

Mammography image quality: Model for predicting compliance with posterior nipple line criterion

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ABSTRACT

Purpose: To develop a model using measurements of pectoral muscle width and length together with the acceptability of the posterior nipple line criteria (PNL) to predict the acceptability of the presentation of the pectoral muscle in the mediolateral oblique view of the breast.

Method: A total of 400 mediolateral oblique mammogram images were randomly selected from BreastScreen NSW South West, Australia. Measurements of length and width of the pectoral muscle and the acceptability of the pectoral muscle position relative to the PNL were recorded. Data analysis involved logistic regression and ROC analysis to test the predictors of width and length and the performance of the model. The model was then used to predict the outcome of acceptable or unacceptable PNL criterion for each case.

Results: The estimated odds ratio for an increase of 10 mm was 1.98 (CI = 1.68, 2.34) for the length predictor and 2.14 (CI = 1.56, 2.93) for the width predictor. A cut off point of 0.6083 was derived from the training set and applied with the developed model to the test set. The area under the ROC curve was 0.9339 demonstrating an accurate model.

Conclusion: This paper describes a model to predict the acceptability of the PNL criterion using the width and length of the pectoral muscle. This model could be used in the automated assessment of image quality which has the potential to enhance the consistency in mammographic image quality evaluation. Optimising image quality contributes to increased accuracy in radiological interpretation, which maximises the early detection of breast cancer and potentially reduces mortality rates.

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1. Introduction

Mammography is currently the most widely used tool for the early detection of breast cancer. Early detection has been found to reduce mortality rates [1–3]. Critical to early detection is the consistent production of high quality mammographic images [4,5]. Achieving consistency is dependent on the use of reliable image evaluation criteria.

Currently the evaluation of mammographic image quality is undertaken using image evaluation criteria which focus on the inclusion and optimal visualisation of all breast tissue [6–9]. Some criteria relate to both specific anatomies identified on the image: the pectoral muscle, nipple and inframammary angle; and other criteria relate to lines, the posterior nipple line (PNL) and the nip-

ple line (NL) that can be drawn on the images. These criteria have been described and evaluated in numerous publications [4–14].

Particularly in the MLO view of the breast, the presentation of the pectoral muscle is used as an important indicator for determining whether all breast tissue is included on the image. The length and width of the muscle should be the maximum possible to ensure all breast tissue anterior to the muscle is visualised. The lack of objectivity of the criteria for determining adequate muscle length and width and its impact on consistency of outcomes has been reported elsewhere [11–13].

Criteria relating to the length of the pectoral muscle include reference to the PNL [6,8] and NL [7,9]. The PNL criterion is defined by the Royal Australian and New Zealand College of Radiologists (RANZCR) and the American College of Radiologists (ACR) in their mammography quality assurance manuals. A recent study reported that 70.8% of surveyed radiographers used the PNL criterion to evaluate image quality in the clinical setting [11]. The PNL is a reference line drawn from the nipple at right angles to the anterior aspect of the pectoral muscle contour or to the back of the image whichever comes first, see Fig. 1 [6,8].

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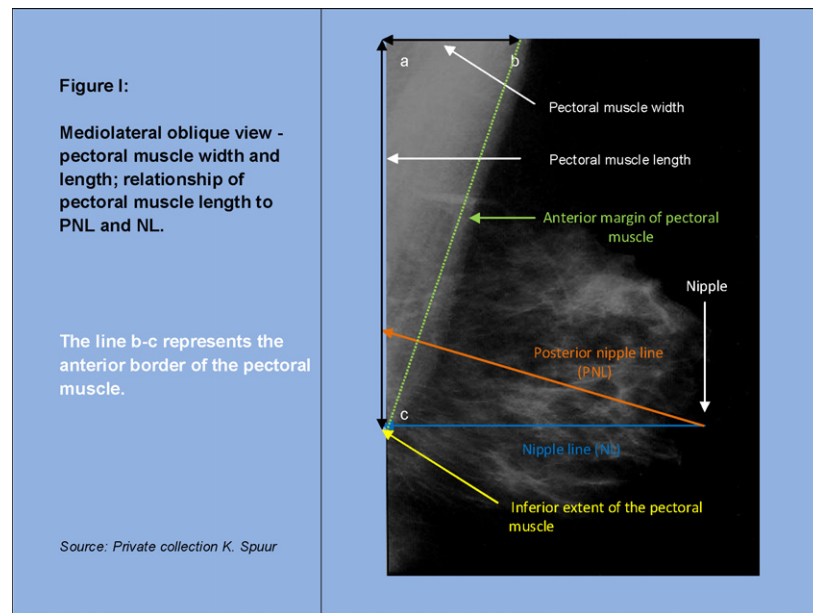


