
Study of Common Requested Radiographs and Relative Exposure Dose in Qassim State

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To cite this article:

Abdulrahman Abdullah Saad Alsayyari, Mohammed Ahmed Ali Omer, Nasraldeen Alnaeem Mohammed Alkhidir, Abdelmoneim Saeed Ahmed Auod. Study of Common Requested Radiographs and Relative Exposure Dose in Qassim State. *International Journal of Medical Imaging*. Vol. 5, No. 2, 2017, pp. 14-18. doi: 10.11648/j.ijmi.20170502.12

Received: February 20, 2017; **Accepted:** March 1, 2017; **Published:** March 18, 2017

Abstract: The objective of the article was to study the common requested radiographs and relative exposure dose in Qassim state in Kingdom of Saudi Arabia. The method was retrospective and analytical study for collected variables as radiographs, relative entrance surface dose (ESD) and the effective dose, patient age, gender and causative factors. The analysis with excel software revealed that: the common requested radiographs were skull, abdomen and chest with male incidence as 75%, 72.2% and 64% respectively relative to whole sample. Traffic accident (71%) and fall-down (45%) were the most causative factors among male and female respectively, with injuries as skull fissure fracture (77%) and intracranial hemorrhage (23%). The skull radiographs noted among the age group of 11-21 years and peaking at 36% among the age group of 22-32 years. The requested abdominal radiographs appeared among the age group of 13-21 years; with frequency of (19%) and peaking at 30% among the age group of 22-30 years; with injuries as spleen ruptures (42%) and liver (27%). The chest radiographs observed among age group of 3-13 years; with frequency of 4% and peaking among age groups of 14-24 & 25-35 years old with frequencies of 19% and 21% respectively, and injuries as Ribs fracture (55%), ribs dislocation (15%), pierced lung (20%) hemorrhage (10%). The average ESD for *abdomen, skull and the chest radiographs* were 1.93 ± 0.8 , 1.53 ± 0.6 and 0.21 ± 0.2 mGy which were increase linearly following the aging. And the average effective doses were 0.24 ± 0.1 , 0.1 ± 0.1 and 0.4 ± 0.2 mSv respectively.

Keywords: Skull, Abdomen, Chest, Exposure, Radiation

1. Introduction

The medical requested examinations (radiologic or laboratory) are common for routine medical checkup, follow up and in case of emergencies; however the rate and the incidence of such examinations influenced by some factors; as the number population, wealth of population, age factor, gender, habits, etc. And the common diagnostic modalities used in radiology field are ultrasound which is a friendly applicable, available and safe in diagnosis for soft tissue pathologies in addition to x-ray and magnetic resonance imaging (MRI). However Kristin and Bjorn, [1] highlighted

some additional factors that may influence the rate of requested radiograph out of questionnaire article which were: (a) new radiological technology, (b) peoples' demands, (c) clinicians' intolerance for uncertainty, (d) expanded clinical indications and (e) availability in addition to over investigation and insufficient referral information were reported as the most frequent causes of unnecessary investigations. And due to such factors the general request or the frequency of radiography has been roughly doubled and in some countries tripled during the five years preceded 2008 as has been reported by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [2].

The use of radiological investigations have been accepted and justified for medical practice in terms of clear clinical benefits to the patient, and small radiation risks. And what is so encourage-able for utilizing x-ray in imaging is the fact stated by ARPANSA [3] that “*patient would need to have approximately 38 chest x-rays to receive an amount of radiation similar to that of normal background radiation that everyone receives for one year from the environment*”. However, even small radiation doses are not entirely without risk, and moreover certain committed mistakes may increase the exposure dose to patient and staff which in turn would increase the stochastic effects; hence some studies [4, 5] impose a responsibility on imaging departments to ensure that all exposures to ionizing radiation should be justified, and that doses are optimized and consequently the organizations and individuals using ionizing radiation must comply with these regulations.

