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MULTIMODALITY IMAGING OF BREAST TRAUMA: DIAGNOSIS AND MANAGEMENT

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Abstract

Purpose:
Breast traumas include road accident, assaults, falls or other minor events; the diagnosis is often delayed, despite several medical imaging techniques because of the priority to most relevant organs and anatomical districts involved in traumatic events. Aim of the study was to evaluate the imaging in breast traumas, the differential diagnosis and correlation with breast cancer and the medical or surgical management of each case described.
Methods: We performed a retrospective study over a period between February 2010 to June 2017. All patients diagnosed with breast injuries were included in the study. Breast clinical examination, mammography, ultrasonography and, in selected cases, Magnetic Resonance (MRI) and ultrasound-guided fine needle aspiration cytology were used for the diagnosis. Logistic regression models were used to estimate unadjusted and adjusted odds ratio and corresponding 95% confidence interval.
Results: Over the study period, 55 patients had a breast trauma; there were 12 cases of major event and 43 minor traumas. 2 males and 53 females have been included. Mean age was 47yo (range 27-71 yo). In 11 cases, surgical therapy was necessary, in 3 cases medical therapy and in 2 follow-up have been performed. In 10 cases, also a breast cancer has been diagnosed, but no association between breast trauma and the risk of breast cancer was observed (odds ratio: 0.85; IC 95%: 0.41-1.75; P: 0.665).
Conclusion: Breast traumas are underestimated if a major event occurred; imaging diagnosis of breast trauma requires often a multimodality approach and can be difficult expecially if a breast cancer also occurs. A dedicated breast radiologist is necessary for a correct differential diagnosis and to palinify a terapeutical approach and follow-up.

Keywords: *breast trauma, breast cancer, retrospective study, differential diagnosis, accident, falls.*

Introduction

The number and clinical consequences of breast traumatic accidents have not the same social relevance of breast cancer (incidence rate of 90-110/100,000 in Europe and US [1], 20% of cancer deaths in women [2] and this may be a consequence of the fact that breast surgery is easy to perform. The signs and symptoms of accidental trauma can mimic those of breast cancer especially if the patient has no memory of the traumatic event.

A major trauma (e.g. road accident) or minor (assaults, falls or other) can cause the formation of a hematoma, followed by central necrosis and liquefaction of the adjacent fat [3,4].

Unless a massive blood extravagation, requiring surgical drainage, occurs, this can lead to the development of a fibrotic or cystic tissues that will almost entirely calcify within 2 or 3 years. Scars associated with skin retractions can be also noticed [5].

In the literature, one case of pneumothorax in a 57 years old woman was reported. This was characterized also by multiple rib fractures, haemothorax and a large pneumothorax, which had passed the superficial fascia of the anterior chest wall reaching the virtual space between large and small pectoral and affecting the homolateral mammary gland [6,7].

Two main points should be taken into account when evaluating a breast trauma: the difficulty in differentiating recent outcomes of trauma (4-204 weeks) from signs/symptoms of neoplasia in the absence of specific symptomatology [8-10]; secondly, the possible correlation between breast trauma and cancer [11-13].

Aim of the study was to evaluate the imaging in breast traumas, the differential diagnosis and correlation with breast cancer and the medical or surgical management of each case described.

Methods

Study population

The population target of this retrospective cohort study were recruited from 1st February 2010 to30th June 2017 in our University Hospital and includes a total of 500 consecutive patients.

Only patients older than 23 years old were included.

Exclusion criteria were: presence of breast cancer with maximum diameter > 2 cm (T2, T3, T4), patients with prostheses, two or more first degree relatives with breast cancer.

Demographic characteristics collected for both cases and controls were: sex, age, previous or current estro-progestinic replacement therapy (average duration ≥3 years), history of trauma and breast trauma characteristics.

We evaluated the assessment of the dynamics of the traumatic event, months after trauma and the severity of the trauma (major – road accident; minor: assaults, falls or other).

All patients underwent breast examination and ultrasonography. Patients older than 40 underwent mammography in addition.

27% of patients (123/500) underwent ultrasound-guided fine needle aspiration cytology.

5% of patients (25/500) had also a Magnetic Resonance Imaging examination.

The study was designed in compliance with the Helsinki declaration.

All patients gave the permission for their images to be used.

Imaging

Clinical breast examination, mammography and ultrasound were performed by a breast radiologist.

