ORIGINAL ARTICLE

Lifetime Attributable Breast Cancer Risk Related to Lung CT Scan in Women with Covid19

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Abstract

Purpose: Organ, effective dose, and Lifetime Attributable Risk (LAR) of breast cancer incidence related to lung Computed Tomography (CT) scans were evaluated. Seven hundred thirty-five female patients (20-50 years old) with Coronavirus (COVID-19) in four medical imaging centers in Tehran, Iran, were surveyed. Patients' data, including age, sex, and exposure information (Kilovoltage (KVp), milliampere-second (mAs), pitch factor, Computed Tomography Dose Index (CTDIvol), and Dose Length Product (DLP)) were extracted from dose report pages in picture archiving and communication systems (PACS).

Materials and Methods: Patients were divided into six age groups of 20-25, 25-30, 30-35, 35–40, 40-45, and 45–50 years. Breast, thyroid, lung, and heart absorbed doses, and also effective doses, were calculated by National Cancer Institute (NCICT) software, and LAR of breast cancer incidence has been evaluated by the Biological Effect of Ionizing Radiation (BEIR) VII in phase 2 report.

Results: The average doses of breast, thyroid, lung, the heart were 3.97, 4.75, 4.10, and 3.37 mGy, respectively. Also, the average effective dose was 2.56 mSv. The average LAR of breast cancer in female patients was 7.45 per 100,000 exposures, decreasing dramatically with age. It was clear that exposure parameters and organ absorbed dose were significantly different between medical imaging centers (P value<0.05).

Conclusion: Although the CT scan is a useful instrument in the diagnosis of Corona disease, it should be suggested with caution due to the increased risk of breast cancer, especially in younger women and pediatrics. Also, low-dose CT scan protocols are recommended to minimize radiation effective and absorbed doses.

Keywords: Computed Tomography Scan; Breast Cancer; Covid19; Lung.

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1. Introduction

Pulmonary disorders are one of the most common and important diseases in human life globally. The coronavirus (COVID-19) is a highly contagious lung disease affecting many people worldwide. The active site of this virus is lung tissue and the respiratory tract, and by causing damage to the lungs, it causes impaired breathing and lung function [1-4].

Therefore, a chest X-ray can be one of the fastest ways to diagnose COVID-19. Although the high radiation dose for a patient with Corona disease undergoes by CT scan, this method is considered an efficient way to produce good quality images of lung tissue in diagnosing this disease [5].

Based on several epidemiological studies, high doses of radiation in diagnostic radiography significantly increase the risk of cancer in radiation-sensitive age groups, including young women and children [6-9]. Although patients benefit from the rapid diagnosis, there is a growing concern about the consequent effect of radiation exposure [10]. Even though radiation induces cancer statistically, i.e., the higher the radiation dose, the more likely it is to cause carcinogenesis, even a lower dose can cause it [11].

Some organs, such as breast tissue, are more sensitive to radiation, especially at younger ages. This subject has been proved in the Biological Effect of Ionizing Radiation (BEIR) report VII [12]. An increased risk of breast cancer has been shown in women who have received high cumulative doses in the thorax area, either by X-ray diagnostic methods or radiation therapy. Also, if a woman under 35 received 0.01 Gy of radiation dose, she is 13.6 times more likely to develop breast cancer [13]. this study aimed to evaluate the effective dose and risk of breast cancer due to lung CT scans in females infected with Covid19.

2. Materials and Methods

2.1. Study Population

We examined 735 female patients aged 20 to 50 with Covid 19 in four Corona centers in Tehran, Iran. Patients were classified into six age groups, including 20-25, 25-30, 30-35, 35–40, 40-45, and 45–50 years.

2.2. Dose Estimation

For measuring breasts' organ dose, scan parameters such as mAs, kVp, scan length, pitch factor, volumetric CT Dose Index (CTDIvol), Dose Length Product (DLP), CT scanner properties (model and manufacturer), and patient age were extracted from dose report pages [14]. Eventually, the breast absorbed dose (mGy) and effective dose were estimated using the National Cancer Institute (NCICT) version 2.01 [15].

