A preliminary study of percentage breast glandularity of Bangladeshi women from mammography data

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Abstract: A study was made to estimate mammographic breast glandularity in Bangladeshi women from generic mammography data. The primary objective of this study was to determine the percentage of breast glandularity of Bangladeshi women which will affect mean glandular dose (MGD) during diagnostic mammography. The secondary objective was to evaluate effect of age and compressed breast thickness on women's glandular tissue. A fitted equation was applied for 80 women who underwent diagnostic mammography. The values of compressed breast thickness (CBT), mAs and target/filter combination, were collected for 80 women ranging in age from 21 to 70. The average breast glandularity of the study sample was 43.7% ± 17.35%. Breast glandularity was found to decrease with breast thickness and age. No significant variation of mean glandularity has been found with Body Mass Index (BMI).

Keywords: *breast glandularity, compressed breast thickness, mammography, radiographic data*

1. Introduction

Breast has a wide range of appearance on mammogram, associated with differences in tissue composition. The fractions of glandular, fibrous and fatty tissue in woman breast differ from individual to individual; and it also depends on age.[1] Presently the 50% glandular and 50% adipose composition are generally accepted and the calculated conversion factor for this composition is used to derive mean glandular dose (MGD) from entrance skin air karma (ESAK).[2,3] But for variation of breast composition with age it is difficult to define the elemental composition or attenuation properties of a mean or standard breast. Some research works showed that for film-screen mammography the MGD for a highly glandular breast is about 40 % higher than that for an adipose rich breast. Klein et al.[4] in their work used conversion factors of Wu et al.[5] and found that differences in MGD of up to 35% occurred due to the assumption made, e.g., 50% glandular and 50% adipose mixture instead of the estimated individual composition. Starting from this assumption our attempt was pointed to specific breast composition for better evaluation of MGD. Specific breast composition is usually termed as mammography breast glandularity. It is also linked to breast cancer risk, and analysis of this tissue can use in risk estimation.[6]

Estimation of glandular portion of specific Bangladeshi woman breast tissue is the main objective of this study. This information will permit mean glandular dose calculations to be extended from breasts of average composition (50% glandular and 50% adipose) to breasts of individually determined composition. Among various approaches a subjective approach is to trace the fibro glandular parts of the breast and measure their percentage of the whole breast area.[7] Some authors have proposed automated approaches to measure breast glandularity, which met the measure

objective.[8] However, these measurements do not correspond to the anatomy of the breast or to the imaging physics. Thus, the map of fibro glandular tissue does not correspond to reality.

More recently, Highnam et al.[9] measured breast glandularity using the thickness of glandular tissue between the pixel and the X-ray source. Kaufhold et al.[10] measured breast glandularity on a pixel basis, with a calibration approach after that of Highnam et al. Bloomquist et al.[11] published a similar work on estimating breast glandularity using a volumetric technique. However, the error arises because of compressed breast thickness estimation, residual scattered radiation, quantum noise, and beam hardening.[10] In the mid-1990s, studies by Cross[12] suggested that breast glandularity could be determined from radiographic data (tube potential kV, tube loading mAs, and compressed breast thickness CBT). Since then, a few studies have looked at breast glandularity estimation from radiographic data. In 2004 a fitted equation was developed by Jamal et al.[13] to estimate breast glandularity from radiographic data.

The purpose of our study was to estimate mammographic breast glandularity in Bangladeshi women from radiographic data. This work is important in two aspects: from a fundamental point of view, it explains the basis of breast glandularity estimation from radiographic data; and from a practical point of view, an estimate of mammographic breast glandularity in Bangladeshi women helps in choosing mean glandular dose conversion factors to calculate the mean glandular dose to the breast.

2. Materials and methods

Estimation of mammographic breast glandularity in Bangladeshi women was done from generic mammography data. A fitted equation developed by Jamal et al.[13] was used in this study to measure percentage of glandular tissue of Bangladeshi woman. To develop fitted equation in Jamal et al. work a mammography x-ray unit was used to expose different thicknesses of phantom material of varying glandular and adipose composition at 27 kV. A least squares method was then used to fit the combined data of phantom glandularity, thickness, and tube loading (mili ampere-seconds). The system was calibrated using a tissue-equivalent breast phantom, with glandularity ranging from 0-100% glandular. CIRS (Computerized Imaging Reference Systems,Norfolk, VA) mammography phantom material was used in this purposes. The fitted equation developed by the work was as follows

$g = (10.19 + \frac{272.1}{t}) \ln(mAs) - (208.6 + \frac{121}{t})$, where g is the breast glandularity and t is the breast thickness.

