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SHORT COMMUNICATION

Repeat Rate Analysis of Lower Limb Radiograph for Digital Radiography in General Radiography at Pantai Klang Hospital Selangor

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Abstract

Assessing the repeat rate is crucial to reduce unnecessary dose to the patient by identifying the major cause for repeating the x-rays exposure to the patient and apply corrective measures. To analyse the repeat rate of routine lower limb projections in direct digital radiography (DR) from general radiology department of Pantai Klang Hospital. 26 months retrospective repeated radiograph was acquired from Picture Archiving and Communication System (PACS) at Hospital Pantai Klang. The retrieved radiographs were grouped based on the reason for the i radiographs being rejected which are incorrect positioning, incorrect collimation, patient movement, incorrect exposure factors, artefact, and other reasons. Total repeated radiographs retrieved for basic lower limbs projections were 13616. Knee was the highest repeted examination and the lowest repeat rate was tibia fibula. (repeat rate: knee = 1.04%, tibia fibula = 0.57%). incorrect positioning is the major causes for repeat exposure for all examinations type, followed by incorrect collimation, other categories, centring ray error, incorrect exposure factors and artifact.

Introduction

General radiography is an essential diagnostic tool and mostly chosen as initial imaging modality to assess pathology in patient. General radiography as such plain radiography offers economical fees, less radiation exposure and fast image acquisition compared to other imaging modalities. However, to achieve an excellent image that allow physicians to diagnose any pathology in patient, the image must include the region of interest with excellent image quality. As radiographers working in general radiography, they certainly would experience scenario where the image is not passable to the physicians. Therefore, the image must be rejected, and patient need repeat the procedure to achieve an image with the important criteria.

Modernisation of x-rays machines allow the fast image acquisition and wide range of image processing. Thus, it is easier also faster for radiographer to delete image and repeat the procedure. Nevertheless, this habit of repeating image retake can increase radiation

exposure to the patient which can cause an effect. X-rays radiation are harmful to cells as it may cause cell mutation and then result in cancer development (Brady et al. 2012). Therefore, radiation protection should be implemented to reduce the repeat rate in general radiography of each institution. 14% of absorbed dose is from repeated radiographic examination. Radiographers should be responsible of ensuring patient safety even in the examination room(Stecker et al. 2009). Therefore, the repetition exposure will increase the amount of dose exposure to the patient (Jabbari, Zeinali, and Rahmatnezhad 2012). Workflow in clinical also will be affect for instance time and energy consuming which reduce the efficiency of workflow in radiology department. This also reduce economical of hospital as repeating the high energy to produce radiographs. Increase repeat rate can portray that the radiographers do not apply the radiation protection principal which proven they lack responsibilities and skills. This study is performed to analys the repeat rate for lower limb projections examinations and investigate the reason for repeated examiation.

Materials and Methods

This study is a retrospective study that is carried out in Hospital Pantai Klang, Selangor. All repeated radiographs, for lower limb that were examined at the radiology department from January 2018 until February 2020, were acquired from PACS. The radiographs include the radiograph acquired from the outpatient, inpatient and also trauma cases using direct digital radiography (DDR). However, only radiograph produced from the basic projection, which are anterior posterior and lateral, are accounted for this study. Routinely, if the radiographer decided to reject the radiograph, which was processed by digital system, and repeat the X-ray examination, they must select the reason for that radiograph being rejected. The reason are categories into six categories which are are incorrect positioning, incorrect collimation, patient movement, incorrect exposure factors, artefact, and other reasons. Thefore, the acquired radiographs for this study were grouped based on the similar catagories and repeat rate was calculated.

Results and Discussion

Total of digital x-rays radiographs acquired for routine LL projections in Pantai Klang Hospital for 26 months are 13,616. They includes an examination of femur, knee, tibia fibula, ankle and foot. Reject rate for all examinations was 0.88% which is below than the reject rate limit (2.5%) recommended by Bahagian Kawalselia Radiasi Perubatan Malaysia.

Total repeated radiograph each part of the lower limb examination was summarized in Table 1. The highest repeat rate is knee projections (1.04%) while the lowest repeat rate was tibula-fibula projections (0.57%). Meanwhile for femur, ankle and foot have the repeat rate between 0.97% and 0.66% (Table 2). Major reason to repeat an X-ray examination for knee was due to incorrect positioning (37.5%). It is also a reason to repeat an examination for other lower limb examination (36.7%). Repeated radiograph due to artefact contributes the lowest percentage for both knee and other lower limb examinations (4.2%) (Figure 1).

Table 1: Total image acquired and total repeat exposure for each type of projections of 26 months.

Projections Type	Total Repeat Exposure	Total Images Acquired	Repeat Rate (%)
Femur	12	1825	0.66
Knee	48	4600	1.04
Tibia-fibula	5	875	0.57
Ankle	33	3393	0.97
Foot	22	2923	0.75

Table 2: Reason for the repeated examination for each part of lower limbs.

