MACROJOURNALS

The Journal of **Macro**Trends in
Health and Medicine

Detection of breast cancer in clinical practice

Vydra J. *, Sroubek F. **, Danes J. *, Bartos M **, Zitova B. **, Lukavcova E.***
* Medico Oncology dpt. Prague Czech Republic
**Institute of Information Theory and Automation Czech Academy of Sciences
Prague Czech Republic
***1.st Medical Faculty Charles University Prague Czech Republic

Supported by Grant Technological agency Czech republic TA04011392

Abstract

Breast cancer is the most common malignancy in women and the second most common cause in cancer–related mortality. The usefulness of mammography, hand held ultrasound and clinical evaluation for the diagnosis was analyzed in a cohort of 146 women with suspected breast cancer, who were followed at our oncology department. The median age was 61 years, minimum 30 years and maximum 90 years, 55% of patients were between 50 and 70 years. The mammography alone revealed 96% true positivity, 1.37% false positive rate and 3.6 % false negative rate, 96 % sensitivity and 67 % specificity. The hand held ultrasound alone had 88% true positive rate, 2% false positivity but unacceptable 12 % false negative rate, 87% sensitivity and 50% specificity. Combining mammography and hand held ultrasound lead to 97% sensitivity and 50% specificity. The clinical evaluation had 28% false negative rate, 70% sensitivity and 33% specificity. We are developing the 3D breast ultrasound technique to ensure the whole breast exam and better depicting of lesions.

Keywords: *breast cancer, clinical practice*

1. Introduction

Breast cancer is the most common malignancy in women and the second most common cause in cancer–related mortality. Introduction of mammography screening to clinical practice leads to reduction of breast cancer mortality, mostly due to capture of lower stages of carcinoma. Nevertheless 9% of breast carcinomas are still found at stage IV and only 26.6 % at stage I. (1). Mammography has been used as a sole cancer screening method for cancer and only suspected cases undergo breast hand held ultrasound. Breast ultrasound is often used to evaluate breast problems that are found by a mammogram, especially for women with palpable lesions on physical exam or with dense breast. For the latter situation, the study (2) revealed that extensive mammographic density, which is the case in more than 50 % in the age group till 60 (for younger woman even 75 %), is reproducibly associated with an increased risk of breast cancer. The aim of our study is to compare the ultrasound and mammography findings, as the basis for improving the ultrasound results using 3D technique.

2. Material and methods

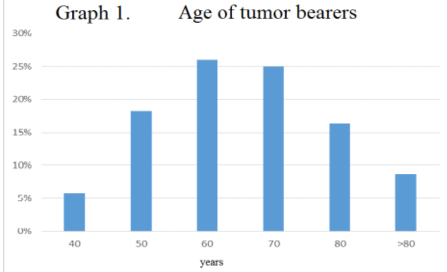
One hundred forty six patients with suspected breast cancer took part in this study. The patients signed informed consent. The median age was 61 years, minimum 30 years and maximum 90 years, 55% of patients were between 50 and 70 years. For tumor classification the TNM Classification of Malignant Tumors version 7 was used. The probands were routinely clinically examined and underwent mammography and hand held ultrasound.

The hardware set-up used to acquire all the necessary data during ultrasound examination consist of a computer with a digital video grabber and an electro-magnetic six degrees of freedom tracking system (TrakSTAR, Ascension Technology Corp., Shelburne, VT, USA). The electro-magnetic field generator, the reference sensor and the sensor mounted on the US probe are connected to the computer through a control unit. The video grabber and the tracking system are controlled using PLUS open-source software package (3), which also allows to do necessary sensor and temporal calibrations (prior to examinations) and synchronization of video and spatial data. The whole process of storing proper data during examinations is controlled by in-house developed software. The software recognizes if the US image is “frozen” or not, which allows the physician to simply interact with the system.

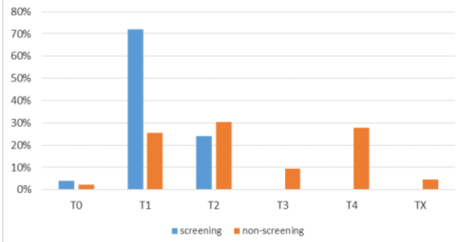
2.1 Patients

The median age of breast cancer bearer was 61 years, minimum 30 years and maximum 90 years, 55% of patients was between 50 and 70 years. The age distribution is shown at graph 1. Fifty one tumors (37%) were found in preventive screening, 89 (63%) patients come with clinical lesions independently on the screening. The tumors found at screening were lower stages than tumors of patients with clinical findings. The distribution of tumor size and stage is shown at graph 2 and 3.

