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THE FEASIBILITY OF CT GUIDED INTERVENTIONAL THORACIC PROCEDURE USING A LOW RADIATION DOSE

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ABSTRACT

The aim of the study was to determine the feasibility of Computed Tomography (CT) guided interventional thoracic procedure using a low radiation dose. Considering the inclusion and exclusion criteria 44 patients were included in the study. The procedures was performed on a Phillips Brilliance Big Bore 16 Slice CT. The first series of the images was obtained at a standard dose of 325 milliampere seconds (mAs) and all subsequent series of images was acquired using low dose of 100 mAs. Parameters such as mAs, Computed Tomography Dose Index volume ($CTDI_{vol}$ and Dose Length Product (DLP) was collected from dose information displayed on workstation monitor for each series of scan. Image quality was reviewed by individual radiologist performing the procedure. Technical success of using low dose was evaluated by observing the frequency of successful cases. The result showed that mean Dose Length Product for low dose was 85.75 mGy*cm compared to 346.55 mGy*cm for standard dose. The study concluded that a low dose protocol yielded a 75.3% decrease in radiation dose with 100 % technical success. Hence, the protocol could be implemented efficiently for the daily interventional procedures allowing the radiographer to reduce the risk of ionizing radiation while maintaining the overall image quality and efficiency.

KEYWORDS: Computed Tomography, milliamperage seconds, Computed Tomography dose index, Dose Length Product

INTRODUCTION

Computed Tomography also called as Computed Axial Tomography scan is a useful diagnostic tool aiding in diagnosis of abnormalities lying within the body parts [(1)]. Computed Tomography examination has increased significantly over the last decade and usage of Computed Tomography has also increased manifold to guide interventional procedures due to its efficiency and accuracy [(2)]. Recently this imaging modality is being used to perform a wide range of image guided diagnostic and therapeutic procedures as it provides the depth information which gives the exact location of the disease [(3)]. Common interventional procedures performed to extract sample from the mass lesion includes Computed Tomography guided thoracic biopsy and fine needle aspiration cytology which covers the lungs, mediastinum and lung parenchyma. Other biopsies include abdominal biopsy, bone biopsy which are uncommon and are performed under the guidance of Computed Tomography [(4,5)]. The role of Computed Tomography is vital in comparison to the other modalities such as ultrasound and fluoroscopy when location of lesion is critical such as close to mediastinum or great vessels. Since Computed Tomography guided interventional procedures involves multiple exposure to the patient, it causes dramatic increase in the dose accumulated throughout the procedure [(6)]. Radiation dose is considered harmful because of its ability to cause biological damage. These effects can be classified as deterministic effect and stochastic effect. In deterministic effect the severity increases with the increase in dose and the effect is noticed only above a threshold value, whereas for stochastic effect to occur there is no threshold required and the effect can take place at any given level of exposure [(7)].

Radiation dose is characterized by special quantities and units which depicts the amount of radiation obtained by the patient [(8)]. Effective dose is used to quantify the risk from limited body exposure to that from an equivalent whole body dose. In Computed Tomography, the effective dose is calculated from the dose length product [(8)]. Dose length product refers to the dose deposited throughout the length of the scanned area and is calculated by scan length and computed tomography dose index volume ($CTDI_{Vol}$) which represents the average absorbed dose in x, y and z directions. [(8)] Dose can be reduced by altering the technical parameters which directly affects the radiation dose delivered by Computed Tomography scanner such as kilo voltage peak, pitch, collimation, milliamperage seconds [(9)]. Milliamperes is the amount of current supplied to the x-ray tube which controls the amount of x-ray photon emission. It is influenced by the current-time product (milliampere-seconds) and is directly proportional to the radiation dose received by the patient [(9)]. However, a reduction in mAs can also degrade the image quality. Image quality is considered an important factor while performing the diagnostic procedures, however when performing a guided therapeutic procedure, the image quality doesn't pose a concern if the needle tip is visible under applied technical setting. As Computed Tomography guided interventional procedures can be performed using lower doses it is important for the technologist as well as the radiologists to understand the efficiency of parameters which affect the dose. Thus, the aim of the study was to determine the feasibility of Computed Tomography guided interventional thoracic procedures using a low radiation dose as radiation exposure is a cause of concern and dose optimization is necessary.