The compliance of organizations and individuals dealing with ionizing radiation will results in avoiding the major health risks (*Cancer occurring many years after the radiation exposure and Health problems in the children due to damage to the reproductive cells in the body*) that occur as a result of exposure to medical ionizing radiation which is agreed with unanimous consensus which stated that: the decreasing of exposure dose would decreases the stochastic effects linearly without threshold [6, 7]. The patient dose in the field of radiography has been quantified in term of Entrance Surface Dose (ESD)/radiograph or in term of Dose Area Product (DAP) for entire examination [8] and for radiation risk better in term of effective dose. The major benefit of using the effective dose is that: it accounts for the absorbed doses and relative radio-sensitivities of the irradiated organs in the patients and, therefore better quantifies the patient risk [9]. However the estimated dose for radiographic case depends on several parameters, such as patient's age and weight, body region and clinical indication. These data are normally stored in several formats and with different nomenclatures, which hinder the continuous and automatic monitoring of these indicators and the comparison between several institutions and equipment unless studied and sorted out in term of ESD/radiograph or DAP, dose length product (DLP). The frequent incidences of radiographic examination requests have significant impact in economic status of the countries, quality of medical services and patient and staff risks [10-12], as these common request of radiologic investigations have consequences of increasing radiation doses; that turn the attention of many scholars [13, 14] as well as the trend of this study in addition to directing the authorized parts in Qassim state to layout some proposed solving for the common and high incidence factors (*Traffic accident, violence driving and fall-down*) that increase the request of radiographic investigation.

2. Methodology

This is a retrospective study based on extraction of

common requested radiographs that performed for the patients during January 1- July 1, 2016 in different hospitals' and clinics' picture archiving communication systems (PACS) at Qassim state, after the approval of the local ethical committee of the institutions for the study method and signing the informal consent. The x-ray systems were digital radiography (GE, healthcare, model A101CII, 2011-German), applied kVp 75±2, mAs 20±3 for the skull, kVp 65±5, mAs 23±3 for abdomen and kVp 70±2, mAs 20±3 for chest while the focal film distance was 100 cm for all cases. The total common cases encountered have been under focus by the researchers and the relative exposure doses, which were represented the skull; chest x-ray and abdomen with relative number as 70, 83, and 88 patients respectively. The collected and sorted data were gender, age, causative factors, abdomen radiographs, chest radiographs, and skull radiographs with their relative entrance surface doses (ESD) in mGy and effective dose (EffD) in mSv. The doses have been derived from the product of system output, mAs, back scatter factor BSF (1.4), focal detector distance FDD and focus – skin-distance FSD based on the equations (1, 2) stated by ICRU, [15] and Davies et al, [16]:

$$\text{Dose (mGy)} = \frac{\text{Output} \left(\frac{\text{mGy}}{\text{mAs}} \right) \times (\text{mAs}) \times (\text{BSF}) \times (\text{FDD})^2}{(\text{FSD})^2} \quad (1)$$

Then the effective dose in mSv has been derived from the equation stated by International Commission on Radiological Protection [16].

$$\text{EffD} = \sum \frac{W_T [H_T(\text{female}) + H_T(\text{male})]}{2} \quad (2)$$

Where W_T refers to weighting factor for organ or tissue and H_T refers to equivalent dose to organ or tissue.

3. Result

The following results will highlighting the common requested radiographs, the relative exposure doses, gender and age and causative factors, being plotted in forms of bars, correlation and graphs in Qassim state.

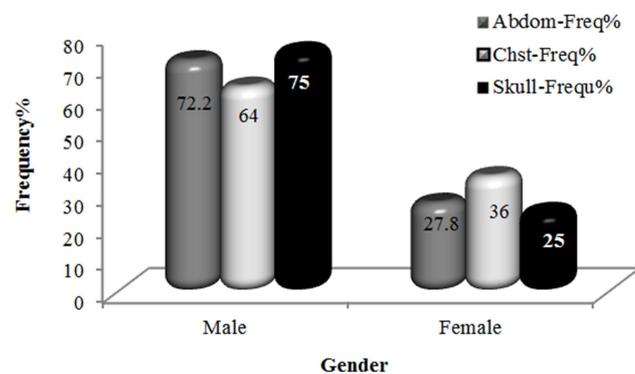


Figure 1. Shows the distribution of requested radiographic cases based on gender.

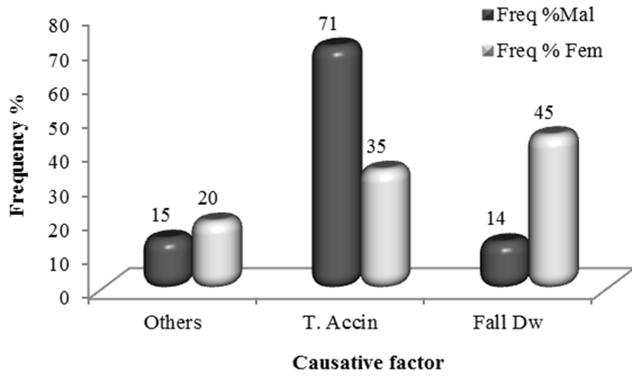


Figure 2. Shows the distribution of requested radiographic cases based on causes.

