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Advantages of Ductal Echography (DE) over Conventional Breast Investigation in the diagnosis of breast malignancies

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Abstract

Ductal Echography (DE) is an anatomical method of breast investigation based upon the identification of mammary internal structures. By using the radial breast scanning DE is superior to other imagistic methods in breast investigation. In this paper the DE aspect of brest cancer will be presentated.

Key words: ductal echography, radial breast scanning, brest cancer

Rezumat

Ecografia ductală (DE) este o metoda de investigare anatomică a sânului bazată pe identificarea structurilor mamare. Prin utilizarea examinării radiale a sânului DE este superioară celorlalte mijloace de investigare a sânului. In acest articol se vor prezenta aspectele tumorilor maligne în examinarea DE.

Cuvinte cheie: ecografia ductală, scanare radială a sânului, tumori maligne

Breast cancer is defined as a neoplastic hyperplasia of the epithelial tissue which lines the ductolobular structures of the breast. It is due to a heritable abnormality of the involved cells which multiply and infiltrate the surrounding tissues through the basal membrane.

Therapeutic results for the breast cancers diagnosed in the early phase allow a 20 year survival rate exceeding 90%. Today, only half of the women with breast cancer may share this hope. It follows from this evidence that today's conventional means of diagnosis (mammography and conventional echography) do not allow a reliable early diagnosis of the disease [1].

Ductal Echography (DE) as a radial scanning is the only technique allowing an intelligible display of the intra-lobar epithelial structures: ducts and lobules. For a decade, its execution remained difficult, occasionally requiring much time for examinations. Now, the recent issue of a new digital ultrasound equipment had made breast examination much easier and faster. Also, the cytological evaluation of cells is now possible, sampled very precisely by an ultrasound guided technique from a selected zone of a malignant lesion (because DE displays the hyperechogenic associated connective alterations distinctly from the hypoechogenic real malignant epithelial part from which the best specimens can be sampled for microscopic assessment) [2,3]. This two-way privilege of paramount importance provides DE with an unequaled diagnostic potential that allows an efficient method of resolving ambiguities of the early macroscopic development of cancers.

Breast cancer and all the specific diseases of the breast present the common denominator of initiating from the epithelium and developing first in the ductolobular structures. Therefore, the observation of these structures provides a direct means for detecting their alterations by the diseases, as soon as they become perceptible. Unfortunately, conventional methods of diagnosis do not show the epithelial structures and this is the cause for their deficiency. Neoplastic progression usually proceeds in steps, with long periods of biological quiescence and sudden upsurges in growth. The breast cancer appears „quite malignant", with no discernible benign phase, although studies suggest that the disease may progress through a benign phase (hyperplasia) [4].

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There are three main morphological types of breast cancers with frequent intermediate or associated patterns. Initially, ducto-lobular and ductal focal cancers have been classified into *multi-focal ductolobular and ductal cancers* (25%), *mono-focal ductal cancers* as half-centimetric or centimetric cancers (40%) and *diffuse cancers* (25%). Since the use of new digital equipment, the above two percentages have been reversed in *lobular cancers* (10%), *ducto-lobular and ductal focal cancers* (65%) and *diffuse cancers* (the same 25%).

Lobular carcinomas are characterized by their localization in lobules and the multiplicity of their foci. Usually there are no important secondary features on the skin and superficial fascia, no ligamentary or fatty signs and no architectural disorders. Lobular carcinomas appear preferentially at the angles of intersection of the superficial Cooper's ligaments with the duct, as few hypoechogenic lobular dilatations on the skin side of the duct. They grow perpendicularly into the duct, measuring about 5 mm longitudinal, isolated from each other (fig 1) [5].

