MR Breast Density Measurement: Comparison of Two Anatomic Landmarks for Breast Segmentation

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Background and Purpose: Breast density is known to be related to breast cancer risk. The evaluation of breast density based on mammogram bears some limitations due to the nature of the projection image. The Breast Cancer Prevention Collaborative Group has recommended that quantitative breast density should be incorporated into the risk prediction model. Several studies comparing breast density using MRI and mammography have been reported. Since the percent density is calculated as the ratio of the volume of fibroglandular tissue to the total volume of breast tissue, a consistent method for segmentation of the breast from the body is very important. This is usually done based on body landmarks. Because there is no obvious boundary indicating where the breast ends; therefore, it is more a problem of consistency rather than accuracy. The goal of this study was to compare the segmentation of breast and the density measurement using two different anatomic landmarks.

Materials and Methods: 61 healthy Asian women who came to our Institution for screening breast MRI study were included. Two anatomic landmarks, one along the most anterior portion of the pectoris major muscle and the other along the dorsal surface of the sternum, were used to perform the horizontal cut (**Figure1**). The analysis was done using non-fat suppressed T1-weighted images acquired using a 1.5T MR scanner. The middle slice of the image sequence containing breast tissue was selected, and a horizontal line was drawn through the most anterior portion of the pectoris major muscle or the dorsal boundary of the sternum, resulting in a horizontally-cut image. The horizontal line defined on this image was then applied to all other slices. The quantification of breast density was based on a 3D MRI-based method developed earlier by our group using a fuzzy c-means (FCM) based segmentation algorithm [Nie et al. Medical Physics 2008; 35:5253-5262]. The breast segmentation results using these two landmarks were compared using the Pearson's correlation analysis. The density measurements, including the fibroglandular tissue volume and the percent breast density, were also compared.

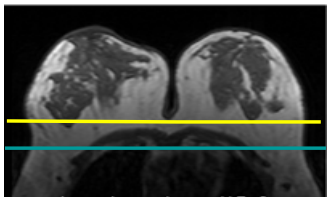

Fig.1. Two body landmarks for breast segmentation. The anterior line (yellow) is across the most anterior portion of the pectoral major muscle. The posterior line (light blue) is parallel to the inner margin of the sternum.

Results: Some portion of fibroglandular tissue was cut-out, and the problem was worse when using pectoralis muscle as the landmark (examples shown in **Figure 2**). Of the 61 subjects, 22 subjects had missing fibroglandular tissue when using the pectoralis major muscle as the landmark, and these cases were excluded in the comparative analysis of density measurements. The measured BV, FV, and BD between two anatomic landmarks were highly correlated ($R^2 > 0.9$) (**Figure 3**). The relative difference (%) of BV and FV measured based on these two landmarks was 29% and 20% respectively.

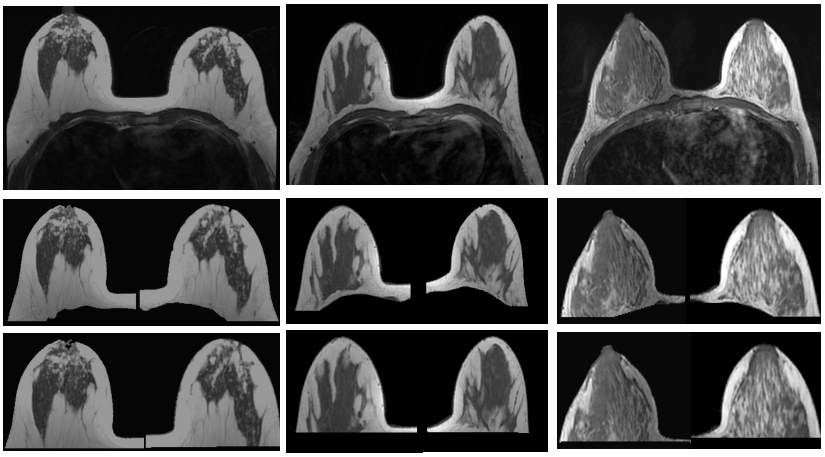

Fig.2: Upper row: original non-fat suppression T1W image; middle row: segmented breast using the sternum as the landmark; bottom row: segmented breast using the pectoris major muscle as the landmark. Left column: A 53 y/o woman with more anterior located fibroglandular tissue and abundant fatty tissue. Note that the fibroglandular tissue was well-preserved using both landmarks. Middle column: A 22 y/o young woman with centrally located fibroglandular tissue. The fibroglandular tissue was well-preserved when using the sternum for the segmentation but some dense tissue was cut out when using the pectoris major muscle as the landmark. Right column: A 31 y/o woman with dense breast. A significant portion of the fibroglandular tissue was cut out using both anatomic landmarks.

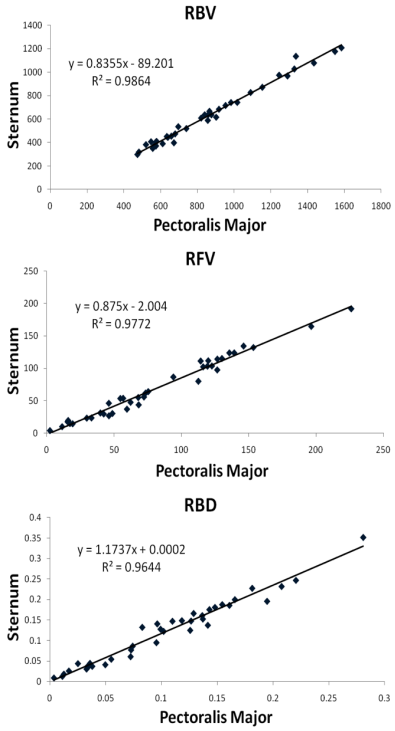

Fig.3: The measured BV, FV, and BD using pectoris major muscle and the sternum as anatomic landmarks are highly correlated.

Conclusion: Although breast density measurements showed a high correlation using these two anatomic landmarks; on the average, there was 29% difference for the BV measurement and 20% difference for the FV measurement. Some portions of fibroglandular tissue might be cut out, and the problem was worse when the pectoris major muscle was used as the landmark. If this mistake were not noted and corrected, it would result in underestimated fibroglandular tissue volume. The breast volume is dependent on the cut-off line, so as the percent density. When the change of breast density is being evaluated for the same woman, the absolute dense tissue volume provides a more robust measurement for comparison.

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