2.3. Lifetime Attributable Risk for Breast (LAR)

According to Table 12D-1 of the BEIR VII report, which was developed by the United States Scientific Committee on the effects of atomic radiation, the LAR of cancer incidence from 100-mSv organ equivalent dose was calculated for each age [10,12]. Since there was not enough statistical information about the prevalence of breast cancer in different age groups of women in Iran, in this study, LAR was calculated using the dosimetry results of NCICT software and by linear interpolation method [16-18].

2.4. Statistical Analysis

One-way ANOVA variance analyses and Kruskal-Wallis tests were used to study the overall mean differences. Tukey's Post-Hoc test was applied to compare hospitals pairwise. All analyses were done considering a significance level of $\alpha=0.05$ and the p-value indicated the differences between centers A, B, C, D, and E.

3. Results

The present cohort study includes 757 women between 20 to 50 years old, 735 of whom had completed available data. In this study, the dose of breast, lung, thyroid, and heart tissue received the highest dose in a chest CT scan. The average doses received by the thyroid gland, lung, breast, and heart were 4.75, 4.10, 3.97, and 3.37 mGy, respectively. Table 1 indicates the average absorbed dose of these organs in each center. Since the breast is one of the sensitive tissues to radiation, and cancer of this organ is one of the most common cancers in women, the risk of breast cancer was investigated.

The organ's radiation dose from any CT scan procedure depends on exposure factors and scanner specification [14]. Some other factors, such as image reconstruction, filter, and image quality, which technologists could set to modify exposure parameters, can affect radiation dose indirectly [15].

The absorbed dose in center A is higher than other centers, and the reason is applying higher CTDIvol compared to the other three centers. On the other hand, the absorbed dose in center B has the lowest value compared to other centers (Table 2).

Table 1. Average of organ dose (mGy) and effective dose (mSv)

	A	B	C	D	P Value
Breast	5.24	1.5	3.97	4.62	<0.05
Thyroid	6.52	1.92	5.07	5.92	<0.05
Lung	6.11	1.58	4.19	4.88	<0.05
Heart	6.48	1.67	4.43	5.16	<0.05
Effective dose	3.39	0.88	2.47	2.73	<0.05

*Significant level is 0.05

In this study, there were significant differences between exposure parameters, including KVp, mAs, scan length, pitch factor, CTDIvol, and DLP (p value<0.05) among four imaging centers, also a significant difference was observed between the absorbed dose of breast tissue in the six groups (p value< 0.05). Table 3 indicates the average value of exposure parameters.

Table 2. Characteristics of CT scanners in each imaging center

Center	CT Company	Model	Number of slices	AEC Presence
A	Siemens	Somatom sensation	MSCT (64slice)	YES
B	Siemens	Somatom emotion	MSCT (16slice)	YES
C	GE	High speed	Dual	NO
D	Philips	Brilliance	MSCT (16slice)	YES

To evaluate a patient's total exposure, an effective dose can be an effective approach, but to demonstrate organ dose and LAR for non-uniform modalities such as CT scan, organ specific dose is more appropriate. For instance, if a patient is irradiated in a way that only her breast tissue is affected, the risk of breast cancer increases [19]. Figure 1 indicates the average LAR in six age groups, and Table 4 shows the average amount of LAR in four centers. As shown in Figure 1, the LAR of breast cancer incidence decreases with age which is in accordance with the study by Tahmasebzadeh *et al.* [20].

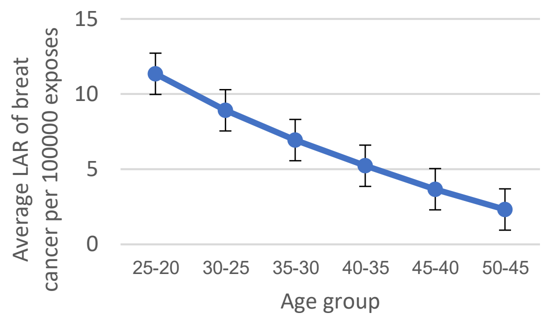

Figure 1. Average LAR (per 100000 exposures) of breast cancer incidence in women who underwent lung CT scan

Table 3. Average of Scan parameters (KVp, mAs, and scan length) used in this study

