Intraindividual Comparison of Two Methods of Volumetric Breast Composition Assessment

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Rationale and Objectives: To compare the results of two software-based methods, Quantra and Volpara, for volumetric breast composition assessment.

Materials and Methods: Four hundred forty-five normal, bilateral, two-view, digital mammograms were included. Breast volume (BV), fibroglandular tissue volume (FTV), and percent density (PD) were measured using both methods and compared. Deming regression was performed to obtain linear equations for mapping the results of one software on the other.

Results: The median and quartile ranges of both methods agreed well for BV but were different for FTV and PD, with Quantra showing much higher values of FTV and PD. The correlation of results obtained by both methods for BV, FTV, and PD was 0.99, 0.91, and 0.94, respectively. Intraclass correlation in the assignment of quartiles of BV, FTV, and PD was 0.96, 0.86, and 0.90, respectively. Both methods showed a similar association of FTV and PD with patient age and similar left-to-right correlation. Mapping of results onto each other using linear equations removed the systematic differences.

Conclusions: Although Quantra and Volpara use different models for analysis of volumetric breast composition and produce different nominal results of FTV and PD, both methods are highly correlated and show very good to excellent agreement in quartile assignment of all parameters measured. Both methods show a similar association with patient age and similar reproducibility. Both methods can be mapped onto each other using the equations suggested.

Key Words: Mammary glands; human; mammography; automatic data processing; breast density.

Mammographic breast density is a strong predictor of breast cancer (1,2). Recent studies indicate that it may also be a useful parameter for assessing the response to tamoxifen (3,4) and for estimating the prognosis of breast cancer patients (5,6). Breast density also strongly affects the sensitivity of screening mammography and may be used as a variable to individualize screening regimens in the future (7).

Visual breast density assessment, which is used in most clinical and many research settings, is fast but is limited by only moderate inter-reader and intra-reader agreement (8–10). Semiquantitative methods were developed to improve reproducibility, but are time consuming because they require reader interaction (11). More recently, several methods for automated volumetric breast composition assessment have been introduced which provide fast and highly reproducible quantification of breast density and absolute volumes of breast tissue components (12,13). Different models are used to derive the volumes of breast tissue components from digital mammogram raw data, and these produce very different results (14–16). This potentially limits the applicability of the results of research studies using either technique. Although the Quantra software (Hologic Inc., Bedford, MA) uses the acquisition parameters of the mammogram together with a model of x-ray attenuation of different breast tissues, the Volpara software (Mātakina, Wellington, New Zealand) uses "relative physics," with features of the mammogram to be analyzed for calibration (14). Individual software algorithms have been compared to visual assessment of breast density (15,17,18) and to magnetic resonance imaging (MRI) as a reference standard (14,19). However, owing to the different models used, it is not clear how the results obtained with different softwares can be compared to each other. The aim of this study was to perform intraindividual comparison of two volumetric breast composition assessment software methods, the Quantra and Volpara, 1) to determine whether there is a linear or a more complex relationship between the results obtained with both methods and 2) to determine how results from one software can be compared to those from the other.