Mammography was performed with Instrumentarium Diamond Mammography (GE Healthcare, Wisconsin, USA). Two projections were performed (cranial-caudal and mediolateral oblique) and, in selected cases, also projections in targeted compression.

If necessary, additional screenings were performed in targeted compression and / or with direct radiographic magnification.

The ultrasound was performed with ultrasound Logiq S6 (GE Healthcare, Wisconsin, USA) with a linear matrix multifrequency probe (7-14 MHz).

MRI was performed with a 1.5-T unit (Symphony, Siemens Healthcare, Erlangen, Germany). All patients were studied in the prone position using a dedicated breast coil. The MRI protocol included a transverse T1 localization sequence, a sagittal T2 sequence with fat saturation and a T1 gradient echo sequence 3D-FLASH (TE 2.5 ms, TR 12.7 ms, acquisition time less than 2 minutes, FA 30 °, slice thickness 3 mm, interslice gap 0 mm, NEX 1, FOV 35, matrix size 256 Å~ 160, pixel size 1.4 Å~ 1.4), with a series of six coronal acquisitions. Images were acquired with contrast starting at 0, 2, 4, 6 and 8

minutes after administration of intravenous contrast. It has been used Gadobutrol (Gadovist, Bayer Schering Pharma AG, Berlin, Germany) as a paramagnetic contrast agent with bolus injection of 0.1 mmol / kg of body weight.

Ultrasound-guided fine needle aspiration cytology was performed using the capillary aspiration technique. After obtaining informed consent, the patients were placed in a comfortable position and lesions were aspirated with 21-gauge needle, the needle being rotated during the sample. Local anaesthesia was not required.

The taken sample was swiped on a slide, fixed and analysed by an experienced pathologist at the Department of Pathology of our hospital.

Statistical analysis

Logistic regression was used to estimate odds ratios (ORs), their corresponding 95% confidence interval (CIs) and associated P values. Known or suspected risk factors for breast cancer (trauma, age, estrogen progestin therapy) were evaluated as potential confounding factors by multivariate analysis.

All P-values were two-sided and those less than 0.05 were considered statistically significant.

Results

Five hundred patients were examined in our study (mean age: 46 years; SD 11; median 47 years) (Table 1).

102 out of 500 consecutive patients (20.4%) were positive for breast cancer (Mean age 46.6 y.o., SD 7.78, range: 23-71 years).

99 out of 102 consecutive patients with breast cancer (97%) were female, 10 of them (10%) had history of trauma, 22 of them (21.6%) took estroprogestinic replacement therapy (average duration ≥3 years).

398 out of 500 consecutive patients (79.6%) were negative for breast cancer (Mean age 46.5 y.o., SD 9. 89, range: 24-72 years).

392 out of 398 consecutive patients without breast cancer (98.2%) were female, 45 of them (11.3%) had history of trauma, 68 of them (17%) took estroprogestinic replacement therapy (average duration ≥3 years).

The time interval between the trauma and the enrollment into the study was 32 months (SD 15; range 1-60 months; median value 29 months). 25% of patients with trauma (n=14) had a major trauma (car accident), 74% had a minor trauma following fall (n 19), attack (n.18) or other (n.4). 71% per cent (n=39) of patients with a history of trauma had no sign of malignant disease at medical examination, nor mammography or ultrasonography. In two patients a hematoma was diagnosed; in one case it was treated with medical therapy (Fig. 1), in one case with surgery. A case of liponecrosis (Fig.2) and a case of fibrosis (Fig 3) were diagnosed. In two patients a post-traumatic Mondor syndrome on the site of a trauma was present (Fig.4) and treated with medical therapy.

10 patients (18%) had a mammarian carcinoma in the same quadrant of previous trauma, surgically treated (Fig.5). 9 out of 10 patients with breast cancer and breast trauma were female, 1 was male. The mean age of those patients was 48.9 years (SD 9.12; range: 40-70); 3 of them took estroprogestinic replacement therapy. 1 patient had a major trauma (road accident), 9 a minor trauma (5 attacks, 3 falls, 1 other cause). The time interval between the trauma and the enrollement in the study was 31.8 months (SD 12.7; range: 12-55).

These patients (9/500) underwent breast examination, mammography, ultrasonography and fine needle aspiration cytology. 3 patients had also Magnetic Resonance Imaging examination.

