Comparison Between Wolfe, Boyd, BI-RADS and Tabár Based Mammographic Risk Assessment

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Abstract. Mammographic risk assessment provides an indication of the likelihood of women developing breast cancer. A number of mammographic image based classification methods have been developed, such as Wolfe, Boyd, BI-RADS and Tabár based assessment. We provide a comparative study of these four approaches. Results on the full MIAS database are presented, which indicate strong correlation (Spearman's > 0.9) between Wolfe, Boyd and BI-RADS based classification, whilst the correlation with Tabár based classification is less straight forward (Spearman's < 0.5, but low correlations mainly caused by one of the classes).

1 Introduction

Mammographic risk assessment metrics commonly used are those based on Wolfe [1], Boyd [2], Tabár [3], or BI-RADS [4] (see Figure 1 for examples). These four metrics can be grouped into two approaches of assessment. Boyd's measures the percentage area of dense breast tissue. By way of contrast, Wolfe, BI-RADS, and Tabár all include patterns and texture information in estimating the classification. The main aim of this study is to investigate how these four metrics are correlated. Brisson *et al.* [5] studied correlation between Wolfe and Boyd metrics. Gram *et al.* [6] reported correlation between Tabár and Wolfe based classification on Tromsö screening mammograms. Gram *et al.* [7] reported a study about correlation between Wolfe, Boyd and Tabár metrics. To our knowledge, this is the first study to investigate the correlation between Wolfe, Boyd, Tabár and BI-RADS classification on a well known publicly available database [8].

1.1 Mammographic Risk Assessment Metrics

Mammographic risk assessment is often related to breast density estimation, and this is claimed to be a robust risk indicator. Moreover, Byrne *et al.* claimed that mammographic density is the strongest risk factor for breast cancer [9]. It should be noted that density estimation can also be used to evaluate how likely abnormalities are hidden from the observer [10].

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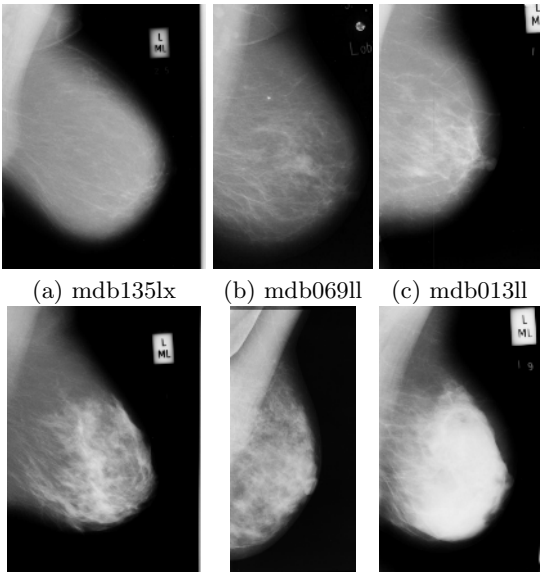

(a) mdb135lx (b) mdb069ll (c) mdb013ll

(d) mdb145lx (e) mdb123lm (f) mdb171ll

Fig. 1. Example mammograms, where: (a) SCC: 0%, W: N1, T: Pattern II, B: I (b) SCC: $0-10\%$, W: N1, T: Pattern III, B: I (c) SCC: $11-25\%$, W: P1, T: Pattern III, B: II (d) SCC: $26-50\%$, W: P2, T: Pattern I, B: III (e) SCC: $51-75\%$, W: P2, T: Pattern IV, B: III and (f) SCC: $> 75\%$, W: DY, T: Pattern V, B: IV

Wolfe [1] proposed four categories of mammographic risk: N1 is defined as a mammogram that is composed mainly of fat and a few fibrous tissue strands; P1 shows a prominent duct pattern and a beaded appearance can be found either in the subareolar area or the upper axillary quadrant; P2 indicates severe involvement of a prominent duct pattern which may occupy from one-half up to all of the volume of the parenchyma and often the connective tissue hyperplasia produces coalescence of ducts in some areas; DY features a general increase in density of the parenchyma (which might be homogeneous) and there may or maynot be a minor component of prominent ducts. These four groups had an incidence of developing breast cancer of 0.1, 0.4, 1.7 and 2.2, respectively [1].

Boyd *et al.* [2] introduced a quantitative classification of mammographic densities. It is based on the proportion of dense breast tissue relative to the breast areas. The classification is known as Six Class Categories (SCC) where the density proportions are: Class1: 0%, Class2: $\langle 0-10\% \rangle$, Class3: $[10-25\%\rangle$, Class4: $[25-50\%\rangle$, Class5: $[50-75\%\rangle$, and Class6: $[75-100\%]$. The increase in the level of breast tissue density has been associated with increase in the risk of developing breast cancer, specifically the relative risk for SCC 3 to 6 are 1.9, 2.2, 4.6, and 7.1, respectively [2].

Tabár *et al.* [3] describes breast composition of four building blocks: nodular density, linear density, homogeneous fibrous tissue, and radiolucent adipose tissues which also define mammographic risk classification. Pattern I: mammograms