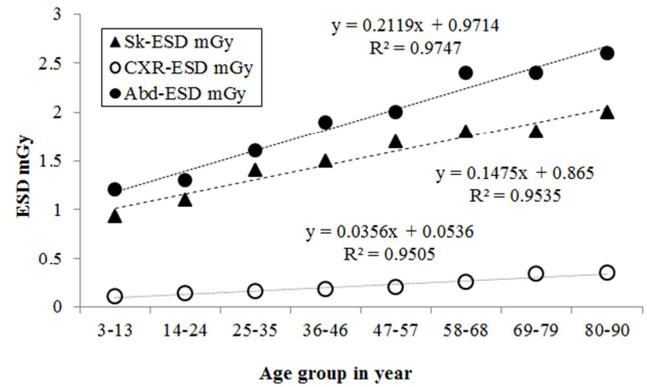


Figure 6. Shows the correlation between entrance surface dose in mGy and patient age group in radiography.

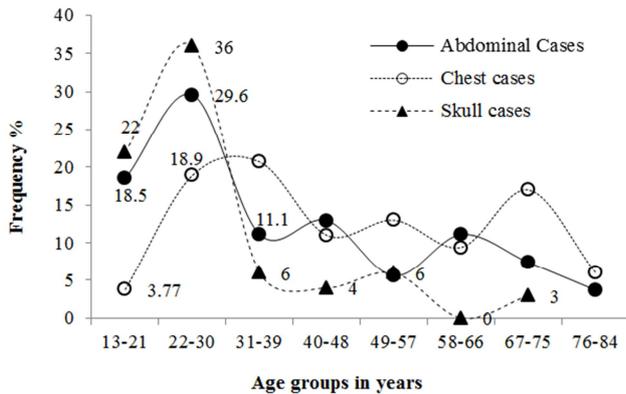


Figure 3. Shows the distribution of the common requested radiographic cases based on age.

4. Discussion & Analysis

Figure 1: shows the distribution of requested radiographic cases based on gender. It revealed that: the common requested radiographic cases were the skull, abdomen and chest with incidences among male representing 75%, 72.2% and 64% respectively relative to total sample. However such high requested radiographs for male were attributed to traffic accident factor with 71% relative to other causative factors such as fall down which represents the common factor for requested radiographic exams among female 45% (Figure 2), while traffic accident represents only 35% among female. In comparison with this study, Colin et al, [18] stated that: the road traffic accident has been as a large burden among developing countries which accounting for 85% of annual deaths and 90% of the disabilities and as well the majority of victims were male with 73% relative to female and the common involved age group was 15-29 and 30-44 years old. In deed such high incidence of traffic accident became in needful to urgent examinations which in turn will increase the radiographic exams requests and other modalities of investigation that burden the economic status in families and countries.

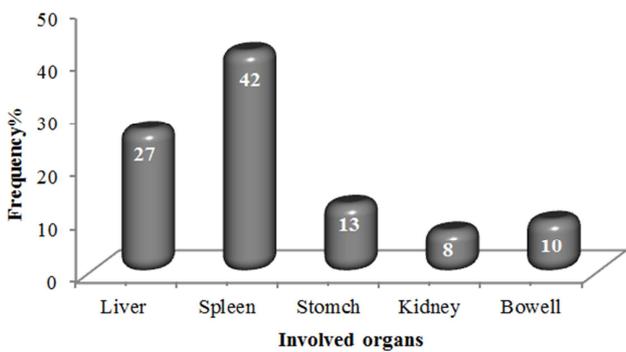


Figure 4. Shows the frequency of abdominal injured organs in traumatic accident.

