

Computational methods used in the study of border breast lesions diagnosed by mammography and ultrasound

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Abstract: The aim of this paper is the assessment of the ultrasound and mammography examination in detection of mammary opacities. This study will analyse the value and the limits of these methods in diagnosis. Mammary ultrasound is complementary to mammography. Combining the two methods will increase the accuracy in finding and defining the mammary nodule, suspect of malignancy.

Key Words: breast, mammography, ultrasound, medical statistics

1. Introduction

The first cause of death in females over 40-years-old is breast cancer. It has an increased occurrence in 45 – 50 and 55 – 60-years of age group. For this reason it is seen as a serious public health matter and it imposes the detection of an efficient therapy due to prolong the survival age. The imagistic screening of female patients resulted in the cut-down in breast carcinoma mortality by 44%.

Majority of the benign lesions are not associated with increased risk for development of subsequent breast cancer. On the other hand, some benign lesions are associated with increased risk for development of breast cancer. Recognition of these lesions is essential for development of successful prevention methods. [3]

The presence of microcalcification clusters in mammograms contributes evidence for the detection of early stages of cancer. The microcalcifications are extracted with an adaptive neural network that is trained with cancer/malignant and normal/benign breast mammograms and a best accuracy rate of 99% for the classification of cancer/normal/benign is achieved. [4] There is no a substantial difference in a number of detected microcalcifications among the several filter banks used and the Neuro-Symbolic Hybrid methodology proposed can improve, in the future, the results of microcalcification recognition [7].

1.1. Classification of breast carcinoma

I. Non-invasive (in situ); occurrence: 15 – 30%.

- Ductal carcinoma in situ (80%) associated with Paget disease.
- Lobular carcinoma in situ (20%).

Invasive carcinoma; occurrence: 70 – 85%.

Ductal invasive carcinoma – common type, regularly

associated with Paget disease; Lobular invasive carcinoma (10%); Tubular carcinoma (6%); Cribriform carcinoma (6%); Mucous (colloid) carcinoma (2%); Medullar (2%); Invasive papillary carcinoma (1%); Adenoid-cystic; Secretory (juvenile) carcinoma; Apocrine carcinoma; Metaplastic; Inflammatory carcinoma. [1, 6]

The development of modern molecular and genetic techniques has allowed researchers to study molecular and genetic events in the development and progression of breast cancer.

Many different studies using different molecular techniques have demonstrated that invasive carcinoma of breast develops due to accumulation of many molecular changes. Although a linear multi-step model of hyperplasia without atypia to atypical hyperplasia to in-situ carcinoma and invasive cancer is proposed and accepted, new molecular genetic studies suggest that this may be only one of the pathways of a complex mechanism of breast carcinogenesis. Although there are some breast cancers that go through this pathway, other malignant transformation pathways may exist. Identification of these different molecular pathways would be very helpful to identify targets for future diagnostics and novel therapies. [8]

1.2. Risk factors

- Genetic factors: Immediate family with breast or ovarian carcinoma. The risk increases if two or more family members were affected before the onset of menopause. Genetic disorders increase the risk of carcinoma by approx. 85% (BRCA-1, BRCA-2)
- Hormonal factors: early menarche (<12 years old), late menopause (>55 years old), increased risk in nullipara, age of first childbirth over 30 years,

hormonal treatment over 5 years increases the risk in females older than 60years, oral contraceptives used more than 5 years increases by 35% the risk, nursing reduces the risk (at least for 3 months).

- Environment and diet: the risk increases linearly with the ionic radiation doses, depends on the patient’s age: below 20 years old – radiosensitive; over 50 years old, the benefit exceeds the risk, obesity, alcohol (>30g/day).
- Other risk factors: age: low incidence <35 years old. The risk is doubles in females with contralateral breast carcinoma, endometrial carcinoma or ovarian carcinoma, breast trauma, long exposure to sun, liability and psychic trauma. [5]