MATERIALS AND METHODS

On approval from Institutional Ethics Committee, Kasturba Hospital. 44 subjects referred for Computed Tomography guided interventional thoracic procedure having a normal body mass index (18.5-25.9) [10] were included in the study based on convenience sampling technique. The procedures were performed on 16 slice MDCT at Dept. Of Radio-diagnosis and Imaging, Kasturba Hospital. Informed consent is obtained from the subjects. The subject was positioned on the Computed Tomography couch either in prone, supine or lateral decubitus as per location of the lesion with head first position. A small slab was planned to include the lesion with thickness and increment of 3mm. The first series of the images were obtained at a standard dose of 325 milliamperage seconds and all subsequent series of images were acquired using low dose of 100 mAs. Dose information such as dose length product was noted down from the Computed Tomography console monitor. Images obtained using low dose was reviewed by individual radiologist performing the procedure for appropriate image quality. If the procedure could not be continued due to lower image quality because of low dose, it would be performed using the standard dose and the study will not be considered successful. Technical success of using low dose was evaluated by observing the frequency of successful cases.

RESULTS

The results showed a 100% success rate for performing CT guided interventional thoracic procedure using a low radiation dose. The mean dose length product was found to be 85.57±39.68 mGy*cm for 100 mAs and 346.55±82.67mGy*cm for 325 mAs respectively as summarized in Table.1. Statistical analysis was dose using the paired t-test. The paired t-test was performed to compare the mean dose length product between the low dose and standard dose. The difference in mean dose length product was found to be 261.05mGy*cm which was statistically significant. The study showed a 75.3 % decrease in radiation dose using the low dose protocol. The mean values for dose length product for standard dose (325 mAs) and low dose (100 mAs) are shown in Figure.1