The result demonstrates that, in our experience, patients with a history of breast trauma have a chance of getting breast cancer almost identical to that of the general population (OR: 0.85, 95% C.I.: 0.41-1.75; p-value: 0.66) (Table 2a) .

Adjustment for age and for estroprogestinic replacement therapy did not change the Odds Ratios (OR: 0.84, 95% C.I 0.41-1.73, p-value: 0.64) (Table 2b).

Discussion

Breast trauma and its consequences, despite rare when compared to the thoracic and abdominal ones, have great clinical relevance because of the differential diagnosis with tumour lesions in the preclinical phase (parenchymal distortions and fibrous scars without typical lipo-necrotic calcifications). (Fig. 3) [14,15].

The findings of the present study show that patients who experienced breast trauma present instrumental negativity.

Furthermore, most of the occasional "minor" traumas of the breast have no biological consequence on the organ.

Every breast trauma may potentially cause intraparenchymal haemorrhage followed by oedema, ischemia and subsequent colliquative necrosis of adipocytes characterized by the formation of vacuoles filled with necrotic lipidic material and surrounded by fibroblasts, foam cells and plurinucleate giant cells. This is later replaced by fibrous tissue. This picture of aseptic inflammation is called "aseptic fat necrosis" and is directly related to trauma, as reported in the literature since 1920 (Fig. 2). A nodulation may possibly be associated with a clinical picture characterized by ecchymosis, erythema, inflammation, pain, skin thickening or retraction. This can involve the entire organ or only a part of it which often correspond to the supero-external quadrants or the superficial retro areolar region. At mammographic evaluation the most common result of a trauma is represented by dystrophic calcifications with clear centre opacities [16].

In many cases it is however possible to find the thickening and deformity of the skin and subcutaneous tissue (16%), presence of focal (13%) or spiculated masses with sharp margins (4%) and clusters of microcalcifications with suspicion of malignancy (4%). When a ultrasonography is performed, it is typical to notice a response of iso / hypoechoic solid nodules with posterior acoustic barrier or intracystic masses hyperechogenicity of subcutaneous tissue (27%), anechoic cysts with or without intralesional echoes with reinforced rear wall (17%), cystic mural nodules (4%) .

These findings may suggest a strong suspect of malignant lesion [17].

MRI is less accurate if performed within 6 months after the traumatic event. This because of the presence of a post-inflammatory granulation tissue which limits the differential diagnosis (risk of False Positive). When performed after at least six months from the traumatic event, the formation of a hypovascular scar with central necrosis makes the diagnosis by MRI more accurate.

The absence of specific symptomatology does not always allow the exclusion of malignancy. In doubtful cases, fine needle aspiration for cytology (sensitivity 87% specificity 99%) or core needle biopsy (False Negative estimated among 1.2-1.5%) are suggested [18-20].

Breast traumas may cause the immediate formation of a hematoma, a contusion, as well as a post-traumatic Mondor's disease (superficial phlebitis). The latter has an incidence of 0.5-0.8% in symptomatic patients, both men and women [21].

In our experience, the two patients with a history of traumatic accident and subsequent Mondor's disorder at trauma site were easily diagnosed during the breast control (visit, bilateral mammography and Doppler ultrasonography). Because of the risk; albeit rare, of association with breast cancer, we addressed the patients to a close follow-up with instrumental control at six months (CAT BIRADS 3) [22-24] (Fig 4).

The finding of 9 cases of breast cancer detected in patients with a history of traumatic event in the same quadrant of trauma, led us to hypothesize the existence of a correlation between trauma and onset of breast cancer. In our case-control study no correlation between recent trauma and onset of breast cancer was demonstrated (OR: 0.85, 95% Confidence interval: 0.41-1.75; P-value: 0.66) (Fig. 5).

Breast traumas are underestimated if a major event occurred; imaging diagnosis of breast trauma requires often a multimodality approach and can be difficult expecially if a breast cancer also occurs [25-27].

A dedicated breast radiologist is necessary for a correct differential diagnosis and to plan a therapeutical approach and follow-up.