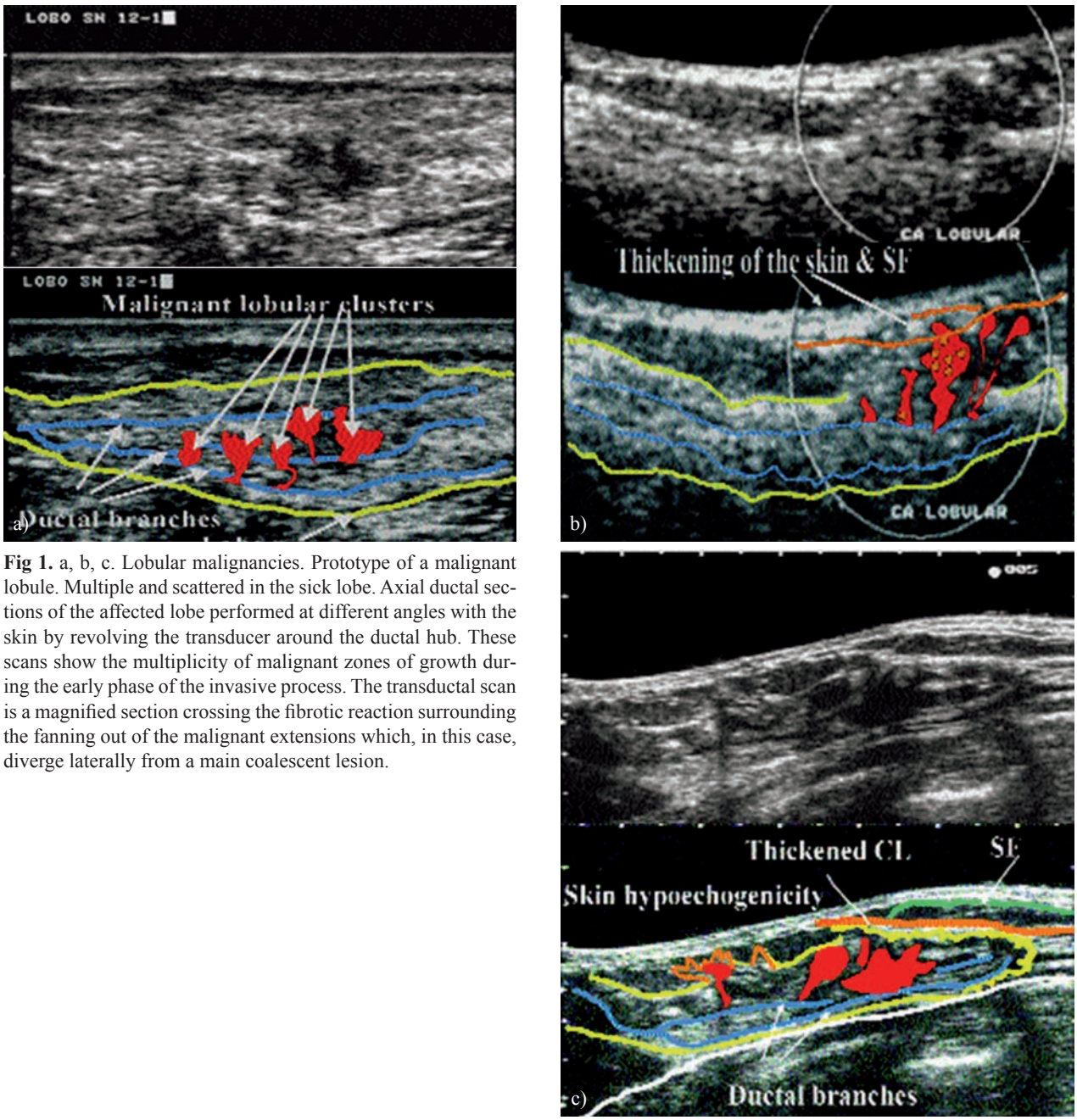


Fig 1. a, b, c. Lobular malignancies. Prototype of a malignant lobule. Multiple and scattered in the sick lobe. Axial ductal sections of the affected lobe performed at different angles with the skin by revolving the transducer around the ductal hub. These scans show the multiplicity of malignant zones of growth during the early phase of the invasive process. The transductal scan is a magnified section crossing the fibrotic reaction surrounding the fanning out of the malignant extensions which, in this case, diverge laterally from a main coalescent lesion.

There are two apparently antagonistic concepts with regard to breast cancer development:

1. The disease seems to be systemic from the outset because in some cases of early intraepithelial cancers malignant cells have been found in the blood, in the iliac bones and in the upper quadrant of the contra-lateral breast.
2. The disease appears to be sequential, with successive stages. Statistics usually show that the smaller the size of the lesion the better the prognosis and for bigger lesions, survival rates decrease while dissemination and recurrence rates increase.

Today, there are strong reasons for reviewing the notion of lesion size. DE technique indisputably shows that malignancies often demonstrate a greater spatial extension than has been suspected before. From the early stages DE views have allowed the direct perception of a malignant diffusion, sprinkling or distinct fragmentation of the main detected malignant masses. The fragmentation could be into several malignant tiny nodules or malignant clusters, close to the main malignant lesion or at a distance along the affected duct [5,6]. DE exhibits these additional malignant features with an increased frequency.

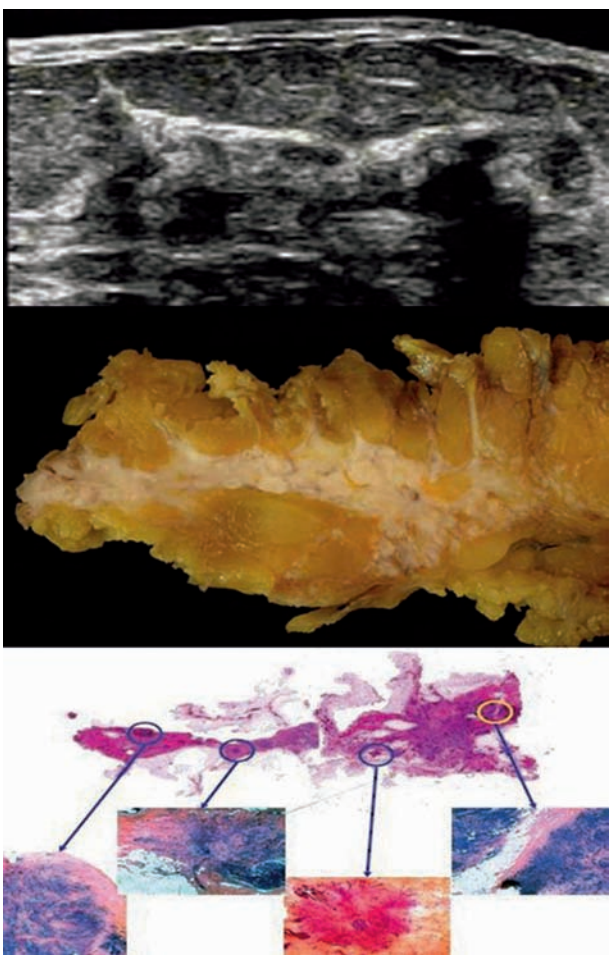


Fig 2. The sick lobe theory on histological basis proving polyfocal malignancy with lobular involvement.

Echographic observations and microscopic studies of breast pathologies have led to the concept of the „sick lobe" as the basic anatomical and pathological entity to be taken into consideration in both diagnostic and therapeutic procedures. This assessment is particularly obvious for malignancies (fig 2, fig 3).

Diffuse malignancies (25% of breast cancers) are characterized by the lack of focal arrangement and evidence of spreading of the malignancy in and along ductalobular structures. DE displays two types of patterns of diffuse cancers:

1. anatomical, showing a thick and long linear spreading of malignancy in ductolobular structures (slow-growing cancers).
2. brambles, showing a rather more restricted diffusion, displayed as a thin and irregular tree network developing into some local terminal ductal branches or the close interstitial space and fatty tissue (acute diffuse malignancies and recurrences in scars) (fig 4, fig 5).

In longitudinal scans they show long hypoechogenic intraductal zones of solid material, sometimes intersected by small liquid zones, sometimes showing papillary formations whose hyperechogenicity corresponds with microcalcifications observed on the mammogram. The duct itself appears well delimited by an uneven but rather neatly delineated contour, sketching a deformed but ana-

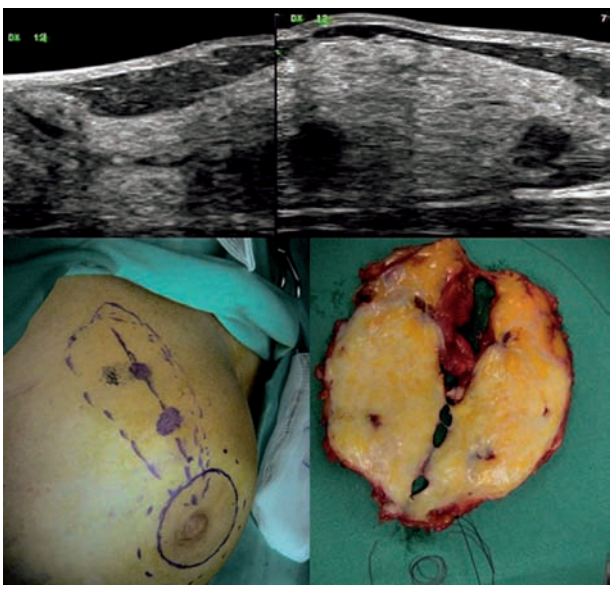


Fig 3. Consequently, also in the therapeutic process, not only lesions but also the whole affected lobe should be delimited by US.

