Automated Breast Tissue Measurement of Women at Increased Risk of Breast Cancer

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Abstract. We have analysed data from a subgroup of thirty-nine women who had previously gained more than 10kg in adult life, and who were amongst those recruited from a family history clinic to a study examining the effects of diet and exercise on breast cancer risk. At entry to the study and after 12 months they underwent a series of investigations, including mammography during which markers were attached to the compression plate to allow accurate measurement of breast thickness. A calibrated stepwedge was placed adjacent to the breast to enable quantitative analysis. The proportions of glandular and fatty tissue were calculated at each pixel from the stepwedge and thickness data and from these, the percentage gland in the breast was computed, both by area and by volume. Statistical analysis showed that the volume of glandular tissue was not related to breast size. Over the 12 month period, the majority of the women lost weight, while some gained weight. It was found that weight change was correlated with change in the volume of fat in the breasts, with those women who lost the largest amount of weight showing the greatest reduction in volume. There was little change in volume of glandular tissue for any of the women. Percentage gland is often used as an indication of risk of developing breast cancer. These results suggest that measures of percentage of gland (e.g. Boyd groups) may be dominated by excess breast fat in overweight women.

1 Introduction

Increased breast density has been associated with an elevated risk of breast cancer by a number of researchers, most notably Wolfe [1] and Boyd [2]. This is of particular

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interest because whilst there are many different risk factors for breast cancer which cannot be altered (e.g. age, parity and family history), breast density can be modified by a variety of methods including diet, exercise and drugs.

Measurement of breast density is generally carried out by radiologists, either by categorising the parenchymal patterns into one of the groups proposed by Wolfe [1], or by estimating the percentage of dense tissue in the breast [2,3,4]. However, these forms of assessment are subjective and do not accurately reflect the three dimensional nature of the breast and its component tissues. The X-ray mammogram is a two-dimensional projection of a three-dimensional structure, with the brightness at any given point in the image depending on the thickness of glandular and other dense tissue projected onto that point. The arrangement of glandular tissue within the breast depends on the way in which the breast is compressed, so measures of the area occupied by dense tissue will vary depending on compression. Furthermore, the overall brightness of the image depends on the imaging parameters, which in turn vary depending on factors such as the degree of compression used, the positioning of the woman and the composition of the breast. The impact of these factors on radiologists' estimates of glandular density has not been quantified. There may also be ambiguity in locating the breast border over which percentage area is estimated. For example, in the medio-lateral view, the pectoral muscle is often excluded from the analysis, although in some mammograms, the glandular tissue may overlap this region. Finally, some approaches to measuring breast density rely on delineation of the breast border and glandular region, and hence calculation of the percentage of the *area* of the breast occupied by gland, whereas others attempt to take into account the relative densities of different regions and treat the density as a *volume*.

In recent years, semiautomated and automated methods have been developed to measure more accurately the proportion of dense tissue in the breast by means of analysis of X-ray mammograms. The most simple methods are designed to facilitate thresholding of images [5]; however, these suffer from many of the limitations described above. Apart from these there are three principal approaches: firstly, a method based on the physical parameters of the imaging process developed in Oxford [6]; secondly a technique using a step wedge to calibrate grey levels developed in Toronto [7] and thirdly another step-wedge based method developed in Manchester [8,9]. The advantage of these approaches is that they enable calculation not only of the percentage of dense tissue, but also of the volumes of dense and fatty tissue in the breast.

In this paper we describe the application of the automated method developed in Manchester to a group of women participating in a study examining the effects of diet and exercise on the risk of developing breast cancer, and present our results relating measures of gland and fat to weight change.

2 The Lifestyle Study

The lifestyle study [10] aims to evaluate the effect of diet and exercise on women at increased risk of developing breast cancer. Premenopausal women in the age range 35-45 were recruited to the study. All had a family history of breast cancer, and had gained at least 10kg of weight since the age of 18. Half the participants were offered