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Table 1. Summary of findings from the review of patients with trauma (n: 55).
Legend - EP: estrogen progestin therapy; MONTHS: months since injury; VME: visit, mammography, echography; MR: Magnetic resonance; C: Fine needle aspiration

No.	SEX	AGE	EP THERAPY	TRAUMA	MONTHS	IMAGING	DIAGNOSIS	THERAPY
1	F	71	no	Fall	19	VME-C	Fat necrosis	Follow-up
2	F	70	no	attack	15	VME	Negative	
3	**F**	**60**	**no**	**road accident**	**30**	**VME**	**Negative**	
4	F	47	no	attack	27	VME	Negative	
5	F	50	no	Fall	54	VME	Negative	
6	**F**	**58**	**no**	**road accident**	**50**	**VME**	**Negative**	
7	F	38	no	Fall	35	VE	Negative	
8	M	44	no	Fall	29	VME	Mondor's disease	Medical therapy
9	F	43	no	attack	48	VME-C	Negative	
10	**F**	**28**	**no**	**road accident**	**18**	**VE**	**Negative**	
11	F	29	no	Fall	26	VE	Negative	
12	F	49	no	Fall	45	VME-C	Cancer	Surgical therapy
13	**F**	**48**	**no**	**road accident**	**1**	**VME**	**Haematoma**	**Medical therapy**
14	F	40	no	attack	35	VME-C	Cancer	Surgical therapy
15	F	43	no	attack	25	VME-C	Cancer	Surgical therapy
16	F	40	no	fall	36	VME	Negative	
17	F	37	no	fall	47	VE-C	Negative	
18	F	35	no	other	35	VE	Negative	
19	F	34	no	attack	48	VE	Negative	
20	**F**	**38**	**no**	**road accident**	**15**	**VE**	**Mondor's disease**	**Medical therapy**
21	F	38	yes	attack	23	VE	Negative	
22	F	41	no	attack	26	VME-C	Negative	
23	**F**	**37**	**no**	**road accident**	**48**	**VE**	**Negative**	
24	F	42	no	attack	29	VME	Negative	
25	F	46	no	fall	14	VME	Negative	
26	F	55	no	fall	38	VME	Negative	
27	M	49	no	attack	36	VME-MR-C	Cancer	Surgical therapy
28	F	50	no	fall	27	VME-C	Cancer	Surgical therapy
29	F	39	no	other	28	VE	Negative	
30	F	36	no	fall	23	VE	Negative	
31	**F**	**27**	**no**	**road accident**	**29**	**VE**	**Negative**	
32	F	56	no	fall	25	VME	Negative	
33	**F**	**56**	**no**	**road accident**	**23**	**VME**	**Negative**	
34	F	56	no	attack	54	VME	Negative	

35	F	52	no	attack	12	VME-C	Cancer	Surgical therapy
36	F	54	yes	fall	55	VME	Negative	
37	F	53	yes	attack	35	VME	Negative	
38	F	39	no	attack	24	VE	Negative	
39	**F**	**46**	**no**	**road accident**	**29**	**VME-C**	**Fibrosis**	**Follow-up**
40	F	47	no	fall	20	VME	Negative	
41	F	54	no	attack	35	VME	Negative	
42	**F**	**70**	**no**	**road accident**	**10**	**VME**	**Negative**	
43	F	67	yes	attack	27	VME-C	Cancer	Surgical therapy
44	F	48	yes	other	24	VME	Negative	
45	F	27	yes	fall	29	VME	Negative	
46	**F**	**50**	**yes**	**road accident**	**26**	**VME-C**	**Haematoma**	**Surgical drainage**
47	**F**	**47**	**yes**	**road accident**	**35**	**VME**	**Negative**	
48	F	48	yes	fall	29	VME	Negative	
49	F	41	yes	fall	55	VME-MR-C	Cancer	Surgical therapy
50	F	55	yes	attack	12	VME	Negative	
51	**F**	**55**	**no**	**road accident**	**38**	**VME-C**	**Cancer**	**Surgical therapy**
52	F	47	no	attack	25	VME	Negative	
53	F	48	no	fall	60	VME	Negative	
54	F	40	yes	other	18	VME-MR-C	Cancer	Surgical therapy
55	**F**	**50**	**no**	**road accident**	**12**	**VME**	**Negative**	

Table 2. Results of retrospective cohort study with pairing the relationship between breast cancer and breast trauma

a) Logistic regression and b) Multiple logistic regression (adjusted for age and Estrogen Progestin therapy) - Odds ratio (OR) with

b) 95% confidence interval (95% C.I.) and respective p-values.