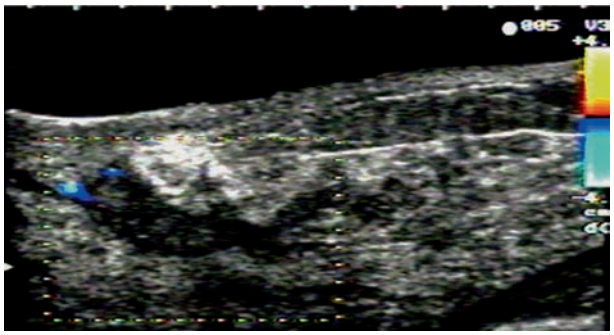


Fig 4. Diffuse carcinoma prototype. Diffused coalescence of malignant cells which fill the affected ductolobular structure.

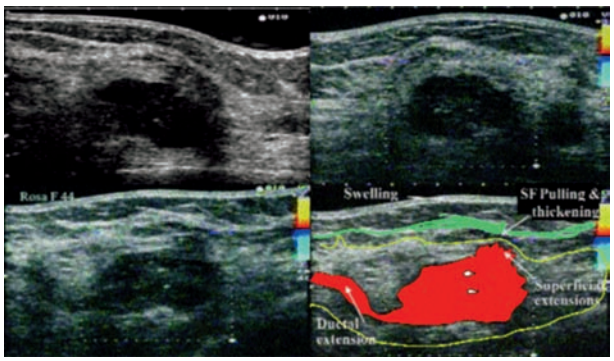


Fig 6. Diffuse cancers. Trans-lobars scans showing a homogenous dark shade and smooth contours, with poor vascularisation, without important associated association architectural distortions, and no skin signs except a bumping of the skin which appears rather slight given the important size of the lesion.

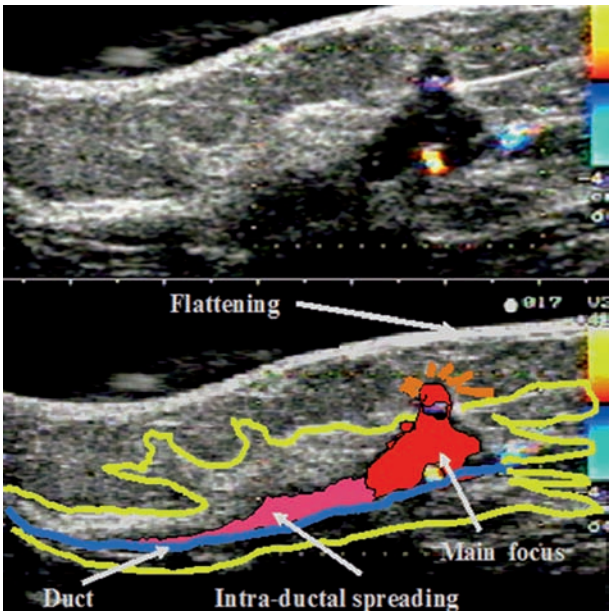


Fig 5. Carcinoma with intra-ductal extension downstream. This lesion is an early invasive malignancy, with the longest part of its growth still at an intra-ductal in situ' stage of development.

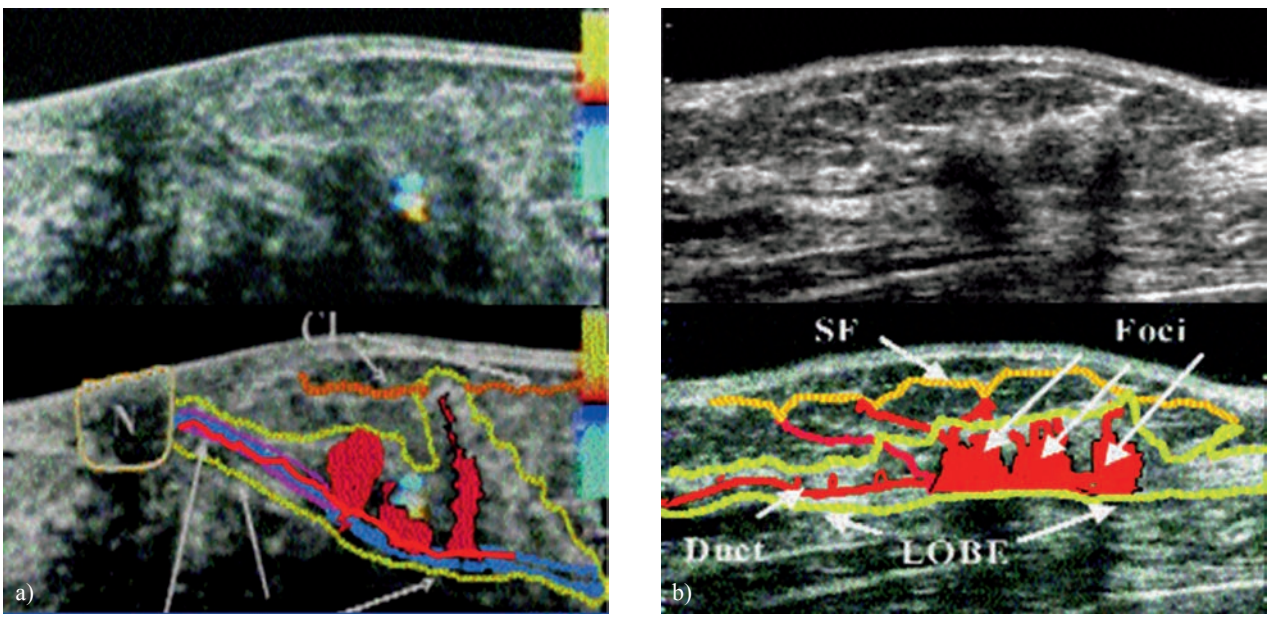


Fig 7. (a,b). Advanced diffused malignancies with close multi-focal cancers. Multiple malignant foci with acoustic shadow („T sign") and skin infiltration.

tomically recognizable ductal or ductolobular structure, surrounded by a slight hyperechogenic stroma reaction.

In transversal ductal scans, the lesions appear as a hypoechogenic oval regular zone, well delineated by an echogenic smooth contour line, with internal echoes, with or without intra-ductal liquid. These regular, smooth patterns show false benign characteristics which can be misleading when axial ductal scans are not performed (fig 6). In advanced cases, these diffuse malignancies appear as diffuse, extended, hypoechogenic areas developed in the whole lobe with almost no remaining observable organized ductolobular structures [5,7].

The change in appearance concerns both the size of foci and their number. The size increases up to 15 mm for two or three lobules which seem to be the main foci. The feet of the lobules remains narrow. The shapes are variable and the orientation is oblique, directed toward the lobe extremity, as the lobules seem to tilt along the duct as they increase [5,9]. The number of foci increases, with many new, small, infiltrated lobules in single file along the duct, appearing downstream and between the two or three main lobular foci (fig 7, fig 8). Malignant trans-basal invasive extensions are visible. They are orientated toward the skin, along the superficial Cooper's ligaments, mainly through the extremity of lobules and secondarily through the sides of wide lobules, drawing „hairy" patterns.