1.3. Mammography aspect related to the histological type [2]

<i>Histological</i>	<i>Mammography aspect</i>
Ductal non-invasive carcinoma in situ	Early calcifications centred in the collecting duct – comedo necrosis; late in acinous cribriform spaces secretion – non comedo Vermicular or powder-type micro calcifications with channel distribution
Ductal invasive	Dense, star-like opacities with powder-type micro calcifications
Lobular invasive	Dense opacities and low defined architectural distortions
Tubular carcinoma	Small star-like opacities usually with micro calcifications
Cribriform invasive	Uncharacteristic aspect
Mucous colloid	Circumcised opacity, lobulate, with / without spiked contour, usually without calcifications
Medullar carcinoma	Circumcised opacity, round-oval, frequently lobulated with homogenous density, sometimes totally /partially coated by a radio lucent haloes (atypical medullar – irregularly, spiked contour) calcifications are usually absent
Invasive papillary	Solitary nodules / multiple w/w calcifications
Inflammatory	Similarly aspect to non-inflammatory carcinoma

Table 1: Mammography aspect related to the histological type

2. Materials and methods

Objective: The present study will evaluate the role of both, ultrasound and mammography in the detection and description of mammary opacities. As well we will research the value and the limits of the two imagistic procedures in the accuracy of breast carcinoma diagnostics.

Material and methods: We did a prospective and retrospective study. 2004 patients were investigated through breast ultrasound and mammography and

followed-up in the Imaging Department of Medis polyclinic Brasov, over 12 months in the year 2009.

The imagistic study was correlated with the histopathology findings in positive certain cases.

During the examination we used a Mammomat 3000 Nova mammography unit and Sonoace 6000C and SonolineG60S and Siemens Acuson X300 ultrasound units.

3. Results and discussions

Lot structures by age groups

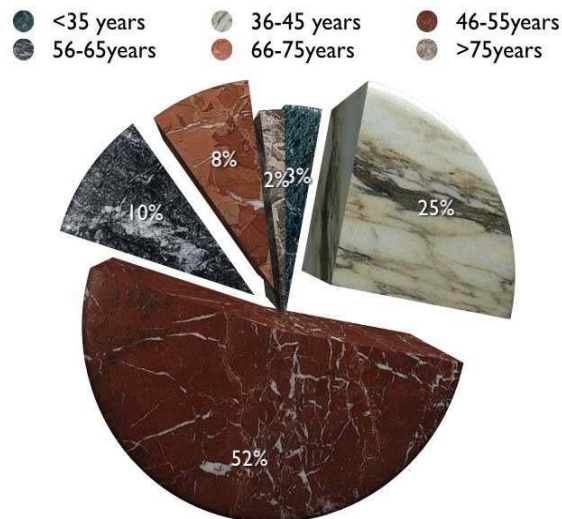


Chart 1: Age group distribution of studied patients

52% of the studied patients were in the 56-55-year-old group, 25% were between 36-45 years old, 10% in the 56-65-year-old group, and 8% in the 66-75-year-old group and less than 3% were younger than 35 years or older than 75 years.

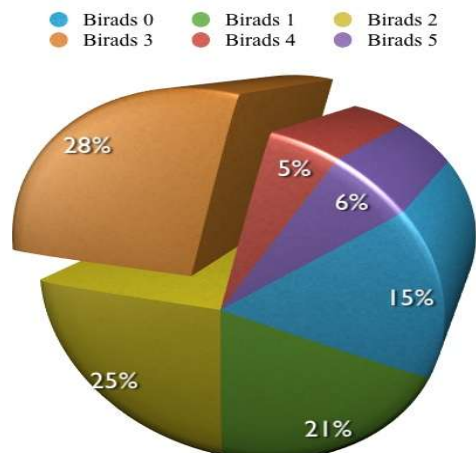


Chart 2: The distribution of patients according to Birads score.

The patient’s distribution accordingly to Birads score revealed that most cases, 25%, were evaluated Birads 2 and 21% were Birads 1. In these patients we found typical benign anomalies. Most of those were macro calcifications, fibroadenoma specific, channel calcifications as in plasmocitary mastitis, oily cysts, round masses or opacities with macrocalcifications.

A quarter of the patients, estimations 28%, were evaluated with Birads 3 score – very probable benign tumours with a malignancy potential <5%. These patients have to be re-evaluated in-between 6 months. Frequent mammography findings were focal density asymmetric images with concave limits and discreet lobulated opacities or masses, with relatively entirely clear contour.