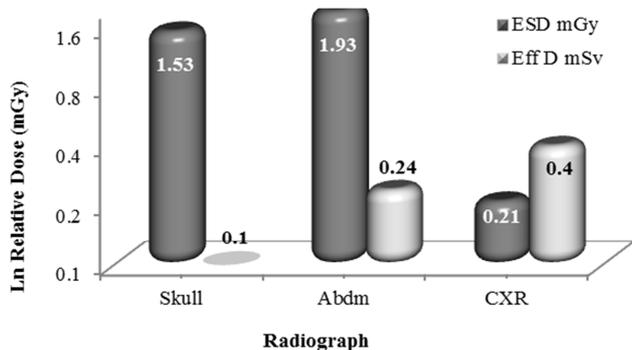


Figure 5. Shows the average ESD in mGy & EffD in mSv received by common anatomical site radiography.

Figure 3: shows the distribution of requested radiographic cases based on age, in which the request skull radiographs have been noted among the age group of 11-21 years old and peaking at 36% among the age group of 22-32 years old then the request of exams decreased rapidly (5% in average) following aging; the most common injuries were fissure skull fracture (77%) and intracranial hemorrhage (23%), while second common requested radiographs were the abdominal cases which noted among the age group of 13-21 years old with frequency of (19%) and peaking at 30% among the age group of 22-30 years old as agreed with Mousami et al, [19], then the request of exams decreased rapidly (8.6% in average) following aging; and the most common noted injuries were spleen ruptures (42%) and liver (27%) (Figure 4) as agreed with Innocent and Mbale, [20] which have been confirmed in ultrasound sections. And the third common requested cases were the chest radiographs which have been noted among age group of 3-13 years old with frequency of 4% and peaking among age groups of 14-24 & 25-35 years

old with frequency of 19% and 21% respectively then the request frequency decreases following aging to an average of 11%, with common injuries as Ribs fracture (55%), ribs dislocation (15%), Pierced lung (20%) hemorrhage (10%). Such high requested radiographs among early youth and teenage ascribed to common violence driving, high speed and as well the customary teenage drivers among the natives of Qassim state. These common requested cases (*abdomen, skull and the chest radiographs*), inevitably accompanied with considerable radiation exposure dose in view of entrance surface dose (ESD) in Milli-Gray (mGy) and effective dose (EffD), in Milli-Severt (mSv) which were 1.93 ± 0.8 , 1.53 ± 0.6 and 0.21 ± 0.2 mGy for ESD respectively and the effective doses for requested chest, abdomen and skull radiographs were 0.4 ± 0.2 , 0.24 ± 0.1 and 0.1 ± 0.1 mSv respectively as shown in Figure (5). In comparison with the study done by Akbar et al, [21] in which the mean ESD were 2.01, 1.39 and 0.37 mGy and the ED were 0.28/abdomen, 0.01/skull and 0.04/chest mSv; it is so obvious that the current study showed less exposure of ESD for abdomen by 0.08, greater dose by 0.14 mG for skull and less exposure dose by 0.16 mGy for chest radiographs. And as well the ED showed that the current study revealed greater exposure dose by 3.6 mSv for chest radiography, less exposure dose by 0.04 mSv for abdomen and greater exposure dose by 0.09 mSv for the skull, however all exposure doses are still within the limits stated by authorized organizations. Also for chest exams; the current study showed less ESD compared with study done by Kofi et al, [22] which was 0.27 mGy while the ED so higher than they obtained (0.02 mSv).

The variation of exposure dose have been noted by many scholars [23-26] even among same aged patients and size, which indicates the influence of other parameters affecting the general exposure dose. However the data also revealed that: the ESD for the requested cases (*abdomen, skull and the chest radiographs*) have been increased following the aging in a linear significant correlation ($R^2 = 0.9$) that could be fitted to equation of the form: $y = 0.2119x + 0.9714$, $y = 0.1475x + 0.865$ and $y = 0.0356x + 0.0536$ respectively; where x refers to the age in years and y refers to ESD in mGy as shown in Figure (6). Indeed the increment of ESD for abdominal cases ascribed to usage of wide large radiation field which is in proportional with aging and due to tissue quality factor in case of effective dose. In comparison with the exposure level stated by International Atomic Energy Agency, these obtained results are still within or below the limits [27, 28].

5. Conclusion

Qassim state in Kingdom of Saudi Arabia, like other universe cities, having the common requested radiographs as skull, abdomen and chest which were ascribed to traffic accidents and violence driving among male aged 14-24 & 25-35 years old and the falling down was the causes for female and the notable cases were the teenage victims due to violence driving. However the exposure doses were below or within the permissible range.

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