Conventional criteria of malignancy (Kobayashy) are used to evaluate centimetric focal malignancies. Only the lesion itself is evaluated (fig 9).

The classical criteria of malignancy used in conventional echography are based upon succinct „geometrical" concepts and aspects of shape, shade, boundaries, uniformity and shadowing. They are limited to the geometrical analysis of an abnormality in an otherwise randomly scanned and meaningless echographic field. These result in the impossibility to relate the image to anatomy and anatomopathology [7].

The new criteria used in DE are based upon „anatomopathological" concepts, concerning the recognition of ductolobular structures and the evaluation of its alterations. It allows the real shape and the orientation of cancers to be determined as well as their relationship with the anatomical structures of the breast. It also shows the differentiation between the epithelial malignancy and the connective reaction; a distinct display of lobular and ductal involvement, a clear representation of intraductal spreading and invasive trans-basal extensions, which are detectable from a very early stage.

The prototype of **Centimetric Ductal Focal Carcinoma *(3 layer roundel)*** recognize from the central to periphery: necrotic fibrosis, medial epithelial malignant layer, surrounding stroma reaction and malignant extension towards the skin (fig 10).

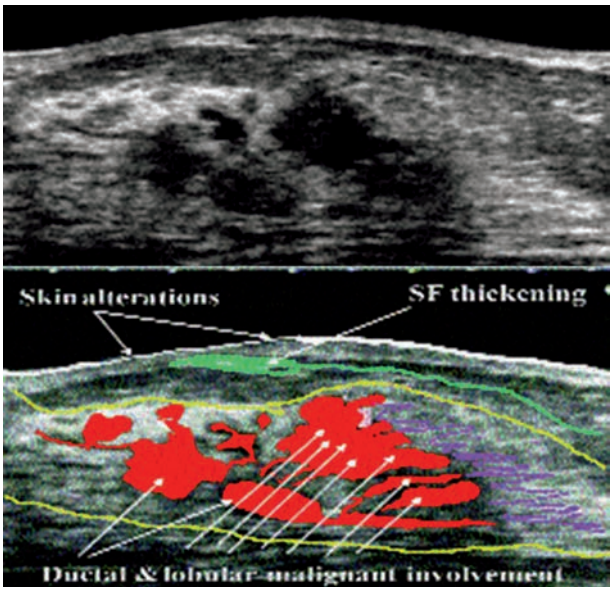


Fig 8. Advanced diffuse cancer with ductal and lobular malignant involvement.

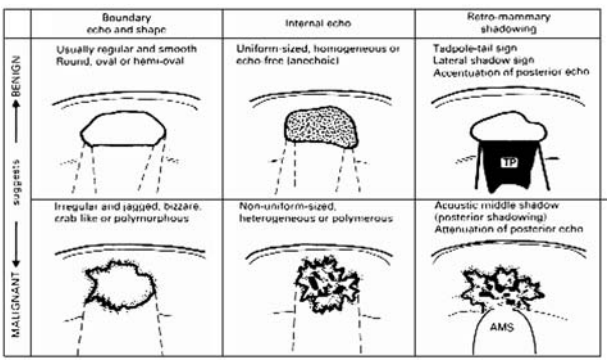


Fig 9. Conventional criteria of malignancy (Kobayashy) are used to evaluate centimetric focal malignancies by boundary echoes and shape, internal echoes and retro-mammary shadowing. Only the lesion itself is evaluated.

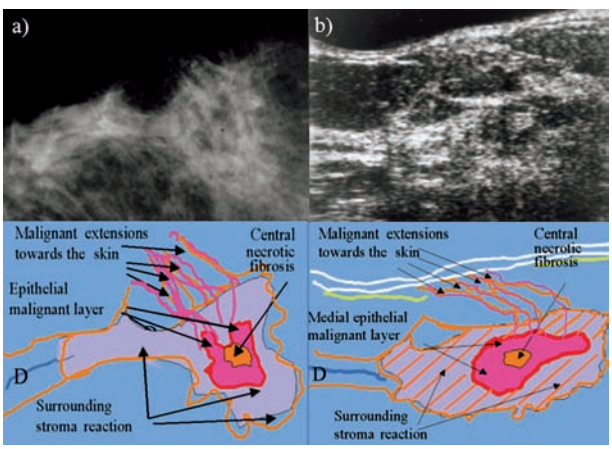


Fig 10. (a,b). Centimetric ductal focal carcinoma: prototype (3 layer roundel) a) mammography, b) DE

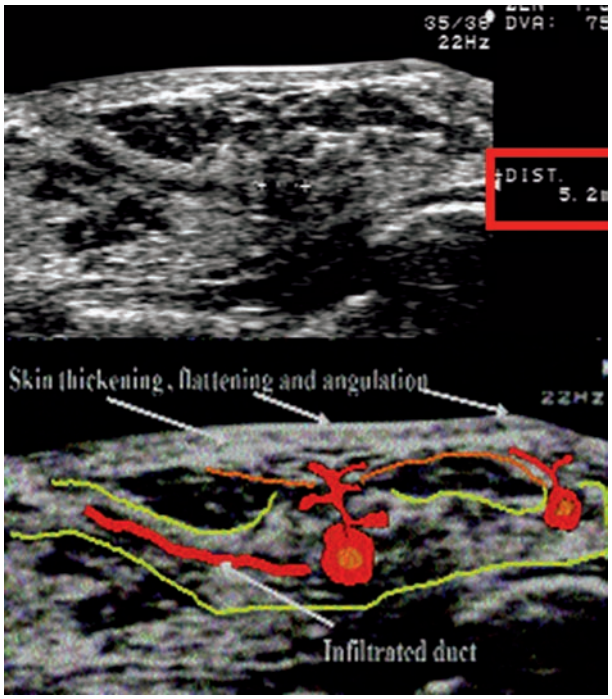


Fig 11. DE allows the diagnosis of millimetric focal malignancies because they are detectable along the affected duct and because they show large multi-centimetric indirect signs (skin thickening and angulation).