Legend: EP: estrogen progestin intake

		breast cancer		
		odds ratio	*95%CI*	*P-value*
a) Logistic regression	trauma	0,85	0.41-1.75	0.66
b) Multiple logistic regression	trauma	0.84	0.41-1.75	0.64
	age	1.00	0.98-1.02	0.97
	EP	1.34	0.78-2.30	0.29

Figure 1. Unresolved outcomes of breast traumas: post-traumatic hematoma difficult to differentiate from mucinous carcinoma and medullary carcinoma.

Case n.13 –A forty-eight years old female, with a history of car accident une month earlier.
a) Mammography in oblique projection: oval opacity with sharp and regular margins.
b) Clinical picture of soft tissue hematoma
c) Ultrasound findings of hematoma: oval hypoecogenity lacuna with disomogeneous aspect due to hyperechogenic spots and not well defined margins
d) Ultrasound finding of mucinous carcinoma: oval hypoecogenity lacuna with clear hyperechogenic spots with clear and regular margins
e) Ultrasound findings of medullary carcinoma: oval hypoecogenity lacuna with disomogeneous aspect and sharp and irregular margins.
146x100mm (150 x 150 DPI)

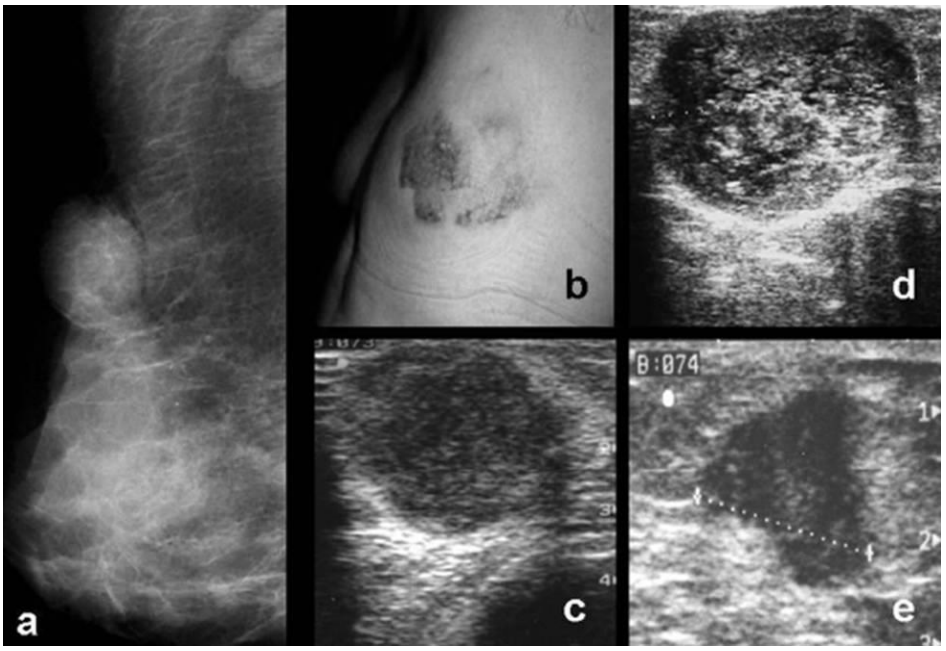

Figure 2. Unresolved outcomes of breast traumas: fat necrosis
Case n. 1_ Seventy-one years old femal, with a history of fall 19 months earlier
a) Mammography in CC left projection: Multiple calcified liponecrotic post-traumatic cysts
b) Mammography in right MLO projection: Large calcified liponecrotic trauma cyst.
142x105mm (150 x 150 DPI)