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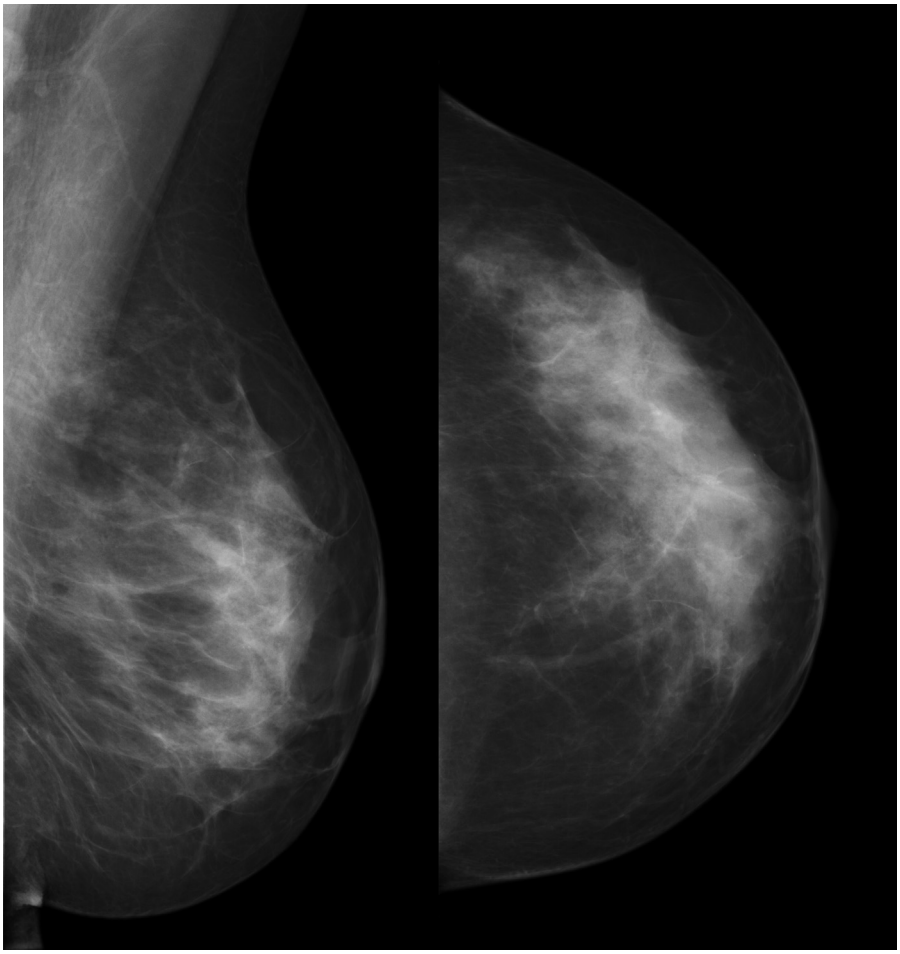

Figure 1. Example of a mammogram (left side only). The results of the volumetric breast composition analysis were as follows: Quantra: breast volume (BV), 593 cc; fibroglandular tissue volume (FTV), 89 cc; percent density (PD), 15%; Volpara: BV, 519 cc; FTV, 67 cc; PD, 13%.

MATERIALS AND METHODS

This retrospective study was approved by the local institutional review board.

Image Data

We analyzed 445 bilateral two-view (craniocaudal and mediolateral oblique) mammograms from a database of patients who were subjects in a longitudinal study on changes in breast composition with aging (20). The mammograms were acquired on the same mammography unit (GE Senographe 2000D, General Electric Company, Fairfield, CT) in our institution between August 2000 and December, 2009. Patients with a history of breast surgery or objects in the projection area were not included in the database. The initial mammogram of each patient was used in the current analysis. Both sides and both views were included. Images were reviewed visually for positioning errors. Minor errors (such as suboptimal depiction of the inframammary fold) were tolerated, whereas sides with major positioning errors were excluded. The minimum normal mammographic follow-up was 2 years. The age range was 28–80 years.

Volumetric Breast Composition Analysis Software

Raw image data of all four views was analyzed with Quantra 2.0 and Volpara Research, version 1.4.3. The software determined breast volume (BV), fibroglandular tissue volume (FTV), and breast percent density (PD). Unless stated otherwise, BV, FTV, and PD of both sides were averaged. An example of a mammography (left side only) and the results of the volumetric breast composition analysis are shown in Figure 1.

Statistical Analysis

On scatter plots of the results of both methods, lines of best fit using linear, quadratic, cubic, and logarithmic models were drawn. No relevant improvement of goodness of fit (r^2) was found for any of the nonlinear models; therefore, linear correlation was assumed. For assessing the correlation of breast composition parameters with patient age and of breast composition parameters of the left and right breasts, the Spearman correlation coefficients were calculated. For assessing correlation of BV, FTV, and PD quartiles, the intraclass correlation coefficient (ICC) for both methods was calculated