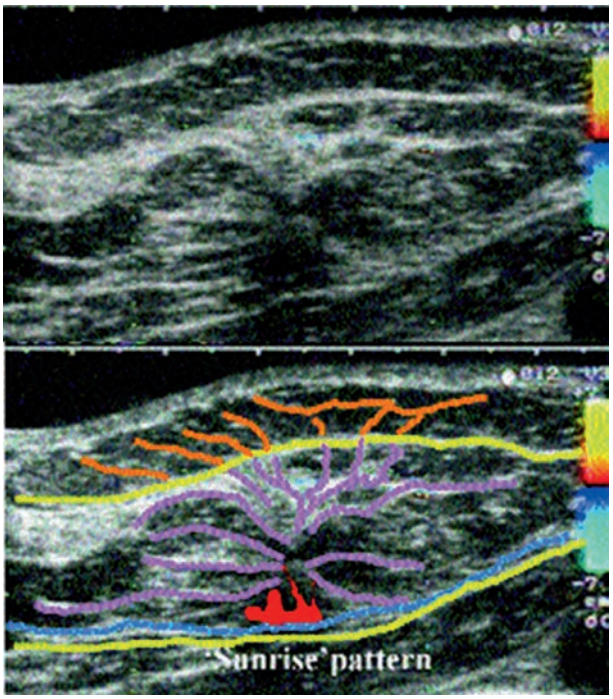


Fig 12. Half centimetric ductal focal cancers. Small hypogenic lesions with thickened and rigid ligaments as called „sunrise pattern".

DE allows the diagnosis of **millimetric** focal malignancies because they are detectable along the affected duct and because they show large multi-centimetric indirect signs [5] (fig 11).

Half centimetric ductal focal cancers. These small „half centimetric" lesions are usually found as primary foci in areas investigated for mammographic or clinical abnormalities, as early isolated superficial foci in the tail of Spencer and as remote secondary foci accompanying another cancer. With new digital equipment, they are more and more frequently diagnosed without any clinical or mammographic sign, as primary foci detected during systematic ultrasonic investigations performed for screening purpose [8,9].

Secondary features are perceptible very early, appear proportionnally extremely extended, over several centimetres, and therefore are mainly used to support the assumption of malignancy (fig 12-14).

However, it is the position of the lesions along the duct that is essential for their initial discovery and their localization as small hypoechogenic ductal alterations. They appear as ovoid beads, with one or few internal echoes and a perceptible surrounding diffuse hyperechogenic reaction, which displays a concentric pattern showing already the trend toward a three rounded pattern: a small

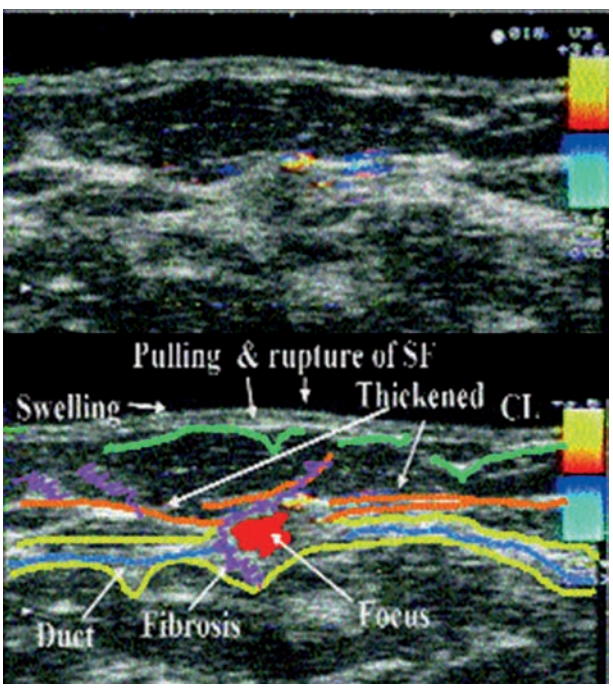


Fig 13. Small hypogenic lesions in large architectural disorder. The associated indirect signs – the pulling down of the lobar deep edge and the obvious convergence of the architectural structures has immediately drawn attention upon the zone of interest.

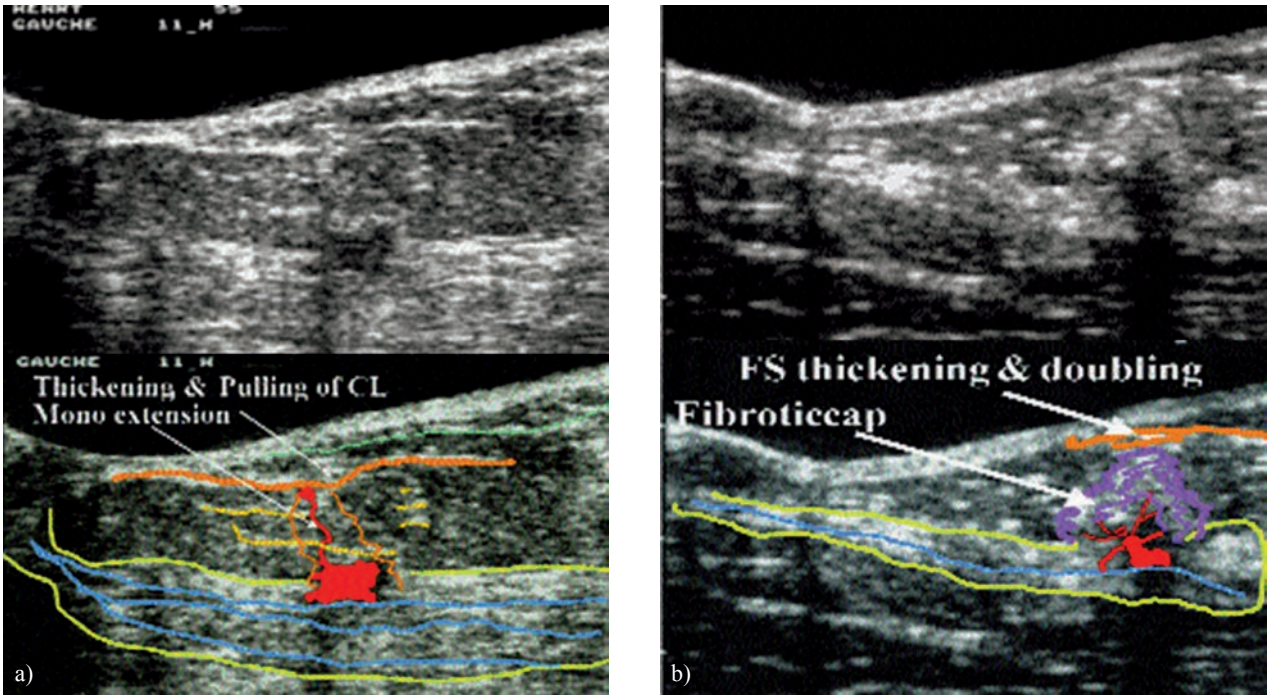


Fig 14. (a, b) Half centimetric ductal focal cancers. Small hypogenic lesions with malignant extensions. (a) and small hypogenic lesions with fibrotic cap (b).