The formula was applied to data recorded for 80 patients who underwent diagnostic (referral) mammography during 2010 that was performed using GE Alpha RT unit (Alpha RT MGF-101, GE Healthcare, Helsinki, Finland) at the Popular Diagnostic Center, Dhaka, Bangladesh. X-ray unit was operated using a molybdenum target and filter. An ant scatter grid with a grid ratio of 5:1 was used with a nominal focal spot size of 0.3 mm and a focus- to-film distance of 66 cm. For each film (left and right breast) the breast glandularity was calculated using the fitted equation. Only craniocaudal images were included in this study. All mammograms were obtained using 27 kV. The milli ampere seconds, compressed breast thickness (CBT), and views obtained were recorded for both images at the time of exposure. The difference between displayed and actual thickness at the chest wall was evaluated by measuring the thickness of five breasts (craniocaudal view). A correction was then applied to the displayed breast thickness. Before collecting radiographic data, quality control of mammography systems was evaluated including beam quality assessment (HVL Measurement), kVp, time accuracy, and reproducibility according to ACR recommendations.[14] In this study data on age, weight, height, compressed breast thickness, width and breadth of breast during compression were recorded for each woman. The BMI, which is a useful classification scheme for the size and shape of a woman, was derived from the ratio of weight/height.[2] The relation of breast glandularity to breast thickness, age and BMI (Body Mass Index) was investigated for Bangladeshi women.

3. Results

From this study it was observed that the mean age of the study sample is 38 years (range: 21-70 years), mean weight being 57 ± 11 kg, which is 1 kg lower than the weight of the standard woman (58 kg). Mean height is 155 ± 5 cm; which is again 5 cm shorter than the standard height of 160 cm. Distribution of breast thickness, age, and breast glandularity of the study samples is given in Tables 1. The average breast glandularity of the study sample was 43.7% ± 17.45%.

The expected dependence of breast glandularity on age and CBT is shown in Figs. 1 and 2. Breast glandularity was found to decrease with breast thickness and age. No significant variation of mean glandularity has been found with Body Mass Index. Comparison of breast glandularity as a function of compressed breast thickness (CBT) as observed in the present work and other studies shown in Table 2. The results of measurement of breast glandularity by using generic radiographic data in the present study are also compared with those of other similar studies performed before in Table 3.

4. Discussions

The dependence of the glandular tissue on the compressed breast thickness (CBT) is of interest for the design of breast phantoms. The dependence of this tissue on age is important for the age-related evaluation of radiation risk, which is relevant especially for screening programs. The results so extracted show (Fig. 1) that breast glandularity decreases with increasing age, and reduces up to 15% between age 36 to 70 years. This decrease is due to an increase in the proportion of adipose tissue in the breast with older age. Whereas Jamal et al.[13] reported that the greatest rate of change occurs from 47 to 72 years. This decreasing tendency is similar to that reported by Klein et al, Beckett and Kotre, and Soares et al[4,15,16] for German, British, and Jamaican studies, respectively. It is also observed that the greatest rate of change of glandularity occurs after the age of 40 to 45 and highest glandularity observed within age range 31 to 35 years. The reason behind is that most of the women in this range are young mother and with good health.

Table 1. Distribution of compressed breast thickness (CBT), age, and breast glandularity.

CBT in cm				**Age in Year**				**Breast Glandularity (g) in %**			
Mean	Median	Min.	Max.	Mean	Median	Min.	Max.	Mean	Median	Min.	Max.
4.91	5	2	8	38.76	40	21	70	43.7	43.2	15.35	86.93

Table 2. Comparison of breast glandularity (g) as a function of compressed breast thickness (CBT) observed in the present work and other studies.

Study	**Country**	**Average Breast Glandularity (%)**	**Breast Glandularity (g) (%) in Different CBT intervals**			
			< 3 cm	**≥ 3 to < 5 cm**	**≥ 5 to < 7 cm**	**≥ 7 cm**
Geise and Palchevsky[18]	United States	34	68 ± 19	42 ± 21	26 ± 18	16 ± 12
Heggie[17]	Australia	42	82 ± 30	54.5 ± 24	30.5 ± 18.5	17 ± 11
Klein et al.[4]	Germany	43	61.3 ± 27.0	41.6 ± 24.1	29.6 ± 17.7	22.1 ± 16.8
Jamal et al.[13]	Malaysia	48.9	79.1 ± 18.0	54.5 ± 20.4	43.2 ± 20.4	30.8 ± 40.0
Present study	Bangladesh	43.7	90.2 ± 12.3	49.3 ± 17.9	44.7 ± 16.9	26 ± 9.0

Table 3. Comparison of result with others similar study.