About 5% of the cases showed spike-like images, without a dense centre, opaque masses with blurry contour, architectural distortions as well as focal density asymmetric images with convex limits. These cases were categorized Birads 4 – suspect or undetermined anomaly with 5-50% malignity risk. 6% of cases were the cases framed in Birads 5, that cases with more than 50% risk of malignancy where the spiculate masses with dense centre, irregular contours, microcalcifications pathological foci.

In a few cases, we found irregular pulver-like microcalcar images presenting a channel distribution, in a triangular shaped aria.

In 11% of the cases with susceptible anomalies we recommended surgical and oncological treatment. The common mammography finding relived spike-like masses with a dense, irregular centre. A relatively high percent of the cases, 12%, showed false positive mammography findings. In these cases we indicated supplementary tests like for example mammary ultrasound, in order to classify them in Birads score 3 or 4.

Almost all histological investigated cases were confirmed as in situ ductal carcinoma. The lesions were in most cases small, certified by mammography as irregular pulver-like microcalcar images with channel distribution.

Analysing cases after injury was observed, as 39% of patients had no breast lesions were framed in Birads 1 score without changes, 48% of patients had benign lesions characters, and the remaining 13% were placed in lesions characters of malignancy.

Correlations between type of lesion and imaging appearance



Chart 3: The distribution of patients according type of lesion and imaging appearance

Most breast calcifications are benign. When the microcalcifications are new, irregular pulver – like, distribution in outbreak is important. This could be an early sign of breast cancer, most frequently non-invasive ductal carcinoma in situ or stage 0 breast cancers.

Correlations between opacity and breast calcifications:

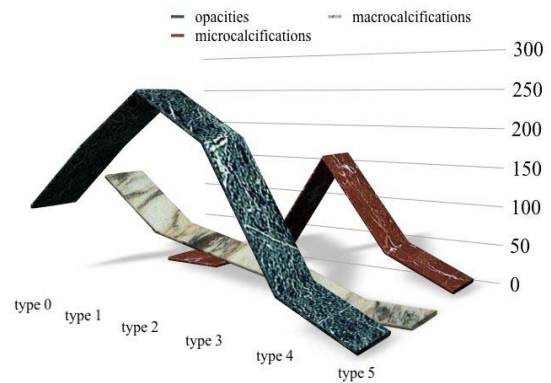


Chart 4: The distribution of patients according to opacity and breast calcifications

Breast macrocalcifications were present mainly in the 48% of cases diagnosed as benign. Were the most representative type 0 - ring with clear centre, then the type 1 - teacup, polyhedral, point regular type 2 and less type 3 - powder, regular.

Breast microcalcifications were found in the group of patients with benign lesions especially those with malignant lesions. They were of type 3 - powder, regular, especially type 4 - point, pleomorphic, irregular arrangement of the atypical foci microcalcifications (branching, triunghiular, bisegmental). Less common were type 5 - vermicular.

Correlating opacity with breast calcifications was found that the opacity of benign calcifications are associated more with type 0, 1 and 2 and possibly 3 but

with the outbreak of calcifications arrangement. Opacity character is associated mainly with malignant breast calcifications type 3, 4 and 5.

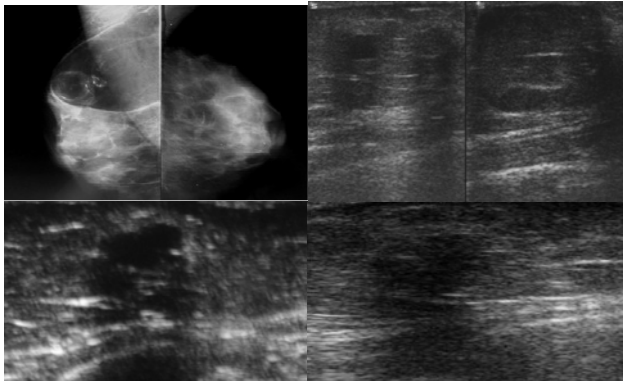


Figure 1. Patient aged 52 years suspected of about three years hamartrom covered a mammogram review and highlight the next one transparent macrocalcifications, irregular nodular formations but also raised the suspicion of malignancy micro calcifications polymorphic both mammography and ultrasound as having a correspondent anechoic lesion at this level irregular lobe with peripheral micro calcifications showing intermittent attenuation (Pathology: Benign lesions with calcification predominantly in adipose included)

Important criteria are benign: oval shape with transverse axis greater lobulated wide, well defined, clearly outline, with or without posterior acoustic strengthening.