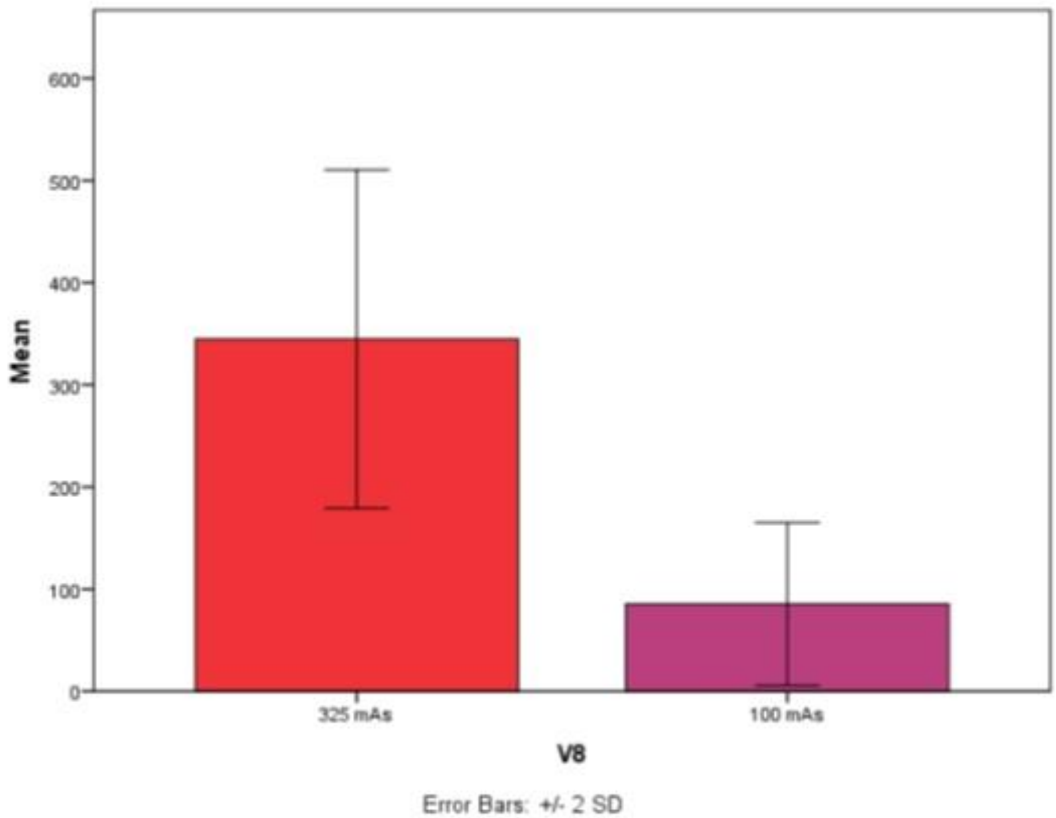

Figure 1: Bar diagram showing the mean Dose Length product between 325 mAs and 100 mAs. Error bar represent the standard deviation.

DISCUSSION

Usage of Computed Tomography has increased manifold in Computed Tomography guided interventional procedures due to its efficiency and accuracy [3]. Since Computed Tomography guided interventional thoracic procedures involves multiple exposure to the patient, it causes dramatic increase in the dose accumulated throughout the procedure. Radiation dose and the risk of radiation induced cancer from various medical imaging procedures have gained a widespread concern throughout the medicine community. Numerous studies on radiation dose reduction techniques to investigate radiation dose to the patient undergoing Computed Tomography guided interventional procedures have been reported in literature. The Dose Length Product obtained in the present study using a lower mAs was found to be 85.75 mGy*cm. Similarly, a study reported by Kallianos et al [11] showed a dose length product of 113.8mGy*cm whereas Smith et al [12] reported a Dose length product as low as 18.3 mGy*cm as shown in Table.1. The variation in dose length product in these studies can be due to the technical parameters adjusted in achieving a low dose protocol. The present study help us to determine the feasibility of performing a Computed Tomography guided interventional procedure using a low mAs, whereas a study conducted by Kallianos et al technical parameters such as kilo voltage peak was also adjusted along with mAs [(11)]. The current study used a milliampere second of 100 as dedicated phantoms was unavailable to assess the image quality. The limitation of using lower mAs is that it decreases the image quality. In the present study, image quality was evaluated by individual radiologists performing the procedure. The technical success in performing the procedure was 100 % success. [Figure 2 &3]. Lucey et al conducted a similar study by 30 mAs and image quality was analysed by calculating the frequency of technical success of the procedure. The technical success in performing the procedure stated 96.7 %[(13)]. However, Smith et al conducted a study to check the technical success in performing a CT guided procedure using an ultra-low dose protocol [100 kVp and 7.5] and evaluated the image quality qualitatively using a 5-point scoring scale. He reported most of studies were rated good or excellent, however a few were rated merely adequate. The technical success in performing the procedure was 92 % [(12)]. Numerous studies reported in literature categorizes subjects into groups. However, in the present study, scan was performed and compared with same subject to maintain the same scan length as to know the efficiency of dose reduction for the scanned area. Further phantom studies can be done to select an optimum milliampere second without compromising the image quality.

Table 1: Mean Dose length product of standard and low dose.

Scan area	**mAs**	**Mean DLP(mGy*cm)**
Thorax	325	346.55 ± 82.67
	100	85.75 ± 39.68

Table 2: Technical success rate of assorted studies.