Study	**Country**	**Average Breast Glandularity (g) (%)**
Geise and Palchevsky	United States	34
Heggie	Australia	42
Klein et al.	Germany	43
Jamal et al.	Malaysia	48.9
Present study (using generic radiographic data)	Bangladesh	43.7

Whereas Jamal et al. reported that the greatest rate of change occurs after 50 years. Variation of glandularity with the compressed breast thickness shows (Fig. 2) that a decrease of glandularity from 60% to 25% occurs in the thickness range 3.5 to 8 cm and an absolute difference of breast glandularity roughly 8% exist between 4 and 6 cm breast thicknesses. This finding is same compare to result reported by Jamal et al. of 9.6% between 3 and 6 cm.

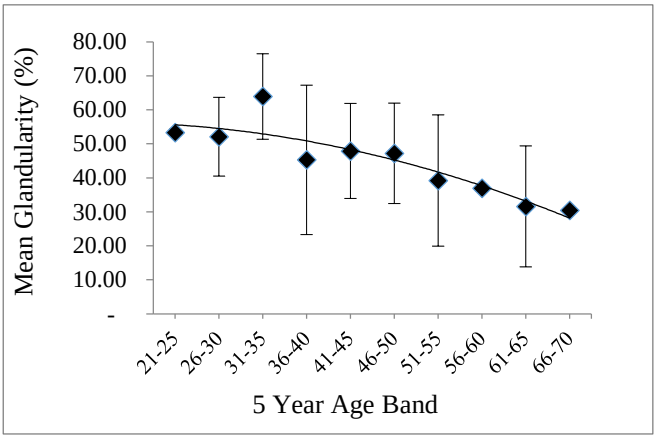

Figure 1. Mean breast glandularity against age with no allowance of effects of compressed breast thickness (CBT). Error bars correspond to ± 1SD of mean.

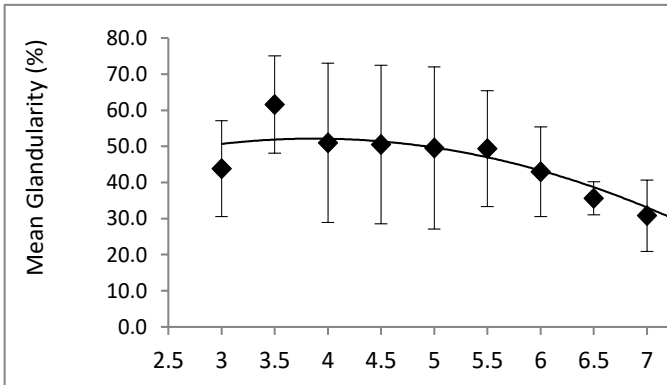

Figure 2. Variation of mean breast glandularity with compressed breast thickness (CBT). Error bars correspond to ±1SD of mean.

Table 2 shows that the average breast glandularity obtained from our study is higher than that reported in the studies on women of United States and are comparable to the values reported for Australia Germany and Malaysia. These differences may be due to the categories of breast (size) studied. It is worth mentioning that Heggie and Geise and Palchevsky[17, 18] estimated breast glandularity without the skin layer in the breast model used; whereas Klein et al.[4] used different types of phantoms with a tungsten anode.

Uncertainties in the result of the present work arose primarily from the level of accuracy of the breast thickness display unit, and variability of CBT values from day to day. The present procedure of measurement of specific patient glandular tissue does not involve image processing techniques or quantitative interpretation of fibro glandular and adipose tissue on mammograms. Further study on quantitative analysis and assessment of mammographic breast glandularity by interactive density-thresholding technique is necessary. In conclusion, the average breast glandularity of the study sample was 43.7% ± 17.4%.

5. Conclusion

A study was made for estimation of mammographic breast granularity in Bangladeshi women from generic mammography data. It provides a preliminary approach for estimation of glandular tissue. This information will permit mean glandular dose calculations to be extended from breasts of average composition (50% glandular and 50% adipose) to breasts of individually determined composition. Further study is undergoing on quantitative analysis and assessment of mammographic breast glandularity by interactive density-thresholding technique.

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