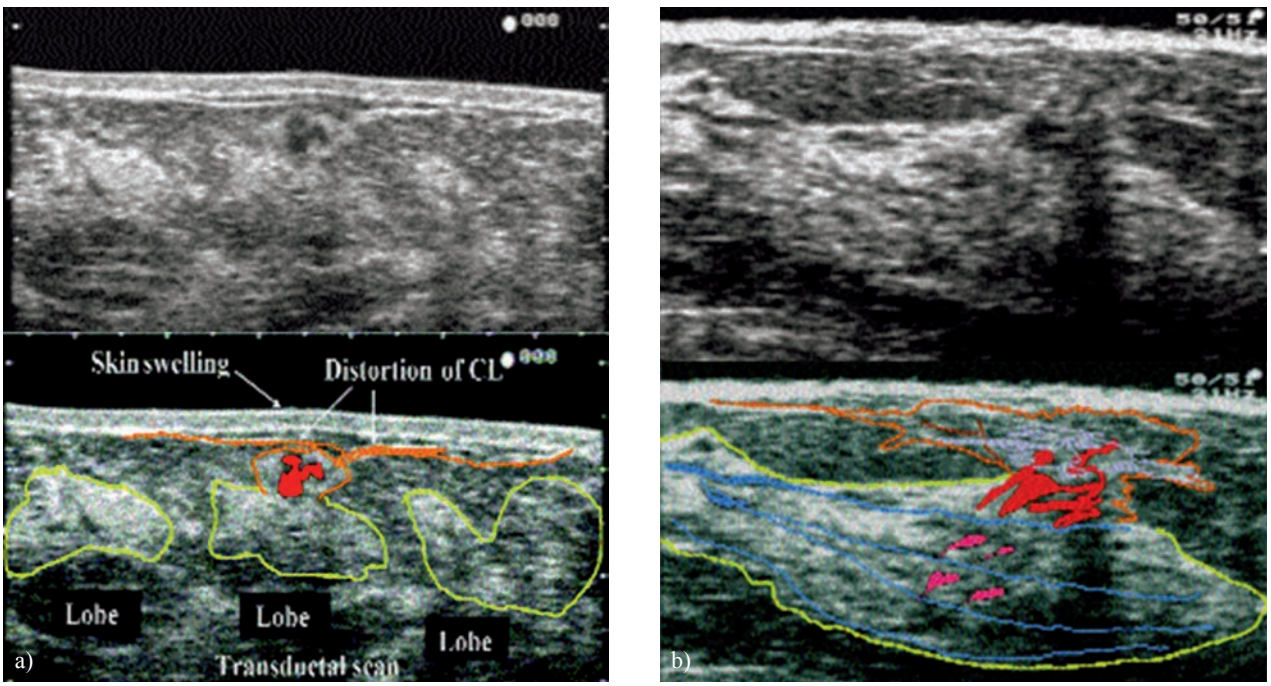


Fig 15. (a, b). Half centimetric ductal focal cancers. Early cancers surging out of the lobe in transductal scan (a) and longitudinal scan (b) with multiple ductal foci.

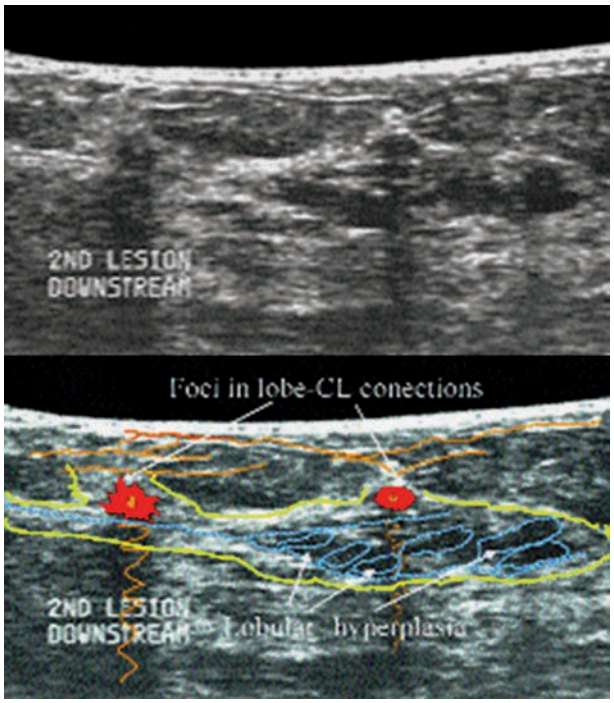


Fig 16. Half centimetric ductal focal cancers. Multiplicity of ductal foci is frequent. Axial ductal scan. Two foci are perceptible, the downstream one seeming slightly bigger. Each focus is at the centre of diverging ligamentary alterations which are more evident around the proximal lesion.

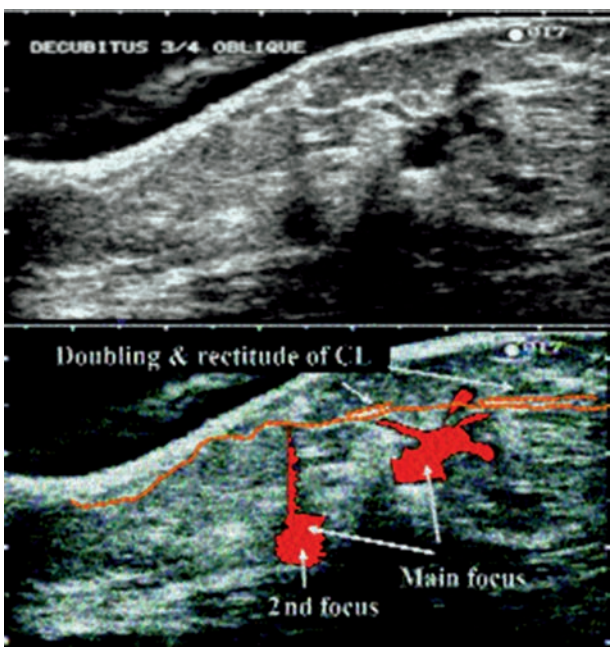


Fig 17. Bi-focal malignancy- one liquid tumor (main focus) and one liquid tumor (second focus) with doubling and rectitude of Cooper ligaments.

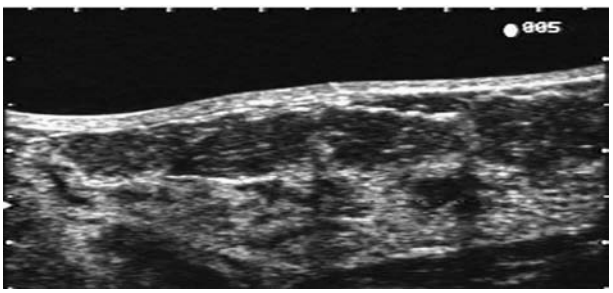


Fig 18. Infra-centimetric ductal focal cancers at about the same stage of development.

