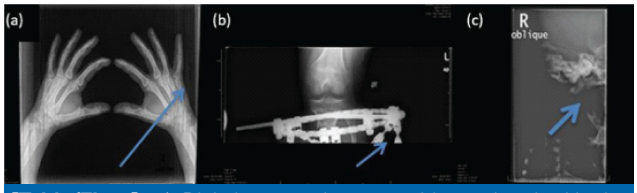
[Table/Fig-1]: Repeat rates of different anatomical regions.



[Table/Fig-2]: Causes of rejection of repeated image.



[Table/Fig-3]: a) Wrong patient preparing; b) Positioning error; c) Selection of the high exposure parameter for chest and collimation error. (left to right)



[Table/Fig-4]: a) Digital waste due to problem related with the equipment; b) Retake due to insufficient information of the doctor; c) Digital waste due to over exposure. (left to right)

[Table/Fig-3] shows a few examples of frequently encountered technician errors. In [Table/Fig-4], a few examples of repeat images related to patient, physician or equipment can be seen.

DISCUSSION

To the best of our knowledge, there is no study on reject analysis in DDR in Turkey. The present data were found to be consistent with international literature. The primary cause of rejects/repeats in the present study arose from technicians, with a rate of 88%. This rate was also 82.3% and 77% in the studies conducted by Andersen ER et al., and Hoffman B et al., respectively [3,8]. This value varied between 30-83% in the studies on CR [1,5,9-12]. The overall hospital's rejection rate was 1.2% which was reported as 12% by Andersen ER et al., 11% by Hoffman B et al., and 4.89% by Lin CS et al., [3,8,13]. Compared with studies on DDR, the present rejection rate was consistent with 1% reported by Akhtar W et al., [14], but remained quite low in comparison to the results of Andersen ER et al., Hoffman B et al., and Lin CS et al., [3,8,13].

These results suggest insufficient expertise and inadequate skills of the technicians working with these new technologies of DDR and CR. The most encountered errors arose from technicians were positioning error (36.11%) of the patient. The present result for positioning error was quite low compared with the results of Andersen ER et al., (77%), Hoffman B et al., (51.3%) and Lin CS et al., (56.05%) while consistent with the results of Akhtar W et al., [14]. Positioning error was the most encountered problem in the CR systems too [1,5,9-12,15,16]. Collimation error was determined as another technician error increasing reject/repeat rates. In the present study, it was 13.1% whereas Hoffman ER et al., reported a collimation error of 6.4% [8]. These results may be due to the deficiency of technicians to reflect theoretical knowledge on collimation adequately to the routine practice.

Chest (adult and child), cranial, lower extremity, upper extremity, vertebra/pelvis, Direct Uriner System (DUS) and abdomen radiographs were selected in the study because they are common in routine DDR practice. The highest reject/repeat rate was found to be in the chest radiograms (38% in adults and 10% in children) while the lowest rate was observed in cranial (3%). The reject/repeat rate in the chest radiograms of our study was above the 6.9% rate reported by Hoffman ER et al. However, our results for the lower extremity (15%) and upper extremity (8%) radiograms were considerably lower than the results of Hoffman ER et al., which were 59.1% for lower extremity and 25.4% for the upper extremity [8]. The reject/repeat rates we obtained concerning the anatomical regions were consistent with the results of Jones AK et al., [12]. The high reject/repeat rate obtained in the chest radiograms may be due to the difficulty in positioning for this region.

With the digital revolution in imaging, it was anticipated that 10-15% reject/repeat rate in conventional radiographs would be reduced to 3-5% in digital radiography (CR and DDR). However, contrary to expectations, reject/repeat rate in digital radiography was found quite high in many studies [3,8,10,12], so the hypothesis regarding expectedly lower reject/repeat rates in digital radiography was invalidated. Nevertheless, this expectation regarding digital systems was supported by the results of several studies on CR [1,5,6,11,15,16].

The rejection rate in the present study was below WHO recommendation of 5% [16], even lower than what was expected from the digital departments, i.e., 2% [6]. This result demonstrated that the rejection rate was within the acceptable limits of Radiology unit quality control and quality assurance studies. However, it is of great importance to advance further with education, training and management plans in quality improvement studies, with a view in reducing preventable reject/repeat rates, by taking into account frequent errors.

CONCLUSION

The rejection rate of our hospital was 1.2% in DDR which was found to be below the recommended reference value of 5% by WHO. This result revealed that, the radiographs taken in our unit are of high quality in terms of diagnostic information, but further training programs are needed to minimize positioning errors and thus making the significant contribution in reducing the rejection rate. The goal is to maintain the continuity of quality control efforts in DDR and to sustain training programs for the technicians in order to ensure reliability in the diagnostic evaluations and to reduce the repeat/reject rate.

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