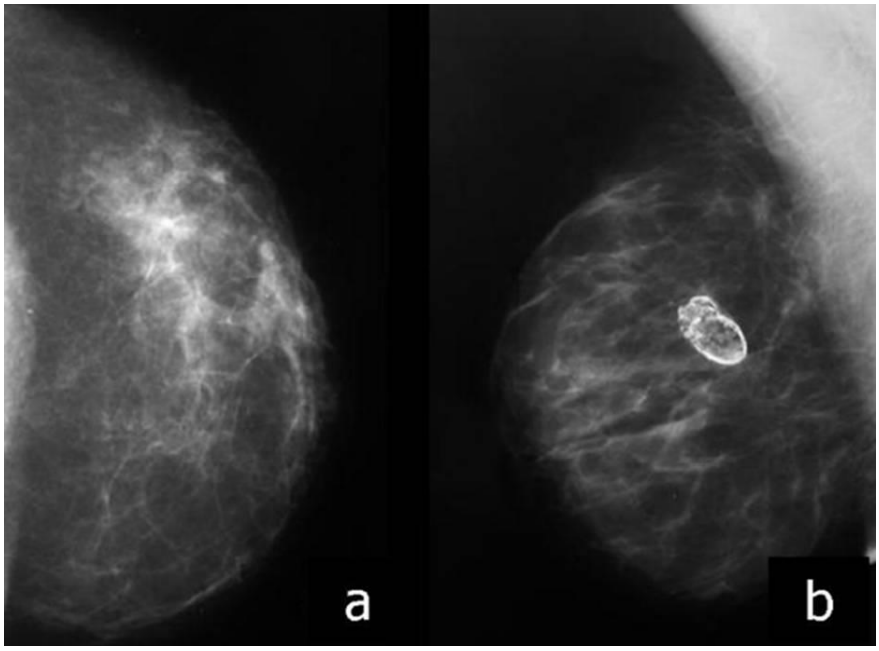

Figure 3. Outcomes of major trauma: Fibro-post-traumatic scar
Case n. 39 _Forty-six years old female, with a history of car accident 29 months before.
Left mammography in CC (a) and MLO (b) projection: vaguely star shaped blurred opacity with dendritic striae, difficult to differentiate from infiltrating lobular carcinoma.
133x148mm (150 x 150 DPI)

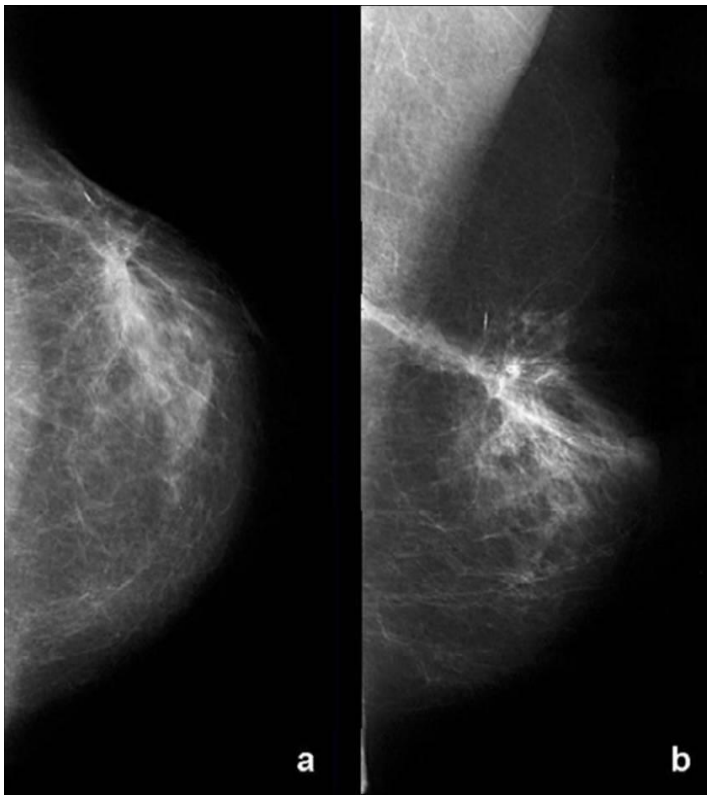

Figure 4. Mondor's post-traumatic superficial thrombophlebitis
a) Case n.20_ Thirty-eight woman, with a history of car accident 15 months earlier
b) Case n.8 – Forty-four years old male, with a history of fall 29 months earlier.
a, b) Clinical image of Mondor's post-traumatic superficial thrombophlebitis at trauma site.
210x121mm (150 x 150 DPI)

Figure 5. Ductal infiltrating carcinoma with focal areas of post-liponecrosis in absence of calcification
Case n. 43 Seventy-years old female, with a history of attack 27 months earlier
Right mammography, CC a) and LL b) projection showing clear and voluminous opacity, with star shape and dendritic striae, short and disomogeneous c) Ultrasound findings: circle shaped mass with hypoecogenic aspect and partially irregular margins and lateral shade cones.
91x105mm (150 x 150 DPI)