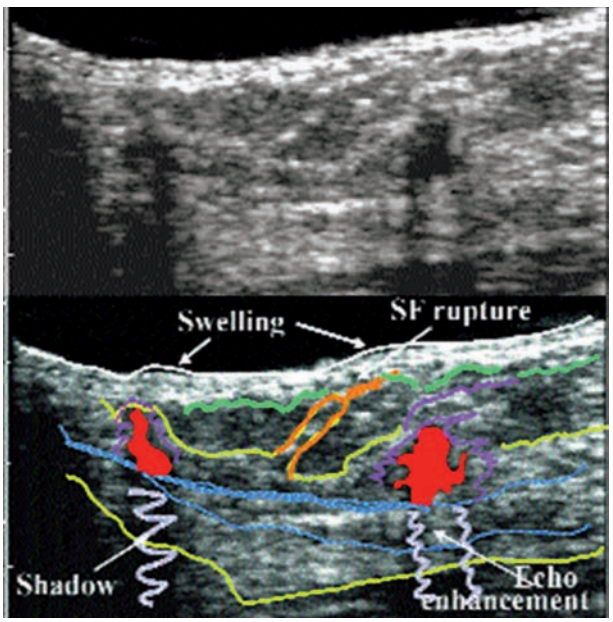


Fig 19. Half centimetric ductal focal cancers at different stages of development.

but strong echo in center, a thin irregular medial hypoechogenic circle, and a peripheral thin or fuzzy surrounding hyperechogenic line from which divergent extensions are already detectable, giving appearance that depend on the initial site of focus [10,11]. They are very different patterns, associate signs, number and size of malignant half centimetric ductal focal cancers at the same or different stages of development and ductal infiltration, some of them with intensive vascularisation (fig 15-21).

DE allows an earlier diagnosis of cancers because it detects malignancies that are not yet radiovisible. DE visualizes more completely radiovisible cancers by showing zones of recent development. DE displays cancers more accurately because it shows their whole real shape, with extensions and fragmentation. DE provides a means to avoid most useless biopsies as the technique can efficiently evaluate mammographic dubious zones and demonstrating the absence of correspondence of the mam-

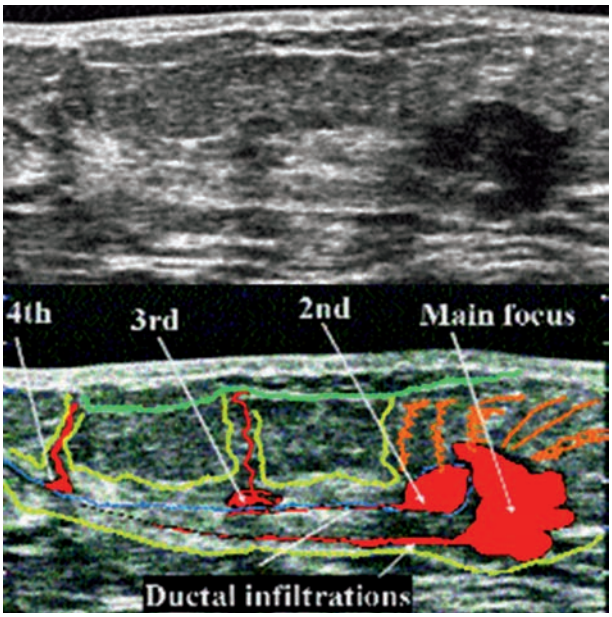


Fig 20. Remote ductal focal cancers at different stages of development. Close ductal focal cancers at similar stages of development. At least four zones of malignancy appear to be developing along two parallel ductal branches.

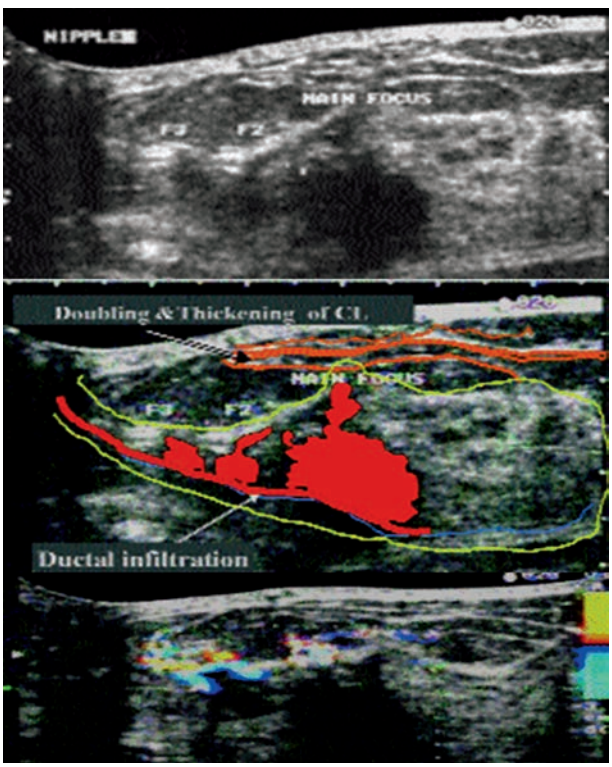


Fig 21. Vascularisation in an advanced multi-focal cancer with ductal infiltration. The foci are perceptible along the duct. The scans display three foci along the duct. The most advanced is developed in the medial part of the lobe. The two other foci, much smaller, developed downstream.

mographic image or by assessing the malignancy through very precise, easy and almost non-traumatic echo-guided micro samplings. DE allows thereby avoiding the long, cumbersome, painful and unreliable X-ray stereotaxic technique [12].

Breast malignancies are often not displayed by mammography, but they induce a stroma-reaction and micro-calcifications which suggest malignancy.

DE allows a better appreciation of evolution of cancers in a shorter time through its ability to reproduce similar scans in a same lobe (which allows more accurate comparisons at closer intervals) or in the remaining part of a lobe (for recurrences and post-therapeutic survey). In cases of persistent doubts, surgery can be postponed for a few months to allow comparative DE examinations which will, either provide a direct visualization of the early macroscopic development of a cancer, or demonstrate the lack of evolving alterations. This few months delay is not harmful because therapeutic results remain excellent during this short period of the early stage of the disease [5,9].

A new approach to breast cancer – **Ductal Carcinomas in Situ (DCIS)** was introduced by Professor Ueno from Tsukuba University Hospital, in Japan. This approach integrated primary and secondary features of multiple milimmetric malignant foci developed in a duct observed directly or by many defects and parenchimal lesions surrounding the duct system. It integrated too the concept of the „sick lobe theory" corresponding to histological studies of Tibor Tot in Sweden showing extensive, diffuse DCIS [8,13].

The most important superiority of DE over Conventional Echography and one of its major contributions in the evaluation of breast cancer lies in its ability to visualize unsuspected macroscopic malignant foci spread in lobes along ductolobular structures and the malignant extension of diffuse malignancies in and along internal anatomical features. DE imagery is consistently demonstrating the following evidence: ***the wide panoramic display of the full macroscopic development of malignant disease evolving in and along ductolobular structures provides an outstanding accurate evaluation of breast cancer that cannot be obtained nor even presumed through the limited display of a tumoral part of the malignancy as restrictively demonstrated by conventional echography. This observation is also evidently true for the general evaluation of other breast diseases*** (fig 22-24).