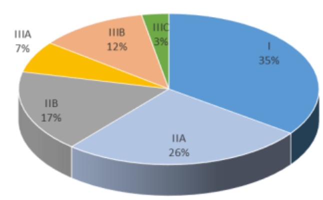
Graph 1. Age of tumor bearers



Graph 2. Tumor size according TNM



Graph 3. Tumor stage



3. Results

The mammography alone revealed 96% true positivity, 1.37% false positive rate and 3.6 % false negative rate, 96 % sensitivity and 67 % specificity. (Table 1). The hand held ultrasound alone had 88% true positive rate, 2% false positivity but unacceptable 12 % false negative rate, 87% sensitivity and 50% specificity (table 2). The clinical evaluation had 28% false negative rate, 70% sensitivity and 33% specificity (table 3). Combining mammography and hand held ultrasound lead to 97% sensitivity and 50% specificity.

Table 1 Mammography

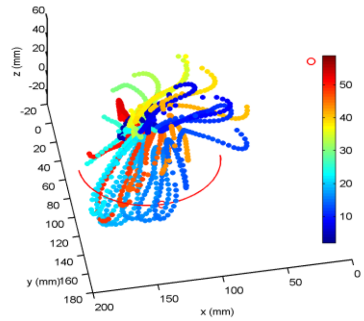
	tumor	
mammography	present (140)	absent (6)
positive	96 %(135)	1.37 %(2)
negative	3.6% (5)	2.7% (4)
total	100% = 140	100% = 146
sensitivity	96%	
specificity		67%

Table 2 Breast ultrasound		
	tumor	
sonography	present (140)	absent (6)
positive	88 %(123)	2 %(3)
negative	12% (17)	2% (3)
total	100% = 140	100% = 146
sensitivity	87%	
specificity		50%

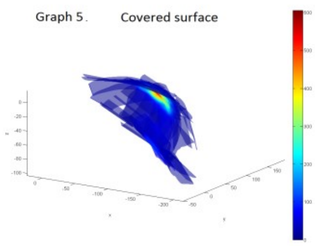
Table 3 Clinical examination		
	tumor	
clinical	present (140)	absent (6)
positive	70 %(135)	2.7 %(4)
negative	28% (30)	1.3% (4)
Total	100% = 140	100% = 146
sensitivity	70%	
specificity		33%

During a breast exam, we record ultrasound images and the position and orientation of the ultrasound probe. For this purpose we use an off-the-shelf grabbing PC card in combination with the tracking device. We are developing the 3D breast ultrasound technique to ensure the whole breast exam and better depicting of lesions using electromagnetic tracking technology and Bayesian inference algorithm for reconstructing 3D volumes. Color-coded trajectory of the probe center on skin during examination is shown at graph 4. Colors represent spend time in seconds. The coordinate system in millimeters is defined by the reference sensor (origin denoted by the right-top circle) and the position of the breast is marked by the semi-circle curve. The covered surface is shown at graph 5. The color denotes in seconds how long every location was examined. Last but not least, we can perform local 3D reconstruction. 3D reconstruction on areas covering potential findings using grow cuts is shown at graph 6.

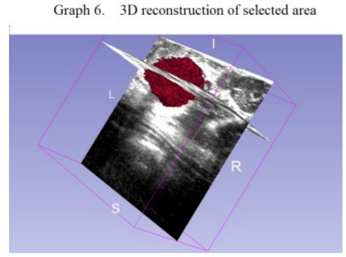
Graph 4. Trajectory of probe center



Graph 5. Covered surface



Graph 6. 3D reconstruction of selected area



4. Discussion

Our results show that either mammography or ultrasound not give the required results. Even the mammography with the highest sensitivity still had 3.6% false negative findings. This agrees with the results of other authors (4). 3.6% false negativity at screening could lead to thousands of missed or late diagnosed carcinomas. Sonographic examination is painless and does not expose patients to radiation. Ultrasound aids in distinguishing normal findings such as cysts or fat lobules from suspicious breast changes that require biopsy. It helps to better evaluate the lymph node involvement. Here, the role of the US exams is hardly replaceable.

Nevertheless, the US cannot be used as sole examination because of the inappropriate high false negative rate (5). The current trend for detection of breast cancer is to use combined investigative techniques, usually mammography and US, and recently as well magnetic resonance imaging (MRI) or dedicated breast CT.

On the other hand, the use of US for breast cancer screening is often limited by experience and skills of the examiners, resolution of device, and as well by the length of exam in the screening. Screening ultrasonography revealed 15% of mammographically occult breast cancers (6). Another drawback of the US examination is the uncertainty whether the whole breast was scanned. To ensure the total breast scanning, the automatic breast ultrasound scanner (ABUS) should be used. The proposed methods could eliminate this problem. ABUS revealed from 8.4% to 20% false positivity when used by different experts (7). We are developing the 3D breast ultrasound technique to ensure the whole breast exam and better depicting of lesions.

4.1 Conclusion

Breast cancer screening needs better imaging techniques. We propose an affordable solution to improve the image quality of ultrasound devices using electromagnetic tracking technology and Bayesian inference algorithm for reconstructing 3D volumes. We can thus monitor the quality of the exam and regions that were examined and minimize the risk of not detecting harmful lesions. The proposed method thus ultimately reconstructs the 3D volume from 2D images while removing noise, blur, increasing resolution and surpassing the quality of the original 2D images.

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