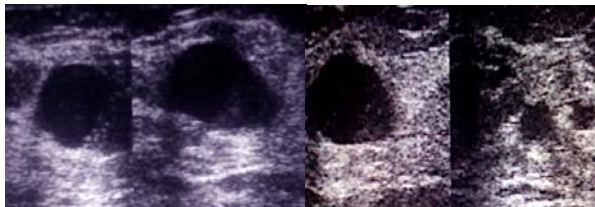


Figure 2. Anechoic lesions suspect - echogenic protrusion formation, irregular edges - suspicious lesion border

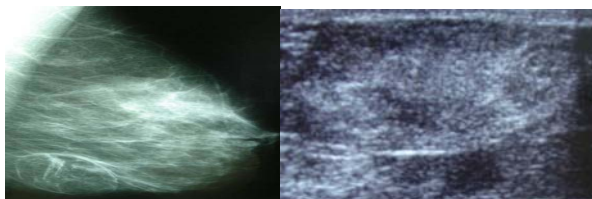


Figure 3. Oblique incidence mammogram that shows a possible benign lesion suggestive of lipoma and ultrasound lesion is imprecise demarcation, heterogeneous appearance - lesion border

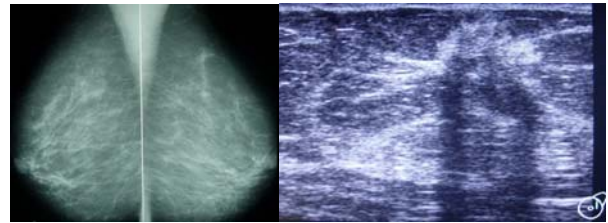


Figure 4. Patients aged 57 years with negative mammography examination ultrasound shows a nodular lesion with suspected posterior attenuation and extensions spiculiforme important to both skin and deep (Pathology: in situ ductal carcinoma).

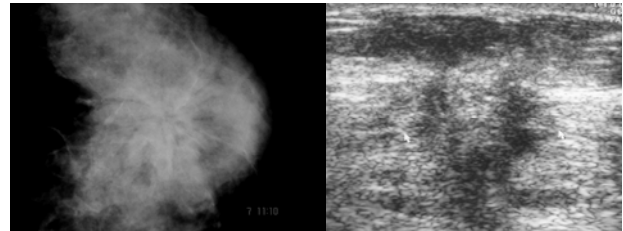


Figure 5. The mammography in a 58-years-old patient, that takes hormonal substitution treatment, presents a high-density breast, with a spike-like image and an opaque centre. The image reveals long spikes, towards the skin, and pulver-like opacities in a triangular shaped area. Mammary ultrasound shows an isoecho nodule with microcalcifer images and hypoechoic haloes, posterior intermittent attenuation (Pathology: ductal carcinoma).

Ultrasound examination allows etiologic characterization of the breast nodule, susceptible to carcinoma. The ultrasound findings present vertical orientation, irregular spike-like limits, possible uneven structure with microcalcifer images that are seen better in mammography, hipoecho with posterior attenuation.

In situ ductal carcinoma is rarely multicentric and can be associated in 75% of the cases with ductal epithelial hypertrophy or in 21% of the cases with in situ lobular carcinoma. That's why the monitoring of the patients will be necessary even post surgery.

Star-like opacities with a dense centre and long spikes with pulver-like or vermicular microcalcifer images were seen very often in patients with positive histology of invasive ductal carcinoma.