Fig. 1. Mediolateral oblique view—pectoral muscle width and length; relationship of pectoral muscle length to PNL and NL. The line b-c represents the anterior border of the pectoral muscle.

Source: Private collection K. Spuur.

As the pectoral muscle contour may be imaged concave, convex or as a mixture of both, the right angle intersection was determined in this study by drawing a line (b-c) between the anterior width (b) and inferior length (c) of the pectoral muscle, see Fig. 1. Using the RANZCR and ACR PNL criterion, images are considered acceptable where the PNL is visualised at the level of or above the inferior aspect of the pectoral muscle, see Figs. 2 and 3.

An additional PNL criterion has been described by Bassett et al. [12] and used in other studies to report the adequacy of mammographic image quality [15]. The criterion reports the PNL to be 10 mm above or below the inferior aspect of the pectoral muscle [12]. Images are considered acceptable where the PNL is no further than 10 mm below the inferior aspect of the pectoral muscle, see Fig. 4. The study by Bassett et al reported 81% compliance for this criterion [12].

The NL criterion is used by BreastScreen Australia [7] and the National Health Service Breast Screening Program (NHSBSP) [9]. The NL is drawn from the nipple parallel to the superior edge of the of the mediolateral oblique (MLO) image to its posterior edge, see Fig. 1 [7,9]. Images are considered acceptable where the NL is visualised at the level of or above the inferior aspect of the pectoral muscle.

Where mammographic image quality is deemed to be unacceptable using IES criteria the image must be repeated. The key performance indicators for image quality in Europe, Australia, the United Kingdom and America include the requirement that technical repeat examinations should be <3% [6,7,16] with a rate of <1% [17] desirable.

This current study has focused on the referencing of the length of the pectoral muscle to the PNL criterion inclusive of the addi-

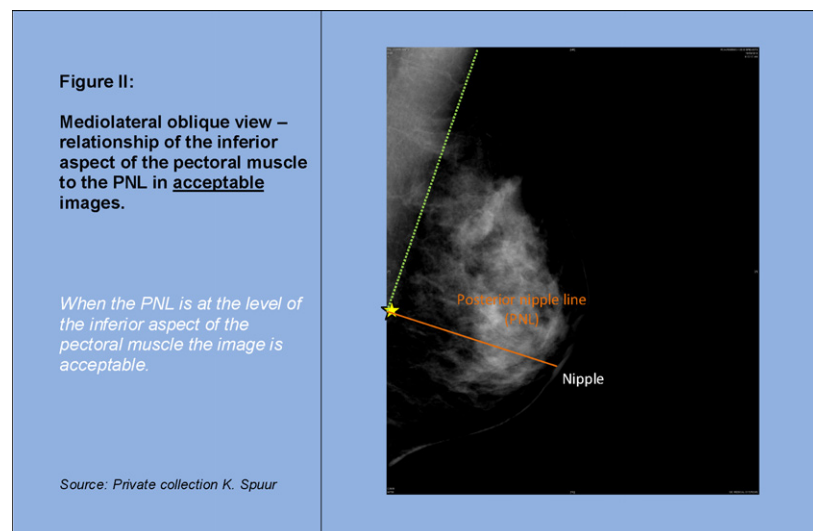


Fig. 2. Mediolateral oblique view—relationship of the inferior aspect of the pectoral muscle to the PNL in acceptable images. When the PNL is at the level of the inferior aspect of the pectoral muscle the image is acceptable.

Source: Private collection K. Spuur.

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