STUDIES	SUCCESS RATE
Lucey et al. (13)	96.7%
Present study	100%

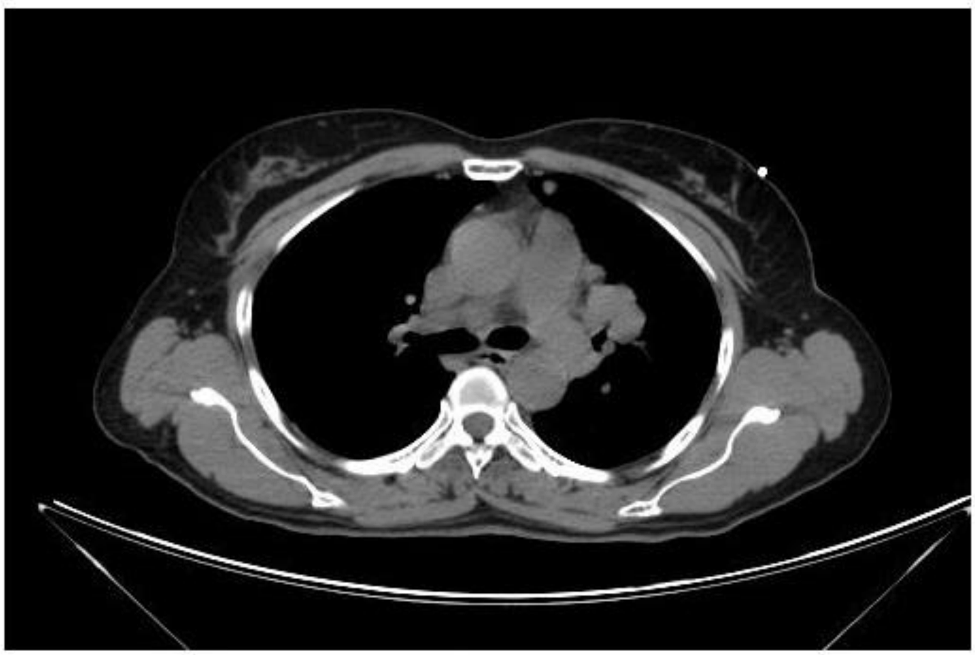

Figure 2: Image showing axial plane of Computed Tomography performed at standard dose of 325 mAs.

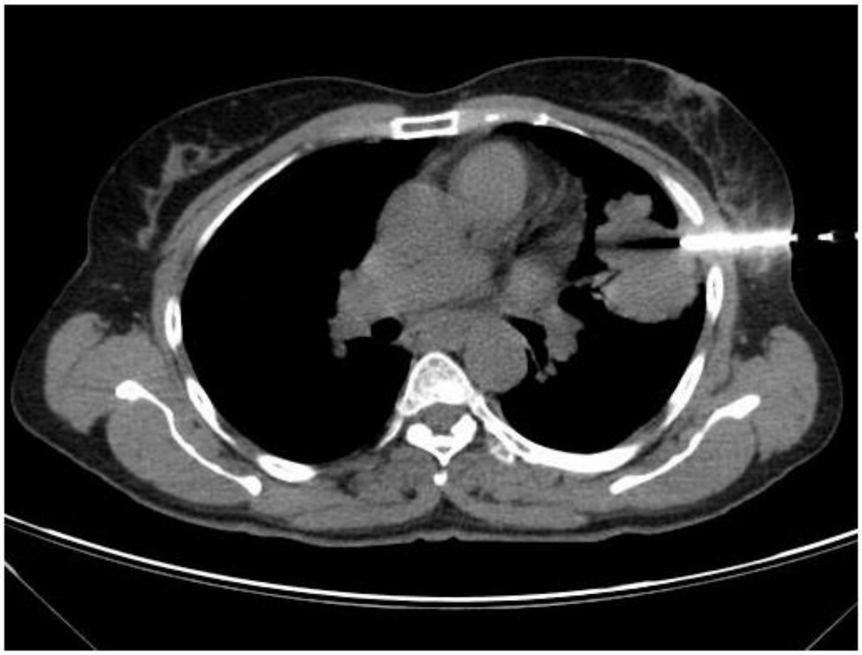

Figure 3: Image showing axial plane of Computed Tomography performed at low dose of 100 mAs.

CONCLUSION

The Dose length product estimated for Computed Tomography guided interventional thoracic procedures by using the low dose protocol was found to be 85.75 mGy*cm which showed a 75.3% reduction in radiation dose. The study also showed a 100 % technical success in performing the procedure using a lower mAs. Various modifications to the image acquisition and scan parameters like kilo voltage peak, rotation time, scan volume and pitch can be made to reduce dose. The dose can also be further optimized using automatic tube current modulation technique. Therefore, the study showed that a low dose protocol can be implemented efficiently for the daily interventional procedures allowing the radiographer to reduce the risk of ionizing radiation while maintaining the overall image quality and efficiency.

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