| Type of Projections	Femur	Knee	TibulaFibula	Ankle	Foot	Total
Incorrect Positioning	3 (25.0%)	18 (37.5%)	2 (40.0%)	11 (33.3%)	10 (45.5%)	44 (36.7%)
Artifact	1 (8.3%)	3 (6.3%)	0 (0.0%)	0 (0.0%)	1 (4.5%)	5 (4.2%)
Incorrect Exposure Factors	1 (8.3%)	3 (6.3%)	1 (20.0%)	4 (12.1%)	2 (9.1%)	11 (9.2%)
Incorrect Collimation	4 (33.3%)	10 (20.8%)	1 (20.0%)	8 (24.2%)	4 (18.2%)	27 (22.5%)
Centering Ray Error	2 (16.7%)	9 (18.8)	0 (0.0%)	3 (9.1%)	1 (4.5%)	15 (12.5%)
Other Categories	1 (8.3%)	5 (10.4)	1 (20.0%)	7 (21.2%)	4 (18.2%)	18 (15.0%)
Total Image Reject	1 (100%)	48 (100%)	5 (100%)	33 (100%)	22 (100%)	120 (100%)
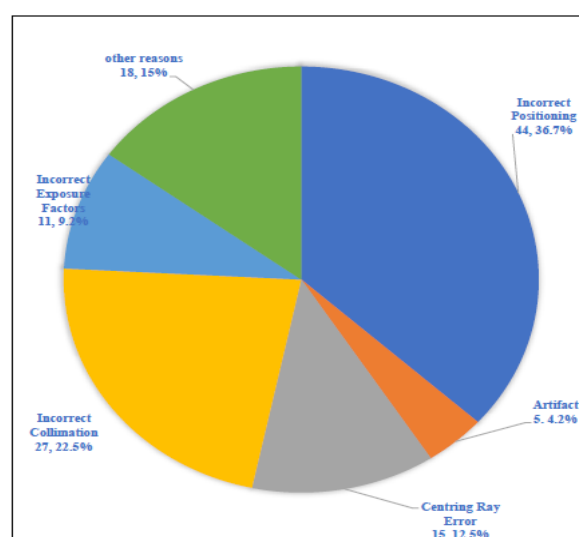
Figure 1: Reason for the repeated examination for lower limbs within in 26 months.

The aims of this study was to analys the repeat rate for lower limb projections examinations and investigate the reason for repeated examination at Hospital Pantai Klang. According to Anderson et al (2011), repeat rate affected by population of patients, type of projections, type of equipment, radiographer's skill, and how the rejected digital image is registered on the examination console (Andersen et al. 2012). From this study, the highest number of the repeated radiograph was due to inaacurate positioning. Other repeated reasons including incorrect collimation, centering ray and incorrect exposure factor. All of these reasons can be categoried under radiographer's error. This may indicate that, radiographer are incompetent or lacking in skill to perform X-ray examination particularly for lower limb. Evarage working experience for radiographer in Pantai Klang Hospital is one year. It can be considered as fresh graduate working experience level. However, with the the total number of radiographer is five, they had to perform numerous radiograhic examination within a day thus strengthen their skill. Other researcher also reported that, repeated examination due to radiographer error contribute 78% for repeated radiograph in lower limb(Jabbari et al. 2012) indicating that radiographer error was the major reason for repeated examination.

Furthermore, the decision for rejecting the radiograph is subjective. It is depend on the radiographer and radiologies and bases on their preference and standard. Some radiographer may reject the image as they feel it is not aesthetic enough for them but for other radiogpher, that radiograph is diagnostically acceptable. Therefore, there is a need for develop a guideline to passing or rejecting a radiograph.

Anderson et al (2019) mentioned that the variety of complexity of individual examination may be the major factor that affecting the repeat rate. Knee is the highest projection with 1.04% and followed by the least repeat rate is tibula-fibula projection with 0.57%. For instance, knee projections may be more complex than other routine LL projections as slight malrotation of patient's knee will reduce the criteria needed to pass the image. Moreover, it become more challenging when encounter geriatric and trauma patients with mobility difficulty.

Quality Assurance Programs (QAP) need to be enhanced as repeat rate analysis have the limitation where consistent and integrity of the data is not assured (Foos et al, 2009). Proper training and education to the radiographers may help to reduce this problem. Radiographers should know the importance of reliable data to identify actual performance. Exportation of data should be done more regularly to avoid any potential data loss. Assess to the deletion of images in PACS should only be available for authorised personnel only. Improvement of system should be made where the number of rejected and acquired should remained permanent even after the actual image is deleted. QAP should be fully utilised to provide excellent services to the patient.

Conclusion

Average for all RR is 0.88% which abide by the standard protocol. Knee projections accounted for highest repeat rate (1.04%) and incorrect positioning is the most causes of repeat exposure for all projections. RR can be reduced by improving radiographers' skills and knowledges, enhance feedback system between radiologist and radiographers, commencing regular overall repeat rate analysis for each of examinations, set a standard criteria in department, regular exporting the data to external devices and providing more options to choose for image rejection in the system.

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References

Andersen, Eivind Richter, Jannike Jorde, Nadia Taoussi, Sadia Halima Yaqoob, Bente Konst, and Therese Seierstad. (2012). "Reject Analysis in Direct Digital Radiography." *Acta Radiologica* 53(2):174–78.

Brady, Z., F. Ramanauskas, T. M. Cain, and P. N. Johnston. (2012). "Assessment of Paediatric CT Dose Indicators for the Purpose of Optimisation." *British Journal of Radiology* 85(1019):1488–98.

Jabbari, Nasrollah, Ahad Zeinali, and Leili Rahmatnezhad. (2012). "Patient Dose from Radiographic Rejects/Repeats in Radiology Centers of Urmia University of Medical Sciences, Iran." *Health* 04(02):94–100.

Stecker, Michael S., Stephen Balter, Richard B. Towbin, Donald L. Miller, Eliseo Vañó, Gabriel Bartal, J. Fritz Angle, Christine P. Chao, Alan M. Cohen, Robert G. Dixon, Kathleen Gross, George G. Hartnell, Beth Schueler, John D. Statler, Thierry de Baère, and John F. Cardella. (2009). "Guidelines for Patient Radiation Dose Management." *Journal of Vascular and Interventional Radiology* 20(7 SUPPL.):S263–73.