	A	B	C	D	P Value
KVp	120	110	120	120	<0.05
mAs	52	77	70	50	<0.05
Pitch factor	1.4	1.5	1.6	0.813	<0.05
Scan length(cm)	32.68	35.29	36.48	35.5	<0.05
$CTDI_{vol}$	3.99	1.02	2.7	3.15	<0.05
DLP	130.39	36	98.5	110.4	<0.05

*Significant level is 0.05

Table 4. Average LAR (per 100000 exposures) of breast cancer incidence in women who underwent lung CT scan

	A N=147	B N=153	C N=256	D N=179	P value
LAR	10.32	2.96	7.82	9.10	<0.05

*Significant level is 0.05

4. Discussion

There was a noticeable variation between available CT scanners in four medical imaging centers, Table 2 shows the scanner characteristics, and Table 3 indicates the average exposure parameters in each medical imaging center. Since the absorbed dose of organs located in the thorax is higher in females than males, the median value of LAR in all cancers is higher in females [21].

It is known that the organ absorbed dose and LAR can be reduced by several scanning parameters such as CTDIvol, tube current, Automatic Exposure Control (AEC), kVp, mAs, scan length, and proper patient position [22, 23]. These items depend on the proficiency and knowledge of the technologist and scanner model [24]. For instance, reducing kilovoltage from 120 to 100 can reduce the median dose by 53% in Cardiac CT Angiography tests (CCA) [25], and so can reduce the organ dose and subsequently LAR of cancer incidence. On the opposite side, the long scan length increases DLP and subsequently, the effective dose and risk of cancer incidence [26].

The average effective dose of chest CT scan in this study was 2.56 mSv, while in Tahmasabzadeh *et al.'s* study [27], it was 4.16 mSv. If low-dose protocols were used, the effective dose could be lower than this value. It is also possible to avoid high doses by using a lower kilovoltage (about 80 KVp) and a higher pitch factor (low dose protocols) in the chest CT scan of patients with Covid19 [28].

Another important issue is the existence of AEC options, such as Automatic Tube Current Modulation (ATCM) in CT scans. Today, every manufacturer of Multi-Detector CT scan machines (MDCT) has added this option to their scanners. Several studies in recent years have suggested that using ATCM in neck and trunk scans reduces the radiation dose without disturbing the image quality [29-34]. Therefore, with the use of new MDCT scanners, the radiation dose is adjusted for each patient [31]. In this study, AEC option was active during chest CT scan procedures in all centers except in center C (Table 2), which is one of the reasons for the higher absorbed dose of the breast compared to other centers.

The average absorbed dose of breast tissue was reported to be 3.97 mGy in this study, while Adnan Lahham *et al.* [10]. and Angel *et al.* [22] reported 15 mGy and 19 mGy, respectively. Also, the average effective dose was reported 2.56 mSv in this study, while it was reported 7mSv by Lapham *et al.* Table 1 shows the average absorbed dose of breast tissue and effective dose in six age groups.

In many organs, such as the breast, the radio sensitivity decrease with age [30]. Studies of survivors of Japanese atomic bombs have shown that it can take up to 12 years to develop malignancy after exposure to acute radiation to breast cancer [23]. So, in this study, older patients who are less radiosensitive had lower LARs in comparison to younger ones [10]. Previous studies about life span expressed a clear relationship between thyroid, leukemia, and breast malignancies with age [15]. In accordance, older women who were less sensitive to radiation effects and also had less opportunity to survive the development of breast cancer had lower LARs compared with younger women [10].

It is necessary to mention that scan parameters, organ dose, effective dose, and also LAR of breast cancer incidence were significantly different amongst medical imaging centers (p value<0.05), so by unifying and optimizing scan protocols, we can decrease the risk of radiation exposure.

5. Conclusion

This study aimed to evaluate the radiation dose received due to lung CT scans and the possibility of increasing the risk of breast cancer in women with Covid 19 in Tehran, Iran. Although the dose values reported in this study were lower than the values reported in older studies, this amount can be reduced by using low-dose protocols [28]. According to the ALARA principle, it is important to optimize the dose used and avoid unnecessary scans in patients, especially younger ones with a higher risk of cancer [20].

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