This statement is relevant to both radio-transparent and radio-dense breasts, and is applicable to all women, under and over the age of 50. This observation is also evidently true for the general evaluation of other breast diseases [4,5].

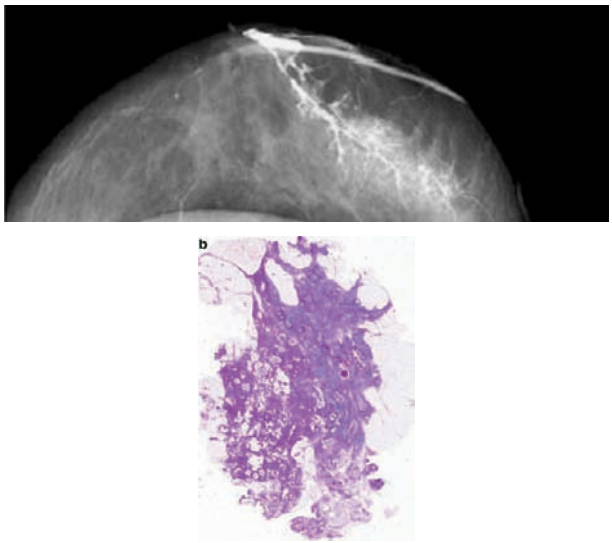


Fig 22. Value of the notion of Ductal Carcinoma In Situ (DCIS). a) Galactogram showing a lobe-like distribution of filling defects and parenchimal lesions surrounding the duct system; b) Corresponding large histological section showing extensive, diffuse DCIS (Tibor Tot).

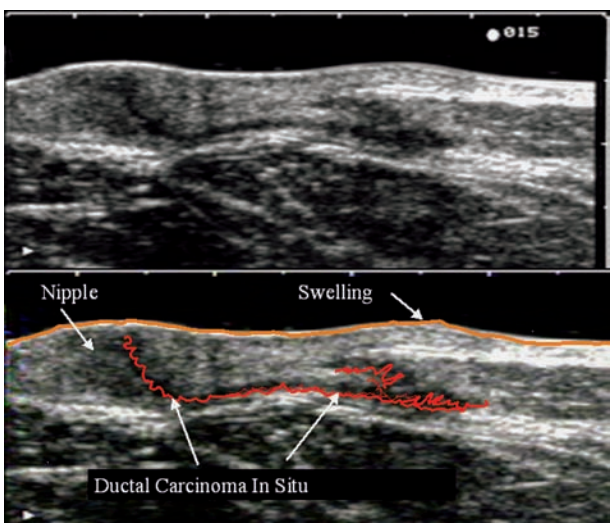


Fig 23. DCIS with very early invasive extension.

Many comparative studies [1,14] have proved the high contribution to the diagnostic of DE comparing with other methods: mammographic evaluation of cancers diagnosed with US showed full positive mammograms 53 %, dubious mammograms 25 %, and extremely important – negative mammograms 22 % (M. Teboul 1995); during 27,825 screening sessions, (MMx and PE) in 11,130 asymptomatic women, 246 cancers were discovered in 221 women. Only women with dense breasts underwent screening US. The comparative sensitivity was MMx and US – 97% and MMx and PE – 74% (Kolb et al, 2002);

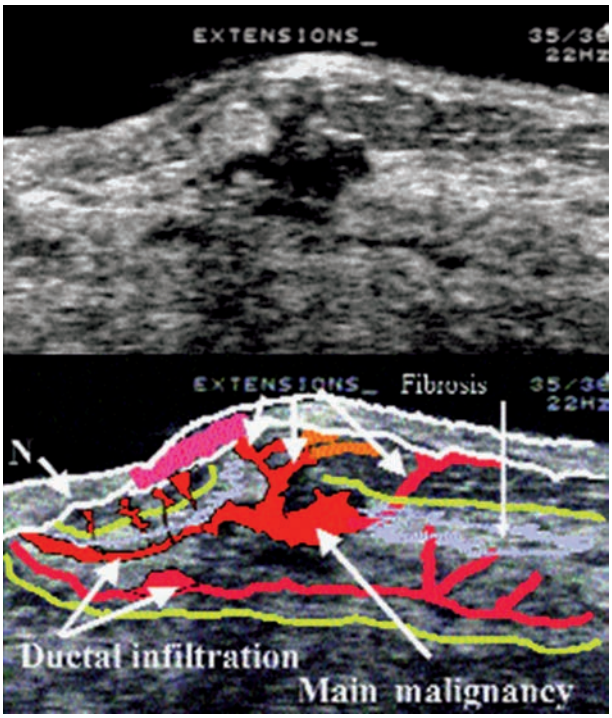


Fig 24. Early focal-ductal cancer with DCIS infiltration. In this longitudinal scan the main lesion shows an obvious extension downstream along its duct. Another ductal branch appears also infiltrated.

in 4236 patients with nonpalpable breast cancers the sensitivity of the mammography to the diagnostic was 56% in grades 3-4, 69% in grades 1-4 and 80% in grades 1-2 comparative to the ultrasound technique which was 88 % in all the cases (Leconte et al 2003); in 183 patients with primary breast cancer the comparative sensitivity of mammography, ultrasound and magnetic resonance was 84.6% vs 97.3% vs 93.7% (Hata T et al. 2004); in 935 women older than 35 years, relatives of breast cancer patients 21 breast cancers were detected (16 invasive cancers and 5 noninvasive cancers). 7 (33.3%) additional cancers were detected when US was added. (Hou MF et al 2002); in 104 women, with clinical suspicion of cancer 27 malignant tumors were detected on pathology, 9 tumors were visible only in US and non-visible in mammography with a Ratio: 9/27 of 30% (Hlawatch et al 2002); in 42,838 examinations 150 (0.35%) cancers were identified only sonographically in average-risk women. Over 90% of the 126 women with sonographically depicted cancers had dense or heterogeneously dense parenchyma (Hlawatch et al 2002).

This improvement in the evaluation of the breast cancer provided by the synoptic views displayed by DE is of high theoretical and practical importance. Since the

macroscopic diffusion and segmentation of malignancies have become directly perceptible with DE, these malignant features should now be taken into consideration for better definition and classification of malignancies. These features demonstrate the distinction that needs to be made between malignant tumor and malignant disease of the breast:this is not only a theoretical notion of academic interest. It is self-evident that this distinction has in daily practice a fundamental, obvious and direct impact on the therapeutic management of breast cancer resulting in a major and immediate benefit for patients.

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