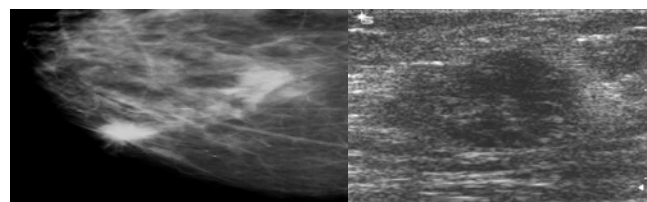


Figure 6. The ultrasound examination of a 51 years old patient revealed an irregular hypoechoic inhomogeneous image with microcalcifer spreads. The mammography shows a dense spike-like opacity with pulver-like microcalcifer images in channel deep distribution.

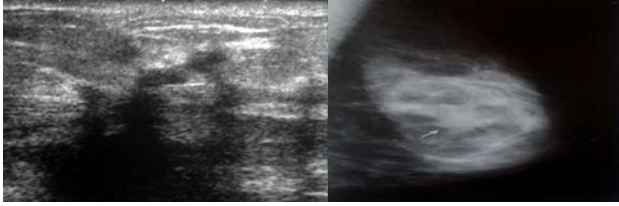


Figure 7. Mammography examination - oblique incidence. We can difficult observe on the mammography an isodense spike-like opacity in the mammary glandular tissue with possible discreet lucent haloes. By ultrasound we see multiple hypoechoic nodular formations with intense posterior attenuation, which do not allow the examination of deeper lesions (Pathology: ductal carcinoma).

The maximum incidence of invasive lobular carcinoma was around 50 years old patients. This was frequently diagnosed by mammography as dense opacities and low defined architectural distortions.

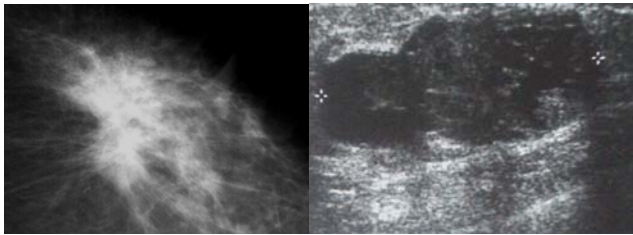


Figure 8. Mammography - irregular dense opacity. On ultrasound examination we recognize a hypoechoic inhomogeneous mass with lobulated margins and partial posterior attenuation (Pathology: invasive lobular carcinoma).

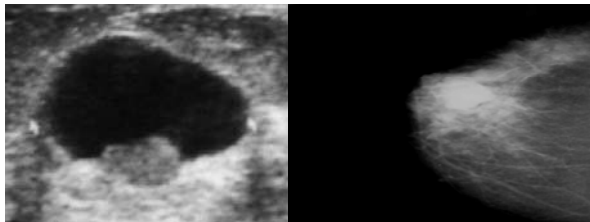


Figure 9. 67 years old patient diagnosed as fibrocystic mastosis 8 years ago and covered by hormonal treatment for the last 5 years, presents papillary ductal carcinoma with invasive carcinoma areas. We can see multiple adenoid lesions and cystic lesions. By annual mammography and ultrasound investigations it was observed a protruding echogen intracystic formation that was treated surgically.

The frequency of invasive cribriform and mucous carcinoma was below 3%. The mammography aspect was frequently uncharacteristic or it revealed a lobulate circumscribed opacity, with or without spike-like contour, usually without calcar images. Medullar carcinoma was found in 1.8% of the cases and those patients had a favourable outcome.

Papillar invasive carcinoma occurs frequently after menopause and had an incidence below 1%. The cases diagnosed with micropapillar invasive carcinoma presented frequently vascular invasion and lymphatic metastases.

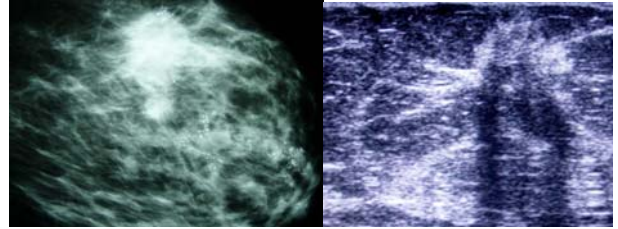


Figure 10. Vermicular microcalcifications and irregular scattered and arranged in triangular and irregular foci suspicious lesions for malignancy

The worst prognosis was remarked in the patients with inflammatory carcinoma. In 90% of these cases they presented lymphatic metastases. The mammary gland has high, heterogeneous density and it's difficult to see irregular opacities. On ultrasound examination, these opacities present susceptible hypoechoic nodule formations as well as lymphatic channels dilatations.

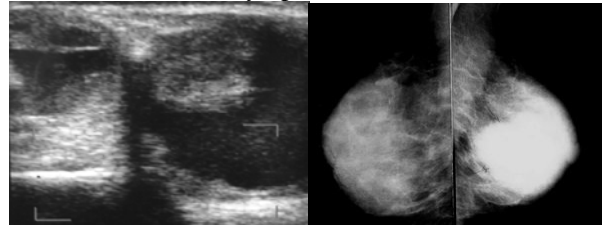


Figure 11. 54 years old patient, were the approx. 1 year posttraumatic ultrasound revealed large hypoechoic masses and inhomogeneous anechoic, with echogenic protrusion areas and walls with contour irregularities. Because of the inflammatory tissue, the breast shows a dense mammography aspect with opacities and uncertain architectural distortions (Pathology: mastitis carcinoma).

4. Conclusions

The study showed that the incidence of breast cancer is in the young population, in the group 46 – 55 years old. This is the reason why women should start the screening immediately after 40-years-old.

A lot of malign diagnosed patients occurred after the onset of menopause. In most of these patients the menopause was surgically induced and they had hormonal treatment prescribed. The majority of the cases with susceptible opacities could be only mammography diagnosed. However, in a lot of these cases, ultrasound examination was indicated in order to establish the diagnostic. In this way, we increased the accuracy of detection and etiological description of tumour susceptible breast nodule.

A number of benign breast dystrophies may be confused with malignant lesions or associated and therefore require surgical verification. In a lot of cases included in this study, where the mammography didn't show clear malignant signs, we used ultrasound examination. In some cases ultrasound examination concurred to malignant suspiciousness, especially in Birads 3 scores. Only in a very few cases the

mammography diagnosed susceptible lesions, were not confirmed by ultrasound. In ultrasound examination they appeared clearly benign. The benign character was confirmed by histopathology exam.

Monitoring is important benign lesions, microlobulated, indistinct, obscured or speculated contour are criterion for malignancy.

Exploration of breast imaging is complex. The sensitivity and specificity of ultrasound mammography can be improved as necessary in determining whether additional examination benign - malignant.

5. References

- [1]. Basset L.W., Kimme-Smith C., Breast sonography; AJR.1991; 156; 449-455.
- [2]. Heywang-Kobrunne S. H., Dershaw D. D., Schreer I., Diagnostic Breast Imaging. Mammography, Sonography, Magnetic Resonance Imaging and Interventional Procedures, 2001; 209-338.
- [3]. Jemal A., Murray T., Ward E., Samuels A., Tiwari R.C., Ghafoor A., et al. Cancer statistics, 2005. CA Cancer J Clin. 2005; 55: 10-30.
- [4]. Khuwaja, Breast Cancer Detection Using Mammography, Proceedings of the 5th WSEAS International Conference on Signal Processing, Istanbul, Turkey, May 27-29, 2006; 20-23.
- [5]. Pamilo M., Soiva M., Anttinen I et. colab., Ultrasonography of breast lesions detected in mammography screening; Acta Radiol. 1991; 32; 220-225.
- [6]. Shaaban A.M., Sloane J.P., West C.R., Moore F.R., Jarvis C., Williams E.M., et al. Histopathologic types of benign breast lesions and the risk for breast cancer: case-control study. Am J Surg Pathol. 2002; 26: 421-30.
- [7]. Vergara Villegas O. O., Ochoa Dominguez H., Cruz Sanchez V. V., Gutierrez Casas E. D., Salgado G. R., Rules and Feature Extraction for Microcalcifications Detection in Digital Mammograms Using Neuro-Symbolic Hybrid Systems and Undecimated Filter Banks, WSEAS Transactions on Signal Processing, Issue 8, Volume 4, August 2008:484-493.
- [8]. Wang J., Constantino J.P., Tan-Chiu E., Wickerman D.L., Paik S., Wolmark N., Lower-category benign breast disease and the risk of invasive breast cancer. J Natl Cancer Inst. 2004; 96: 616-20.